

Outcomes of Maternal Weight Gain

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Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-based Practice Centers (EPCs), sponsors the development of evidence reports and technology assessments to assist public- and private-sector organizations in their efforts to improve the quality of health care in the United States. The reports and assessments provide organizations with comprehensive, science-based information on common, costly medical conditions and new health care technologies. The EPCs systematically review the relevant scientific literature on topics assigned to them by AHRQ and conduct additional analyses when appropriate prior to developing their reports and assessments.

To bring the broadest range of experts into the development of evidence reports and health technology assessments, AHRQ encourages the EPCs to form partnerships and enter into collaborations with other medical and research organizations. The EPCs work with these partner organizations to ensure that the evidence reports and technology assessments they produce will become building blocks for health care quality improvement projects throughout the Nation. The reports undergo peer review prior to their release.

AHRQ expects that the EPC evidence reports and technology assessments will inform individual health plans, providers, and purchasers as well as the health care system as a whole by providing important information to help improve health care quality.

We welcome comments on this evidence report. They may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 540 Gaither Road, Rockville, MD 20850, or by e-mail to epc@ahrq.gov.

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Structured Abstract

Objectives. The RTI International–University of North Carolina at Chapel Hill Evidence-based Practice Center (RTI-UNC EPC) systematically reviewed evidence on outcomes of gestational weight gain and their confounders and effect modifiers, outcomes of weight gain within or outside the 1990 Institute of Medicine (IOM) guidelines, risks and benefits of weight gain recommendations, and anthropometric measures of weight gain.

Data Sources. We searched MEDLINE[®], Cochrane Collaboration resources, Cumulative Index to Nursing & Allied Health Literature, and Embase.

Review Methods. We included studies published in English from 1990 through October 2007. We excluded studies with low sample size (based on study design: case series < 100 subjects and cohorts < 40 subjects).

Results. Overall, strong evidence supported an association between gestational weight gains and the following outcomes: preterm birth, total birthweight, low birthweight (<2,500 g), macrosomia, large-for-gestational-age (LGA) infants, and small-for-gestational-age (SGA) infants; moderate evidence supported an association for cesarean delivery and intermediate-term weight retention (3 months to 3 years postpartum). The studies reviewed provided strong evidence for the independent association of pregravid weight status and outcomes, moderate evidence for age and parity, and weak evidence for race.

Regarding outcomes of weight gain within or outside 1990 IOM guidelines, moderate to strong evidence suggests an association between weight gain below IOM recommendations and preterm birth, low birthweight, SGA birthweights, and failure to initiate breastfeeding, and strong evidence for the association between weight gain above IOM recommendations and high birthweight, macrosomia, and LGA birthweights. Moderate evidence supports an association between weight gain above IOM guidelines and cesarean delivery and postpartum weight retention in the short, intermediate, and long term.

Included research is inadequate for objective assessments of the range of harms and benefits of providing all women, irrespective of age, race or ethnicity, or pregravid body mass index (BMI), with the same recommendation for weight gain in pregnancy.

Conclusions. Gestational weight gain is associated with some infant and maternal outcomes. One weight gain recommendation for all women is not supported by the evidence identified in this review. To understand fully the impact of gestational weight gain on short- and long-term outcomes for women and their offspring will require that researchers use consistent definitions of weight gain during pregnancy, better address confounders in their analyses, improve study designs and statistical models, and conduct studies with longer followup.

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Appendixes and Evidence Tables for this report are provided electronically at <http://www.ahrq.gov/downloads/pub/evidence/pdf/admaternal/admaternalapp.pdf>.

Executive Summary

Introduction

This systematic review of outcomes of gestational weight gain, often referred to as maternal weight gain, is motivated by several trends in perinatal health that are of great public health concern. Women are increasingly gaining weight during pregnancy beyond the thresholds set forth by the Institute of Medicine (IOM); increases are pronounced among overweight and obese women; obesity levels among women of childbearing ages are rising dramatically; and pregnancy complications associated with excess gestational weight gain such as large-for-gestational-age babies and cesarean delivery have increased in prevalence. These trends point to the need for assessment of the guidelines to address optimal weight gain for all women during pregnancy.

The RTI International–University of North Carolina at Chapel Hill Evidence-based Practice Center (RTI-UNC EPC) conducted a systematic review of the literature to review the evidence on influence of gestational weight gain on various outcomes. We systematically assessed the evidence for five key questions (KQs):

- KQ 1. What is the evidence that either total weight gain or rate of weight gain during pregnancy is associated with (1) birth outcomes, (2) infant health outcomes, and (3) maternal health outcomes? Does any evidence suggest that either total weight gain or rate of weight gain is a causal factor in infant or maternal health outcomes?
- KQ 2. What are the confounders and effect modifiers for the association between gestational weight gain (overall and patterns) and birth outcomes? Based on the findings in KQ 1, do these confounders and effect modifiers themselves contribute to antepartum or postpartum complications or to longer-term maternal and fetal complications, including development of adult obesity?
- KQ 3. What is the evidence that weight gains above or below thresholds defined in the 1990 IOM body mass index (BMI) guidelines or weight loss in pregnancy contribute to antepartum or postpartum complications or longer-term maternal and fetal complications? How do these relationships vary by sociodemographic characteristics (i.e., race and age)?
- KQ 4. What are the harms or benefits of offering the same weight gain recommendations to all pregnant women, irrespective of age and body weight considerations (e.g., pregravid weight, actual body weight at a particular time point, or optimal body weight)?
- KQ 5. What are the anthropometric tools for determining adiposity and their appropriateness for the pregnancy state? What are the risks and benefits of measuring adiposity for (1) clinical management of weight gain during pregnancy and (2) evaluation of the relationship between weight gain and outcomes of pregnancy?

Methods

We searched MEDLINE[®], Cochrane Collaboration resources, Cumulative Index to Nursing & Allied Health Literature, and Embase. We dually reviewed each study against a priori

inclusion/exclusion criteria. For included articles, a primary reviewer abstracted data directly into evidence tables; a second senior reviewer confirmed accuracy. We included 150 studies in English, published from 1990 through October 2007. We excluded studies with low sample size (cases series < 100 and cohorts < 40) or failure to control for pregravid weight. We rated individual studies for quality, based on the assessment of nine domains of quality: background, sample selection, specification of exposure, specification of outcome, soundness of information, followup, analysis comparability, analysis of outcome, and interpretation. In assessing the strength of evidence for each outcome as strong, moderate, weak, or absent, we incorporated the quality of the studies in addition to consistency and volume of the evidence.

Results

KQ 1 and KQ 3: Outcomes of Gestational Weight Gain

KQ 1 asks about outcomes of gestational weight gain for infants and for mothers; more than 30 outcomes were specified as being of interest. KQ 1 also asks what evidence exists to demonstrate causality. Nearly all the studies in this review are observational studies; therefore, generally this evidence base cannot demonstrate a causal link between gestational weight gain and outcomes. The analysis of outcomes related to weight gains in relationship to IOM recommendations (KQ 3) classified outcomes into six categories as with KQ 1: maternal antepartum outcomes, maternal intrapartum outcomes, birth outcomes (neonatal outcomes at the time of birth), infant outcomes (<1 year), child outcomes (≥ 1 year), and short- and long-term maternal outcomes. To enable synthesis and help identify gaps in the evidence, we combined discussion of the findings for KQ1 and KQ3 and focus below on outcomes for which the evidence is either strong or moderate.

Maternal intrapartum outcomes. We examined the literature for 11 maternal and intrapartum outcomes. For one of these—cesarean delivery—the evidence was of moderate strength. For all other outcomes, evidence was weak.

Cesarean delivery. Of the 21 studies identified in KQ 1 (14 fair, 7 poor), all but 4 showed some degree of association between higher weight gain and cesarean delivery; the evidence was moderate. The association appeared to be stronger among overweight and obese women.

Nine studies (8 fair, 1 poor) examined the association between gestational weight gain classified by the IOM guidelines and cesarean delivery (KQ 3). These studies suggest moderate evidence for increased risk of cesarean for weight gain above IOM recommendations for underweight and normal weight women, and weak inconsistent evidence for obese or morbidly obese women.

Overall, the majority of studies suggested an association between weight gain and cesarean delivery. Our findings of a higher risk of cesarean for overweight and obese women, coupled with the lack of significance of weight gain above IOM recommendations among obese or morbidly obese women, suggests that underlying health risks (such as increased risks of abnormal glucose tolerance) associated with high pregravid weight are likely confounders in the relationship between gestational weight gain and cesarean delivery.

Birth outcomes. The knowledge base about the association between gestational weight gain and birth outcomes is, on the whole, stronger than the knowledge base for any other set of outcomes with moderate to strong evidence for low gestational weight gain and preterm birth, low birthweight, and small-for-gestational-age (SGA) birthweights, and strong evidence for the

association between high weight gain and high birthweight, macrosomia, and large-for-gestational-age (LGA).

Preterm birth. Strong evidence from 12 studies (2 good, 7 fair, 3 poor) suggests that both low and high weight gains result in an increased risk of premature birth (KQ 1). Despite little consistency in terms of adjustment for covariates, definition of preterm birth (with or without premature rupture of membranes), and the methods used to define and categorize gestational weight gain, eight of nine studies reported at least one significant association between low gestational weight gain and preterm birth; four of five studies focused on high gestational weight gain (as defined in each study) reported at least one significant association between gestational weight gain and preterm birth.

Among the studies that examined preterm birth using categories of gestational weight gain (i.e., low, adequate, and high), seven of eight reported a significant increased risk of preterm birth with low gestational weight gain and four of five reported a significant increased risk with high gestational weight gain. In general, low rates of weight gain were ≤ 0.37 kg per week and high rates of weight gain were > 0.52 kg per week throughout gestation.

Four studies, all of fair quality, reported on the association between rate of gestational weight gain according to the IOM guidelines and preterm birth (KQ 3). Despite inconsistencies in the definitions and timing of rate of weight gain calculations, the four studies are consistent in showing increased risks of preterm birth for underweight and normal-weight women who have a low rate of gain.

Overall, the majority of studies found a consistent effect of low gestational weight gain on preterm birth, and a less consistent effect of high gestational weight gain on preterm birth. The association for low gestational weight gain holds whether total weight gain or rate of weight gain is used as the relevant exposure of interest.

Birthweight. Evidence from 25 studies (4 good, 12 fair, 9 poor) provided strong evidence that gestational weight gain is associated with infant birthweight (KQ 1). This relationship held true for various measures of gestational weight gain. Evidence from seven studies reported that birthweight increased between 16.7 and 22.6 g for every 1 kg increase in weight gain. Two studies reported values by BMI status, suggesting that the effect of increased gestational weight gain on infant birthweight was more pronounced at lower BMI levels. Three studies examined the effect of weight gain by trimester on infant birthweight. All three studies were consistent in demonstrating the least effect of gestational weight gain in the third trimester. Two of three studies that used similar definitions of trimester found that a 1-kg increase in gestational weight gain during the first trimester was associated with 18-31 g increases in birthweight, whereas during the second trimester, such gains were associated with increases of 26-32.8 g, and increases of 7-17 g during the third trimester.

10 articles (1 good, 8 fair, and 1 poor) from nine databases provide strong evidence that weight gain below IOM recommendations is associated with lower birthweights (KQ 3). Seven studies found an association between high weight gains and higher birthweights, particularly for underweight and normal-weight women.

Overall, we found strong evidence in support of an association between gestational weight gain and birthweight. Low gestational weight gain is associated with lower birthweights across all pregravid weight status groups whereas high gestational weight gain resulting in higher birthweight appears to be limited to underweight and normal-weight women.

Low birthweight (LBW). Thirteen studies (one good, nine fair, three poor) provided strong evidence that low weight gain increases the risks of LBW (KQ 1).

Ten studies published in twelve articles (two good, seven fair, and three poor) provided strong, consistent evidence of an association between weight gain below the IOM guidelines and LBW for only underweight and normal-weight women (KQ 3).

Overall we found strong evidence for an association between low gestational weight gain and low birthweight. The evidence appears to be stronger among women of underweight and normal-weight pregravid status than among overweight and obese women.

Macrosomia. Eleven of 12 studies (1 good, 9 fair, 1 poor) provided strong evidence that high gestational weight gain is associated with greater risks of macrosomia (KQ 1). The relationship between high gestational weight gain and macrosomia held despite variations in definition of macrosomia (> 4,500 g or > 4,000 g). Generally, the highest weight gains were associated with the highest risks of macrosomia.

Seven studies examined the association between gestational weight gain categorized according to the IOM and macrosomia defined as either > 4,000 g or > 4,500 g (2 good, 1 poor, the remaining fair) (KQ 3). These studies suggest moderate evidence for the association between weight gains above the IOM recommendations and macrosomia for overweight and obese women.

Overall, moderate to strong evidence suggests that high weight gains are associated with macrosomia.

Large-for-gestational-age (LGA). Fourteen studies (one good, eight fair, five poor) with varying definitions of weight gain and LGA were consistent in demonstrating an association between high gestational weight gain and LGA; we graded the evidence for this association as strong (KQ 1). This association held whether LGA was defined as birthweight greater than the 90th percentile, or as birthweight more than two standard deviations above the mean. Whether BMI modifies this relationship is unclear.

Eight articles examined gestational weight gain according to the IOM and LGA (2 good, 5 fair, 1 poor) (KQ 3). These studies provided strong evidence that high weight gains are associated with an increased risk of LGA infants. Weight gains below IOM guidelines, by contrast, were protective against LGA in only four studies (moderate evidence).

Overall, we found strong evidence of the association between high gestational weight gain and LGA despite differences in the definition of LGA.

Small-for-gestational-age (SGA). Twenty publications (1 good, 12 fair, and 7 poor) provided strong evidence that women in the lowest weight gain categories had higher percentages of SGA infants and were at increased risk of delivering an SGA infant, despite differences across studies in the definition of weight gain and SGA (KQ 1). In general, the risk of SGA among women with low weight gain decreased as BMI increased.

Ten articles (three good, one poor, and the rest fair) examined the association between gestational weight gain categorized according to the IOM guidelines on SGA (KQ 3). The evidence is strong that SGA is associated with weight gains below the IOM guidelines. Weight gains above the IOM were associated with a lower risk of SGA in four out of six studies suggesting a moderate degree of evidence.

Overall, we found strong evidence for an association between low gestational weight gain and the risk of having an SGA infant.

Maternal short- and long-term outcomes. The literature covered eight maternal outcomes. Of these, the evidence is moderate for only intermediate-term (3 months to 3 years postpartum) postpartum weight retention (PPWR) for both KQ 1 and KQ 3. In addition, we found moderate strength of evidence to support the association between gestational weight gain and breastfeeding

initiation, short-term PPWR (≤ 11 weeks postpartum) and long-term PPWR (> 3 years postpartum). The evidence for all other outcomes (breastfeeding duration, fat accrual, interpregnancy weight retention, and premenopausal breast cancer) was weak (except for lactation, for which no literature was available at all).

Breastfeeding initiation. Three studies, published in four articles, all fair, examined the association of weight gain in relation to the IOM guidelines and breastfeeding (KQ 3) and provide moderate evidence of an association between weight gains below the IOM guidelines and lower likelihood of breastfeeding initiation.

Short-term PPWR (≤ 11 weeks). Four studies (all fair) provide moderate evidence that weight gains exceeding IOM guidelines (KQ 3) were associated with PPWR measured at or before 11 weeks postpartum.

Intermediate PPWR (3 months to 3 years). Five studies (one good, three fair, and one poor) provide moderate evidence for an association between gestational weight gain and intermediate PPWR (KQ 1).

Six studies (five fair and one poor) examined the association between weight gain categorized according to the IOM and intermediate-term PPWR (KQ3). They consistently indicated that women who gained above the IOM recommendations retained more weight than those who gained within the guidelines (moderate strength of evidence). They provided only weak evidence about any association when weight gains were below IOM guidelines.

Overall, we found moderate evidence for an association between high gestational weight gains and intermediate PPWR.

Long-term postpartum weight retention (>3 years). Three fair studies provided moderate evidence of an association between high gestational weight gain, defined according to the IOM (KQ 3), and weight retention later in life, but the magnitude of weight retained was small.

Other outcomes. We found no moderate or strong evidence for maternal antepartum outcomes (hyperemesis, abnormal glucose metabolism, hypertensive disorders, gallstones, and maternal discomforts of pregnancy), infant outcomes (neonatal hypoglycemia, neonatal distress, hyperbilirubinemia, neonatal hospitalization, other infant morbidity, infant BMI, and other infant growth characteristics), or childhood health outcomes (childhood obesity and childhood hospitalization).

KQ 2: Confounders and Effect Modifiers of Gestational Weight Gain

KQ 2 asks about the confounders and effect modifiers relevant for examining any associations between gestational weight gain (overall and patterns) and birth outcomes; it also asks about the extent to which these confounders and effect modifiers themselves contribute to outcomes. As reported in our results and discussion for KQ 1, the types of confounders and effect modifiers vary considerably by the type of outcome being considered. Little consistency exists within the body of evidence for each outcome on which confounders are to be included, and even less consistency exists on their definition.

Given the large variations in the overall body of evidence on the confounders and effect modifiers, our discussion of KQ 2 is limited to outcomes with moderate or strong evidence of association with gestational weight gain. These are preterm birth, mode of delivery, birthweight, low birthweight, macrosomia, LGA infants, SGA infants, and intermediate-term PPWR.

Because age, race and ethnicity, and pregravid weight status are key considerations in the 1990 IOM weight gain recommendations, we further limit our discussion of KQ 2 to the consideration of these key variables. We additionally consider parity. The included studies

defined these four variables in highly variable fashion. Finally, because KQ 2 asks about the *independent* association between confounders and effect modifiers, we considered results only from multivariate analyses for confounders and effect modifiers that included gestational weight gain as a predictor of the outcome. These studies together provide strong evidence of the independent association of pregravid weight status on outcomes, moderate evidence on age and parity, and weak evidence, largely because of insufficient data, on the effect of race.

KQ 4: Benefits and Harms of Gestational Weight Gain Recommendations

Research is inadequate to permit objective assessment of harms and benefits of providing all women, irrespective of age, race or ethnicity, or pregravid BMI, with the same recommendation for weight gain in pregnancy. The majority of the studies present evidence suggesting that one recommendation for all women would be disadvantageous, but the findings are not consistent and do not fully explore harms. Most studies limited their analyses to short-term outcomes related to the pregnancy, the intrapartum, and the neonatal period. A full examination of harms would require long-term, rigorously designed studies to determine unexpected consequences of specific recommendations; we found no such investigations.

KQ 5: Anthropometrics of Gestational Weight Gain

Our review required that included studies estimated adiposity using body weight or BMI. Ten studies collected data using other anthropometric measurements and incorporated them into varying body composition equations or models to estimate body fat.

These measurements included bioelectrical impedance analysis, dual energy X-ray absorptiometry, body circumferences, total body water, total body potassium, magnetic resonance imaging, and underwater weighing. Collectively, these studies do not provide sufficient evidence to judge whether alternate methods of weight measurement are more informative or predictive of infant and maternal outcomes than standard body weight (including BMI) and height measurements.

Discussion

We found strong evidence to support the association between gestational weight gains and preterm birth, birthweight, macrosomia, LGA, SGA, low birthweight, and preterm birth. Moderate evidence supported the association between gestational weight gain and breastfeeding initiation, mode of delivery, and PPWR.

As reported in our results and discussion for KQ 1, the types of confounders and effect modifiers vary considerably by the type of outcome being considered. Little consistency exists within the body of evidence for each outcome on which confounders are to be included, and even less consistency exists on their definition. The studies reviewed provide strong evidence for the independent association of pregravid weight status and outcomes, moderate evidence for age and parity, and weak evidence for race and ethnicity.

Existing research is inadequate to permit objective assessments of the range of harms and benefits of providing all women, irrespective of age, race or ethnicity, or pregravid BMI, with the same recommendation for weight gain in pregnancy.

Clear clinical recommendations based on this systematic review will be challenging to formulate because of major shortcomings in the body of research investigating gestational weight gain and pregnancy outcomes. The research is almost all observational; it lacks uniformity of definitions, methodologies, and analyses. To understand fully the impact of gestational weight gain on the short- and long-term outcomes for women and their offspring will require that researchers use consistent definitions of gestational weight gain and the outcomes, describe the criteria used to assess confounding in their analysis, use statistical methods that allow for the evaluation of more than one outcome at a time, make improvements in study design to allow better collection of weight and weight gain data, and follow women and infants for longer periods.

Evidence Report

Chapter 1. Introduction

This systematic review of outcomes of maternal weight gain, often referred to as gestational weight gain,^{*} is motivated by several trends in perinatal health that are of great public health concern. First, since 1990, women have increasingly gained weight during pregnancy beyond the thresholds set forth by the Institute of Medicine (IOM);¹ these increases are pronounced among overweight and obese women.²⁻⁴ Second, overweight and obesity levels among women of childbearing ages are rising dramatically⁵⁻⁸ as are the levels among preschool children.⁹ Third, pregnancy complications associated with excess weight such as gestational diabetes and large-for-gestational-age babies¹⁰ and cesarean delivery¹¹ have increased in prevalence. These trends, coupled with the limitations of the current guidelines, point to the need for assessment of the guidelines to address optimal weight gain for all women during pregnancy.

Background

Weight Gain Recommendations in the United States

Ideal weight gain during pregnancy has long been debated. Gestational (formerly maternal) weight gain includes the products of conception, which include the fetus and placenta, and increases in maternal fat stores, plasma volume, and uterine and breast tissue. Because pregnancy is the only common clinical situation when the provider has at least two patients, the mother and the fetus(es), balancing the amount of weight gain needed to optimize the size of the baby without jeopardizing the health of the mother both in the short and long term is essential. The balance has proven challenging.

In the 1930s, the recommendation to all pregnant women, irrespective of pregravid weight status, was 6.8 kg (~ 15 pounds). This recommendation to restrict weight gains to decrease the risk of pregnancy complications continued until 1970; it stemmed largely from the observation that increased maternal weight gains were positively related to higher birthweights.¹² In 1970, however, the IOM determined that restriction of weight gain was likely to be harmful with respect to birthweight; subsequently, weight gain recommendations were eased from less than 20 pounds throughout pregnancy to a range of 20 to 27 pounds.¹³

Over the next two decades, accumulating research suggested that one guideline was unlikely to benefit all women and their fetuses. This recognition led an IOM committee to issue guidelines that offered standardized guidance to providers and to the general public based on a woman's pregravid weight status.¹ The recommendations were weight gains of (a) 28 to 40 pounds for women with low body mass index (BMI), defined as < 19.8; (b) 25 to 35 pounds for women with normal BMI (19.8-26); and (c) 15 to 25 pounds for women with high BMI (> 26.0-29.0). Further, the recommendations included a weight gain of at least 15 pounds for obese women (BMI > 29), weight gain in the upper end of the recommended range for adolescents and black women, and weight gain in the lower end of the recommended range for short women (< 157 centimeters [cm] or 62 inches).

These recommendations were the first to account for pregravid weight status and to encourage obese women to gain weight during pregnancy in recognition of the needs of the fetus.

^{*} Hereafter in this report, we refer to gestational weight gain for consistency across the text and to clarify that we focus on weight gained during gestation as the exposure of interest.

They also addressed patterns of weight gain by providing guidance on the ideal amount to be gained in the first trimester and rates of weight gain in the second and third trimesters. These recommendations tended to focus on the prevention of low birthweight deliveries rather than the impact on maternal obesity and related health outcomes.

In 1996, an expert panel assembled by the Maternal and Child Health Bureau of the US Health Resources and Services Administration reexamined these recommendations. At the time, the panel decided that revisions were unnecessary. They found, however, that the evidence to date suggested that the recommendations for higher weight gains by black women and adolescents and lower weight gains for women of short stature were not well supported; they concluded that these subpopulations should be advised to stay within the IOM's recommended weight range specific for their pregravid BMI.¹⁴

Gestational Weight Gain Patterns in the United States

Since the 1990 IOM recommendations appeared, several studies have documented the proportion of women meeting the guidelines. In a 1998 study of more than 120,000 women, only 34 percent gained weight within the recommended ranges.¹⁵ Specifically, the proportion of women gaining more than the recommended range increased over the time span from 42 percent to 44 percent. The figures for women gaining less than the recommended amount remained relatively stable over time (23 percent to 22 percent). Other studies reporting on various subpopulations since the 1990 report found that only 30 percent to 40 percent of women gained weight within the recommended ranges.^{4,16-25} Although the IOM recommendations have been in existence for almost 2 decades, between 35 percent and 60 percent of pregnant women reported receiving no advice from their providers about appropriate pregnancy weight gain.^{26,27} Pregnant women who reported being advised about the appropriate amount of weight to gain during pregnancy were more likely to gain within the recommended range than women who did not report receiving such advice.^{28,29} This association is based on a handful of studies; moreover, most had been conducted before or soon after the revised IOM guidelines were made public.^{26,28,29}

Persistent nonadherence to weight gain guidelines and the wide variability in the amount of weight gained during pregnancy has served as the impetus for much research on predictors of the adequacy of gestational weight gain. This body of work suggests that a multifactorial model may be at play.^{27,30,31} The bulk of research in this area has emphasized the importance of pregravid weight status, parity, height, race or ethnicity, age, age at menarche, physical activity, and psychosocial stress.^{27,30-33} Although such investigations are important, even more basic is an understanding of the short- and long-term benefits and risks of gestational weight gain for the mother, the fetus, and the child. This systematic evidence review was undertaken to fully explore what has been learned about the impact of gestational weight gain since the IOM recommendations were released in 1990.

Key Questions and Analytic Framework

Key Questions

Increases in the body weight of women of childbearing ages combined with a rising trend in weight gain during pregnancy outside the IOM recommendations have raised concerns about the

1990 IOM recommendations. Of particular interest is assembling and evaluating evidence linking gestational weight gain and birth, infant, and maternal health outcomes.

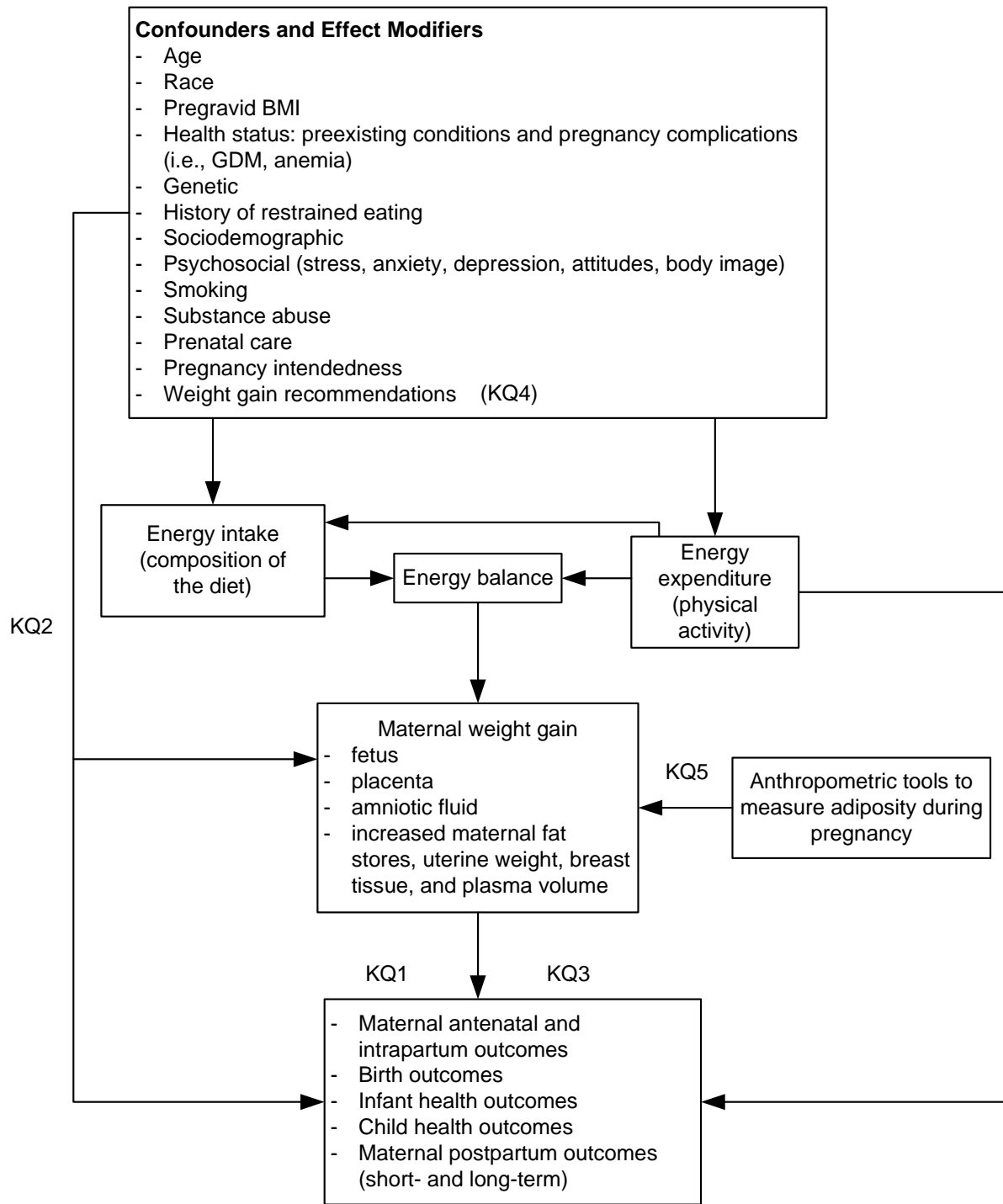
To accomplish this, the Agency for Healthcare Research and Quality (AHRQ) commissioned the RTI International–University of North Carolina Evidence-based Practice Center (RTI-UNC EPC) to complete this systematic review. The partner for this work was the American Dietetic Association. The EPC received and revised key questions (KQs) after discussions with internal technical staff, AHRQ staff, an American Dietetic Association representative, and our Technical Expert Panel (TEP, see below). The final KQs are as follows:

- KQ 1. What is the evidence that either total weight gain or rate of weight gain during pregnancy is associated with (1) birth outcomes, (2) infant health outcomes, and (3) maternal health outcomes? Does any evidence suggest that either total weight gain or rate of weight gain is a causal factor in infant or maternal health outcomes?
- KQ 2. What are the confounders and effect modifiers for the association between maternal weight gain (overall and patterns) and birth outcomes? Based on the findings in KQ 1, do these confounders and effect modifiers themselves contribute to antepartum or postpartum complications or to longer-term maternal and fetal complications, including development of adult obesity?
- KQ 3. What is the evidence that weight gains above or below thresholds defined in the 1990 Institute of Medicine BMI Guidelines or weight loss in pregnancy contribute to antepartum or postpartum complications or longer-term maternal and fetal complications? How do these relationships vary by sociodemographic characteristics (i.e., race and age)?
- KQ 4. What are the harms or benefits of offering the same weight gain recommendations to all pregnant women, irrespective of age and body weight considerations (e.g., pregravid weight, actual body weight at a particular time point, or optimal body weight)?
- KQ 5. What are the anthropometric tools for determining adiposity and their appropriateness for the pregnancy state? What are the risks and benefits of measuring adiposity for (1) clinical management of weight gain during pregnancy and (2) evaluation of the relationship between weight gain and outcomes of pregnancy?

Analytic Framework for Outcomes of Maternal Weight Gain

The analytic framework adopted from the 1990 IOM report shown in Figure 1 (i.e., the conceptual model developed to guide this systematic review) summarizes the critical topics addressed by this report and their links to the key questions. KQs 1 and 3 focus on identifying and evaluating evidence. KQ 5 attempts to explore the practicality and clinical utility of methods to assess maternal fat accrual (often thought to be the causative agent for many of the adverse outcomes).³⁴ KQs 2 and 4 are essentially derivative of information obtained for KQs 1 and 3.

Figure 1. Outcomes of gestational weight gain for singleton pregnancies: conceptual framework



Modified from the Institute of Medicine (IOM) 1990 report *Nutrition during Pregnancy. Part I, Weight Gain*¹

BMI, body mass index; GDM, gestational diabetes mellitus; KQ, key question.

The KQs are noted on the relevant arrows connecting the main boxes or within boxes, as appropriate. Our conceptual framework recognizes that energy balance, which is a result of

dietary intake and energy expenditure, directly influences maternal weight gain. We note, however, that this systematic review focuses on outcomes of weight gain during pregnancy, not on the predictors of that weight gain. As a result, we do not directly address strategies to reduce or modify maternal weight gain. Furthermore, this field of research consists predominantly of observational studies, which by their nature do not prove causality and, at most, provide evidence on a temporal sequence of events. The majority of the studies included in this systematic review are observational in nature. For that reason, we do not infer causality between gestational weight gain and health outcomes and instead focus on the strength of association.

Production of This Evidence Report

Organization of This Evidence Report

Chapter 2 describes our methods, including our search strategies and inclusion/exclusion criteria; we also document our approach to grading the quality of articles and rating the strength of evidence. We conducted extensive systematic literature searches and appraisal of evidence for included articles only for KQs 1, 3, and 5. In Chapter 3, we report the results of literature searches and synthesis of retained articles for KQs 1, 2, 3, and 5. Chapter 4 presents our conclusions and discusses KQ 4 in detail; it also offers our recommendations for future research.

References and included studies follow Chapter 4. Appendixes include a detailed description of our search strings (Appendix A),[†] data collection forms (Appendix B), detailed evidence tables (Appendix C), excluded studies (Appendix D), and acknowledgments (Appendix E).

Technical Expert Panel (TEP)

We identified six technical experts in nutrition, nursing, obstetrics, and family medicine to provide assistance throughout the project (Appendix E); one was a member of the American Dietetic Association. The TEP contributed to AHRQ's broader goals of (1) creating and maintaining science partnerships as well as public-private partnerships and (2) meeting the needs of an array of potential customers and users of its products. Thus, the TEP was both an additional resource and a sounding board during the project.

To ensure robust, scientifically relevant work, we called on the TEP to provide reactions to work in progress and advice on substantive issues or possibly overlooked areas of research. Specifically, TEP members participated in conference calls and discussions through e-mail to:

- refine the analytic framework and key questions at the beginning of the project;
- discuss the preliminary assessment of the literature, including inclusion/exclusion criteria; and
- provide input on the information and categories included in evidence tables.

Because of their extensive knowledge of the literature, including numerous articles authored by TEP members themselves, and their active involvement in professional societies and as practitioners in the field, we also asked TEP members to participate in the external peer review of the draft report.

[†] Appendixes and evidence tables cited in this report are provided electronically at <http://www.ahrq.gov/downloads/pub/evidence/pdf/admaternal/admaternalapp.pdf>.

Uses of This Report

This evidence report addresses the key questions outlined above using methods described in Chapter 2 to conduct a systematic review of published literature. We anticipate that the report will be of value to all women's health care providers, including the American Dietetic Association, the American College of Obstetricians and Gynecologists, the American College of Nurse Midwives, the Association of Women's Health, Obstetric and Neonatal Nurses, the American Society of Reproductive Medicine, and other groups concerned with health outcomes during childbearing and beyond, such as the American Academy of Family Physicians and the American Academy of Nurse Practitioners, and the American Academy of Pediatrics. This report can bring practitioners up to date about the current state of evidence, and it provides an assessment of the quality of studies that aim to determine the outcomes of maternal weight gain.

The report will be of use to various parts of the US Department of Health and Human Services, including the National Institutes of Health, Centers for Disease Control and Prevention, Centers for Medicare & Medicaid Services, and Health Resources and Services Administration, and the US Department of Agriculture; all these agencies have offices or bureaus devoted to women's health issues. We also anticipate that it will be of use to private sector organizations concerned with women's health, such as Our Bodies Ourselves, the National Women's Health Network, and the National Black Women's Health Imperative. In addition, this review will be of use to the Institute of Medicine in proposed revisions to the national guidelines.

Researchers can obtain a concise analysis of the current state of knowledge in this field. They will be poised to pursue further investigations that are needed to understand the causal links between maternal weight gain and health outcomes for mother and baby, clarify risk factors, develop prevention strategies, and optimize guidelines offered to women.

Chapter 2. Methods

In this chapter, we document the procedures that the RTI International–University of North Carolina Evidence-based Practice Center (RTI–UNC EPC) used to develop this comprehensive evidence report on outcomes of maternal weight gain. The team was led by a senior health services researcher (Meera Viswanathan, PhD, Study Director), a senior epidemiologist (Anna Maria Siega-Riz, PhD, RD, Scientific Director), and a senior nurse-researcher (Merry-K Moos, FNP, MPH, co-Scientific Director).

We first describe our strategy for identifying articles relevant to our five key questions (KQs), our inclusion and exclusion criteria, and the process we used to abstract relevant information from the eligible articles and generate our evidence tables. We also discuss our criteria for grading the quality of individual articles and for rating the strength of the evidence as a whole. Finally, we explain the peer-review process.

Literature Review Methods

Inclusion and Exclusion Criteria

Our inclusion and exclusion criteria are documented in Table 1. As noted in Chapter 1, this systematic review focuses on outcomes of maternal weight gain with respect to the 1990 recommendations from the Institute of Medicine (IOM).¹ Largely for that reason, we limited our searches to articles published in 1990 and thereafter. We also restricted our searches to developed countries so that we could have data generally relevant for maternal weight gain and health outcomes in the United States.

Table 1. Inclusion/exclusion criteria for gestational weight gain

Category	Criteria
Study population	Women of any age with singleton pregnancies
Study settings and geography	KQ 1, KQ 2, KQ 4: Developed nations: United States, Canada, Western Europe, Japan, Australia, New Zealand KQ 3: United States KQ 5: All countries
Time period	January 1990 through October 2007
Publication languages	English only
Admissible evidence (study design and other criteria)	<u>Admissible designs</u> <ul style="list-style-type: none">Controlled trials ($n \geq 40$), nonrandomized controlled trials ($n \geq 40$), systematic reviews, meta-analyses, prospective trials with historical controls ($n \geq 40$), prospective or retrospective observational cohort studies ($n \geq 40$), and medium to large case series ($n \geq 100$) <u>Other criteria</u> <ul style="list-style-type: none">Original research studies must provide sufficient detail regarding methods and results to enable use and adjustment of the data and results.Relevant outcomes must be abstractable from data presented in the papers.Sample sizes must be appropriate for the study question addressed in the paper; single case reports or small case series (fewer than 100 subjects) are excluded.For KQ 1, 2, 3, and 4: prepregnancy body mass index (BMI) or weight must be accounted for in the relationship between maternal weight gain and outcome.Studies limited to women with preexisting health conditions only are excluded.

We excluded studies that (1) were published in languages other than English (given the available time and resources); (2) did not report information pertinent to the key clinical questions; (3) had fewer than 40 subjects for randomized controlled trials (RCTs) or nonrandomized cohorts with comparisons or fewer than 100 subjects for case series; and (4) were not original studies.

For KQ 1, 2, 3, and 4, we required that the reported association between maternal weight gain and health outcomes accounted for prepregnancy body mass index (BMI) or weight, either through stratified univariate analysis or multivariate analysis.

Literature Search and Retrieval Process

Databases. We used multifaceted search strategies to include current and valid research on the KQs, which we applied to four standard electronic databases—MEDLINE®, Cochrane Collaboration resources, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Embase. We also hand-searched the reference lists of relevant articles to make sure that we did not miss any relevant studies. We consulted with our Technical Expert Panel (TEP) about any studies or trials that are currently under way or that may not yet be published.

Search terms. Based on the inclusion/exclusion criteria above, we generated a list of Medical Subject Heading (MeSH) search terms (Table 2 and Appendix A).^{*} Our TEP also reviewed these terms to ensure that we were not missing any critical areas, and this list represents our collective decisions as to the MeSH terms used for all searches.

Table 2. MEDLINE® search strategy and unduplicated results for February 2007

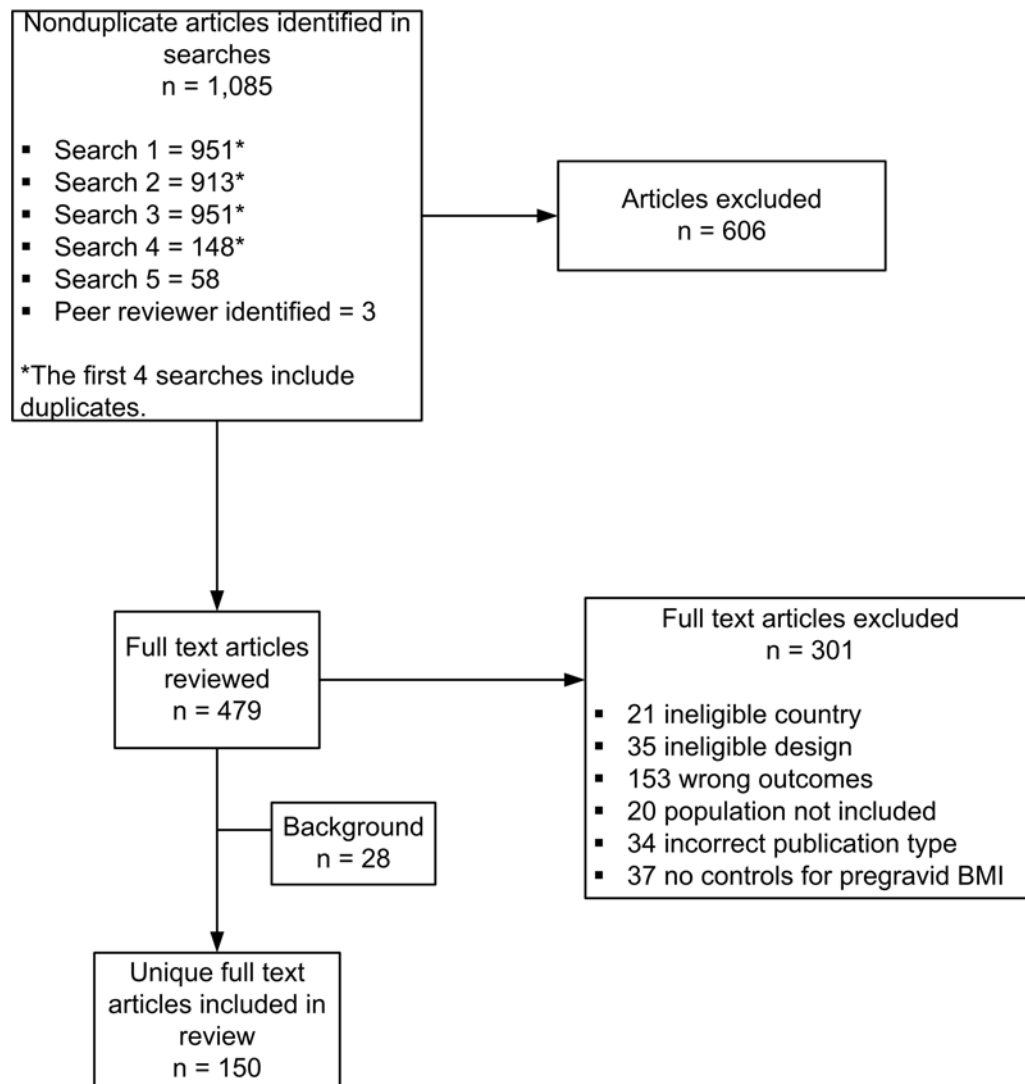
Search Terms	Search Results
#2 Search "Weight Gain"[MeSH]	13,220
#5 Search pregnancy [MeSH]	577,647
#6 Search #2 AND #5	1,808
#7 Search gestational weight gain	1,725
#8 Search #6 OR #7	3,023
#9 Search #6 OR #7 Limits: English, Humans	1,696
#15 Search ("Outcome Assessment (Health Care)"[MeSH] OR "Outcome and Process Assessment (Health Care)"[MeSH] OR "Pregnancy Outcome"[MeSH]) OR "Reproductive History"[MeSH] OR "birth outcomes" OR "infant health outcomes" OR "maternal health outcomes" Limits: English, Humans	332,914
#16 Search #9 AND #15 Limits: English, Humans	474
#19 Search ("Counseling"[MeSH] OR "Directive Counseling"[MeSH])	23,091
#20 Search #9 AND #19	12
#25 Search "Body Weights and Measures"[MeSH]	279,399
#26 Search #9 AND #25	1,044
#29 Search "Anthropometry"[MeSH]	71,849
#30 Search #26 AND #29	359

^{*} Appendixes and evidence tables cited in this report are provided electronically at <http://www.ahrq.gov/downloads/pub/evidence/pdf/admaternal/admaternalapp.pdf>.

Our searches in MEDLINE® produced 715 unduplicated records. Searches in other databases yielded in 190 new records from CINAHL and 4 from Embase. Similar searches in Cochrane did not produce any new citations. Following an update on October 3, 2007, and additional searches for KQ 5, we ultimately identified 1,082 unduplicated records. In addition, peer reviews suggested 3 new citations that met our inclusion criteria.

Figure 2 presents the yield and results from our searches, which we conducted from February through October 3, 2007. Beginning with a yield of 1,085 articles, we retained 150 articles that we determined were relevant to address our KQs and met our inclusion/exclusion criteria (Table 1). We reviewed titles and abstracts of the articles against the basic inclusion criteria above; we retained relevant articles, all published after our search cutoff date of January 1990, and used them as appropriate in the discussion in Chapter 4.

Figure 2. Disposition of articles for gestational weight gain



BMI, body mass index

Article selection process. Once we had identified articles through the electronic database searches, review articles, and reference lists, we examined abstracts of articles to determine whether studies met our criteria. Each abstract was independently, dually reviewed for inclusion or exclusion, using an Abstract Review Form (Appendix B).^{*} If one reviewer concluded that the article should be included in the review, we retained it.

Of this entire group of 1,085 articles, 479 required full review. For the full article review, one team member read each article and decided whether it met our inclusion criteria, using a Full Text Inclusion/Exclusion Form (Appendix B). Reasons for article exclusion are listed in Appendix D.

Literature Synthesis

Development of Evidence Tables and Data Abstraction Process

The senior staff who conducted this systematic review jointly developed the evidence tables. We designed the tables to provide sufficient information to enable readers to understand the studies and to determine their quality; we gave particular emphasis to essential information related to our KQs. We based the format of our evidence tables on successful designs that we have used for prior systematic reviews.

We trained abstractors by having them abstract several articles into evidence tables and then reconvening as a group to discuss the utility of the table design. The abstractors repeated this process through several iterations until they decided that the tables included the appropriate categories for gathering the information contained in the articles.

Three junior epidemiologists (Sunni Mumford, SM; Andrea Deierlein, MS, MPH; and Julie K. Knaack, MPH, RD, LDN) shared the task of initially entering information into the evidence tables. Senior staff reviewed the articles and edited all initial table entries for accuracy, completeness, and consistency. Abstractors reconciled all disagreements concerning the information reported in the evidence tables. The full research team met regularly during the article abstraction period and discussed global issues related to the data abstraction process.

The final evidence tables are presented in their entirety in Appendix C. Studies are presented in the evidence tables alphabetically by the last name of the first author. A list of abbreviations and acronyms used in the tables appears at the beginning of that appendix.

Quality Rating of Individual Studies

The evidence for this systematic review is based almost entirely on observational studies. This fact presents a challenge for rating individual studies. Quality rating forms for RCTs have been validated and in use for several years; a similarly well-validated form for observational studies does not exist.

Thus, as a parallel effort, we developed a form to rate observational studies.³⁵ This form, which can be used to rate the quality of a variety of observational studies, was based on a review of more than 90 AHRQ systematic reviews that included observational studies; we supplemented this review with other key articles identifying domains and scales.^{36,37} We structured the resultant

^{*} Appendixes and evidence tables cited in this report are provided electronically at <http://www.ahrq.gov/downloads/pub/evidence/pdf/admaternal/admaternalapp.pdf>.

form largely on the basis of the domains and subdomains suggested by Deeks and colleagues;³⁶ we then adapted it for use in this systematic review (Appendix B).*

The form currently includes review of nine key domains: background, sample selection, specification of exposure, specification of outcome, soundness of information, followup, analysis comparability, analysis of outcome, and interpretation. Each of these domains was further evaluated on aspects of quality of the study design or reporting that would influence the reader's perception of internal validity of the journal article (Table 3). We note that variations in reporting could result in different scores for studies drawing from the same sample.

Table 3. Scoring algorithm for subdomains and overall quality rating for individual studies

Definition and Scoring Algorithm	Rating
Score algorithm for background (presented in the context of previous research, hypothesis clearly described)	
• Both elements present	Good
• Neither present	Poor
• One of two elements present	Fair
Score algorithm for sample definition (explicitly stated inclusion/exclusion criteria, uniform application of criteria, clear description of recruitment strategy, clear description of characteristics of the participants, power analysis or some other basis noted for determining the adequacy of study sample size)	
• > Three elements present	Good
• < Two elements present	Poor
• Two or three elements present	Fair
Score algorithm for exposure (clear definition of weight gain, check for plausibility of pregravid weight, clear explanation of actions taken on outliers)	
• All three elements present or clearly defined	Good
• Poor definition of weight gain	Poor
• Moderate or very clear definition of weight gain, one or more other elements present	Fair
Score algorithm for outcome (clear description of primary outcomes)	
• All essential details described	Good
• Few or no essential details described	Poor
• Some essential details described	Fair
Score algorithm for soundness of information (quality of source of information on exposure, confounders, and outcome)	
• Good for all three	Good
• Poor on source of information for exposure	Poor
• Any other score	Fair

* Appendixes and evidence tables cited in this report are provided electronically at <http://www.ahrq.gov/downloads/pub/evidence/pdf/admaternal/admaternalapp.pdf>.

Table 3. Scoring algorithm for subdomains and overall quality rating for individual studies (continued)

Definition and Scoring Algorithm	Rating
Score algorithm for followup (adequate reporting of reasons for loss to followup)	
• Retrospective or prospective study with clear reporting on loss to followup	Good
• Prospective study, no reporting on followup	Poor
• Retrospective study with no reporting on loss to followup	Fair
Score algorithm for analysis comparability (comparability of cohorts through design, reasonable choice of control variables, clear description of confounders, adequate adjustment for confounders)	
• All elements present	Good
• Inadequate adjustment for confounding	Poor
• Any other score	Fair
Score algorithm for analysis outcome (withdrawals, lost to followup, and missing data adequately accounted for in the analysis, and appropriate statistical methods used)	
• Both elements clearly present	Good
• Neither element present	Poor
• Any other score	Fair
Score algorithm for interpretation (results interpreted appropriately based on study design and statistics, clinically useful, appropriate presentation, presented in the context of prior research, and conclusion supported by results)	
• All elements clearly present	Good
• Conclusions not supported by results	Poor
• Any other score	Fair
Score algorithm for overall quality	
• 5 or more good ratings and no poor ratings on subdomains	Good
• 3 or more poor ratings on subdomains	Poor
• <5 good ratings and <3 poor ratings on subdomains; 5 or more good ratings and any poor ratings	Fair

As described in Table 3, we combined these elements to generate overall scores. We set the default as fair and then focused on the threshold required for good and poor studies; the algorithm is also described in Table 3. Fair studies, therefore, include studies that were predominantly fair (four to nine fair ratings on domains) and could not be rated either good (fewer than five good ratings for subdomains) or poor (fewer than three poor ratings for subdomains). Studies with more than five good ratings for domains that also received one or two poor ratings were downgraded to fair quality.

Key methodological concerns in this literature relate to the source of information on weight gain and the timing of measurement of weight gain. Studies that relied solely on self-reported pregravid and final pregnancy weights suffer from well-documented issues of recall bias. In addition, women tend to misreport their weight, and this bias varies by weight status³⁸ and ethnicity.³⁹ The timing of weight measurement (for pregravid weight and final weight) can vary depending on the design of the study; when unreported, the total weight gain during pregnancy cannot be assumed to be collected at similar time points for all women within the study, resulting in further bias. Our rating algorithm, therefore, paid special attention to the source of data on gestational weight gain and the timing of measurement. Studies that relied solely on recalled

prepregnancy and total pregnancy weight were rated poor on that domain, but if they defined their gestational weight variable clearly (providing details on the timing of measurement for pregravid and final weight measurements) and either checked for the biological plausibility of pregravid weight status or explained how outliers were dealt with, they could receive an overall fair rating (assuming that they received fewer than three poor ratings overall).

Strength of Available Evidence

Our scheme follows the criteria applied in an earlier RTI-UNC EPC systematic review of systems for rating the strength of a body of evidence.⁴⁰ That system has three domains: quality of the research (as evaluated by the quality rating algorithm described above), quantity of studies (including number of studies and adequacy of the sample size), and consistency of findings. Two senior staff members assigned grades by consensus.

We graded the body of literature for each KQ and present those ratings as part of the discussion in Chapter 4. The possible grades in our scheme are as follows:

- I. **Strong:** The evidence is from studies of sound design (good quality); results are both clinically important and consistent with minor exceptions at most; results are free from serious doubts about generalizability, bias, or flaws in research design. Studies with negative results have sufficiently large samples to have adequate statistical power.
- II. **Moderate:** The evidence is from studies of sound design (good quality), but some uncertainty remains because of inconsistencies or concern about generalizability, bias, research design flaws, or adequate sample size. Alternatively, the evidence is consistent but derives from studies of weaker design (fair quality).
- III. **Weak:** The evidence is from a limited number of studies of weaker design (fair or poor quality). Studies with strong design (good quality) either have not been done or are inconclusive.
- IV. **No evidence:** No published literature.

External Peer Review

As is customary for all evidence reports and systematic reviews done for AHRQ, the RTI-UNC EPC requested review of this report from a wide array of individual outside experts in the field, including our TEP, and from relevant professional societies and public organizations. AHRQ also requested review from its own staff. We sent 20 invitations for peer review: 6 TEP members, 6 relevant organizations, and 8 individual experts. Reviewers included clinicians (e.g., obstetrics and gynecology, women's health/general health), representatives of federal agencies, advocacy groups, and potential users of the report.

We charged peer reviewers with commenting on the content, structure, and format of the evidence report, providing additional relevant citations, and pointing out issues related to how we had conceptualized and defined the topic and KQs. We also asked them to complete a peer review checklist. We received comments from 11 of the invited peer reviewers in addition to comments from AHRQ staff. The individuals listed in Appendix E* gave us permission to

* Appendixes and evidence tables cited in this report are provided electronically at <http://www.ahrq.gov/downloads/pub/evidence/pdf/admaternal/admaternalapp.pdf>.

acknowledge their review of the draft. We compiled all comments and addressed each one individually, revising the text as appropriate.

Chapter 3. Results

This chapter presents the results of our evidence review for the following four key questions (KQs): KQ 1, outcomes of gestational weight gain; KQ 3, outcomes of gestational weight gain within or outside the recommendations of the Institute of Medicine (IOM); and KQ 5, anthropometrics of gestational weight gain.

We note that KQ 2, on modifiers of outcomes, is derivative of KQ 1. KQ 4, on recommendations for weight gain, is derivative of KQ 3. Because we framed KQ 2 and KQ4 as synthesis questions, we cover them in Chapter 4.

Appendix C* provides the detailed evidence tables for KQs 1, 3, and 5. Our summary tables below feature groups of studies addressing each outcome; we present these text tables only when we have three or more studies pertaining to that particular outcome. These tables are organized by quality (good, then fair, then poor), and then alphabetically.

The summary tables generally provide information to identify the study (author and date), sample size, study quality, definition of gestational weight gain, definition of outcome, results, and confounders and effect modifiers. Unless otherwise noted, we use the metrics (e.g., grams, kilograms, pounds) that each study article used; we did not recalculate measures into the same metric.

KQ 1: Outcomes of Gestational Weight Gain

We present outcomes in the physiological order, beginning with maternal antepartum and intrapartum outcomes, then birth outcomes (neonatal outcomes at the time of birth), infant outcomes (<1 year), child outcomes (≥ 1 year), and finally maternal short- and long-term outcomes. Evidence Tables 1-35 (Appendix C) include studies relevant for KQ 1, listed alphabetically by author. For each outcome, we describe study characteristics and then report an overview of results, followed by detailed results. When meaningful, we present results separately for varied measures of gestational weight gain (categorical measures of weight gain, rate of weight gain, total weight gain, and other). For some bodies of evidence, variations in the definition of the outcome and inconsistencies in the direction of effect may suggest that an overall assessment of the effect is more meaningful than separate assessments of outcomes associated with each measure of gestational weight gain. Summary tables and text include information on the confounders and effect modifiers accounted for in each study.

Maternal Antepartum Outcomes

Maternal discomforts of pregnancy.

Study characteristics. Five studies (Evidence Table 1) investigated the relationship between weight gain and diverse maternal discomforts of pregnancy: a composite of pregnancy discomforts,⁴¹ physical energy and fatigue,⁴² stretch marks,^{43,44} and heartburn.⁴⁵

Overview of results. Two fair^{41,42} and three poor studies⁴³⁻⁴⁵ found no differences for women who gained an excessive amount of weight compared to those who did not, irrespective of body mass index (BMI) group,⁴² a higher frequency of symptoms from midpregnancy through the 36th

* Appendixes and evidence tables cited in this report are provided electronically at <http://www.ahrq.gov/downloads/pub/evidence/pdf/admaternal/admaternalapp.pdf>.

week of gestation,⁴⁶ no association between gestational weight gain and heartburn in gestation,⁴⁵ and some increased risk of stretch marks with increased weight gain.^{43,44}

Detailed results. A prospective cohort study in Sweden examined symptoms across pregnancy and attempted to document the prevalence and frequency of 27 pregnancy symptoms while controlling for biomedical factors.⁴¹ A cohort of 476 nulliparous women was assessed six times during gestation (gestational ages of 10, 12, 20, 28, 32, and 36 weeks). The investigators sought to determine the prevalence of various symptoms in pregnancy and to explore whether psychosocial variables are explanatory while controlling for possible confounding variables such as medical risk, smoking, and weight gain. Pregravid BMIs were calculated from self-reported weight information and women were weighed when they arrived at the hospital to give birth. Total weight gain was associated with a higher frequency of symptoms from midpregnancy through the 36th week of gestation. Reflecting on their findings, the researchers recommend that weight gain be included in future studies exploring the etiology of symptoms during pregnancy.

A secondary analysis of data collected in a US prospective cohort study investigated the relationship of prepregnancy weight and gestational weight gain on levels of physical energy and physical symptoms collected through a series of questionnaires that had been administered in patient homes in early, mid, and late pregnancy.⁴² All weight data were self-reported. The researchers found no differences in the number of physical symptoms or level of physical energy reported by women who gained an excessive amount of weight compared with those who did not, irrespective of BMI group. Women whose weight gain was greater than the IOM guidelines reported a lower level of functional status in the third trimester than women whose weight gain was within the guidelines ($P = 0.014$). Women participating in this study were 30.9 years of age on average, married, English-speaking, and of low medical risk. No confounders or effect modifiers were accounted for in the analysis.

The one study (rated poor quality) that investigated the determinants of heartburn in pregnancy undertook a cross-sectional study in the United Kingdom of 602 women of different gestational lengths who self-reported their pregravid weight and completed a questionnaire.⁴⁵ The analysis, which considered age, race, parity, and pregravid BMI, found that weight gain in pregnancy was not a risk factor for heartburn in gestation.

Two studies (both rated poor quality) reported on the relationship between stretch marks (striae gravidarum) and weight gain.^{43,44} One was a small retrospective cohort ($N = 48$) recruited from one private and one teaching hospital in the United States.⁴³ Mean total weight gain was significantly greater in women with abdominal striae than women without stretch marks ($P < .05$) but the analysis did not account for any confounders or effect modifiers. The other study reported on a cross-sectional sample of 324 primiparous women who were assessed within 48 hours of giving birth in Great Britain.⁴⁴ Logistic regression analysis found maternal age, BMI, weight gain, and neonatal birthweight to be independently associated with striae. Weight gain was a weakly significant risk factor (OR, 1.08; 95% CI, 1.02-1.14).

Hyperemesis.

Study characteristics. A retrospective cohort study compared the experiences of 1,270 women who had an antepartum admission before 24 weeks of gestation for hyperemesis with those of 154,821 women who experienced no antepartum admission related to vomiting (Evidence Table 2).⁴⁷ Baseline weight and weight gain were abstracted from the Nova Scotia Atlee Perinatal Database, but the authors did not explain how the weights entered into the database were assessed.

Overview of results. One poor study found a correlation between increasing likelihood of total gestational weight gain of < 7 kg with increasing numbers of antenatal admissions for hyperemesis.⁴⁷

Detailed results. The study, undertaken to determine the relationship between hyperemesis and a variety of outcomes, used the number of antenatal admissions as a marker for severity of disease. The study found a correlation between increasing likelihood of total gestational weight gain of < 7 kg with increasing numbers of antenatal admissions. Many potential confounders were incorporated into the analysis including previous pregnancy experiences, psychiatric disorders, pregravid weight, and preexisting medical diseases. Weight gain information, however, was missing for approximately 17 percent of the cohort.

Abnormal glucose metabolism.

Study characteristics. Eleven studies specifically investigated the relationship between weight gain in pregnancy and the development of abnormal glucose metabolism (Evidence Table 3, Table 4).^{3,48-57} Of these, four were done outside the United States.^{49,50,52,53} Numerous inconsistencies in methodology and definitions, such as differences in criteria used for the diagnosis of gestational diabetes mellitus (GDM), preclude clear summations regarding the research.

Table 4. Gestational weight gain and abnormal glucose control

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Kieffer et al., 2006 ⁴⁸ US Michigan federally qualified community health center 1,041 Latinas All BMIs Good	Pregravid weight: Self-report; if unknown calculated from wt at ≤ 10 wks gestation Total weight gain: Computed from last weight recorded within 7 days delivery	Note: study aim to determine relationship of anthropometric and metabolic variables on infant outcomes	Women with GDM had significantly lower average weight gain than those without GDM but weight gain was not significantly related to glucose category	Parity, pregravid BMI, weight gain
Saldana et al., 2006 ³ US North Carolina prenatal study 2,254 All BMIs Good	Pregravid weight: Self-report Total weight gain: Calculated on prenatal measurement to end of second trimester		Weight gain ratio (observed/recommended) IGT OR (95% CI) 0.9 (0.7-1.1) GDM OR (95% CI) 1.2 (0.9-1.4)	Race, maternal age, gestation age of weight measurement

AA, African American; ACOG, American College of Obstetrics and Gynecology; BMI, body mass index; CHC, community health center; CI, confidence interval; G, group; GA, gestational age; GDM, gestational diabetes mellitus; GIP, gastric inhibitory polypeptide; IGT, impaired glucose tolerance; IOM, Institute of Medicine; NS, not significant; OR, odds ratio; PNV, prenatal visit.

Table 4. Gestational weight gain and abnormal glucose control (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Edwards et al., 1996 ⁵⁵	Pregravid weight: Self-report	Pregravid wt 19.8- 26.0 BMI: G1: < 11.5 kg gain G2: 11.6-16 kg gain G3: > 16 kg gain	Incidence gestational diabetes: G1: 2.3% G2: 3.3% G3: 2.9% (<i>P</i> = .759)	Maternal age, parity, race, prenatal smoking, prenatal alcohol use, prenatal illicit drug use, pregravid health, weight and adequacy of prenatal care
US Minnesota, births at specific medical center	Total weight gain: Last prenatal assessment	Pregravid wt > 29 kg G4: lost/gained nothing G5: 0.5-6.5 kg gain G6: 7-11.5 kg gain G7: 12-16 kg gain G8: >16 kg gain	G4: 13.3% G5: 24.3% G6: 11.9% G7: 16.7% G8: 17.3% (<i>P</i> = .554)	
1,343 divided between obese women (BMI > 29) matched to nonobese (BMI 19.8-26.0)				
Fair				
Hackmon, et al., 2007 ⁵⁷	Pregravid weight: How determined not described		There was no difference in maternal weight gain during early pregnancy between patients with abnormal versus normal GCT values (mean±SD of 4.13±3.2 and 4.16±1.67, respectively).	Gravidity, parity, ethnicity, BMI
US inner city population	Weight gain: Weight at 24-28 weeks end point for calculations			
75				
All BMIs				
Fair				
Kieffer et al., 2001 ⁵⁶	Pregravid weight: Self-report or, if unknown, weight assessment in 1st 10 wks gestation	Wt gain to 28 wk GA: Latinas: G1: < 14 lbs gain G2: 14-28 lbs gain (reference) G3: >28 lbs gain	Multiple logistic regression analyses revealed statistically significant risk factors for GDM included increasing weight gain during first 28 wks of gestation	Age, family history diabetes, parity, BMI, weight gain first 28 weeks, ethnicity
US Detroit health care system	Total weight gain: How determined not described	AAs: G4: < 14 lbs gain G5: 14-28 lbs gain G6: > 28 lbs gain		
1,334 AA and Hispanic				
All BMIs				
Fair				
Murakami et al., 2005 ⁵²	Pregravid weight: Self-report on first visit	G1: < 8.5 kg gain G2: 8.5-12.5 kg gain G3: >12.5 kg gain	AOR (95% CI) gestational diabetes G1: 5.14 (0.97-27.20) G2: Reference G3: 3.91 (0.61-24.73)	Maternal age, parity, smoking, weight gain, gestational weeks; pregravid BMI
Japan hospital data	Total weight gain: Measured on admission for birth			
633				
All BMIs				
Fair				

Table 4. Gestational weight gain and abnormal glucose control (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Thorsdottir, et al., 2002 ⁵³	Pregravid weight: Self-report	G1: <11.5 kg gain G2: 11.5-16.0 kg gain G3: 16.1-20.0 kg gain G4: >20 kg gain	Incidence gestational diabetes G1: 2.9% G2: 0 G3: 0 G4: 0 (<i>P</i> = .015)	Age, parity, height, gestational age
Iceland University Hospital 615 BMI: 19.5-25.5 Fair	Total weight gain: Maternity records (no specifics offered)			
Bianco, et al., 1998 ⁵⁴	Pregravid weight: Self-report	Reported only for BMI > 35: G1: weight loss or no gain G2: 1-15 lb gain G3: 16-25 lb gain G4: 26-35 lb gain G5: > 35 lb gain	Incidence GDM: G1: 15.7% G2: 15.0% G3: 14.4% G4: 13.4% G5: 12.5% (<i>P</i> = NS)	Race, parity, clinic service, substance abuse, and preexisting medical conditions
US New York Medical Center Database 11,840 Nonobese (BMI 19-27) and Morbidly obese (BMI > 35) ages 20-34 Poor	Total weight gain: Computed from measured weight within 4 weeks of delivery			
Brennan et al., 2005 ⁴⁹	Pregravid weight: Measured weight ≤14 wk GA used as proxy	G1: "Low weight gain" G2: "Acceptable weight gain" G3: "Excessive weight gain"	Incidence GDM: G1: 38.6% G2: 27.3% G3: 19.3% (<i>P</i> = 0.011)	None reported
Quebec, Canada, First Nation's People (Cree) 603 All BMIs ≥18.5 Poor	Total weight: Last recorded weight within 4 wks of giving birth	All categories per Canadian Guidelines	Incidence IGT: G1: 12.0% G2: 15.2% G3: 7.9% (<i>P</i> = 0.249)	
Kabiru and Raynor, 2004 ⁵¹	Pregravid weight: First prenatal visit	BMI < 25 first assessment: G1: no change BMI category G2: increase 1 category G3: increase > 1 category	Incidence gestational diabetes G1: 0.5% G2: 1.5% G3: 3.7% (<i>P</i> = .005)	Pregravid weight
US Atlanta public hospital database 5,131 All BMIs ≥ 20 Poor	Total weight gain: Computed on weight at admission for birth	BMI ≥ 25 first assessment: G4: no change BMI category G5: increase 1 category G6: increase >1 category	G4: 1.0% G5: 3.3% G6: 1.9% (<i>P</i> = .005)	

Table 4. Gestational weight gain and abnormal glucose control (continued)

Author, Year	Country, Setting	Sample Size	Baseline BMI	Pregravid Weight (How Measured)	Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Seghieri et al., 2005 ⁵⁰				Pregravid weight: How determined not described			Weight gain as predictor of GDM OR (95% CI)	Parity, age, pregestational BMI, weight gain, family history diabetes
	Italy Outpatient Diabetes Unit	1,880		Total weight gain: How determined not described			1.024 (0.974-1.077) (P = NS)	
All BMIs								
Poor								

The diagnostic algorithm for assigning the diagnosis of GDM in most asymptomatic women begins with administration and interpretation of a 1-hour glucose challenge test; those women who have a glucose level following the challenge above a specified level then receive a 3-hour glucose tolerance test (GTT). Abnormalities in the GTT results are considered diagnostic of GDM. The set point for determining if the glucose challenge test is abnormal is not universally agreed upon. Therefore, more women in one setting may be tested for disease than in another setting, not because of an increased prevalence of disease but because of differing definitions of abnormal. In addition, impaired glucose tolerance (IGT) is not clearly defined. Women with an abnormal glucose challenge test who subsequently have a normal GTT are sometimes identified as having IGT; more commonly, women who have one abnormal value in their GTT are designated as having IGT. The lack of standardization in the criteria necessary to be considered to have IGT and GDM hampers the body of research exploring the relationship between weight gain and abnormal glucose tolerance in pregnancy. Further hampering understanding of the relationship is that GDM is generally diagnosed around 28 weeks of gestation and is treated, in part, by dietary counseling and efforts to control weight gain. Similar attention is not directed toward women without this diagnosis. Therefore, using total weight gain as a predictor of disease or as a comparison point to a population without the diagnosis is likely to result in methodologically flawed conclusions.

Overview of results. Four studies (1 good,³ 2 fair,^{55,56} 1 poor⁵¹) found that greater weight gains in pregnancy were positively associated with abnormal glucose tolerance. Three studies (1 good quality,⁴⁸ 1 fair,⁵³ 1 poor⁴⁹) found that women having lower than average weight gains had higher likelihood of GDM. Finally, four studies (2 poor,^{50,54} 1 fair^{52,53,57}) found no significant association.

Detailed results. Whether total weight gain or the distribution of the gain across trimester or weeks of pregnancy predicts development of GDM is unclear from the articles we reviewed. As previously noted, treatment of the condition can alter total weight gain. Three studies^{3,56,57} analyzed the association between weight gain in the first two trimesters of pregnancy and the diagnosis of GDM. A good-quality study reported that a weight gain ratio at the end of the second trimester of pregnancy that was greater than the IOM recommendations correlated with abnormalities of glucose metabolism.³ A fair study found no correlation between weight gain in the first 24 to 28 weeks of gestation and an abnormal glucose challenge test, the first step in the

testing process to identify GDM.⁵⁷ A third study assessed to be of fair quality reported that weight gain in the first 28 weeks of gestation was a significant predictor of the diagnosis of GDM (OR, 1.02; 95% CI, 1.004-1.042; $P = 0.015$) for their total sample of 987 black and Latina women but that total weight gain was not.⁵⁶ The OR for black women was the same (1.02; 95% CI, 1.002-1.044; $P = 0.30$). However, the range of weight gain included in the reference category was large (14-28 pounds) especially given that nearly 50 percent of the sample entered into the reported pregnancies with BMIs > 26.0.

Overall, family history of diabetes,^{50,56} maternal age,^{3,50,56} parity,⁵⁰ and BMI^{3,50,56,57} were found to be more predictive of abnormal glucose metabolism than gestational weight gain in the research we reviewed.

Maternal hypertensive disorder.

Study characteristics. Twelve studies investigated the relationship between weight gain and pregnancy-induced hypertensive disorders (Evidence Table 4, Table 5).^{4,25,49,51-55,58-61} Six of the studies were conducted outside the United States,^{49,52,53,58,59,61} six studied US cohorts.^{4,25,51,54,55,60} While all of these studies reported on blood pressures that became elevated during gestation, the criteria for diagnosing gestational hypertension (also called pregnancy-induced hypertension) and preeclampsia were often poorly defined; in addition, criteria for the various diagnoses lacked consistency between studies.

Table 5. Gestational weight gain and pregnancy-induced hypertension

Author, Year	Country, Setting	Sample Size	Baseline BMI	Quality	Pregravid Weight (How Measured)	Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Cedergren, 2006 ⁵⁸	Swedish Medical Birth Registry	245,526	All BMIs	Fair	Pregravid weight: Self-report; if unknown "standardized measurement" used	Total weight gain: Computed on weight at presentation for delivery	G1: BMI < 20 G2: BMI 20-24.9 G3: BMI 25-29.9 G4: BMI 30-34.9 G5: BMI > 35	Preeclampsia by BMI for weight gain < 8 kg (reference gain 8-16 kg). OR (95% CI): G1: 0.90 (0.55-1.48) G2: 0.73 (0.61-0.89) G3: 0.64 (0.54-0.76) G4: 0.52 (0.42-0.62) G5: 0.63 (0.51-0.79)	Age, parity, smoking in early pregnancy, year of birth
								Preeclampsia by BMI for weight gain >16 kg (reference weight gain 8-16 kg): Odds ratios (95% CI) G1: 2.23 (1.83-2.71) G2: 2.31 (2.15-2.49) G3: 1.88 (1.72-2.06) G4: 1.65 (1.43-1.92) G5: 1.50 (1.17-1.92)	

AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; G, group; GA, gestational age; HTN, hypertension; kg, kilogram; lb, pounds; NS, not significant; OGTT, oral glucose tolerance test; OR, odds ratio; PIH, pregnancy-induced hypertension; USA, United States of America; wt, weight; wts, weights.

Table 5. Gestational weight gain and pregnancy-induced hypertension (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
DeVader, et al., 2007 ²⁵ USA Missouri, birth certificate data 94,696 BMI: 19.8-26.0 Fair	Pregravid weight: Noted on prenatal record or reported at postpartum stay Total weight gain: As stated on birth certificate data. Specifics not provided	G1: Weight gain < 25 lbs G2: Weight gain 25-35 lbs G3: Gained > 35 lbs	AOR for preeclampsia (95% CI) G1: 0.56 (0.49-0.64) G2: 1 G3: 1.88 (1.74-2.04)	Maternal age, race/ethnicity, education, Medicaid status, tobacco and alcohol use, maternal height, adequacy of prenatal care, child's sex, child's birth year
Edwards et al., 1996 ⁵⁵ USA Minnesota, births at specific medical center 1,343 divided between obese women (BMI > 29) matched to nonobese (BMI 19.8-26.0) Fair	Pregravid weight: Self-reported Total weight gain: Last prenatal assessment	Pregravid wt 19.8-26.0 BMI: G1: < 11.5 kg gain G2: 11.6-16 kg gain G3: > 16 kg gain Pregravid wt > 29 kg G4: lost/gained nothing G5: 0.5-6.5 kg gain G6: 7-11.5 kg gain G7: 12-16 kg gain G8: > 16 kg gain	Preeclampsia: G1: 2.8% G2: 2.9% G3: 6.6% (<i>P</i> = .048) G4: 10.7% G5: 7.7% G6: 8.3% G7: 7.9% G8: 16.5% (<i>P</i> = .076) Gestational HTN: G1: 2.3% G2: 3.8% G3: 3.3% (<i>P</i> = .607) G4: 9.3% G5: 8.3% G6: 11.3% G7: 10.3% G8: 9.0% (<i>P</i> = .832)	Maternal age, parity, race, prenatal smoking, prenatal alcohol use, prenatal illicit drug use, pregravid health, weight and adequacy of prenatal care
Kiel et al., 2007 ⁴ USA Missouri, birth certificate data 120,251 BMIs ≥ 30.0 Fair	Total weight gain: As stated on birth certificate data. Specifics not provided	Analysis done by each class of obesity and weight changes in gestation including: weight loss ≥ 10 lbs; weight loss 2-9 lbs; no weight change; gain 2-9 lbs; gain 10-14 lbs; gain 15-25 lbs; gain 26-35 lbs; gain > 35 lbs	Data all presented in graph form: Using a gain of 15-25 pounds as reference for each obesity class, OR of preeclampsia lower with less weight gain and higher with more weight gain	Age, education, poverty (defined as participation in one or more subsidized programs) tobacco use, parity, chronic hypertension

Table 5. Gestational weight gain and pregnancy-induced hypertension (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Murakami et al., 2005 ⁵² Japan hospital data 633	Pregravid weight: Self-reported at first visit Total weight gain: Measured on admission for birth	G1: < 8.5 kg gain G2: 8.5-12.5 kg gain G3: >12.5 kg gain	Estimated OR (95% CI) preeclampsia G1: 0.74 (0.37-1.48) G2: 1 G3: 0.57 (0.24-1.32)	Maternal age, parity, smoking, weight gain, gestational weeks; pregravid BMI
All BMIs				
Fair				
Ogunyemi et al., 1998, ⁶⁰ USA, rural Alabama 582	Pregravid weight: Self-reported Total weight gain: Weight at last prenatal visit	G1: "low weight gain" G2: "normal weight gain" G3: "high weight gain"	Incidence preeclampsia: G1: 10% G2: 7% G3: 19% (<i>P</i> < .01)	Age, parity, pregravid BMI, tobacco use, hypertension
All BMIs				
Fair				
Thorsdottir, et al., 2002 ⁵³ Iceland, university hospital 615 BMI: 19.5-25.5	Pregravid weight: Self-reported Total weight gain: Maternity records (no specifics offered)	G1: <11.5 kg gain G2: 11.5-16.0 kg gain G3: 16.1-20.0 kg gain G4: > 20 kg gain	% gestational HTN G1: 1.5% G2: 4.6% G3: 5.1% G4: 9.2% (<i>P</i> = 0.026) % preeclampsia G1: 1.4% G2: 2.3% G3: 5.4% G4: 4.4% (<i>P</i> = 0.262)	Age, parity, height, gestational age
Fair				
Bianco, et al., 1998 ⁵⁴ USA, New York Medical Center Database 11,840	Pregravid weight: Self-reported Total weight gain: Computed on measured weight within 4 weeks of delivery	Reported only for BMI > 35: G1: weight loss or no gain G2: 1-15 lb gain G3: 16-25 lb gain G4: 26-35 lb gain G5: > 35 lb gain	Incidence PIH G1: 11.8% G2: 13.7% G3: 13.7% G4: 12.4% G5: 21.3% (<i>P</i> = NS)	Race, parity, clinic service, substance abuse, and preexisting medical conditions
Nonobese (BMI 19-27) and morbidly obese (BMI > 35) ages 20-34				
Poor				

Table 5. Gestational weight gain and pregnancy-induced hypertension (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Brennand et al., 2005 ⁴⁹ Quebec, Canada, First Nation's People (Cree) 603 BMI ≥ 18.5 Poor	Pregravid weight: Measured weight ≤ 14 wk GA used as proxy Total weight gain: Computed on last recorded weight within 4 wks of giving birth	G1: "Low weight gain" G2: "Acceptable weight gain" G3: "Excessive weight gain" All categories per Canadian Guidelines	HTN disorders G1: 7.3% G2: 12.5% G3: 19.3% (<i>P</i> = 0.051) PIH: G1: 3.7% G2: 6.3% G3: 4.4% (<i>P</i> = 0.698) Preeclampsia G1: 3.7% G2: 6.3% G3: 14.9% (<i>P</i> = 0.013)	None reported
Jensen et al., 2005 ⁵⁹ Danish medical centers 481 BMI ≥ 30 Poor	Pregravid weight: Self-reported Total weight gain: Details not provided	G1: < 5 kg gain G2: 5.0-9.9 kg gain G3: 10.0-14.9 kg gain G4: ≥ 15.0 kg gain	OR (95% CI) gestational HTN G1: 1 G2: 2.1 (0.8-5.7) G3: 3.6 (1.3-9.8) G4: 4.8 (1.7-13.1) (<i>P</i> = 0.001)	Results of 2 hour OGTT, age, pregravid BMI, gestational age, parity, smoking, ethnicity, and site of prenatal care
Kabiru and Raynor, 2004 ⁵¹ USA Atlanta, public hospital database 5,131 BMI ≥20 Poor	Pregravid weight: First prenatal visit Total weight gain: Computed on weight at admission for birth	BMI < 25 first assessment: G1: no change BMI category G2: increase 1 category G3: increase > 1 category BMI ≥ 25 first assessment: G4: no change BMI category G5: increase 1 category G6: increase > 1 category	Incidence preeclampsia G1: 1.9% G2: 3.2% G3: 1.6% (<i>P</i> = .203) G4: 2.8% G5: 3.7% G6: 3.7% (<i>P</i> = .002)	Pregravid weight
Wataba et al., 2006 ⁶¹ Japanese medical center 21,718 All BMIs Poor	Total weight gain: Computed by delivery weight less pregravid weight (no details on how assessed) divided by gestational age	Separate analyses done for low, medium and high pregravid weight groups by following intervals of kg/week gain: < 0.15: 0.15-.20; 0.20-.25; 0.25- .30; 0.30-.35; 0.35-40; >0.40	No clear trends for preeclampsia or severe preeclampsia by pregravid weight status and kg/week weight gains. AOR generally crossed 1.0 or had wide confidence intervals.	

Overview of results. The vast majority of the studies (7 fair,^{4,25,53,55,58-60} 3 poor,^{49,51,61}) found that increasing weight gain was associated with increasing likelihood of a pregnancy-induced hypertensive disorder. Two studies, one fair⁵² and one poor,⁵⁴ did not support this association.

Detailed results. Six studies specifically examined the impact of weight gain on the development of pregnancy-induced hypertension in women classified as obese by their pregravid weight status.^{4,49,54,55,58,59} A prospective cohort study from Sweden examined the relationship of weight gain by pregravid BMI on pregnancy outcomes for 245,526 women who delivered term infants between 1994 and 2002.⁵⁸ When compared to a reference gain of 8-16 kg, the researchers found that gains of less than 8 kg were protective against the development of preeclampsia for all pregravid BMI categories. The finding was not significant, however, for those with BMIs < 20. Gaining more than 16 kg increased the likelihood of developing preeclampsia, especially for women who entered pregnancy with lower BMIs. The greatest increased risk was for women entering pregnancy at a BMI of 20 to 24.9 (OR, 2.31; CI, 2.15-2.49); the lowest increased risk was for women who entered pregnancy at a BMI \geq 35 (OR, 1.50; CI, 1.17-1.92).

One US retrospective cohort study studied 771 women with BMIs of 30 or greater matched by race or ethnicity, delivery date, age categories, and parity categories with women of normal pregravid BMIs (19.8-26.0).⁵⁵ For women of normal weight, as weight increased the prevalence of preeclampsia steadily increased ($P = .048$) but increasing weight was not associated with the prevalence of gestational hypertension. For obese women, weight gain and the development of either gestational hypertension or preeclampsia were not significantly associated.

In a retrospective cohort study of 603 Cree women in Canada (rated poor quality), Brennand et al.⁴⁹ found that overweight and obese women had a significant unadjusted OR of 2.25 to 4.25 times higher, respectively, than normal weight women for pregnancy-induced hypertension and 1.25 to 3.45 times higher for preeclampsia.

Three retrospective cohorts were limited to women who entered pregnancy with BMIs \geq 30.^{4,54,59} In a study of 481 Danish women, the authors, using < 5 kg as the reference weight gain, found a statistically significant trend for development of pregnancy-associated hypertension with increasing weight ($P = 0.0001$).⁵⁹ A US study examined birth certificate data for 120,251 obese women classified according to the 1998 National Institute of Health obesity classes.⁴ The researchers found that the amount of weight gain associated with minimal risk for preeclampsia differed by class of obesity but that, in all classes, a gain of less than 15 pounds was protective. The third study (rated poor quality) specifically investigated pregnancy and neonatal risks associated with BMIs > 35 in 527 morbidly obese women.⁵⁴ Although these women were more likely to experience obstetrical complications than a control population (BMIs 19-27), gestational weight gain did not affect the complication rate.

One other study did not support the association between weight gain and pregnancy-induced hypertension.⁵² In this study, 633 Japanese women who gave birth to a singleton infant at 24-42 weeks of gestational age were studied. Pregravid BMI categories were those defined by the IOM. At the time of the study (2005) the Japan Society of Obstetrics and Gynecology did not have a recent guideline for weight gain during pregnancy; as a result, researchers used the frequency distributions from their population to set quartiles regarding weight gain and then set the parameters for insufficient and excessive gains accordingly. In this study, insufficient gain was defined as less than 8.5 kg and excessive gain as 12.5 kg. Finding no significant influence on weight gain and various perinatal outcomes of the mother or infant, the research team used other cut-off points and was still unable to find an appropriate criterion for predicting risk. The authors stated that their sample size was not sufficient to prove a lack of significance. Of note, the mean

pregravid BMI of the sample was 20.9 ± 2.8 and the mean weight gain was $10.5 \text{ kg} \pm 3.4$. While this study was assessed to be of fair quality, it has little, if any, generalizability to the United States because our population of childbearing women is more racially and ethnically diverse and have a higher mean BMI.

Gallstones.

Study characteristics. Two studies reported on the relationship between weight gain in pregnancy and cholelithiasis (gallstones)^{62,63} (Evidence Table 5).

Overview of results. Two studies (1 poor⁶² and 1 fair⁶³) suggest a potential relationship between weight gain and cholelithiasis.

Detailed results. One study reported on weight and the development of gallstones in a prospective study of 128 northern plains Native American and white women in 2004.⁶³ Nine independent variables including BMI, prenatal weight gain, prenatal physical activity, dietary fat, iron supplementation, age, parity, history of gallbladder disease, and serum cholesterol were analyzed. Weight assessments during pregnancy were carefully collected; how pregravid weights were determined is not specifically stated. Gestational weight gain had a nonsignificant, partial correlation of 0.09 and a beta coefficient of 0.13. A case-control study (rated poor quality), using data abstracted from birth certificates, reported on 6,211 women from the state of Washington who had a gallstone-related diagnosis at delivery or in the first year postpartum between 1987 and 2001.⁶² Four controls were randomly selected for each case and matched for year of delivery. Multiple logistic regression found an inverse relationship between gestational weight gain and gallbladder disease. The OR per kg was. 0.98 (95% CI, 0.97-0.99; $P = < 0.001$). Maternal age, race, BMI based on self-reported pregravid weight, GDM, and infant gestational age were accounted for in the analysis.

Maternal Intrapartum Outcomes

Premature rupture of membranes (PROM).

Study characteristics. Investigators explored the relationship of gestational weight gain and the risks for premature rupture of membranes (PROM) in two studies (Evidence Table 6).^{64,65} One involved a total of 1,176 women who had experienced preterm delivery, defined as gestation ≤ 36 weeks, with PROM ($n = 220$), preterm delivery without PROM ($n = 184$), full-term delivery with PROM, defined as gestation ≥ 37 weeks, with at least 3 hours of PROM before the onset of labor, ($n = 184$), and 588 controls. Women were recruited following delivery at two academic medical centers in the United States.⁶⁴ In another study,⁶⁵ the investigators analyzed data for 62,167 women enrolled in the Danish National Birth Cohort who had pregravid weight and total weight gain recorded in the registry. They assessed the impact of obesity and gestational weight gain on the risk of various subtypes of preterm birth, including PROM. Pregravid weight and gestational gains were self-reported.

Overview of results. Two fair studies^{64,65} suggest that low weight gain (< 21 pounds) or low rate of weight gain (< 275 g per week) is associated with a higher risk of PROM for full-term pregnancies and preterm pregnancies.

Results for categorical measures of weight gain. A retrospective case-control study,⁶⁴ published in 1992, found that weight gain below the reference category of 21 pounds to 30 pounds significantly increased the risk of preterm delivery with PROM while weight gain above the reference category significantly reduced the risk of PROM. Similar trends were noted for full-term PROM. However, they were statistically significant only for gestational weight gain of 31 to 40 pounds when compared with women who gained 21 to 30 pounds (OR, 0.56; 95% CI,

0.33-0.94). Many potential confounders and effect modifiers were included in the analyses, including diet quality, BMI, age, race, parity, gestational iron supplementation, various medical conditions such as chlamydia that are considered risks for PROM, and smoking. The authors did not say if they adjusted for gestational age as a continuous variable. All variables, including pregravid weight and total weight gain, were assessed through a questionnaire administered to most of the subjects within 72 hours of giving birth.

Results for rate of weight gain. In the Danish cohort study, women with a weekly weight gain of less than 275 grams per week had an adjusted hazards ratio for PROM of 1.5 (95% CI, 1.2-1.7) compared with women gaining between 276 grams and 675 grams weekly. When compared with women with BMIs of 18.5 to 24.9, those with either low (< 18.5) or high (> 30) BMIs had significantly higher rates of preterm delivery with PROM. The authors adjusted for prepregnancy BMI, weight gain, parity, mother's age, socio-occupational status, and lifestyle exposures in early pregnancy including smoking and alcohol exposure.⁶⁵

Preterm labor.

Study characteristics. One poor study (Evidence Table 7) examined the relationship between gestational weight gain and preterm labor.⁶⁶ Preterm labor was not defined. This study, set in the United States, examined data from 11,505 women at the Boston Hospital for Women. The study defined gestational weight gain as pounds gained per week (≤ 0.4 , 0.41 to 0.65, 0.66 to 0.9, and > 0.9).

Overview of results. One poor study suggested that weight gain below 0.65 to 0.9 pounds per week significantly increased the risk of preterm labor.⁶⁶

Results. After controlling for an extensive list of confounders and effect modifiers (race, height, prepregnancy weight, infant sex, maternal age, education, health insurance, marital status, planned pregnancy, parity, previous induced or spontaneous abortion, previous stillbirth, uterine exposure to diethylstilbestrol, incompetent cervix, uterine anomaly, maternal morbidity, substance abuse, caffeine use, and prenatal care), the study found that weight below the reference range of 0.66 to 0.9 pounds per week significantly increased the risk of premature labor (AOR for 0.41-0.65 pounds per week: 1.7, 95% CI, 1.3-2.1; AOR for ≥ 0.4 pounds per week: 3.0; 95% CI, 2.2-4.2). Weight gain above 0.9 pounds per week did not have a significant effect on premature labor.

Postterm pregnancy. *Study characteristics.* One study⁵⁸ used data from 245,526 pregnancies identified through the Swedish Medical Birth Registry (Evidence Table 8).

Overview of results. One fair study found no evidence of association between gestational weight gain and postterm gestation.⁵⁸

Results. The author examined the effects of low (< 8 kg) and high weight gain (> 16 kg), compared with the effect of average weight gain (8-16 kg), on deliveries at > 41 weeks of gestation across strata of maternal pregravid BMI strata. After adjusting estimates for maternal age, parity, smoking in early pregnancy, and year of birth, no significant associations emerged between gestational weight gain and postterm gestational age. The study suggests that low or high gestational weight gain has no effect on postterm gestation.

Induction of labor.

Study characteristics. Five studies examined the relationship between gestational weight gain and labor induction (Table 6, Evidence Table 9) Of these, three were set in the United States,^{25,51,67} one in Denmark,⁵⁹ and one in Finland.⁶⁸ Of these five studies, three were of poor quality.^{51,59,68} Three examined induction of labor^{59,67,68} and two examined failed induction of labor (defined as a birth that required a cesarean delivery despite induction of labor).^{25,51} One of

five studies was limited to obese, glucose-tolerant women,⁶⁷ and one to women of normal weight;²⁵ the other studies included women with a range of pregravid BMI. Each of the five studies defined gestational weight gain differently. Three used categories of gestational weight gain, with different cutpoints.^{25,59,67} One stratified its sample by weight gain categories, comparing women with normal prepregnancy weight and weight gain during pregnancy with those with abnormal weight gain during pregnancy, defined as ≥ 20 kg or ≤ 5 kg during pregnancy; the study did not specify the prepregnancy weight status of women in these “abnormal” weight gain categories.⁶⁸ Another study characterized weight gain as change in BMI class between prepregnancy weight and weight at delivery.⁵¹ The study defined BMI categories as follows: normal, BMI 20 to 24.9; overweight, BMI 25 to 29.9; obese I, BMI 30 to 34.9; obese II, BMI 35 to 39.9; morbid obesity, BMI ≥ 40 .⁵¹

Table 6. Gestational weight gain and induction of labor

Author, Date	Country, Setting	Pregravid Weight (How Measured)	Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
DeVader et al., 2007 ²⁵	USA, birth certificate data	Pregravid weight: Medical record: If missing, obtained from mother during postpartum hospital stay	Total weight gain: Obstetrical records	G1: < 30 lbs G2: 30-35 lbs G3: > 35 lbs	AOR for failed induction of labor vs. other birth outcomes G1: 0.68 (95% CI, 0.59-0.78) G2: 1.0 G3: 1.51 (95% CI, 1.39-1.64)	Maternal age, maternal race or ethnicity, maternal education, Medicaid status, tobacco use, alcohol use, maternal height, prior pregnancy, adequacy of prenatal care, child's sex, and child's birth year
	94,696					
	Normal weight only					
	Fair					
Graves et al., 2006 ⁶⁷	USA, midwifery practices	Pregravid weight: Actual prepregnant weight or early first trimester weight documented in medical records	Total weight gain: Last prenatal assessment	≤ 45 pounds vs. > 45 pounds	OR induction of labor for > 45 lb: 1.5 (95% CI, 1.0-2.4)	Maternal BMI, infant birthweight, and gestational age at delivery
	1,500					
	All weights/BMI					
	Fair					
Ekblad and Grenman, 1992 ⁶⁸	Finland, hospital	Pregravid weight: Data from records, unclear if self-reported	Total weight gain: Last prenatal assessment	G1: weight gain ≤ 5 kg G2: weight gain ≥ 20 kg G3: reference (normal prepregnancy weight and normal weight gain [undefined])	Percentage induced G1: 23% G2: 43% G3: 24 $P < 0.05$ for G2 vs. G3	NA
	357					
	Normal weight only					
	Poor					

AOR, adjusted odds ratio; BMI, body mass index; G, group; GWG: gestational weight gain; OGTT, oral glucose tolerance test.

Table 6. Gestational weight gain and induction of labor (continued)

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Jensen et al., 2005 ⁵⁹ Denmark, university hospitals 481 Obese only Poor	Pregravid weight: Records or self- report of pregravid BMI Total weight gain: Last prenatal assessment	G1: < 5.0 kg G2: GWG 5.0-9.9 kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15 kg	OR for induction of labor G1: 1.0 G2: 2.7 (95% CI, 1.3-5.7) G3: 2.8 (95% CI, 1.3-5.9) G4: 3.7 (95% CI, 1.7-8.0) P for trend = 0.002	Age, pregravid BMI, 2 hour OGTT result, smoking, gestational age
Kabiru and Raynor, 2004 ⁵¹ USA, hospital 5,131 All BMIs > 20 Poor	Pregravid weight: Weight at first prenatal visit Total weight gain: Weight at admission for birth	G1: normal BMI, no change in BMI between first prenatal visit and delivery G2: normal BMI, 1 category increase in BMI between first prenatal visit and delivery G3: normal BMI, > 1 category increase in BMI between first prenatal visit and delivery G4: overweight BMI, no change in BMI between first prenatal visit and delivery G5: overweight BMI, 1 category increase in BMI between first prenatal visit and delivery G6: overweight BMI, > 1 category increase in BMI between first prenatal visit and delivery	Percent failed induction of labor G1: 4.7 G2: 9.2 G3: 15.9 P < 0.001 G4: 7.9 G5: 10.3 G6: 14.6 P < 0.001	NA

Overview of results. Two fair^{25,67} and three poor^{51,59,68} studies examined the association of increased gestational weight gain and labor induction^{59,67,68} or failure of labor induction,^{25,51} and found a risk of labor induction or failure of induction with increased gestational weight gain.

Results. The three studies that looked at induction of labor found a statistically significant increase in the risk of labor induction with increases in gestational weight gain.^{59,67,68} The magnitude of the effect across all three studies cannot be summarized because of differences in the definition of weight gain and in the nature of confounders controlled for in the analysis. Both studies examining failed induction of labor found a significant association between gestational weight gain and increase in the risk of failed induction compared with all other delivery routes.^{25,51}

Length of labor.

Study characteristics. Three cohort studies, set in Finland and the United States, examined the association between gestational weight gain and labor (Table 7, Evidence Table 10).⁶⁸⁻⁷⁰ Two studies focused on length of labor,^{68,69} one on labor abnormalities.⁷⁰ The definition of gestational weight gain differed across studies. One study examined an overall increase in weight of > 25 percent or ≤ 25 percent for women with normal pregravid weight (90-120 percent of normal weight for height based on Metropolitan Life Insurance Company Table for 1983).⁶⁹ Another reported on categories of gestational weight gain (< 16 pounds, 16-25 pounds, 26-35 pounds, and > 35 pounds) for pregravid BMI categories defined by the IOM.⁷⁰ The third study, of poor quality, stratified its sample by weight gain categories, comparing women with normal prepregnancy weight and weight gain during pregnancy with those with abnormal weight gain (≥ 20 kg, or ≤ 5 kg) during pregnancy; the study did not specify the prepregnancy weight status of women in these “abnormal” weight gain categories.⁶⁸

Table 7. Gestational weight gain and length of labor

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Johnson et al., 1992 ⁷⁰ USA, prenatal clinics 3,191 All weights/BMI Fair	Pregravid weight: Self-report collected at first antepartal visit Total weight gain: Last prenatal visit	G1: total weight gain < 16 pounds G2: total weight gain 16-25 pounds G3: total weight gain 26-35 pounds G4: total weight gain > 35 pounds	Elevated odds of labor abnormalities only in the group gaining > 35 pounds compared with women gaining < 16 pounds; not significant when adjusted for confounders Trend analysis showed risk of labor abnormalities with increased weight gain, a difference in 10 lb. corresponds to OR=2 (P< 0.0001) after adjusting for BMI, patient care (private vs. nonprivate), parity, infant sex, hypertension, and macrosomia	Prepregnancy weight quartile, height (tertile), BMI category, race/ethnicity, marital status, private physician, parity, infant sex, maternal age, hypertension, and birthweight
Purfield and Morin, 1994 ⁶⁹ USA, Tertiary care medical center 104 Normal weight women only Fair	Pregravid weight: Self-report as noted in medical chart Total weight gain: Weight at admission to hospital for birth	G1: prepregnant weight increased by 25% or less G2: prepregnant weight increased by more than 25%	Normal weight primigravidas with a low risk pregnancy who gained an excessive amount of weight had a longer mean length of second stage labor than women who gained less weight Minutes of length of second stage in minutes by weight groups (SD): G1: 72.42 (46.69) G2: 93.28 (52.87) t = -2.05 P = 0.02	NA

BMI, body mass index; G, group; SD, standard deviation.

Table 7. Gestational weight gain and length of labor (continued)

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Ekblad and Grenman, 1992 ⁶⁸ Finland, hospital 357 Normal weight only Poor	Pregravid weight: Data from records, unclear if self- reported Total weight gain: Last clinically measured weight prior to delivery	G1: weight gain ≤ 5 kg G2: weight gain ≥ 20 kg G3: reference (normal prepregnancy weight and normal weight gain [undefined])	Labor pattern - I stage (minutes± SD) G1: 333±208 G2: 374±208 G3: 346±188 Labor pattern - II stage (minutes) G1: 15±18) <i>P</i> < 0.05 compared to reference category G2: 27±25 G3: 21±18 Labor pattern - III stage (minutes) G1: 13±13 G2: 13±11 G3: 12±12	NA

Overview of results. Two of three studies (2 fair,^{69,70} 1 poor⁶⁸) suggested that higher weight gain among normal weight women of normal weight was associated with longer labor.^{68,69}

Results. The two studies that examined length of labor demonstrated significantly longer second stage of labor for women with high weight gain, based on samples of 357⁶⁸ and 104⁶⁹ respectively. Neither study controlled for confounders or effect modifiers.

The study that reported on labor abnormalities found higher odds of labor abnormalities for women gaining > 35 pounds compared with women gaining < 16 pounds. These odds lost statistical significance when adjusted for confounders. In a trend analysis, the study found a higher risk of labor abnormalities with increased weight gain, suggesting that a difference of 10 pounds corresponds to an OR of 2 (*P* < 0.0001) after adjusting for BMI, patient care (private vs. nonprivate), parity, infant sex, hypertension, and macrosomia.⁷⁰

Mode of delivery.

Study characteristics. Twenty-one cohort studies reported on the relationship between gestational weight gain and mode of delivery (Table 8, Evidence Table 11).^{4,25,49,51,52,54,58,59,61,67-78} Thirteen studies were set in the United States,^{4,25,51,54,67,69-71,73-77} three in Canada,^{49,53,72,78} two in Japan,^{52,61} one in Sweden,⁵⁸ one in Denmark,⁵⁹ and one in Finland.⁶⁸

Table 8. Gestational weight gain and mode of delivery

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Cedergren, 2006 ⁵⁸ Sweden, Medical Birth Registry 245,526 All weights/BMI Fair	Pregravid weight: Self-report; if unknown, standardized measurement is made during first visit to maternity health care center Total weight gain: Measured when woman entered delivery unit	Weight gain < 8 kg, 8- 16 kg, and > 16 kg for each BMI class below G1: BMI < 20 G2: BMI 20-24.9 G3: BMI 25-29.9 G4: BMI 30-34.9 G5: BMI ≥ 35	AOR for weight gain < 8 kg for cesarean section compared with weight gain 8-16 kg (95% CI) G1: 1.07 (0.89-1.29) G2: 0.98 (0.92-1.05) G3: 0.88 (0.82-0.95) G4: 0.81 (0.73-0.90) G5: 0.75 (0.66-0.87) AOR for weight gain > 16 kg for cesarean section compared with weight gain 8- 16 kg (95% CI) G1: 1.29 (1.17-1.43) G2: 1.24 (1.19-1.29) G3: 1.23 (1.17-1.30) G4: 1.22 (1.10-1.35) G5: 1.27 (1.05-1.52) AOR for weight gain < 8 kg for instrumental delivery compared with weight gain 8- 16 kg (95% CI) G1: 0.89 (0.71-1.11) G2: 0.88 (0.80-0.96) G3: 0.85 (0.76-0.95) G4: 0.75 (0.63-0.88) G5: 0.83 (0.65-1.03) AOR for weight gain > 16 kg for instrumental delivery compared with weight gain 8- 16 kg (95% CI) G1: 1.28 (1.15-1.43) G2: 1.19 (1.14-1.25) G3: 1.14 (1.06-1.23) G4: 1.09 (0.93-1.27) G5: 1.04 (0.77-1.40)	Maternal age, parity, smoking in early pregnancy, and year of birth
Chen et al., 2004 ⁷³ USA, private practice 3,355 All weights/BMI Fair	Pregravid weight: Weight taken at first prenatal visit if presented before 20 weeks; if after 20 weeks, self report Total weight gain: Last clinically measured weight prior to delivery	Gestational weight gain in lbs	Progression of AOR of cesarean delivery weight gain (for every 5 lbs): 1.094 (1.074- 1.115)	BMI, maternal height, maternal age, pregnancy weight gain, gestational age at delivery, and fetal birthweight

AOR, adjusted odds ratio; BMI, body mass index; G, group; GDM, gestational diabetes mellitus; kg, kilogram; lbs, pounds; LGA, large-for-gestational-age; SGA, small-for-gestational-age.

Table 8. Gestational weight gain and mode of delivery (continued)

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
DeVader et al., 2007 ²⁵ USA, birth certificate data 94,696 Normal weight only Fair	Pregravid weight: Medical record; if missing, obtained from mother during postpartum hospital stay Total weight gain: Obstetrical records	G1: < 30 lbs G2: 30-35 lbs G3: > 35 lbs	AOR for cesarean (95% CI): G1: 0.82 (0.78-0.87) G2: 1.0 G3: 1.35 (1.29-1.40) AOR for instrumental (95% CI): G1: 0.97 (0.90-1.04) G2: 1.0 G3: 1.03 (0.97-1.08)	Maternal age, maternal race or ethnicity, maternal education, Medicaid status, tobacco use, alcohol use, maternal height, prior pregnancy, adequacy of prenatal care, child's sex, and child's birth year
Graves et al., 2006 ⁶⁷ USA, midwifery practices 1,500 All weights/BMI Fair	Pregravid weight: Actual prepregnant weight or early first trimester weight documented in medical records Total weight gain: Last prenatal assessment	≤ 45 lbs vs. > 45 lbs	Greater weight gain in pregnancy was not associated significantly with route of delivery	Prepregnancy BMI category, total prenatal weight gain category, induction of labor, newborn birthweight ≥ 4,000 g, gestational age > 41 weeks, and race/ethnicity
Jain et al. 2007 ⁷⁷ USA, birth certificate records and Pregnancy Risk Assessment Monitoring System 7,661 All weights/BMI Fair	Pregravid weight: Not stated Total weight gain: Birth certificate	G1: WG ≤ 15 lbs G2: WG 15-24 lbs G3: WG 25-35 lbs G4: WG ≥ 35 lbs	AOR for primiparous cesarean delivery (from model including interaction term for overweight/obese + > 25 lbs weight gain) G1: 0.95 (0.59-1.52) G2: 1.0 (ref) G3: 1.10 (0.76-1.60) G4: 1.62 (1.10-2.39) AOR for multiparous cesarean delivery (from model including interaction term for overweight/obese + > 25 lbs weight gain) G1: 1.11 (0.60-2.04) G2: 1.0 (ref) G3: 1.08 (0.63-1.85) G4: 1.95 (1.02-3.72)	Maternal age, pregravid BMI, parity, education, race/ethnicity, US/foreign origin, interaction terms for pregravid BMI and weight gain
Johnson et al., 1992 ⁷⁰ USA, prenatal clinics 3,191 All weights/BMI Fair	Pregravid weight: Self report collected at first antepartal visit Total weight gain: Last prenatal visit	G1: total weight gain < 16 lbs G2: total weight gain 16-25 lbs G3: total weight gain 26-35 lbs G4: total weight gain > 35 lbs	AOR for unscheduled cesarean (95% CI) G1: 1.0 G2: 0.95 (0.6-1.5) G3: 1.3 (0.86-1.95) G4: 1.95 (1.32- 2.87)	Prepregnancy weight quartile, height (tertile), BMI category, private physician (yes/no), maternal age, parity, birthweight, diabetes, hypertension, and maternal education

Table 8. Gestational weight gain and mode of delivery (continued)

Author, Date	Country, Setting	Sample Size	Baseline BMI	Quality	Pregravid Weight (How Measured)	Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Joseph et al., 2003 ⁷²	Nova Scotia	Atlee Perinatal Database	100,259	All weights/BMI	Pregravid weight: Data taken from standardized forms and hospital medical records - no mention of self report	Total weight gain: Not explained by authors - data taken from maternity records	G1: < 5 kg G2: 5-9 kg G3: 10-14 kg G4: 15-19 kg G5: ≥ 20 kg	AOR for cesarean delivery (95% CI) G1: 1.10 (1.00-1.20) G2: 1.04 (0.99-1.10) G3: 1.00 G4: 1.09 (1.05-1.14) G5: 1.41 (1.35,-1.47)	Age, parity, prepregnancy weight, smoking, pregnancy (singleton or multiple), hypertension, diabetes, previous fetal death, induction, epidural, physician type, time
Kiel et al., 2007 ⁴	USA	birth registry	120,170	Obese women only	Pregravid weight: Self report from data on birth certificate Total weight gain: Abstracted from medical chart	All obese women G1: Loss 10 lbs or more G1: Loss 2-9 lbs G1: No change G1: Gain 2-9 lbs G1: Gain 10-14 lbs G1: Gain 15-25 lbs G1: Gain 25-35 lbs	Compared with women who gained 15-25 lbs during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births Magnitude differed by obesity classification, even after adjusting for known or suspected confounders	Age, race, parity, education, poverty (enrollment in Medicaid, WIC, food stamp programs), tobacco use, chronic hypertension	
Murakami et al., 2005 ⁵²	Japan	hospital	633	All weights/BMI	Pregravid weight: Self report at first visit to clinic Total weight gain: Based on last clinically measured weight prior to delivery	G1: < 8.5 kg G2: 8.5-12.5 kg G3: > 12.5 kg	AOR for cesarean delivery (95% CI) G1: 1.08 (0.56-2.07) G2: 1.00 G3: 1.23 (0.61-2.48)	Maternal age, parity, smoking, prepregnancy BMI, and gestational age (weeks)	

Table 8. Gestational weight gain and mode of delivery (continued)

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Purfield and Morin, 1995 ⁶⁹ USA, Tertiary care medical center 104 Normal weight women only Fair	Pregravid weight: Self report as noted in medical chart Total weight gain: Weight at admission to hospital for birth	G1: prepregnant weight increased by 25% or less G2: prepregnant weight increased by more than 25%	Higher rate of vacuum extraction and cesarean delivery and lower rate of spontaneous vaginal delivery with excessive weight gain No difference in forceps delivery and vaginal delivery by weight gain status Vaginal delivery G1: n = 27 G2: n = 9 Vacuum extraction G1: n = 14 G2: n = 25 low forceps G1: n = 8 G2: n = 8 Cesarean section G1: n = 3 G2: n = 10 $\chi^2 = 15.87, P = 0.001$ for all 4 modes of delivery by weight groups	NA
Rosenberg et al., 2005 ⁷¹ USA, vital statistics data 329,988 All weights/ no BMI Fair	Pregravid weight: Self report on birth certificate Total weight gain: Weight data on birth file	< 41 vs. \geq 41 pounds	AOR for primary cesarean (95% CI): 1.38 (1.34-1.41)	Age, parity, GDM, pregnancy-induced hypertension, preeclampsia, prepregnancy weight, chronic diabetes, chronic hypertension, marital status, maternal education, mother's birthplace, prenatal care payer, social risk, trimester prenatal care began

Table 8. Gestational weight gain and mode of delivery (continued)

Author, Date	Country, Setting	Sample Size	Baseline BMI	Quality	Pregravid Weight (How Measured)	Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Shepard et al., 1998 ⁷⁵	USA, obstetrical practices	2,301	All weights/BMI	Fair	Pregravid weight: Self report before 15 weeks of gestation	Total weight gain: Self report of weight at delivery	Proportional weight gain (total weight gain/ prepregnancy weight) and absolute weight gain	G1: Proportional Gain: Adjusted Relative Risk (95% CI) G2: Absolute Gain: Adjusted RR (95% CI) Underweight (< 19.4), ≤ median G1: 1.00 G2: 1.00 Underweight (< 19.4), > median G1: 2.08 (0.86-5.04) G2: 1.20 (0.56-2.59) Low-Average (19.5-22.4), ≤ median G1: 1.62 (0.90-3.67) G2: 1.00 (0.54-1.84) Low-Average (19.5-22.4), > median G1: 2.35 (1.06-5.21) G2: 1.62 (0.94-3.02) High-Average (22.5-28.4), ≤ median G1: 2.78 (1.26-6.12) G2: 1.80 (1.01-3.21) High-Average (22.5-28.4), > median G1: 3.06 (1.40-6.73) G2: 2.02 (1.14-3.57) Obese (> 28.5), ≤ median G1: 3.25 (1.40-7.54) G2: 2.13 (1.12-4.08) Obese (> 28.5), > median G1: 2.69 (1.18-6.16) G2: 1.65 (0.90-3.03)	Preeclampsia, gestational diabetes, placental problems, fetal distress, macrosomia, induction, maternal age and height, parity, ethnicity, and marital status

Table 8. Gestational weight gain and mode of delivery (continued)

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Sherrard et al., 2007 ⁷⁸ Canada, hospital database 63,390 All BMIs Fair	Pregravid weight: Self report Total weight gain: Self report or measured	Rate of weight gain (kg/wk) G1: Low (≤ 0.17) G2: Normal (0.18- 0.50) G3: High (> 0.50)	AOR for unlabored cesarean, primary G1: 0.79 (0.59-1.05) G2: 1.00 (ref) G3: 1.03 (0.64-1.64) AOR for labored cesarean, primary G1: 0.77 (0.68-0.86) G2: 1.00 (ref) G3: 1.40 (1.23-1.60) AOR for unlabored cesarean, repeat G1: 0.91 (0.76-1.09) G2: 1.00 (ref) G3: 1.38 (1.04-1.83) AOR for labored cesarean, repeat G1: 0.79 (0.54-1.15) G2: 1.00 (ref) G3: 1.22 (0.72-2.09)	BMI, gestational diabetes, pregnancy-induced hypertension, macrosomia, socioeconomic factors, parity, and maternal age
Witter et al., 1995 ⁷⁶ USA, obstetric database at major medical center 4,346 All weights/BMI Fair	Pregravid weight: Self report, unclear at what timepoint Total weight gain: Weight recorded at last prenatal visit	Pregnancy weight gain (kg)	AOR for cesarean (95% CI): 1.04 (1.02-1.05)	Age, pregravid BMI, height, at least one previous viable pregnancy, diagnosis of preeclampsia during the current pregnancy, previous cesarean delivery
Bianco et al., 1998 ⁵⁴ USA, major medical center 11,926 BMI OF 27 and 34 are excluded from analysis Poor	Pregravid weight: Unclear Total weight gain: Weight from before 36 weeks gestation or not within 4 weeks of delivery Maternal weight gain outcomes by BMI presented for morbidly obese women only, N: 613	G1: 0 or weight loss G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs	Cesarean % G1: 25.8% G2: 26.8% G3: 28.8% G4: 35.0% G5: 33.8% ($P = NS$)	NA

Table 8. Gestational weight gain and mode of delivery (continued)

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Brennand et al., 2005 ⁴⁹ Canada, medical records 603 All weights/BMI Poor	Pregravid weight: Routine prenatal care medical records, measured within 14 weeks of gestation Total weight gain: Based on last clinically measured weight prior to delivery: within 4 weeks of birth Primigravid women (maternal weight gain outcomes by BMI presented only for obese women)	Primigravid women (maternal weight gain outcomes by BMI presented only for obese women) G1: Obese - low weight gain (< 7 kg) G2: Obese - acceptable weight gain (7-11.5 kg) G3: Obese - excessive weight gain (> 11.5 kg) G4: Total	Cesarean section (%) G1: 25.3 G2: 23.5 G3: 23.7 $\chi^2 P = 0.952$ G4: 24.1	NA
Ekblad and Grenman, 1992 ⁶⁸ Finland, hospital 357 Normal weight only Poor	Pregravid weight: Data from records, unclear if self reported Total weight gain: Routine prenatal care or maternity records based on last clinically measured weight prior to delivery	G1: weight gain \leq 5 kg G2: weight gain \geq 20 kg G3: reference (normal pregnancy weight and normal weight gain [undefined])	Normal vaginal delivery (%) G1: 90 $P < 0.05$ compared to reference category G2: 64 G3: 71 Forceps or vacuum delivery (%) G1: 3 G2: 13 G3: 5 Breech (%) G1: 1 G2: 0 G3: 2 Cesarean section - elective% G1: 3 G2: 5 G3: 13 Cesarean section - emergency% G1: 3 G2: 18 G3: 9	NA

Table 8. Gestational weight gain and mode of delivery (continued)

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Jensen et al., 2005 ⁵⁹ Denmark, university hospitals 481 Obese only Poor	Pregravid weight: Records or self report of pregravid BMI Total weight gain: Last prenatal assessment	G1: GWG 5.0-9.9 kg G2: GWG 10.0-14.9 kg G3: GWG ≥ 15 kg	OR for cesarean delivery (95% CI) G1: 1.0 G2: 2.4 (1.1-5.3) G3: 3.0 (1.4-6.4) G4: 3.6 (1.6-7.8) P for trend=0.002	2-h OGTT result, maternal age, prepregnancy BMI, gestational age (continuous variables), parity, smoking, ethnic background, and clinical center (categorical variables)
Kabiru and Raynor, 2004 ⁵¹ USA, hospital 5,131 All BM's > 20l Poor	Pregravid weight: First prenatal visit Total weight gain: Weight at admission for birth	Primary cesarean G1: normal BMI, no change in BMI between first prenatal visit and delivery G2: normal BMI, 1 category increase in BMI between first prenatal visit and delivery G3: normal BMI, > 1 category increase in BMI between first prenatal visit and delivery G4: overweight BMI, no change in BMI between first prenatal visit and delivery G5: overweight BMI, 1 category increase in BMI between first prenatal visit and delivery G6: overweight BMI, > 1 category increase in BMI between first prenatal visit and delivery	Operative vaginal delivery G1: 11.4 G2: 12.4 G3: 12.2 P = 0.837 G4: 8.4 G5: 11.4 G6: 17.3 P < 0.001 Cesarean delivery rate for failure to progress G1: 2.5 G2: 6.5 G3: 10.2 P = 0.203 G4: 3.5 G5: 6.9 G6: 10.2 P = 0.002	Pregravid BMI, none other

Table 8. Gestational weight gain and mode of delivery (continued)

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Wataba et al., 2006 ⁶¹ Japan, academic medical center 21,718 All weights/BMI Poor	Pregravid weight: Unreported Total weight gain: From hospital database/ register	Rate of weight gain, categorized differently across different BMI groups	For nulliparous, low BMI women: Higher risk of cesarean delivery for women with weight gain ≥ 0.4 kg/week (AOR: 2.30 [95% CI, 1.06-4.98] compared with women gaining 0.25-0.3 kg/week) For nulliparous, medium BMI women: Higher risk of cesarean delivery for women with weight gain ≥ 0.4 kg/week (AOR: 1.61 [95% CI, 1.21-2.14] compared with women gaining 0.25-0.3 kg/week) and for women with weight gain 0.35-0.4 kg/week (AOR: 1.68 [95% CI, 1.22- 2.30] compared with women gaining 0.25-0.3 kg/week) For nulliparous, high BMI women: No increased risk For parous, medium BMI women: Higher risk of cesarean delivery for women with weight gain 0.25-0.3 kg/week (AOR: 1.49 [95% CI, 1.09-2.04] compared with women gaining 0.20-0.25 kg/week) No data presented on cesarean delivery for other BMI groups for parous women	Parity, baseline BMI
Young et al., 2002 ⁷⁴ USA, private practice 3,375 All weights/BMI Poor	Pregravid weight: Self reported Total weight gain: Based on last clinically measured weight prior to delivery	G1: < 30 lbs G2: 30-35 lbs G3: > 35 lbs	Increase in overall cesarean delivery rate with increased weight gain was significant at all BMI levels	BMI

All 21 studies examined cesarean delivery as an outcome. Five examined instrumental delivery in addition to cesarean delivery.^{25,51,58,68,69} Eight studies reported on cesarean delivery without providing further definition.^{4,25,49,54,58,59,74,76} The studies that offered some detail varied

in their definition; these studies defined cesarean delivery as failure to progress,⁵¹ unscheduled cesarean,^{67,70} cesarean including elective and emergency,⁵² elective cesarean and emergency cesarean,^{61,68} cephalopelvic disproportion/failure to progress, fetal distress, breech, and other indications,⁷³ cesarean delivery for cephalic presentation,⁷⁷ and cesarean delivery for singleton cephalic presentation separately analyzed for primary and repeat cesareans, with and without labor.⁷⁸ A key consideration in assessing the risk of cesarean delivery is the route of previous delivery; with the declining prevalence of vaginal birth after cesarean (VBAC), a history of prior cesarean delivery is likely to result in cesareans for all subsequent pregnancies. Studies that fail to account for prior route of delivery cannot therefore control for its confounding effect. Eleven studies did not take into account prior route of delivery.^{4,25,49,52,54,58,59,61,67,68,70}

Definitions of gestational weight gain also varied greatly. Some studies used categorical definitions designed to identify high weight gain alone,^{67,71} weight gain across a spectrum of gain,^{4,25,49,52,54,58,59,70,72,74,77} continuous weight gain,^{73,76} rate of weight gain,^{61,78} and weight gain in relation to pregravid weight.^{51,68,69,75}

Overview of results. Across the 14 fair^{4,25,52,58,67,69-73,75-78} and 7 poor^{49,51,54,59,61,68,74} studies that examined gestational weight gain as a predictor of route of delivery, only four (2 poor) failed to show an effect of gestational weight gain on route of delivery.^{49,52,54,67} The remainder demonstrated higher risks of cesarean delivery associated with gestational weight gain, with some evidence suggesting more pronounced risks associated with high pregravid BMI status. Notably, only 10 studies controlled for route of previous delivery. Of these, five controlled for co-morbidities that could have been significant confounders for route of delivery.^{71,72,75,76,78} One study explicitly examined the interactions between weight gain and pregravid weight; it did not find any significant effect.⁷⁷

Results across BMI categories for categorical measures of weight gain. Fifteen studies considered weight gain across a range of pregravid weight categories. Of these, two fair studies defined gestational weight gain as a categorical variable (≤ 45 pounds vs. > 45 pounds,⁶⁷ and < 41 vs. ≥ 41 pounds⁷¹). One of these two studies, limited to primary cesarean, found a significant association between weight gain and cesarean delivery (AOR, 1.38; 95% CI, 1.34-1.41).⁷¹ This study found pregravid BMI, diabetes, and hypertension to also be strong predictors of cesarean delivery. The other, which did not control for route of previous delivery, did not find any association between gestational weight gain and route of delivery.⁶⁷

Six studies defined gestational weight gain in categories that allowed for the identification of both low and high weight gain, across a spectrum of pregravid weight categories;^{52,58,70,72,74} of these, one was rated poor quality⁷⁴ and the remainder fair. One study showed no difference in cesarean delivery by weight gain category.⁵² All others showed some patterns of association with higher levels of weight gain, although the magnitude of the effect varied.^{58,70,72,74} Three studies found similar thresholds for the rise in risk of cesarean delivery, namely, weight gains in excess of 15 kg⁷² or greater than 35 pounds.^{70,77} One study looked at both relatively low weight gain (< 8 kg) and relatively high weight gain (> 16 kg) in comparison with weight gain of 8 to 16 kg.⁵⁸ The study found no statistically significant risk of cesarean delivery for low or normal BMI categories but significantly higher risk with higher weight gain for overweight, obese, and morbidly obese women.⁵⁸ One study examined the effects of pregravid weight, gestational weight gain, and the interaction between the two as predictors of cesarean delivery for primiparous and multiparous women (defined in two different ways). The study found that pregravid overweight or obese status as well as weight gain over 35 pounds are associated with the risk of cesarean delivery for primiparous women, but no significant effect of the interaction

between weight gain and pregravid weight. The study did not find consistently significant effects of these variables on cesarean delivery for multiparous women; the previous route of delivery, a likely confounder, was not controlled in these analyses.

Results across BMI categories for rate of weight gain. Two studies, one rated fair⁷⁸ and the other poor,⁶¹ examined the rate of weight gain across a range of pregravid weight categories. The fair study separately examined the risks of primary and repeat cesarean, with and without labor in models that accounted for gestational diabetes, pregnancy-induced hypertension, macrosomia, socioeconomic factors, parity, or maternal age. The study found that a high rate of weight gain (> 0.5 kg/week) significantly increased the risk of a labored primary cesarean, while a low rate of weight gain (\leq 0.17 kg/week) significantly reduced the risk, compared with an average rate of weight gain (0.18-0.50 kg/week). High rate of weight gain significantly increased the risk of unlabored repeat cesareans. The rate of weight gain during pregnancy did not predict the risk of primary unlabored cesarean or repeat labored cesarean. In contrast, pregravid overweight and obese status was a significant risk factor for all types of cesarean delivery. The poor study examined associations between cesarean delivery and rates of weekly weight gain (seven categories), categorized differently across different BMI groups (three groups) and parity (two categories), resulting in 42 comparisons.⁶¹ As with the fair study, a subset of results were significant, suggesting that for nulliparous women with low or medium BMI, high rates of weight gain increased the risks of cesarean delivery. Specifically, the study found:

- among nulliparous, low-BMI women, a higher risk of elective cesarean delivery for women with weight gain \geq 0.4 kg per week (AOR: 2.30 [1.06-4.98]) than for women gaining between 0.25 and 0.3 kg per week.
- among nulliparous, medium-BMI women, a higher risk of elective cesarean delivery
 - for women with weight gain \geq 0.4 kg per week (AOR: 1.61 [1.21-2.14]) than for women gaining 0.25 to 0.3 kg per week and
 - for women with weight gain of 0.35 to 0.4 kg per week (AOR: 1.68 [1.22-2.30]) than for women gaining 0.25-0.3 kg per week.

The study examined risk of emergency (rather than elective) cesarean for high BMI nulliparous women and failed to find an association with gestational weight gain rates.

In examining outcomes for parous women, with a single exception—a higher risk of cesarean delivery for women with weight gain 0.25-0.3 kg/wk (AOR, 1.49 [1.09-2.04]) than for women gaining 0.20 to 0.25 kg/week—the poor study did not find statistically significant effects for rate of weight gain on cesarean delivery for parous, medium-BMI women. No data were presented on cesarean delivery (emergency or elective) for low or high BMI groups for parous women.

Results across BMI categories for continuous measures of weight gain. Of the 15 studies that considered a range of pregravid weight categories, two fair studies modeled gestational weight gain as a continuous variable.^{73,76} Both found significantly higher risks of cesarean delivery with increasing weight. One study identified the progression of AOR of cesarean delivery weight gain for every 5 pounds of gestational weight gain to be 1.094 (95% CI, 1.074-1.115).⁷³ The second study calculated the attributable risk for cesarean delivery of gaining more than 16 kg to be 6.9 percent.⁷⁶ Both studies account for route of previous delivery.

Results across BMI categories for other measures of weight gain. Of these same 15 studies, three (1 fair,⁷⁵ and 2 poor^{51,53,68}) defined gestational weight gain as a function of pregravid weight.^{51,68,75} Two of three studies controlled for previous route of delivery by limiting their

sample to primary cesareans. The fair study used underweight women who gained less than the median for proportional weight gain (total weight gain/prepregnancy weight) as the referent.⁷⁵ This study found higher risks of cesarean delivery for all other categories, although risks were statistically significant only for women in the high and obese BMI category in all weight gain categories and women in the average BMI category who gained less than the median proportional weight gain. One poor-quality study characterized weight gain as change in BMI class between prepregnancy weight and at delivery. BMI categories were defined as follows: normal, BMI 20 to 24.9; overweight, BMI 25 to 29.9; obese I, BMI 30 to 34.9; obese II, BMI 35 to 39.9; morbid obesity, BMI \geq 40.⁵¹ This study found no statistically significant association between weight gain and cesarean delivery among normal-BMI women but did find a positive association for high-BMI women. The extent to which these results corroborate findings from the fair study is hard to determine given the differences in the reference category, but both studies imply that increased risks of cesarean are pronounced among overweight and obese women. A third study, also of poor quality, examined differences in route of delivery between women with normal prepregnancy weight and weight gain during pregnancy with those with abnormal weight gain (\geq 20 kg or \leq 5 kg) during pregnancy; the study did not specify the prepregnancy weight status of women in these “abnormal” weight gain categories.⁶⁸ Unlike the other two studies in this category, the rates for cesarean delivery were not statistically significantly different across groups. The study did find a statistically significant higher rate of normal vaginal delivery for low weight gain women compared with the reference category of normal prepregnancy weight and weight gain. Notably, this study did not control for route of previous delivery.

Results within BMI categories for other measures of weight gain. Two studies were limited to women of normal BMI.^{25,69} Both suggested an increase in the risk of cesarean delivery with increasing weight gain, defined in one study as 25 percent gain over prepregnancy weight,⁶⁹ and in the other as a weight gain > 35 pounds as compared with a weight gain of 30 to 35 pounds. Weight gain of < 30 pounds was associated with a lower risk of cesarean delivery, suggesting a linear increase in the risk of cesarean delivery with weight gain for women of normal weight. One of the two studies controlled for previous cesarean delivery by limiting its sample to primigravidas.⁶⁹

Four studies limited their analysis to obese women or morbidly obese women.^{4,49,54,59} Of these, two studies (both rated poor quality) suggested no difference in cesarean delivery outcomes by gestational weight gain.^{49,54} Neither accounted for route of previous delivery.

The other two studies suggested that the risk of cesarean delivery increased with higher levels of weight gain for obese and morbidly obese women.^{4,59} One poor study suggested that risk increases with higher levels of weight gain.⁵⁹ Compared with the risk of cesarean delivery for women gaining < 5 kg, the results were as follows: AOR of cesarean delivery for women gaining 5 to 9.9 kg, 2.4 (95% CI, 1.1-5.3); AOR for women gaining 10 to 14.9 kg, 3.0 (95% CI, 1.4-6.4); and AOR for women gaining \geq 15 kg, 3.6 (95% CI, 1.6-7.8).⁵⁹ The other study suggested that women who had lower weight gain than women who gained 15 to 25 pounds had lower risks of cesarean delivery, but the magnitude of the association varied by obesity classification.⁴ Overall, across a range of outcomes the study suggested that minimal risk may correspond to a weight gain of 10 to 25 pounds for class I obese women (BMI 30-34.9), a weight gain of 0 to 9 pounds for class II obese women (BMI 35-39.9), and a weight loss of 0 to 9 pounds for class III obese women (BMI > 40). Neither of these studies controlled for route of previous delivery.

Results for instrumental delivery. Five studies examined instrumental delivery in addition to cesarean delivery.^{25,51,58,68,69} Two found no association.^{25,68} Of the remaining studies, one found a higher risk of instrumental delivery with increased weight gain only for normal BMI and overweight women,⁵⁸ and a second found this only for overweight women.⁵¹ A third study, limited to women of normal weight, examined differences in the rate of vacuum extraction and forceps delivery by amount of weight gain; it found a higher rate of vacuum extraction with excessive weight gain but no difference in rate of forceps delivery.⁶⁹

Results controlling for confounding. Studies varied in their adjustment for confounding factors. Seven studies controlled for route of previous delivery by limiting their sample to primary cesarean^{51,71,72,75} or primigravidas.^{69,73,74} Three studies included multigravidas but accounted for previous cesarean delivery in the analysis.⁷⁶⁻⁷⁸ The remaining 11 studies did not control for route of previous delivery.^{4,25,49,52,54,58,59,61,67,68,70}

Of the 10 studies that controlled for route of previous delivery, five studies examined underlying health risks (e.g., preeclampsia, pregnancy-induced hypertension) as predictors of cesarean delivery; all five found these health factors to be significantly associated with risks of cesarean delivery.^{71,72,75,76,78}

Vaginal birth after cesarean.

Study characteristics. One US cohort study (rated poor quality) examined the effect of weight gain on the success of vaginal birth after cesarean (VBAC) (Evidence Table 12).⁷⁹

Overview of results. A single poor study found that gestational weight gain of 40 pounds or more increased the risk of VBAC failure.

Results. Women who gained more than 40 pounds during pregnancy were less likely to have VBAC success than women who gained 40 pounds or less (OR, 0.65; 95% CI, 0.42-0.98). This study controlled for previous normal spontaneous vaginal delivery, previous VBAC, diabetes, induction, birthweight > 4,000 g, recurrent indication, one layer closure, pregnancy complications, and BMI, but it failed to account for age or parity. The study suggested that pregravid BMI was also a predictor of VBAC success, with lower pregravid BMI being predictive of success.

Vaginal lacerations.

Study characteristics. Two cohort studies examined vaginal lacerations (Evidence Table 13).^{51,68} One US study (rated poor quality) examined the incidence of third- or fourth-degree lacerations among women.⁵¹ Weight gain was characterized as change in BMI class between prepregnancy weight and weight at delivery. BMI categories were defined as follows: normal, BMI 20 to 24.9; overweight, BMI 25 to 29.9; obese I, BMI 30 to 34.9; obese II, BMI 35 to 39.9; morbid obesity, BMI \geq 40. The second study (described earlier, also rated poor quality) was set in Finland.⁶⁸ It examined the rate of vaginal repairs for women with normal prepregnancy weight and weight gain during pregnancy and for those with abnormal weight gain (\geq 20 kg, or \leq 5 kg) during pregnancy.⁶⁸

Overview of results. Two studies, both of poor quality, did not report consistent results on the effects of gestational weight gain on vaginal lacerations.

Results. The US study found no differences in the incidence of third- and fourth-degree lacerations among women who were overweight before pregnancy.⁵¹ It did find a statistically significant difference among normal weight women; the incidence of lacerations rose from 24 percent for women with no change in BMI category to 29.3 percent for women gaining enough to change weight status by one BMI category and to 31.7 percent for women who gained enough to change weight status by more than one BMI category. The Finnish study found no statistical

differences between study and control mothers in the rate of repair of second- or third-degree lacerations.⁶⁸ Neither study controlled for any variable other than pregravid BMI.

Shoulder dystocia.

Study characteristics. Three studies, set in Ireland,⁸⁰ the United States,⁵¹ and Finland,⁶⁸ examined the effect of gestational weight gain on shoulder dystocia (Table 9, Evidence Table 14). The Irish study, a case-control investigation (rated poor) comparing cesarean delivery for shoulder dystocia with cephalic vaginal term deliveries, distinguished between two groups of gestational weight gain (< 12 kg and ≥ 12 kg).⁸⁰ The Finnish study (described earlier and rated poor quality), stratified its sample by weight gain categories, comparing women with normal prepregnancy weight and weight gain during pregnancy with those with abnormal weight gain (≥ 20 kg or ≤ 5 kg) during pregnancy.⁶⁸ The US case-control study (also rated poor quality), stratified its sample between normal and overweight BMI categories and examined the effect of change in BMI class between prepregnancy weight and weight at delivery. The Irish study defined shoulder dystocia to include mild, moderate, and severe cases;⁸⁰ the other two studies did not define their outcome variable.^{51,68}

Table 9. Gestational weight gain and shoulder dystocia

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Ekblad and Grenman, 1992 ⁶⁸	Pregravid weight: Data from records, unclear if self reported	G1: weight gain ≤ 5 kg G2: weight gain ≥ 20 kg G3: reference (normal pregnancy weight and normal weight gain [undefined])	Shoulder dystocia% G1: 3 G2: 2 G3: 0.6	NA
Finland, hospital 357	Total weight gain: Last clinically measured weight prior to delivery			
Normal weight only				
Poor				
Geary et al., 1995 ⁸⁰ Ireland, hospital 363	Pregravid weight: First prenatal visit Total weight gain: Not described	Weight gain < 12 kg and ≥ 12 kg for cases shoulder dystocia and controls G1: Cases with shoulder dystocia G2: Controls	Maternal weight gain < 12 kg G1: 59.1% G2: 74.1% OR 2.0 (1.6-2.2)	Parity Previous birth ≥ 4,000 g
All weights/BMI				
Poor				

BMI, body mass index; g, gram; G, group; kg, kilogram; N, number; OR, odds ratio.

Table 9. Gestational weight gain and shoulder dystocia (continued)

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Kabiru and Raynor, 2004 ⁵¹ USA, hospital 5,131 All weights/BMI Poor	Pregravid weight: First prenatal visit Total weight gain: Weight at admission for birth	G1: normal BMI, no change in BMI between first prenatal visit and delivery G2: normal BMI, 1 category increase in BMI between first prenatal visit and delivery G3: normal BMI, > 1 category increase in BMI between first prenatal visit and delivery G4: overweight BMI, no change in BMI between first prenatal visit and delivery G5: overweight BMI, 1 category increase in BMI between first prenatal visit and delivery G6: overweight BMI, > 1 category increase in BMI between first prenatal visit and delivery	Shoulder dystocia% G1: 0.5 G2: 1.4 G3: 1.1 <i>P</i> = 0.278 for associations within normal BMI categories G4: 1.0 G5: 1.8 G6: 1.9 <i>P</i> = 0.357 for associations within overweight BMI categories	NA

Overview of results. Only one⁸⁰ of three poor studies found a positive association between gestational weight gain and shoulder dystocia.

Results. The three studies found rates of shoulder dystocia ranging from 0.6 percent to 1.4 percent.^{51,68,80} Two studies reported no statistically significant differences in rates of shoulder dystocia between weight gain groups.^{51,68} The Irish case-control investigation found that higher gestational weight gain during pregnancy was a significant predictor of shoulder dystocia (OR, 2.0; 95% CI, 1.6-2.2; *P* = 0.015). The authors calculated positive predictive value percentages from the study group and applied them to the total hospital population of singleton vaginal deliveries without shoulder dystocia over the same time period. These results suggest a positive predictive value of 1 percent for shoulder dystocia when gestational weight gain is 12 kg or greater.

The Irish study accounted for a subset of confounders and effect modifiers other than pregravid BMI.⁸⁰ Multiparity and birth of a previous heavy baby were significant and independent determinants for shoulder dystocia, in addition to gestational weight gain. However, the investigators noted that each predictor individually accounted for less than 2 percent of the positive predictive value for shoulder dystocia, and all three put together accounted for less than 3 percent.

Cephalopelvic disproportion.

Study characteristics. Two US cohort studies examined the association between gestational weight gain and cephalopelvic disproportion (CPD) (Evidence Table 15).^{25,74} One study, using Missouri birth certificate data, defined CPD as the condition when the size, presentation, or

position of the fetal head to the maternal pelvis prevented cervical dilation or descent of the fetal head.²⁵ This study controlled for a range of demographic confounders but not for maternal health characteristics.²⁵ The other study (rated poor quality) defined CPD among primiparous women as little or no progress over a 2- to 4-hour period, with contractions documented to be adequate and cervix dilated to at least 3 cm or preferably 4 cm. However, if the delivering physician defined the indication as CPD, the decision was accepted without chart review, despite the definitions listed earlier.⁷⁴

Both studies defined weight gain in categories: < 30 pounds, 30 to 35 pounds, and > 35 pounds. The study using birth certificate data limited inclusion to normal weight women (pregravid BMI 19.8-26.0);²⁵ the other study examined the association between gestational weight gain and CPD across four pregravid BMI categories: < 20, 20 to 25, 25 to 30, and > 30.

Overview of results. Both studies (1 fair²⁵ and 1 poor⁷⁴) showed that, for normal-weight women, the risk of CPD rose with higher gestational weight gain

Results. The fair study reported an AOR of 1.58 (95% CI, 1.44-1.75) for women gaining > 35 pounds compared with women gaining 25 to 30 pounds, after adjusting for maternal age, maternal race or ethnicity, maternal education, Medicaid status, tobacco use, alcohol use, maternal height, prior pregnancy, adequacy of prenatal care, child's sex, and child's birth year.²⁵ The poor study showed similar results, with an unadjusted OR of CPD of 1.85 (95% CI, 1.63-2.06) for normal-weight women gaining > 35 pounds compared with women gaining < 30 pounds. This study also showed an increased risk of CPD for underweight women gaining > 35 pounds compared with women gaining < 30 pounds (unadjusted OR: 3.8; 95% CI, 3-4.6). The relationship between weight gain and CPD was not statistically significant at higher pregravid BMI levels.⁷⁴

Complications of labor and delivery.

Study characteristics. Two retrospective cohort studies, one from Iceland⁵³ and the other from the United States,⁸¹ evaluated the impact of gestational weight gain on complications of labor and delivery (Evidence Table 16).

Overview of results. Two studies, of fair⁵³ and poor⁸¹ quality respectively found conflicting evidence on the risks of complications. One failed to find statistically significant results;⁵³ the other reported that gestational weight gain of more than 40 pounds increased the risk for the previously listed complications by 40 percent.⁸¹

Results. The fair study from Iceland analyzed the quartiles of total weight gain in women with normal pregravid BMIs (19.5-25.5) to determine the impact of weight gain on labor and delivery processes.⁵³ After adjusting for age, height, parity, gestational length, and birthweight, they found that weight gain of 11.5 to 16.0 kg was associated with the highest likelihood of a normal vaginal delivery, defined to include no shoulder dystocia and no asphyxia, and the least likelihood of operative procedures including cesarean delivery and forceps- or vacuum-assisted deliveries. The findings of this study, however, were not statistically significant.

The poor US study enrolled 493 women at 37 or more weeks of gestational age to determine the relationship between various lifestyle choices and complications in term pregnancy.⁸¹ Complications included dystocia, postpartum hemorrhage, retained placenta, fetal and neonatal distress, and pregnancy-induced hypertension. All complications were grouped together for the analysis. Smoking had a protective effect against complications, but entering pregnancy with excess weight for height and gaining more than 40 pounds during gestation both predicted complications. A gestational weight gain of more than 40 pounds increased the risk for the previously listed complications by 40 percent.

Birth Outcomes

Preterm birth.

Study characteristics. Twelve studies (Table 10, Evidence Table 17) examined the relationship between weight gain and birth outcomes.^{23,59,65,71,82-89} These include eight cohort studies,^{59,65,82-86,89} two case-control studies,^{87,88} and two cross-sectional studies.^{23,71} The majority of the studies defined preterm birth as delivery occurring prior to 37 weeks of gestation; the one exception defined it as delivery between 24 and 35 weeks of gestation.⁸⁷ Each study defined weight gain differently. Two studies examined associations of weight gain with early and late preterm birth,^{23,65} and two studies examined associations across subtypes of preterm delivery.^{65,84}

Table 10. Gestational weight gain and preterm birth

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Kramer et al., 1995 ⁸⁸	Pregravid weight: Self-report	Gestational weight gain categories (kg/wk): G1: < 0.27 G2: ≥ 0.27	AOR (95% CI) for cases with preterm delivery versus controls G1: 1.56 (0.94-2.58) G2: 1.00 (reference)	Parity, marital status, language, age, education, matched on smoking history
Canada, University Hospitals	Total weight gain: Self-report			
396				
All weight/BMI				
Good				
Siega-Riz et al., 1996 ⁸⁴	Pregravid weight: Self-reported	Categories of 3rd trimester weekly weight gain rates (kg/week): G1: Inadequate (Underweight, < 0.34; Normal weight, < 0.35; Overweight/ Obese, < 0.30) G2: Adequate (Underweight, > 0.34; Normal, > 0.35; Overweight/Obese, > 0.30)	AOR (95% CI) for rate of preterm birth: G1: 1.91 (1.40-2.61) G2: 1.00 (reference) AOR (95% CI) for rate of preterm labor: G1: 1.75 (1.15-2.64) G2: 1.00 (reference) AOR (95% CI) for rate of PPROM: G1: 2.70 (1.35-5.42) G2: 1.00 (reference)	Iron status, parity combined with maternal age, ethnicity, hypertension (chronic or pregnancy induced), smoking status, week prenatal care began
USA, Public Health Clinics (California)	Total weight gain: Measured			
7,589				
All weight/BMI				
Good				
Carmichael et al., 1997 ⁸²	Pregravid weight: Self-report	Total gestational weight gain (continuous)	Linear regression analysis of gestational age (days) as dependent variable and gestational weight gain (kg) as independent variable: Regression coefficient = 0.51; t-statistic = 13.1; P < 0.001 AOR (95% CI) of spontaneous preterm birth/ kg increase in total weight gain: 0.84 (0.82-0.87)	BMI, maternal age, infant sex cigarettes per day maternal height, parity, race, pattern of gain derived from quadratic curves
USA, University Hospital (California)	Total weight gain: Maternity Records			
7,259				
Nonobese				
Fair				

AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; HR, hazards ratio; kg, kilogram; n, number; OR, odds ratio; PPRM, preterm premature rupture of amniotic membranes; RD, risk difference; USA, United States of America; wk, week.

Table 10. Gestational weight gain and preterm birth (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Dietz et al., 2006 ²³ USA, Pregnancy Risk Assessment Monitoring System 113,019 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Birth Certificates	Categories of mean rate of gestational weight gain (kg/wk) during second and third trimesters stratified by pregravid BMI and type of preterm birth (very preterm, 20-31 weeks; moderate preterm, 32-36 weeks): G1: < 0.12 G2: 0.12-0.22 G3: 0.23-0.68 G4: 0.69-0.79 G5: > 0.79	In general, in comparison to women with normal BMI in G3: underweight women in G1- G5 and normal weight women in G1, G2, and G5 were at increased risk of very preterm births (AOR: 1.5-9.8). Underweight women in G1-G3 and G5 and normal women in G1, G2, and G5 were at increased risk moderate preterm births (AOR: 1.4-3.1). Overweight and obese women in G1 and G5 were at increased risk of very preterm birth (AOR: 2.3-2.5) but had no elevated risk of moderate preterm birth. Very obese women with G1, G4, G5 had increased risks of very preterm births (AOR: 2.1-2.8) and with G4 had increased risks of moderate preterm birth (AOR: 1.3)	Race, Medicaid recipient, parity, marital status
Nohr et al., 2007 ⁶⁵ Danish National Birth Cohort 16,167 All weight/BMI Fair	Pregravid weight: Self-reported Total weight gain: Self-reported	Rate of gestational weight gain (g/wk) for women with early preterm birth (22-33 weeks) with PPROM : G1: < 275 G2: 276-675 G3: ≥ 676 Rate of gestational weight gain (g/wk) for women with early preterm birth (22-33 weeks) without PPROM : G4: < 275 G5: 276-675 G6: ≥ 676 Rate of gestational weight gain (g/wk) for women with late preterm birth (34-36 weeks) with PPROM: G7: < 275 G8: 276-675 G9: ≥ 676	HR (95% CI): G1: 2.1 (1.5-3.0) G2: 1.0 (ref) G3: 1.2 (0.8-1.8) HR (95% CI): G4: 1.9 (1.3-2.6) G5: 1.0 (ref) G6: 1.9 (1.3-2.6) HR (95% CI): G7: 1.3 (1.0-1.6) G8: 1.0 (ref) G9: 1.2 (1.0-1.5) HR (95% CI): G10: 1.0(0.9-1.2) G11: 1.0(ref) G12: 1.0 (0.9-1.2)	Pregravid BMI, age, height, parity, socio-occupational status, smoking alcohol consumption

Table 10. Gestational weight gain and preterm birth (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Nohr et al., 2007 ⁶⁵ (continued)		Rate of gestational weight gain (g/wk) for women with late preterm birth (34-36 weeks) without PPRM: G10: < 275 G11: 276-675 G12: ≥ 676		
Rosenberg et al., 2005 ⁷¹ USA, New York City birth files 329,988 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Self-report	Categories of total gestational weight gain (lbs): G1: <41 G2: ≥ 41	AOR (95% CI) for Preterm Birth: G1: 1.00 (reference) G2: 0.54 (0.52-0.57)	Pregravid weight, chronic diabetes, GDM, chronic hypertension, PIH preeclampsia, maternal age marital status maternal education birthplace, prenatal care payer, social risk, parity, trimester that prenatal care began
Schieve, et al., 1999 ⁸⁶ USA, Pregnancy Nutrition Surveillance System (PNSS) 266,172 All weight/BMI Fair	Pregravid weight: Self-reported Total weight gain: Self-reported	Rate of weight gain (kg/week) in percentiles stratified by Low, Average, High, and Obese pregravid BMI: G1: 5th,0.10 G2: 10th, 0.16 G3: 25th,0.26 G4: 50th,0.35 G5: 75th, 0.46 G6: 90th, 0.57 G7: 95th, 0.65	Reference category of rate of weight gain: 0.35-<0.46 kg/wk RD of preterm birth varied by prepregnant BMI and gestational weight gain. Overall, women gaining 0.26-0.46 kg/wk had the lowest RD of preterm birth. The highest RD occurred for women gaining the least and most amount of weight, irrespective of prepregnant BMI; however, the highest RD of preterm births were among women of low BMI	None
Stotland et al., 2006 ⁸⁵ USA, University Hospital (California) 15,101 Underweight/Normal BMI Fair	Pregravid weight: Medical Charts Total weight gain: Medical Charts	Categories of rate of gestational weight gain (kg/wk): G1: < 0.27 G2: 0.27 to 0.52 G3: > 0.52	AOR (95% CI) for preterm delivery < 37 weeks: G1: 2.6 (2.1-3.2) G2: 1.0 (reference) G3: 1.0 (0.8-1.2) AOR (95% CI) for preterm delivery < 34 weeks: G1: 3.0 (2.0-4.8) G2: 1.0 (ref)	Race, age pregravid BMI, year of delivery, parity, previous preterm birth, number of days between last weighing and delivery, smoking

Table 10. Gestational weight gain and preterm birth (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Wen et al., 1990 ⁸⁹ USA, University Hospital (Alabama) 17,149 All weight/BMI Fair	Pregravid weight: Measured at first prenatal visit Total weight gain: Medical records	Rate of weight gain (kg/wk) after 20 weeks gestation G1: < 0.24 G2: 0.24-0.57 G3: 0.58-0.74 G4: ≥0.75	AOR for preterm birth: G1: 1.52 (<i>P</i> < 0.05) G2: 1.11 (NS) G3: 1.00 (ref) G4: 1.71 (<i>P</i> < 0.05)	Race, parity, infant sex, marital status, education, age, previous preterm delivery, smoking, alcohol consumption, drug use, height, pregravid weight
Jensen et al., 2005 ⁵⁹ Denmark, University hospital centers 481 Obese Poor	Pregravid weight: Self-report Total weight gain: Hospital records	Total gestational weight gain categories (kg): G1: < 5.0 G2: 5.0-9.9 G3: 10.0-14.9 G4: > 15.0	Percent (%) preterm delivery by weight gain categories: G1: 6.5 G2: 6.0 G3: 4.6 G4: 2.5 <i>P</i> for trend = 0.11	NA
Spinillo et al., 1998 ⁸⁷ Italy, University Hospital 690 All weight/BMI Poor	Pregravid weight: Self-report Total weight gain: Medical records	G1: Prepregnancy BMI ≤ 19.5 and 2nd/3rd trimester weight gain ≤ 0.37 kg/wk G2: Prepregnancy BMI > 19.5 and 2nd/3rd trimester weight gain ≤ 0.37 kg/wk G3: Prepregnancy BMI ≤ 48 kg and 2nd/3rd trimester weight gain ≤ 0.37 kg/wk G4: Prepregnancy BMI > 48 kg and 2nd/3rd trimester weight gain ≤ 0.37 kg/wk	AOR (95% CI) for cases with spontaneous preterm delivery versus controls: G1: 5.63 (2.35-13.8) G2: 2.45 (1.60-3.75) <i>P</i> = 0.06 for interaction between G1 and G2 G3: 5.29 (1.45-20.90) G4: 2.42 (1.65-3.55) <i>P</i> = 0.21 for interaction between G3 and G4	Pregravid BMI, pregravid weight, height, age, parity, smoking, social class education, infant sex

Table 10. Gestational weight gain and preterm birth (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Velonakis et al., 1997 ⁸³	Pregravid weight: Self-reported	Total gestational weight gain (continuous)	Regression analysis with gestational age (weeks) as the dependent variable and net gestational weight gain as the independent variable: B = 0.191 (SE, 0.06) P = 0.001	Age, race, gravidity, previous diseases, parity, abortions, marital status, pathology of index pregnancy, infant sex, height
France, Hospital 2040 All weight/BMI Poor	Total weight gain: Measured			pregravid weight, job classification, alcohol, smoking, APGAR score, duration of pregnancy

Overview of results. Taken collectively, the results of these two good,^{84,88} seven fair,^{23,65,71,82,85,86,89} and three poor^{53,59,83,87} studies suggest an association between preterm birth and both low and high rates of weight gain and with low total weight gain, with one study reporting a 16 percent decrease in preterm birth associated with a 1 kg increase in maternal weight. The cut points for low and high weight gains and the severity of the risks of preterm birth associated with them differ by pregravid BMI. In general, low rates of weight gain were ≤ 0.37 kg per week and high rates of gain were > 0.52 kg per week throughout gestation, with the greatest risks found among underweight women. However, as pregravid BMI increases, the risk of preterm birth decreases for women gaining in the lower range of the low rate of weight gain and increases for women gaining in the lower range of the high rate of weight gain, such that the range of adequate rates of weight gain is shifted down for heavier women compared to their lighter counterparts. Some evidence also suggests that low rate of weight gain is associated with greater risks of early preterm birth as well as preterm birth due to premature rupture of the amniotic membranes.

Detailed results from categorical measures of total rate of weight gain. Four studies used categorical definitions of rate of weight gain averaged for the entire length of gestation;^{85,86,88,89} one study was rated good⁸⁸ and the others rated fair.^{85,86,89} In the good study,⁸⁸ a rate of weight gain of < 0.27 kg per week was not associated with preterm birth (OR, 1.56; 95% CI, 0.94-2.58). Among the fair studies, all three studies found evidence of an association between low rate of weight gain and preterm birth, and two studies found evidence of an association between high rate of weight gain and preterm birth.^{86,89}

One study used a retrospective, US-hospital-based cohort of deliveries from 1976 to 2001 to examine the association of preterm birth and gestational weight gain by maternal race or ethnicity.⁸⁵ Weight gain was categorized into three groups based on rate of weight gain: < 0.27 kg per week, 0.27-0.52 kg per week, and > 0.52 kg per week. Within the entire cohort and across four racial or ethnic groups (white, black, Latina, and Asian), the highest percentages of preterm birth occurred among women gaining < 0.27 kg per week. The adjusted odds of spontaneous preterm birth were 2.5 times higher in women with rates of weight gain < 0.27 kg per week than

in women gaining 0.27 to 0.52 kg per week. The adjusted odds ratios for this association were statistically significant across the different racial or ethnic groups, ranging from 2.1 (95% CI, 1.4-3.1) for white women to 3.6 (95% CI, 2.2-6.0) for black women. No association between spontaneous preterm birth and rate of weight gain > 0.52 kg per week (relative to a weight gain of 0.27 to 0.52 kg per week) was seen either within the entire cohort or across the racial or ethnic groups.

Another study, conducted in a population of young, primarily black, disadvantaged women, found statistically significant higher odds of preterm delivery among women gaining < 0.24 kg per week and > 0.74 kg per week than among women gaining 0.58 to 0.74 kg per week.⁸⁹

The final study used data collected from women participating in US federally funded prenatal public health programs via the Pregnancy Nutrition Surveillance System (PNSS).⁸⁶ Gestational weight gain was defined as rates of weight gain and net weight gain (kg/week) and categorized by the percentile distributions based on the total sample. Women with rates of weight gain between 0.35 and 0.46 kg per wk (the 50th through the 74th percentiles) were used as the reference for risk difference calculations. In general, the risk of preterm birth was highest among women with the smallest and greatest rates of weight gain, < 0.10 kg per week and \geq 0.65 kg per week, respectively. The lowest risks of preterm delivery occurred among women gaining between 0.26 and 0.46 kg per week (the 25th through the 74th percentiles). Preterm risk differences did vary by maternal pregravid BMI status. An increased risk of preterm birth was associated with rates of weight gain for the following pregravid BMI categories:

- pregravid BMI < 19.8: < 0.26 kg per week;
- pregravid BMI of 19.8 to 26.0: < 0.26 kg per week and > 0.65 kg per week;
- pregravid BMI of 26.1 to 29.0: < 0.10 kg per week and > 0.65 kg per week; and
- pregravid BMI > 29.0: \geq 0.57 kg per week.

The results were similar when rates of weight gain per week excluded the first 14 weeks of gestation.

Results from categorical measures of trimester rate of weight gain. Four studies used categorical definitions of rate of gestational weight gain measured during specific trimesters of pregnancy.^{23,65,84,87} All of the studies found evidence for an association between preterm birth and low rate of weight gain and two studies found evidence for an association between preterm birth and high rate of weight gain.

One study of good quality used a cohort of mainly Hispanic women recruited from public health clinics to examine the association between preterm birth and rate of weight gain during the third trimester.⁸⁴ Women with preterm deliveries had significantly lower rates of third trimester weight gain than women with term deliveries, 0.50 (standard error of mean [SEM]: 0.02) kg per week versus 0.53 (SEM: 0.004) kg per week, respectively ($P < 0.05$). The odds of preterm birth were 1.91 (95% CI, 1.40-2.61) times greater among women with inadequate third trimester weight gains (defined as a rate of weight gain less than the 25th percentile of gain in each pregravid weight status: 0.34 kg/week, underweight; 0.35 kg/week, normal weight; 0.30 kg/week, overweight and obese) than among women with adequate rates of weight gain. When data were stratified by the type of preterm delivery, women with inadequate weight gains were 1.75 (95% CI, 1.15-2.64) times more likely to have preterm delivery resulting from preterm labor and 2.70 (95% CI, 1.32-5.42) times more likely to have preterm delivery resulting from preterm

premature rupture of the amniotic membranes (PPROM) than women with adequate rates of weight gain.

One study, rated fair quality, used data from the Danish National Birth Cohort to assess the impact of gestational weight gain on early (22-33 weeks), late (34-36 weeks), and all (22-36 weeks) preterm births with PPRM, without PPRM, and with medical inducement.⁶⁵ Gestational weight gain was categorized as low (< 275 g/week), medium (275-675 g/week), and high (> 675 g/week) based on two self-reported measurements recorded at least 6 weeks apart between 12 and 37 weeks of gestation. Women with medium rates of weight gain were used as the reference. Overall, low rates of weight gain were significantly associated with an increased risk of early spontaneous preterm birth with and without PPRM and with all spontaneous preterm births with PPRM, adjusted odds ratios ranged from 1.5 to 2.1. High rates of weight gain were significantly associated with an increased risk of early spontaneous preterm births without PPRM (AOR, 1.9; 95% CI, 1.3-2.6) and early, late, and all medically induced early preterm births. However, when women with obesity-related diseases and abruptio placenta were excluded, the associations for medically induced preterm births were no longer significant.

Another fair quality study used information collected for the Pregnancy Risk Assessment Monitoring System (PRAMS) to examine the effect of rate of weight gain during the second and third trimesters on preterm birth.²³ These investigators stratified women by prepregnancy BMI status and examined the risk of preterm birth in two categories: moderate length of gestation (32-36 weeks) and very short length of gestation (20 to 31 weeks). Second and third trimester rate of weight gain was categorized, in kg per week, as follows: < 0.12, 0.12-0.22, 0.23-0.68, 0.69-0.79, and > 0.79; the investigators also used five pregravid BMI groups: underweight (< 19.8), normal weight (19.8-26.0), overweight (26.1-28.9), obese (29.0-34.9), and very obese (\geq 35.0). Women of normal weight with rates of weight gain of 0.23 to 0.68 kg per week were used as the reference for analyses. After adjusting for covariates and excluding women with diabetes, hypertension, or small-for-gestational-age (SGA) infants, significant associations (AOR range, 1.3-3.1) were reported between moderate preterm birth and rates of weight gain as follows: < 0.69 and > 0.79 kg per week among underweight women; < 0.23 and > 0.79 kg per week among normal weight women; and 0.69 to 0.79 kg per week among obese and very obese women. Significant associations (AOR range, 1.5-9.8) were reported between very preterm birth and rates of weight gain as follows: all weight gain categories among underweight women; < 0.23 and > 0.79 kg per week among normal weight women; < 0.12 and > 0.79 kg per week among overweight and obese women; and < 0.12 and > 0.68 kg per week among very obese women. In general, the greatest odds were found among underweight women and in the extreme weight gain categories.

Results from a poor study⁸⁷ were consistent with those of the other studies and revealed an overall increased odds of preterm birth (between 24 and 35 weeks' gestation) with gestational weight gain \leq 0.37 kg per week in the second and third trimesters; however, the odds were greater among women with pregravid BMI \leq 19.5 compared to those with BMI >19.5.

Results from categorical measures of total weight gain. Two studies,^{59,71} one rated fair and the other poor, used categories of total weight gain. In the fair study, data from the New York City birth file from 1999 through 2001 was used to examine the odds of preterm birth associated with different levels of gestational weight gain.⁷¹ After adjusting for covariates, the investigators determined that the odds of preterm birth were significantly decreased (OR, 0.54; 95% CI, 0.52-0.57) among women who gained at least 41 pounds compared with women who gained less than 41 pounds. Results from the poor study,⁵⁹ which used a population of obese women, showed the

highest proportion of preterm birth among those with the lowest gestational weight gain (< 5.0 kg).

Results from continuous measures of weight gain. The remaining two studies, one rated fair and the other poor, used gestational weight gain as a continuous measure.^{82,83} Both studies reported a significant increase in length of gestation for a 1 kg increase in total gestational weight gain.

In the fair study,⁸² simple regression techniques were used to develop a variable for pattern of weight gain that reflected the variation between a woman's pattern of weight gain and a linear pattern of weight gain.⁸² Deviations in the pattern of weight gain, such as pronounced speeding up or slowing down of weight gain later in gestation, from an average pattern of weight gain were associated with decreased gestational age and increased risk of spontaneous preterm birth. A 1-kg increase in total gestational weight gain was associated with 0.51 day's increase in gestational age ($P < 0.001$). The odds of spontaneous preterm birth were decreased by 16 percent for each 1-kg increase in total gestational weight gain (OR, 0.84; 95% CI, 0.82-0.87; $P < 0.001$).

Birthweight.

Study characteristics. Twenty-five studies examined the association between gestational weight gain and infant birthweight (Evidence Table 18).^{48,54,55,59,68,70,75,83,90-106} These studies consisted of various groups of women, in many different countries. Nine studies were completed outside the United States, in Canada,¹⁰⁵ France,^{83,92} Italy,^{91,100} Denmark,⁵⁹ Norway and Sweden,⁹⁹ Finland,⁶⁸ and Austria.⁹³

One study observed the association for adolescent mothers.⁹⁵ The association was also evaluated for mothers with gestational diabetes mellitus (GDM),¹⁰⁰ mothers who had a positive diabetic screen but normal glucose tolerance levels,⁹¹ and obese glucose-tolerant women.⁵⁹ Seventeen studies adjusted their analyses for multiple confounders, including maternal age, BMI, smoking, glucose levels, race, marital status, and parity.^{48,55,59,70,75,90-93,97-103,105}

Overview of results. The results for four good,^{48,98,103,106} 12 fair,^{55,65,70,75,92,93,97,99-102,104,105} and nine poor^{54,59,68,83,90,91,94-96} studies consistently demonstrate an association between higher gestational weight gain and birthweight.

Results from categorical measures of weight gain. Eight studies analyzed the relationship between weight gain and birthweight by categorizing gestational weight gain (Table 11).^{54,59,68,94,95,99,101,106} One study was rated to be of good quality,¹⁰⁶ two of fair quality,^{99,101} and five of poor quality.^{54,59,68,94,95} These studies suggest a positive association between gestational weight gain and infant birthweight.

A U.S. study rated of good quality found that higher values for maternal weight near term, categorized by the percentage of standard weight-for-height, were associated with higher birthweight for black and Hispanic mothers.¹⁰⁶ Specifically, black mothers > 135 percent of standard weight for height gave birth to infants that weighed on average 512 g more than infants born to black mothers < 100 percent of standard weight for height. Hispanic mothers > 135 percent of standard weight for height gave birth to infants that weighed on average 338 g more than infants born to Hispanic mothers < 100 percent of standard weight for height.

In one Scandinavian study (fair quality), estimated birthweights decreased by 131 g for women who gained less than 11 kg and increased by 164 g for women who gained more than 17 kg, as compared with estimated birthweights for women gaining between 11 and 17 kg.⁹⁹ A fair-quality US study examined patterns of weight gain and infant birthweight in a population of white nonobese women.¹⁰¹ Low weight gain by trimester was defined as having weight gain less than the 25th percentile. Infants of mothers with low weight gain in all three trimesters had

weighed 248.1 g less, on average, than infants of mothers in other groups. Low weight gain for the first trimester was associated with a decrease in birthweight of 133 g; low weight gain for the second and third trimesters was associated with an 88.5 g decrease in birthweight.

Table 11. Total gestational weight gain (categorical) and infant birthweight

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hickey et al., 1990 ¹⁰⁶	Pregravid weight: Self-report	Infant BW for groups defined by maternal weight near term (% of standard weight-for-height)	G1: 3,325 g ± 460 G2: 3,543 g ± 410 G3: 3,200 g ± 389 G4: 3,381 g ± 385 G5: 3,157 g ± 373 G6: 3,282 g ± 400 G7: 3,025 g ± 494 G8: 3,154 g ± 375 G9: 2,813 g ± 289 G10: 3,205 g ± 472	N/A
United States, prenatal clinics 325 All weight/BMI Good	Total weight gain: Routine prenatal care or maternity records	G1: > 135%, Black G2: > 135%, Hispanic G3: 120-135%, Black G4: 120-135%, Hispanic G5: 110-119%, Black G6: 110-119%, Hispanic G7: 100-109%, Black G8: 100-109%, Hispanic G9: < 100%, Black G10: < 100%, Hispanic		
Abrams et al., 1995 ¹⁰¹	Pregravid weight: Self-report	G1: Infant BW among nonobese women	3,485.8 g ± 523.1	Maternal age, parity, pregravid BMI, height, smoking, infant sex, difference in weeks between the last measured weight and delivery
USA, university hospital 4,420 Nonobese Fair	Total weight gain: Routine prenatal care or maternity records			
Zaren et al., 1997 ⁹⁹	Pregravid weight: Self-report	β is estimated change in infant BW (g)	G1: $\beta = -131$ ($P = 0.0001$) G2: $\beta = 164$ ($P = 0.0001$)	Maternal age, height, pregravid weight, smoking
Norway and Sweden, university hospitals 1,099 All weights/BMI Fair	Total weight gain: Routine prenatal care or maternity records	G1: GWG ≤ 11 kg: G2: GWG ≥ 17 kg:		
Bianco et al., 1998 ⁵⁴	Pregravid weight: Self-report	Infant BW for GWG:	G1: 3,302 G2: 3,192 G3: 3,337 G4: 3,506 G5: 3,453 ($P < 0.05$)	N/A
USA, medical center 613 Morbidly obese (BMI > 35) Poor	Total weight gain: Routine prenatal care or maternity records	G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: >35 lbs		

β unstandardized coefficient from multiple regression; BMI, body mass index; BW, birthweight; cm, centimeters; g, grams; GWG, gestational weight gain; kg, kilogram; lbs, pounds; SC, standardized coefficient; N/A, not applicable; NR, not reported; RCT, randomized controlled trial; SD, standard deviation

Table 11. Total gestational weight gain (categorical) and infant birthweight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Cherry et al., 1993 ⁹⁵ USA, hospital RCT 599 All weights/BMI Poor	Pregravid weight: Measured by study investigators Total weight gain: Routine prenatal care or maternity records	Infant BW by Quartiles of weight gain Quartiles defined as weekly weight gain in g per cm height G1: Quartile 1 ($\leq 1.87g$) G2: Quartile 2 (1.88-2.68g) G3: Quartile 3 (2.69-3.58g) G4: Quartile 4 ($\geq 3.59g$)	G1: 2,829 g G2: 2,990 g G3: 3,112 g G4: 3,189 g	N/A
Ekblad and Grenman, 1992 ⁶⁸ Finland, hospital 357 Prepregnancy weight 20% over or under ideal body weight for height and normal weight Poor	Pregravid weight: Medical records Total weight gain: Routine prenatal care or maternity records	Infant BW by group G1: Normal prepregnancy weight and normal weight gain G2: Weight gain ≤ 5 kg G3: Weight gain ≥ 20 kg	G1: 3,538 g \pm 535 G2: 3,284 g \pm 880 G3: 3,803 g \pm 538 ($P < 0.005$ compared to G1)	N/A
Jensen et al., 2005 ⁵⁹ Denmark, university hospitals 481 Obese Poor	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	Infant BW for groups defined by GWG G1: GWG < 5.0 kg G2: GWG 5.0-9.9 kg G3: GWG 10-14.9 kg G4: GWG ≥ 15.0 kg	G1: 3,456 g \pm 620 G2: 3,624 g \pm 675 G3: 3,757 g \pm 582 G4: 3,784 g \pm 597 $P < 0.0001$	N/A
Shapiro et al., 2000 ⁹⁴ USA, community hospital 159 All weight/BMI Poor	Pregravid weight: Routine prenatal care Total weight gain: Routine prenatal care or maternity records	Infant BW for groups defined by BMI and weight gain G1: Low BMI (< 25), Low gain (< 35 lbs) G2: Low BMI (< 25), High gain (> 35 lbs) G3: High BMI (> 25), Low gain (< 35 lbs) G4: High BMI (> 25), High gain (> 35 lbs)	G1: 3,363 g G2: 3,636 g G3: 3,565 g G4: 3,774 g	N/A

The five poor-quality studies also found that increases in gestational weight gain resulted in larger infant birthweights.^{54,59,68,94,95} This trend held among studies of obese glucose-tolerant women,⁵⁹ Finnish women,⁶⁸ and adolescent mothers.^{94,95} One study stratified by maternal BMI and found that among women with low BMI (< 25) those that gained > 35 lbs had infants that were, on average, 273 g heavier than infants born to women gaining < 35 lbs. Among women with high BMI (> 25), women that gained > 35 lbs had infants that were, on average, 209 g heavier than infants born to women who gained < 35 lbs. One study among morbidly obese women (BMI > 35) found a similar trend, although it was inconsistent at the extremes of weight gain. Specifically, the following infant birthweights were found for each of the gestational weight gain categories: weight loss or 0 lbs, 3,302 g; 1-15 lbs, 3,192 g; 16-25 lbs, 3,337 g; 26-35 lbs, 3,506 g; >35 lbs, 3,453 g.

Results for continuous total weight gain. Fourteen studies (Table 12) evaluated the relationship between continuous total weight gain and birthweight using linear regression techniques to determine the effect of every 1 kg increase in weight gain.^{48,55,59,90,92,93,96,98,100-105} Of these studies, three^{48,98,103} were rated of good quality, eight^{55,92,93,100-102,104,105} of fair quality, and three^{59,90,96} of poor quality. Seven studies of good and fair quality reported that birthweight increased between 16.7 and 22.6 g for every 1 kg increase in weight gain.^{48,93,98,101-103,105} Three poor-quality studies reported that birthweight increased between 18.4 and 44.3 g for every 1 kg increase in weight gain.^{59,90,96}

Table 12. Total gestational weight gain (continuous) and infant birthweight

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Brown et al., 2002 ⁹⁸ USA, primary care clinics 389 All weight/BMI Good	Pregravid weight: Measured by study investigators Total weight gain: Collected by study investigators	G1: Increase in birthweight per 1 kg increase in total pregnancy weight gain	G1: $\beta = 20$ g ($P < 0.0001$)	Maternal age, parity, pregravid BMI, height, infant sex, gestational age
Groff et al., 1997 ¹⁰³ USA, multispecialty clinics 341 All weights/BMI Good	Pregravid weight: Self-report 82% First prenatal visit 18% Total weight gain: Routine prenatal care or maternity records	G1: Increase in birthweight per 1 lb increase in total pregnancy weight gain	G1: $\beta = 10.1\text{g} \pm 1.76$ ($P \leq 0.001$)	Pregravid BMI, infant sex, smoking

AGA, Appropriate for gestational age; β , unstandardized coefficient from multiple regression; BMI, body mass index; g, gram; GDM, gestational diabetes mellitus; kg, kilogram; lb, pound; LGA, large-for-gestational-age; NR, not reported

Table 12. Total gestational weight gain (continuous) and infant birthweight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Kieffer et al., 2006 ⁴⁸ USA, community health center 1,041 All weights/BMI Good	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: Increase in birthweight per 1 kg increase in total pregnancy weight gain	G1: $\beta = 19.7 \text{ g} \pm 2.8$ ($P < 0.01$)	Parity, pregravid BMI, height, 1-hour glucose value, gestational age
Abrams et al., 1995 ¹⁰¹ USA, university hospital 4,420 Nonobese Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: Increase in birthweight per 1 kg increase in total pregnancy weight gain	G1: $\beta = 22.6 \text{ g}$ ($P < 0.001$)	Maternal age, parity, pregravid BMI, height, smoking, infant sex, gestational age
Butte et al., 2003 ⁹⁷ USA, US Agriculture Research Service Children's Nutrition Research Center 63 All weights/BMI Fair	Pregravid weight: Measured by study investigators Total weight gain: Measured by study investigators	G1: Correlation coefficient G2: Variability in birthweight accounted for by gestational age, pregravid weight, and total pregnancy weight gain	G1: 0.28 G2: 37.9%	Maternal race, pregravid BMI, gestational age
Edwards et al., 1996 ⁵⁵ USA, hospital 1,443 Normal and obese BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: Increase in birthweight per 1 kg increase in total pregnancy weight gain for obese women G2: Increase in birthweight per 1 kg increase in total pregnancy weight gain for normal weight women	G1: $\beta = 11 \text{ g} \pm 2$ ($P \leq 0.001$) G2: $\beta = 15 \text{ g} \pm 2$ ($P \leq 0.001$)	Maternal age, parity, pregravid BMI, pregnancy- induced hypertension, adequacy of prenatal care, alcohol use, drug use, smoking, gestational age

Table 12. Total gestational weight gain (continuous) and infant birthweight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Guihard-Costa et al., 2004 ⁹² France, hospital database 13,972 All weights/BMI Fair	Pregravid weight: Routine prenatal care Total weight gain: Routine prenatal care or maternity records	G1: Standardized coefficient for effect of pregnancy weight gain on infant birthweight. Standardized coefficients are regression coefficients calculated as if all of the independent variables had a variance of 1	G1: SC = 0.199	Maternal age, parity, pregravid BMI, height
Hediger et al., 1994 ¹⁰² USA, setting not stated 608 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: Increase in birthweight per 1 kg increase in total pregnancy weight gain	G1: $\beta = 16.7 \text{ g} \pm 2.5$ ($P = 0.001$)	Maternal age, maternal race/ethnicity, parity, pregravid weight, height, gestational age, prior poor outcome, fat loss, pregravid weight: low weight, fat accretion, smoking, infant sex
Kirchengast and Hartmann, 2003 ⁹³ Austria, university hospital 8,011 All weights/BMI Fair	Pregravid weight: Estimated from measured weight at first prenatal visit Total weight gain: Routine prenatal care or maternity records	G1: Increase in birthweight per 1 kg increase in total pregnancy weight gain	G1: $\beta = 17.32$ (14.62, 20.03)	Maternal age, age at menarche, pregravid weight, height, distantia cristarum
Luke et al., 1996 ¹⁰⁴ USA, clinic 487 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	Increase in birthweight per 1 kg increase in total pregnancy weight gain for BMI categories: G1: Underweight G2: Normal weight G3: Overweight	G1: $\beta = 44.9 \text{ g} \pm 6.8$ ($P < 0.01$) G2: $\beta = 22.9 \text{ g} \pm 3.9$ ($P < 0.01$) G3: $\beta = 11.9 \text{ g} \pm 5.2$ ($P < 0.05$)	Maternal age, parity, black ethnicity, smoking, gestational age, infant sex

Table 12. Total gestational weight gain (continuous) and infant birthweight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Muscati et al., 1996 ¹⁰⁵ Canada, public health department 371 All weight/BMI Fair	Pregravid weight: Medical records Total weight gain: Collected by study investigators	G1: Increase in birthweight per 1 kg increase in total weight gain up to week 20	G1: $\beta = 22 \text{ g} \pm 6$ ($P < 0.01$)	Parity, pregravid standard weight, pregravid excess weight, birth length, infant sex
Pezzarossa et al., 1996 ¹⁰⁰ Italy, not stated 192 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	Increase in birthweight per 1 kg increase in total pregnancy weight gain for: G1: Controls (normal glucose tolerance) G2: GDM	G1: $\beta = 27.8 \text{ g}$ ($P = 0.0001$) G2: $\beta = 39.5$ ($P = 0.0001$)	Pregravid BMI, fasting plasma glucose
Di Cianni et al., 2004 ⁹¹ Italy, diabetes clinic 180 All weights/BMI Poor	Pregravid weight: Not reported Total weight gain: Collected by study investigators		F statistic = 3.16, $P = 0.08$	Pregravid BMI, maternal triglycerides, plasma glucose
Jensen et al., 2005 ⁵⁹ Denmark, university hospitals 481 Obese Poor	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: Increase in birthweight per 1 kg increase in total pregnancy weight gain	G1: $\beta = 18.4 \text{ g}$ ($P < 0.001$)	Maternal age, pregravid BMI, smoking, gestational age, result of 2-hour oral glucose tolerance test
Paauw et al., 2005 ⁹⁰ USA, hospital 351 All weights/BMI Poor	Pregravid weight: Self-report Total weight gain: Self-report	G1: Increase in birthweight per 1 kg increase in total pregnancy weight gain	G1: $\beta = 21.0 \text{ g}$	Maternal race, pregravid weight, marital status, smoking, gestational age

Table 12. Total gestational weight gain (continuous) and infant birthweight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Springer et al., 1992 ⁹⁶	Pregravid weight: Self-report	G1: Increase in birthweight per 1 lb increase in total pregnancy weight gain	G1: $\beta = 20.1\text{g}$	Maternal age, pregravid weight, length of gestation, smoking, weight gain at 20 weeks
USA, university hospital	Total weight gain: Routine prenatal care or maternity records			
107				
All weights/BMI				
Poor				

Two studies of fair quality reported these values by BMI status.^{55,104} One found that 1 kg increases in weight gain among normal-weight women were associated with a 15 g increase in infant birthweight and, among obese women, an 11 g increase in infant birthweight.⁵⁵ The other study reported, for each 1 kg increase in gestational weight gain, a 44.9 g increase in birthweight for underweight women, a 22.9 g increase for women of normal weight, and an 11.9 g increase for overweight women.¹⁰⁴

In the one fair-quality study that stratified by GDM, the association of total weight gain and infant birthweight was stronger among mothers with GDM than among women not diagnosed with GDM.¹⁰⁰ Specifically, 1 kg increases in weight gain raised infant birthweight by 27.8 g among nondiabetic mothers and by 39.5 g among mothers with GDM.

Several studies reported statistically significant correlations between gestational weight gain and infant birthweight. Correlation coefficients between birthweight and total weight gain ranged from 0.22 to 0.28 in two fair-quality studies.^{97,105} A poor-quality study among obese, glucose-tolerant women reported a nonsignificant correlation value of $r^2 = 0.062$.⁹¹

Results for continuous total weight gain by trimester. Three studies reported on the effects of gestational weight gain, by trimester, on infant birthweights (Table 13).^{98,101,105} One US study (rated good quality) reported that weight gain during the first trimester was associated with a 31 g increase in birthweight per kg of gestational weight gain. Comparable gains in infant birthweight for each kg of gestational weight gain in the second and third trimesters were 26 g and 7 g.⁹⁸ This study also found that infant birthweight decreased by 211 g among mothers who lost weight during the first trimester.⁹⁸

A Canadian study of fair quality found similar results: for each 1 kg increase in weight gain up to week 20, birthweight increased by 22 g; increases from week 21 to 30 increased birthweight by 31 g; and weight gain from week 31 to term increased birthweight by 12 g.¹⁰⁵ Lastly, another US study of fair quality reported an 18 g increase in birthweight for each kilogram gained by the mother in the first trimester. Corresponding increases in the second and third trimesters were 32.8 g and 17.0 g, respectively.¹⁰¹

Table 13. Continuous gestational weight gain by trimester and infant birthweight

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Brown et al., 2002 ⁹⁸ USA, primary care clinics 389 All weight/BMI Good	Pregravid weight: Measured by study investigators Total weight gain: Collected by study investigators	G1: Increase in birthweight per 1 kg increase in first trimester weight gain G2: Increase in birthweight per 1 kg increase in second trimester weight gain G3: Increase in birthweight per 1 kg increase in third trimester weight gain	G1: $\beta = 31$ g ($P < 0.0007$) G2: $\beta = 26$ g ($P < 0.007$) G3: $\beta = 7$ g ($P < 0.40$)	Maternal age, parity, pregravid BMI, height, infant sex, gestational age
Abrams et al., 1995 ¹⁰¹ USA, university hospital 4,420 Nonobese Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: Increase in birthweight per 1 kg increase in first trimester weight gain G2: Increase in birthweight per 1 kg increase in second trimester weight gain G3: Increase in birthweight per 1 kg increase in third trimester weight gain	G1: $\beta = 18.0$ g \pm 2.4 ($P < 0.001$) G2: $\beta = 32.8$ g \pm 2.8 ($P < 0.001$) G3: $\beta = 17.0$ g \pm 2.9 ($P < 0.001$)	Maternal age, parity, pregravid BMI, height, smoking, infant sex, gestational age
Muscatti et al., 1996 ¹⁰⁵ Canada, public health department 371 All weight/BMI Fair	Pregravid weight: Medical records Total weight gain: Collected by study investigators	G1: Increase in birthweight per 1 kg increase in total weight gain from weeks 21 to 30 G2: Increase in birthweight per 1 kg increase in total weight gain from weeks 31 to term	G1: $\beta = 31$ g \pm 7 ($P < 0.001$) G2: $\beta = 12$ g \pm 6 ($P < 0.05$)	Parity, pregravid standard weight, pregravid excess weight, birth length, infant sex

β , unstandardized coefficient from multiple regression; BMI, body mass index; g, gram; kg, kilogram; lbs, pounds.

Results from other measures of weight gain (net weight gain and proportional weight gain). Four studies examined the associations between infant birthweight and various other measures of gestational weight gain. Three studies (1 rated poor quality) of net weight gain (total gestational weight gain minus infant birthweight) showed that infant birthweight increased as net gestational weight gain increased (Table 14).^{70,83,104} In one study, for every 1 kg increase in net weight gain, birthweight rose by 15.4 g.⁷⁰ In another, which examined differences by BMI status, increases of 1 kg in net weight gain raised infant birthweight as follows: for underweight women, 41.9 g; for women of normal weight, 19.2 g; and for obese women, 9.1 g.¹⁰⁴ Each kilogram of net weight gain associated with an increase of 111.2 g in birthweight in another study.⁸³

Table 14. Net and proportional gestational weight gain and infant birthweight

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Johnson et al., 1992 ⁷⁰ USA, prenatal clinics 3,191 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: Increase in birthweight per 1 lb increase in net pregnancy weight gain	G1: $\beta = 15.4 \text{ g} \pm 2.2$ ($P < 0.0001$)	Maternal race, parity, pregravid BMI, height, pregravid weight, marital status, education, tobacco/alcohol/drug use, pregnancy-induced hypertension, gestational age, macrosomia, infant sex
Luke et al., 1996 ¹⁰⁴ USA, clinic 487 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	Increase in birthweight per 1 kg increase in net pregnancy weight gain for BMI categories: G1: Underweight G2: Normal weight G3: Overweight	G1: $\beta = 41.9 \text{ g} \pm 7.5$ ($P < 0.01$) G2: $\beta = 19.2 \text{ g} \pm 3.9$ ($P < 0.01$) G3: $\beta = 9.1 \text{ g} \pm 5.3$	Maternal age, parity, black ethnicity, smoking, gestational age, infant sex
Shepard 1998 ⁷⁵ USA, obstetrical practices in New Haven, CT 2,301 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	Infant birthweight for mothers with: G1: Low average BMI (19.5 to 22.4), proportional weight gained > median G2: Low average BMI (19.5 to 22.4), gained < median G3: High average BMI (22.5 to 28.5), gained > median G4: High average BMI (22.5 to 28.5), gained < median G5: Obese (> 28.5 BMI), gained > median G6: Obese (> 28.5 BMI), gained < median	G1: 3,231 g G2: 3,553 g G3: 3,395 g G4: 3,620 g G5: 3,685 g G6: 3,453 g	N/A
Velonakis et al., 1997 ⁸³ France, hospital 2,040 All weights/BMI Poor	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: Increase in birthweight for net pregnancy weight gain	G1: $\beta = 111.17 \text{ g} \pm 12.94$ ($P = 0.000$)	Maternal age, parity, pathology of previous/current pregnancy, previous diseases, reproductive history, marital status, employment, infant sex, height, weight, smoking, alcohol use, APGAR score, gestational age, nationality

β , unstandardized coefficient from multiple regression; BMI, body mass index; C-section, cesarean section; g, gram; kg, kilogram; lbs, pounds; N/A, not applicable.

The fourth study, which considered proportional gestational weight gain (total gestational weight gain divided by pregravid weight) found that for mothers with BMIs of 19.5 to 22.4, those who gained above the median proportional gestational weight gain had infants who were 322 g heavier than the infants of mothers who gained below the median.

Similar results were found for mothers with BMIs of 22.4 to 28.5: those who gained above the median gave birth to infants who were 225 g heavier. Finally, for women with BMIs above 28.5, the increase in birthweight was 232 g.⁷⁵

Low birthweight.

Study characteristics. Thirteen studies examined the effect of gestational weight gain on low birthweight (LBW) (Evidence Table 19).^{2,4,52,54,70,71,75,93,95,106-109} LBW is defined as infant birthweight < 2,500 g. Overall, the risk of LBW decreased as gestational weight gain increased. In general, risks for LBW began to decrease for gestational weight gains above 25 to 30 pounds. In 11 of these studies, the analyses were adjusted for multiple confounders, including maternal age, pregravid BMI, smoking, alcohol use, gestational age, parity, race, marital status, maternal education, pregnancy complications, and infant sex.^{2,4,52,70,71,75,93,106-109}

Overview of results. Ten studies considered the relationship between LBW and total gestational weight gain (Table 15).^{2,4,52,54,71,93,106-109} One of these studies was rated good quality,¹⁰⁶ seven of fair quality,^{2,4,52,71,93,107,108} and two of poor quality.^{54,109} In general, as gestational weight gain increased, LBW decreased.

Table 15. Total gestational weight gain and low birthweight (LBW)

Author, Year	Country, Setting	Sample Size	Baseline BMI	Quality	Pregravid Weight (How Measured)	Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hickey et al., 1990 ¹⁰⁶	United States, prenatal clinics	325	All weights/BMI	Good	Pregravid weight: Self-report	Total weight gain: Routine prenatal care or maternity records	G1: Percent BW < 3,000, Low weight gain < 120% of standard G2: Percent BW ≥ 3,000, Low weight gain < 120% of standard G3: Percent BW < 3,000, Acceptable weight gain ≥ 120% of standard G4: Percent BW ≥ 3,000, Acceptable weight gain ≥ 120% of standard	G1: 38.2 G2: 61.8 G3: 22.1 G4: 77.9	N/A
Cogswell et al., 1994 ²	USA, Pregnancy Nutrition Surveillance System	53,541	Normal/Overweight/Obese	Fair	Pregravid weight: Self-report	Total weight gain: Self-report	ORs and 95% CI, for LBW by GWG and prepregnancy BMI G1: Normal BMI, GWG < 15 lbs G2: Normal BMI, GWG ≥ 40 lbs G3: Normal BMI, GWG 25-29 lbs (Reference for normal BMI) G4: Overweight BMI, GWG 30-34 lbs G5: Overweight BMI, GWG 35-39 lbs G6: Overweight BMI, GWG ≥ 40 lbs G7: Overweight BMI, GWG 15-19 lbs (Reference for overweight BMI)	G1: 2.1 (1.6-2.6) G2: 0.5 (0.4-0.6) G3: 1.0 G4: 0.5 (0.3-0.8) G5: 0.6 (0.3-1.1) G6: 0.4 (0.3-0.7) G7: 1.0	Maternal age, maternal race, height, smoking, infant sex, gestational age

BMI, body mass index; BW, birthweight; CI, confidence interval; GDM, gestational diabetes mellitus; GWG, gestational weight gain; kg, kilogram; lbs, pounds; LBW, low birthweight; N/A, not applicable; OR, odds ratio.

Table 15. Total gestational weight gain and low birthweight (LBW) (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Rosenberg et al., 2005 ⁷¹ USA, vital statistics data 329,988 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	OR and 95% CI, for LBW G1: GWG ≥ 41 lbs G2: GWG < 41 lbs	G1: 0.41 (0.39- 0.43) G2: Reference	Maternal age, parity, GDM, pregnancy-induced hypertension, preeclampsia, pregravid weight, chronic diabetes, chronic hypertension, marital status, maternal education, mother's birthplace, prenatal care payer, social risk, trimester prenatal care began
Zhou and Olsen, 1997 ¹⁰⁸ Denmark, two communities 7,122 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	OR and 95% CI, for LBW for GWG categories by BMI G1: GWG < 11 kg, Underweight (Reference) G2: GWG < 11 kg, Normal weight G3: GWG < 11 kg, Overweight G4: GWG 12-15 kg, Underweight G5: GWG 12-15 kg, Normal weight G6: GWG 12-15 kg, Overweight G7: GWG ≥16 kg, Underweight G8: GWG ≥16 kg, Normal weight G9: GWG ≥16 kg, Overweight	G1: 1.0 G2: 0.9 (0.5-1.5) G3: 0.8 (0.3-2.0) G4: 0.5 (0.2-1.0) G5: 0.8 (0.4-1.5) G6: 0.9 (0.2-3.8) G7: 0.3 (0.1-1.0) G8: 0.4 (0.2-0.8) G9: 0.0 (0.0-2,500)	Maternal age, parity, alcohol, no diabetes, term delivery, smoking, infant sex, gestational age
Bianco et al., 1998 ⁵⁴ USA, medical center 613 Morbidly obese (BMI > 35) Poor	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	% LBW for GWG: G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs	G1: 2 G2: 11.1 G3: 8.3 G4: 5.2 G5: 3.8	N/A

Table 15. Total gestational weight gain and low birthweight (LBW) (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Lasker et al., 2005 ¹⁰⁹ USA, hospital 5,528 All weights/BMI Poor	Pregravid weight: Not stated Total weight gain: Routine prenatal care or maternity records	OR and 95% CI, for LBW G1: GWG < 10 lbs G2: GWG > 30 lbs G3: GWG 21-30 lbs (Reference)	G1: 2.43 (1.45-4.05) G2: 0.63 (0.47-0.85) G3: 1.00	Maternal age, maternal race, marital status, prenatal care, prior term births, prior abortions, prior preterm births, BMI at delivery, preeclampsia, bleeding, smoking, multiple births, premature birth, congenital anomaly, incompetent cervix, smoking

Three studies evaluated measures of gestational weight gain other than total gestational weight gain (Table 16).^{70,75,95} Two^{70,75} studies were of fair quality and one⁹⁵ was of poor quality. These studies suggest reduced risk of LBW in association with increases in net, proportional, or other measures of change in weight gain.

Results for total gestational weight gain and LBW. Results taken from a figure from a good-quality study of low-income black and Hispanic women showed the trend of decreasing LBW as maternal weight near term compared to the standard weight-for-height increased.¹⁰⁶ A population-based cohort study in New York City reported a protective effect for LBW (OR, 0.41; 95% CI, 0.39-0.43) for women who gained more than 41 pounds compared with women who gained less than 41 pounds.⁷¹ A study in Denmark found that the risk of LBW was significantly reduced only for underweight women gaining at least 12 kg when compared to underweight women gaining less than 11 kg (OR, 0.5; 95% CI, 0.2-1.0).¹⁰⁸ A study in Austria⁹³ found that the odds ratio of LBW was 0.9 (95% CI, 0.85-0.95) for each 1 kg increase in gestational weight gain. A study among obese women also found that the risk of having a LBW infant was increased for low gestational weight gains.⁴

Among low-income women the effect of weight gain varied by pregravid BMI;² only among women of average weight was there a consistent decrease in LBW risk as gestational weight gain increased from < 15 pounds to ≥ 40 pounds. Mothers of average weight who gained less than 15 pounds had an OR for delivering an LBW infant of 2.1 (95% CI, 1.6-2.6). The odds of LBW were substantially lower for women who gained more than 40 pounds (OR, 0.5; 95% CI, 0.4-0.6). There was no reduction in the percentage of LBW infants for weight gains above 30 to 34 pounds for overweight women, and for weight gains above 15 to 19 pounds for obese women. For overweight women gaining 30 to 34 pounds, the OR was 0.5 (95% CI, 0.3-0.8). The poor-quality studies showed results in the same general direction.^{54,109}

ratios reported are in comparison with women gaining < 14.9 pounds. For mothers gaining > 33 pounds, the OR was 0.38 (95% CI, 0.2-0.8); for women gaining 24 to 33 pounds, the OR was 0.54 (95% CI, 0.28-1.04); and for women gaining 14.9 to 23.5 pounds, the OR was 0.51 (95% CI, 0.27-0.98) The association between risk of LBW infants and proportional weight gain (total gestational weight gain divided by pregravid weight) above and below the median was also evaluated in relation to BMI status.⁷⁵ Obese women had a higher percentage of LBW infants than underweight women. The risk of LBW was even higher for women gaining less than the median.

A study of adolescent mothers (rated poor quality) showed similar effects. Mothers who shifted to lower weight classes during pregnancy were more likely to have LBW babies, and mothers who progressed to higher weight classes had lower percentages of LBW.⁹⁵

Macrosomia.

Study characteristics. Twelve studies examined the influence of gestational weight gain on macrosomia in their infants (Evidence Table 20).^{2,4,49,59,70,77,93,108,110-113} Studies did not define macrosomia consistently. Four studies defined macrosomia as birthweight > 4,500 g.^{2,108,110,113} Seven of the remaining eight studies defined macrosomia as birthweight > 4,000 g.^{4,59,70,77,93,111,112} One study applied both definitions.⁴⁹ One¹¹⁰ study was rated to be of good quality, nine^{2,4,70,77,93,108,111-113} of fair quality, and two^{49,59} of poor quality.

Overview of results. In four studies (all fair^{2,108,110,113}) defining macrosomia as birth > 4,500 g and seven (6 fair^{4,70,77,93,111,112} and 1 poor⁵⁹) studies defining macrosomia as birthweight > 4000 g, the highest weight gains were demonstrated to be associated with macrosomia. A single poor study failed to show a significant association, using either definition of macrosomia.⁴⁹

Detailed results. In four of the studies in which macrosomia was defined as birthweight > 4,500 g,^{2,108,110,113} the highest weight gains were associated with increased risk of macrosomia (Table 17). These four studies adjusted for multiple confounders such as age, BMI, race, parity, glucose levels, placental weight, smoking status, gestational age, and infant sex.^{2,108,110,113} A nested case-control study (rated good quality), using women gaining 0.22 to 0.31 kg per week as the reference group, found that women with the highest rates of pregnancy weight gain (0.40 to 1.03 kg/week) were at increased risk for macrosomia (OR,2.23; 95% CI, 1.54-3.22) and that women with the lowest rates (-0.26 to 0.21 kg/week) were at decreased risk (OR,0.52; 95% CI, 0.34-0.79).¹¹⁰ Results were similar when considering rates of weight gain only before 24 to 28 weeks of gestation.

A fair-quality study in Denmark also showed increased risk of macrosomia at the highest weight gains, with the highest risks among overweight and obese women.¹⁰⁸ However, the confidence intervals from this study are very imprecise. A fair-quality study in Norway showed similar results, with increasing ORs as weight gain increased. Women with weight gain in the fourth quartile, as compared to weight gain in the first quartile, had the highest OR of 4.3 (95% CI, 1.9-9.8).¹¹³

Table 17. Gestational weight gain and macrosomia > 4,500 g

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hedderson et al., 2006 ¹¹⁰	Pregravid weight: Self-report	ORs and 95% CI, for macrosomia based on rate of weight gain	G1: 0.52 (0.34-0.79) G2: 1.00 G3: 0.99 (0.67-1.47) G4: 2.23 (1.54-3.22)	Maternal age, maternal race/ethnicity, parity, pregravid BMI, screening glucose value, gestational age
USA, Kaiser Permanente Medical Care Program 45,245 All weights/BMI	Total weight gain: Routine prenatal care or maternity records	Rate of gain kg/wk: G1: -0.26 to 0.21 G2: 0.22 to 0.31 (Reference) G3: 0.32 to 0.39 G4: 0.40 to 1.03		
Good				
Clausen et al., 2005 ¹¹³	Pregravid weight: Routine prenatal care	ORs and 95% CIs for macrosomia	G1: 1.0 G2: 2.1 (0.8-5.1) G3: 3.5 (1.5-8.0) G4: 4.3 (1.9-9.8)	Maternal age, parity, smoking, placental weight, gestational diabetes, first trimester BMI
Norway, university hospital 2050 All weights/BMI	Total weight gain: Routine prenatal care of maternity records	G1: WG, Quartile 1 (Reference) G2: WG, Quartile 2 G3: WG, Quartile 3 G4: WG, Quartile 4		
Fair				
Cogswell et al., 1994 ²	Pregravid weight: Self-report	ORs and 95% CIs for macrosomia by GWG and prepregnancy BMI	G1: 1.0 G2: 1.5 (1.0-2.3) G3: 3.3 (2.3-4.7) G4: 1.0 G5: 4.0 (1.6-10.1) G6: 1.0 G7: 1.9 (1.3-2.9) G8: 2.1 (1.3-3.2) G9: 2.3 (1.6-3.3)	Maternal age, maternal race, height, smoking, infant sex, gestational age
USA, Pregnancy Nutrition Surveillance System 53,541 Normal/Overweight/ Obese Fair	Total weight gain: Self-report	G1: Normal BMI, GWG 25- 29 lbs (Reference for normal BMI) G2: Normal BMI, GWG 35- 39 lbs G3: Normal BMI, GWG ≥ 40 lbs G4: Overweight BMI, GWG 15-19 lbs (Reference for overweight BMI) G5: Overweight BMI, GWG ≥ 40 lbs G6: Obese, GWG 15-19 lbs (Reference for obese GMI) G7: Obese BMI, GWG 30- 34 lbs G8: Obese BMI, GWG 35- 39 lbs G9: Obese BMI, GWG ≥ 40 lbs		

BMI, body mass index; CI, confidence interval; GWG, gestational weight gain; kg, kilogram; kg/wk, kilogram per week; N/A, not applicable; OR, odds ratio; wk, week.

Table 17. Gestational weight gain and macrosomia > 4,500 g (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Zhou and Olsen, 1997 ¹⁰⁸	Pregravid weight: Self-report	OR and 95% CI, for macrosomia by GWG categories and BMI	G1: 1.0 G2: 52.8 (0.3-22.9) G3: 9.7 (1.2-81.8) G4: 0.0 (0.0-7x10 ⁵) G5: 6.8 (0.9-51) G6: 27.1 (3.3-220) G7: 6.1 (0.7-52.5) G8: 15.7 (2.2-114) G9: 45.6 (6.0-349)	Maternal age, parity, alcohol, no diabetes, term delivery, smoking, infant sex, gestational age
Denmark, two communities 7,122 All weights/BMI Fair	Total weight gain: Routine prenatal care or maternity records	G1: GWG < 11 kg, underweight (Reference) G2: GWG < 11 kg, normal weight G3: GWG < 11 kg, overweight G4: GWG 12-15 kg, underweight, G5: GWG 12-15 kg, normal weight G6: GWG 12-15 kg, overweight G7: GWG ≥ 16 kg, underweight G8: GWG ≥ 16 kg, normal weight G9: GWG ≥ 16 kg, overweight		
Brennand et al., 2005 ⁴⁹	Pregravid weight: Medical records	% Macrosomia among obese women only	G1: 16.9% G2: 15.3% G3: 18.4% (<i>P</i> = 0.834)	N/A
Canada, medical records 603 Normal/Overweight/ Obese Poor	Total weight gain: Routine prenatal care or maternity records	G1: Low WG, < 7 kg G2: Acceptable WG, 7-11.5 kg G3: Excessive WG, > 11.5 kg		

Among low-income women enrolled in the Supplemental Food Program for Women, Infants, and Children (WIC), a fair-quality US study reported significant associations between weight gain and macrosomia only for women gaining more than 30 to 34 pounds when compared with women gaining 25 to 29 pounds for women of normal weight or with women gaining 5 to 19 pounds for overweight and obese women.² For average-weight women, the OR was 1.5 (95% CI, 1.0-2.3), for those gaining 35 to 39 pounds and 3.3 (95% CI, 2.3-4.7) for women gaining 40 pounds or more. Overweight women also had high risks for macrosomia, but only at weight gains of 40 pounds or more (OR, 4.0; 95% CI, 1.6-10.1). The OR among obese women gaining 30 to 34 pounds was 1.9 (95% CI, 1.3-2.9). Similar results were found for obese women gaining more than 35 pounds with odds ratios ranging from 2.1 to 2.3.

In a US study of Cree women (rated poor quality), weight gain among obese women was not significantly associated with macrosomia.⁴⁹

Of the eight studies that considered macrosomia as > 4,000 g, seven found a significant association between gestational weight gain and macrosomia (Table 18).^{4,59,70,77,93,111,112} In

general, the highest weight gains were associated with an increased risk of macrosomia. Six^{4,70,77,93,111,112} of these studies were rated of fair quality, and one⁵⁹ of poor quality. These studies were adjusted for multiple confounders including maternal age, race, education, parity, height, pregravid weight, pregravid BMI, distantia cristarum, length of gestation, glucose levels, smoking status, and infant sex.

Table 18. Gestational weight gain and macrosomia > 4,000g

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Bergmann et al., 2003 ¹¹²	Pregravid weight: Not stated	ORs and 95% CIs of macrosomia	G1: 1.0 G2: 1.85 (1.77-1.93) G3: 3.37 (3.22-3.53)	Pregravid BMI, height, parity, smoking, diabetes, postterm delivery
Germany, Berlin Perinatal Registry 206,308	Total weight gain: Not stated	G1: WG < 10 kg (Reference) G2: WG 10-16 kg G3: WG ≥ 16 kg		
All weights/BMI				
Fair				
Jain et al., 2007 ⁷⁷	Pregravid weight: Not stated	ORs and 95% CIs for macrosomia	G1: 0.49 (0.30-0.82) G2: 1.0 G3: 1.17 (0.82-1.65) G4: 2.83 (2.04-3.92)	Maternal age, pregravid BMI, parity, education, race/ethnicity, US/foreign origin
USA, birth certificate records and Pregnancy Risk Assessment Monitoring System 7,661	Total weight gain: Birth certificate	G1: WG ≤ 15 lbs G2: WG 15-24 lbs G3: WG 25-35 lbs G4: WG ≥ 35 lbs		
All weights/BMI				
Fair				
Johnson et al., 1992 ⁷⁰	Pregravid weight: Self-report	OR and 95% CI, for macrosomia	G1: 1.0 G2: 1.20 (0.83-1.75) G3: 1.77 (1.24-2.52) G5: 2.86 (2.02-4.02)	Maternal race, parity, pregravid BMI, height, pregravid weight, marital status, education, tobacco/alcohol/drug use, pregnancy-induced hypertension, gestational age, macrosomia, infant sex
USA, prenatal clinics 3,191	Total weight gain: Routine prenatal care or maternity records	G1: Net WG < 14.9 lbs (Reference) G2: Net WG 14.9-23.5 lbs G3: Net WG 24-33 lbs G4: Net WG > 33 lbs		
All weights/BMI				
Fair				

BMI, body mass index; CI, confidence interval; GA, gestational age; GWG, gestational weight gain; lbs, pounds; OGTT, oral glucose tolerance test; OR, odds ratio; WG, weight gain.

Table 18. Gestational weight gain and macrosomia > 4,000g (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Kiel et al., 2007 ⁴ USA, birth certificate registry 120,251 Obese Fair	Pregravid weight: Medical records Total weight gain: Routine prenatal care or maternity records	G1: Odds of macrosomia for WG > 25 lbs G2: OR of macrosomia for WG < 15 lbs G3: Reference WG 15-25 lbs	G1: Odds of Macrosomia are higher for women in this group G2: Odds of Macrosomia are lower for women in this group Numerical value for ORs not reported in study	Maternal age, maternal race, maternal education, poverty, smoking, parity, chronic hypertension
Kirchengast and Hartmann 2003 ⁹³ Austria, university hospital 8,011 All weights/BMI Fair	Pregravid weight: Estimated from measured weight at first prenatal visit Total weight gain: Routine prenatal care or maternity records	G1: OR and 95% CI, for Macrosomia	G1: 1.07 (1.05-1.10)	Maternal age, pregravid weight, height, distantia cristarum
Takimoto et al., 2006 ¹¹¹ Japan, obstetric units 112,257 All weights/BMI Fair	Pregravid weight: Medical records Total weight gain: Routine prenatal care or maternity records	ORs and 95% CI, for macrosomia G1: Total GWG < 25th percentile for GA G2: Total GWG 25-49th percentile for GA G3: Total GWG 50-74th percentile for GA (Reference) G4: Total GWG 75-89th percentile for GA G5: Total GWG ≥90th percentile for GA	G1: 0.31 (0.20,-0.47) G2: 0.49 (0.34-0.70) G3: 1.0 G4: 1.62 (1.24-2.12) G5: 2.41 (1.83-3.17)	Maternal age, parity, pregravid weight, gestational age, infant sex
Brennand et al., 2005 ⁴⁹ Canada, medical records 603 Normal/Over- weight/Obese Poor	Pregravid weight: Medical records Total weight gain: Routine prenatal care or maternity records	% Macrosomia among obese women only G1: Low WG, < 7 kg G2: Acceptable WG, 7- 11.5 kg G3: Excessive WG, > 11.5 kg	G1: 47.0% G2: 42.9% G3: 54.4% (P = 0.234)	N/A

Table 18. Gestational weight gain and macrosomia > 4,000g (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Jensen et al., 2005 ⁵⁹	Pregravid weight: Self-report	ORs and 95% CIs for Macrosomia	G1: 1.0 G2: 1.8 (0.8-3.8) G3: 2.2 (1.0-4.7) G4: 4.0 (1.8-9.0)	Maternal age, pregravid BMI, gestational age, 2- hour OGTT, parity, smoking, ethnicity, clinical center
Denmark, university hospitals	Total weight gain: Routine prenatal care or maternity records	G1: GWG < 5.0 kg (Reference) G2: GWG 5.0-9.9 kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0 kg		
481				
Obese				
Poor				

Among the fair-quality studies of gestational weight gain on macrosomia, ORs for this association were between 2.41 and 3.37 for the highest weight gains when compared to weight gains within the normal range.^{70,77,111,112} Among a cohort of Japanese women (fair-quality study), the group with total weight gain above the 90th percentile for gestational age had an OR for macrosomia of 2.41 (95% CI, 1.83-3.17) relative to the group in the 50th to 74th percentile.¹¹¹ The effect was reduced for total weight gain based on percentile for gestational age for the lower percentile ranges. A fair-quality US study looked at the association between net weight gain (total gestational weight gain minus infant birthweight) and macrosomia.⁷⁰ With women gaining < 14.9 pounds as the reference group, the strongest effect was noted among women gaining > 33 pounds (OR, 2.86; 95% CI, 2.02-4.02), followed by women gaining 24 to 33 pounds (OR, 1.77; 95% CI, 1.24-2.52); no significant effect was observed for women gaining 14.9 to 23.5 pounds. A fair-quality study in Germany found a higher risk of macrosomia for women gaining more than 16 kg as compared to women gaining less than 10 kg (OR, 3.37; 95% CI, 3.22-3.53).¹¹² Similar results were noted in a fair-quality US study where weight gains above 35 pounds (as compared to weight gains of 15 to 25 pounds) were associated with an OR for macrosomia of 2.83 (95% CI, 2.04-3.92).⁷⁷ A fair-quality study in Austria found that for each 1 kg increase in gestational weight gain, the OR for macrosomia was 1.07 (95% CI, 1.05-1.10).⁹³ Of the poor-quality studies, one found results in a similar direction.⁵⁹ One poor-quality study among obese Cree women found that the percent macrosomia did not differ between weight gain groups.⁴⁹

Size based on gestational age.

Study characteristics. Twenty-five articles from 23 studies examined the association between gestational weight gain and large-for-gestational-age (LGA) and small-for-gestational-age (SGA) infants.^{4,51,58,59,61,66,68,89,95,100,105,108,111,114-123} These investigators used various definitions to

classify both LGA and SGA infants. Some defined LGA as birthweight greater than the 90th percentile or more than 2 standard deviations (SD) above the mean. Some defined SGA as birthweight less than the 10th (or 15th) percentile or more than 2 (or 1.5) SD below the mean.

Of the 14 articles addressing LGA (Evidence Table 21),^{4,54,58,59,61,68,100,105,115,116,118,120-122} two defined LGA using the > 2 SD criterion.^{58,120} Ten used the commonly applied 90th percentile definition,^{4,54,59,61,100,105,115,116,118,121} one study evaluated multiple percentiles,⁶⁸ and one defined

LGA as fetal growth ratio (FGR) > 1.15.¹²² FGR is the ratio of the observed birthweight at a given gestational age to the mean birthweight at a given gestational age for a certain fetal growth distribution.

SGA definitions varied considerably as well: birthweight < 10th percentile; < 2 (or 1.5) SD below the mean; FGR < 0.85; or a combination of birthweight and percentile of placenta weight. If a study used a definition other than birthweight < 10th percentile, the specific criterion used will be noted in the text below. In general, the lowest weight gains were associated with increased risks for SGA.

Overview of results for LGA. Among the studies that did not use BMI status (Table 19), six^{100,105,115,118,121,122} were rated of fair quality and four^{54,59,68,120} of poor quality. All reported lower risks of LGA with lower gestational weight gain. Studies that stratify by BMI status present greater challenges to synthesis. Two studies (1 good¹¹⁶ and 1 fair⁵⁸) examined a range of BMI categories, and found inconsistent results: one reported that the estimates of LGA did not differ greatly across BMI categories¹¹⁶ while the other reported that high weight gain (> 16 kg) was strongly associated with LGA, and this association was most pronounced in the lowest BMI categories. A fair-quality study of obese women⁴ observed lower odds of LGA among women who gained less than the reference group (15-25 pounds) and higher odds of LGA among women who gained more the reference group. A poor-quality study among Japanese women found that nulliparous women in the highest weight gain category (> 0.40 kg/week) had ORs for LGA of 2.25 (95% CI, 1.03-4.94) for low BMI women and 2.58 (95% CI, 1.71-3.89) for medium BMI women.⁶¹

Table 19. Gestational weight gain and LGA

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Bo et al., 2003 ¹¹⁵ Italy, university clinic 700 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Not collected	G1: OR and 95% CI, for LGA for each 1 kg increase in GWG	G1: 1.08 (1.03-1.12)	Maternal age, pregravid BMI, smoking, gestational hyperglycaemia
Kitajima et al., 2001 ¹²¹ Japan, university hospital 146 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: OR and 95% CI, for LGA for each 1 kg increase in GWG	G1: 1.08 (0.81-1.44)	Pregravid BMI, maternal plasma glucose levels, gestational age, infant sex

BMI, body mass index; CI, confidence interval; g, grams; GDM, gestational diabetes mellitus; GWG: gestational weight gain; kg, kilogram; lbs, pounds; LGA, large-for-gestational-age; N/A, not applicable; NS, non-significant; OR, odds ratio; SD: standard deviation; USCF, University of Southern California at San Francisco; WG, weight gain.

Table 19. Gestational weight gain and LGA (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Kramer et al., 1990 ¹²² Canada, university hospital 8,719 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: OR and 95% CI, for LGA for each 5 kg decrease in net gestational WG	G1: 0.73 (0.68-0.79)	Pregravid weight, infant sex, smoking, parity, maternal diabetes, height, previous LBW infant, severe pregnancy-induced hypertension
Muscatti et al., 1996 ¹⁰⁵ Canada, public health department 371 All weight/BMI Fair	Pregravid weight: Medical records Total weight gain: Collected by study investigators	G1: OR for LGA per 1 kg increase in WG up to week 20 G2: OR for LGA per 1 kg increase in WG from weeks 21 to 30 G3: OR for LGA per 1 kg increase in WG from weeks 31 to term	G1: 1.17 (<i>P</i> < 0.001) G2: 1.16 (<i>P</i> < 0.01) G3: 1.02 (<i>P</i> = NS)	Parity, pregravid standard weight, pregravid excess weight, birth length, infant sex
Parker and Abrams, 1992 ¹¹⁸ USA, hospital 6,690 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	ORs and 95% CIs of LGA for high WG G1: Compared to UCSF Cohort 25-75th percentile of WG G2: Compared to UCSF 10-90th percentile of WG	G1: 1.89 (1.51-2.37) G2: 1.87 (1.39-2.52)	Maternal age, maternal race, parity, gestational age, smoking, pregravid BMI, height
Pezzarossa et al., 1996 ¹⁰⁰ Italy, not stated 192 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	Relative risks for LGA G1: GWG < 9 kg G2: GWG 9-14 kg	G1: Relative risks for LGA similar between non-diabetic and GDM groups G2: GDM group has 2 times higher risk than non-diabetics Numerical results not reported.	Pregravid BMI, fasting plasma glucose
Bianco et al., 1998 ⁵⁴ USA, medical center 613 Morbidly obese (BMI > 35) Poor	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	% LGA for GWG: G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs	G1: 12.0 G2: 11.8 G3: 18.8 G4: 25.8 G5: 23.8 (<i>P</i> < 0.01)	N/A

Table 19. Gestational weight gain and LGA (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Ekblad and Grenman, 1992 ⁶⁸	Pregravid weight: Medical records	Infant BW by group	G1: 1% G2: 6% G3: 35%	N/A
Finland, hospital 357	Total weight gain: Routine prenatal care or maternity records	Infant weight percentile for mothers with normal pregravid weight and normal weight gain	G4: 43% G5: 13% G6: 2%	
Prepregnancy weight 20% over or under ideal body weight for height and normal weight		G1: < 2.5% G2: 2.5-10% G3: 10-50% G4: 50-90% G5: 90-97.5% G6: > 97.5%	G7: 3% G8: 14% G9: 32% G10: 34% G11: 14% G12: 3%	
Poor		Infant weight percentile for mothers with weight gain ≤5 kg	G13: 0% G14: 2% G15: 42% G16: 29% G17: 20% G18: 7%	
		Infant weight percentile for mothers with weight gain ≥20 kg	G13: < 2.5% G14: 2.5-10% G15: 10-50% G16: 50-90% G17: 90-97.5% G18: > 97.5%	
Jensen et al., 2005 ⁵⁹	Pregravid weight: Self-report	ORs and 95% CIs for LGA	G1: 1.0 G2: 2.4 (1.1-5.3) G3: 2.1 (1.1-4.8) G4: 4.7 (2-11)	Maternal age, pregravid BMI, gestational age, 2 hour OGTT, parity, smoking, ethnicity, clinical center
Denmark, university hospitals 481	Total weight gain: Routine prenatal care or maternity records	G1: GWG < 5.0 kg (Reference) G2: GWG 5.0-9.9 kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0 kg		
Obese Poor				
Sunehag et al., 1991 ¹²⁰	Pregravid weight: Not stated	G1: Association between LGA and GWG > 18 kg	G1: $\chi^2 = 8.2$ ($P < 0.005$)	N/A
Italy, prenatal clinics 133	Total weight gain: Not stated			
All weights/BMI Poor				

Detailed results. Among the studies that did not use BMI status (Table 19), three fair-quality studies that evaluated the impact of a 1 kg increase in weight gain produced similar results.^{105,115,121} For Italian women, the OR of having an LGA infant was 1.08 (95% CI, 1.03-1.12).¹¹⁵ For nondiabetic Japanese women with a positive diabetic screen, the OR was 1.08 (95% CI, 0.81-1.44).¹²¹ The third study evaluated this relationship separately for weight gain by time: up to week 20, from week 21 to week 30, and from week 31 to term. It found ORs of 1.17, 1.16, and 1.02 (non-significant), respectively.¹⁰⁵ The OR for weeks 31 to term was not significant. In other words, the odds of giving birth to an LGA infant tends to increase for each 1 kg increase in gestational weight gain during the first and second trimester.

Two fair-quality studies^{100,118} considered the association between categorical weight gain and LGA. In a US study,¹¹⁸ women with the highest weight gains were at increased risk for LGA (OR, 1.89; 95% CI, 1.51-2.37) relative to women in the 25th to 75th percentile of weight gain and to women in the 10th to 90th percentile (OR, 1.87; 95% CI, 1.39- 2.52). In a study involving mothers with GDM,¹⁰⁰ the risks for LGA were similar for weight gains up to 9 kg. However, for weight gains of 9 to 14 kg, the risk of LGA for mothers with GDM was two times that for nondiabetic mothers.

In a study that defined LGA as FGR > 1.15,¹²² the OR for having an LGA infant given a 5 kg decrease in net gestational weight gain (total gestational weight gain minus infant birthweight) was 0.73 (95% CI, 0.68-0.79). This result is consistent with other studies reporting that the odds of LGA drops with lower gains in maternal weight.

The poor-quality studies showed similar results. LGA was significantly related to the highest weight gains among studies of GDM mothers,¹²⁰ obese glucose-tolerant mothers,⁵⁹ and morbidly obese mothers.⁵⁴ A Finnish study⁶⁸ noted that women gaining ≥ 20 kg were more likely to have babies in the higher weight gain percentile categories, but these differences were not significantly different.

Four studies stratified results by BMI status (Table 20).^{4,58,61,116} In a good-quality US study, the estimates of LGA did not differ greatly across BMI categories.¹¹⁶ The ORs of LGA for rate of weight gain of 50 g per week were as follows: among underweight women, 1.25 (95% CI, 1.11-1.41); among women of normal weight, 1.14 (95% CI, 1.08-1.20); and among overweight and obese women, 1.14 (95% CI, 1.07-1.20). In a fair-quality study based on the Swedish birth registry,⁵⁸ high weight gain (> 16 kg) was strongly associated with LGA, and this association was most pronounced in the lowest BMI categories. In comparison with the risk of LGA among women with weight gain between 8 and 16 kg (the reference group), adjusted ORs by BMI categories were as follows: BMI < 20, 3.26 (95% CI, 2.76-3.86); BMI ≥ 35 , 1.54 (95% CI, 1.24-1.90).

Table 20. Gestational weight gain and LGA by BMI status

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Caulfield et al., 1998 ¹¹⁶ USA, hospital obstetric database 3,870 All weights/BMI Good	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	ORs and 95% CIs for LGA per 50g/wk increase in rate of weight gain by BMI G1: Underweight G2: Normal weight G3: Overweight	G1: 1.25 (1.11-1.41) G2: 1.14 (1.08,-1.20) G3: 1.13 (1.07-1.20)	Maternal age, race, parity, pregravid BMI, height, hypertension, provider type, smoking, infant sex
Cedergren, 2006 ⁵⁸ Sweden, Medical Birth Registry 245,526 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	ORs and 95% CIs for LGA (> 2 SD above the mean) Weight gain < 8 kg G1: BMI < 20 G2: BMI 20-24.9 G3: BMI 25-29.9 G4: BMI 30-34.9 G5: BMI ≥ 35 Weight gain > 16 kg G6: BMI < 20 G7: BMI 20-24.9 G8: BMI 25-29.9 G9: BMI 30-34.9 G10: BMI ≥ 35 Weight gain 8-16 kg (Reference)	G1: 0.43 (0.24-0.75) G2: 0.53 (0.47-0.61) G3: 0.48 (0.43-0.53) G4: 0.66 (0.59-0.75) G5: 0.54 (0.46-0.63) G6: 3.26 (2.76-3.86) G7: 2.73 (2.60-2.88) G8: 2.14 (2.01-2.28) G9: 2.24 (2.00-2.51) G10: 1.54 (1.24-1.90)	Maternal age, parity, smoking, year of birth
Kiel et al., 2007 ⁴ USA, birth certificate registry 120,251 Obese Fair	Pregravid weight: Medical records Total weight gain: Routine prenatal care or maternity records	G1: Odds of LGA for weight gain > 25lbs G2: OR of LGA for weight gain < 15lbs G3: Reference weight gain 15-25 lbs	G1: Odds of LGA are higher for women in this group G2: Odds of LGA are lower for women in this group Numerical value for ORs not reported in study	Maternal age, maternal race, maternal education, poverty, smoking, parity, chronic hypertension

BMI, body mass index; CI, confidence interval; g, grams; g/wk, gram per week; kg/wk, kilogram per week; LGA, large for gestational age; OR, odds ratio; SD, standard deviation; WG, weight gain.

Table 20. Gestational weight gain and LGA by BMI status (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Wataba et al., 2006 ⁶¹ Japan, academic medical center 21,718 All weights/BMI Poor	Pregravid weight: Not stated Total weight gain: Routine prenatal care or maternity records	ORs and 95% CIs for LGA Nulliparous G1: Low BMI (< 18), WG > 0.40 kg/wk G2: Medium BMI (18- 23.9), WG 0.20-0.25 kg/wk G3: WG 0.25-0.30 kg/wk (Reference) G4: Medium BMI, WG 0.30-0.35 kg/wk G5: Medium BMI, WG 0.35-0.40 kg/wk G6: Medium BMI, WG > 0.40 kg/wk Parous G7: Low BMI (< 18), WG > 0.40 kg/wk G8: WG 0.20-0.25 kg/wk (Reference for low/med BMI) G9: Medium BMI (18- 23.9), WG 0.25-0.30 kg/wk G10: Medium BMI, WG 0.30-0.35 kg/wk G11: Medium BMI, WG 0.35-0.40 kg/wk G12: Medium BMI, WG > 0.40 kg/wk G13: High BMI (≥24), WG 0.15-0.20 kg/wk G14: WG ≥ 0.30 kg/wk (Reference for high BMI)	G1: 2.25 (1.03-4.94) G2: 1.41 (1.31-1.76) G3: 1.0 G4: 1.76 (1.38-2.23) G5: 2.34 (1.77-3.10) G6: 2.58 (1.71-3.89) G7: 2.16 (0.63- 7.44) G8: 1.0 G9: 1.48 (1.15-2.33) G10: 1.64 (1.18-2.27) G11: 2.23 (1.51-3.31) G12: 3.94 (2.56-6.03) G13: 2.27 (1.31-3.95) G14: 1.0	Preeclampsia, C- section, 1-minute Apgar score < 4

In a fair-quality study of obese women,⁴ lower odds of LGA were observed among women who gained less than the reference group (15-25 pounds) and higher odds of LGA were observed among women who gained more the reference group. Minimal risk for LGA was observed at weight gains of 10 to 25 pounds for class I obese women (BMI 30-34.9), at gains of 0 to 9 pounds for class II obese women (BMI 35-39.9), and at gains of 0 to 9 pounds for class II obese women (BMI ≥ 40). A poor-quality study among Japanese women found that nulliparous women in the highest weight gain category (> 0.40 kg/week) had ORs for LGA of 2.25 (95% CI, 1.03-4.94) for low BMI women and 2.58 (95% CI, 1.71-3.89) for medium BMI women.⁶¹

Eleven studies^{4,58,59,61,100,105,115,116,118,121,122} adjusted for potential confounders including age, pregravid BMI, glucose levels, smoking status, parity, and gestational age.

Overview of results for SGA. Twenty studies examined the relationship between gestational weight gain and SGA (Evidence Table 22).^{4,51,54,58,59,61,66,68,89,95,105,108,111,114,116,118,119,122-124} One study was of good quality,¹¹⁶ twelve of fair quality,^{19,24,53,69,72,76,79,83,85,89-91} and seven of poor quality.^{11,14,20,22,29,31,59} SGA births as a percentage of all births tended to be highest for the lowest weight gains.

Detailed results for SGA. As with LGA results, we discuss results relating to the simple association between weight gain and risk for SGA separately (Table 21) from those that also take BMI status into account (Table 22). Among indigent US women (fair-quality study),⁸⁹ the percentage of SGA infants was 9.9 among women gaining < 0.24 kg per week, and 5.7 among the group gaining ≥ 0.75 kg per week. Similar results were observed among a cohort of Japanese women (fair-quality study),¹¹¹ which defined SGA as birthweight < 1.5 SD below the mean. The percentage of SGA infants ranged from 10.9 percent in the lowest weight gain group (< 25th percentile of weight gain) to 3.1 percent in the highest weight gain group (≥ 90th percentile of weight gain). Another fair-quality US study observed an increased incidence of SGA at low weight gains; the incidence among obese women with low weight gain was two times that among obese women with normal weight gain.¹¹⁸ Similar results were obtained in a poor-quality study of morbidly obese women.⁵⁴

Table 21. Gestational weight gain and SGA

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Parker and Abrams, 1992 ¹¹⁸ USA, hospital 6,690 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	ORs and 95% CIs of SGA for low WG G1: Compared to UCSF Cohort 25- 75th percentile of WG G2: Compared to UCSF 10-90th percentile of WG	G1: 2.06 (1.62-2.63) G2: 1.82 (1.35-2.47)	Maternal age, maternal race, parity, gestational age, smoking, pregravid BMI, height
Cheng et al., 2004 ¹²⁴ USA, birth certificate registry 14,114 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Not stated	OR and 95% CI, for SGA G1: WG < 0.2 kg/wk G2: WG ≥ 0.2 kg/wk (Reference)	G1: 1.9 (1.8-2.2) G2: 1.0	Maternal age, education, Medicaid status, pregravid BMI, smoking, previous SGA, adequacy of prenatal care, maternal cardiac disease, preeclampsia, year of birth of second infant

BMI, body mass index; CI, confidence interval; EW, expected weight; FGR, fetal growth ratio; G, group; GWG, gestational weight gain; kg, kilogram; kg/wk, kilogram per week; lb, pound; NS, non-significant; OR, odds ratio; SGA, small-for-gestational-age; WG, weight gain.

Table 21. Gestational weight gain and SGA (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Cnattingius et al., 1998 ¹²³ Sweden, Medical birth register 167,750 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	ORs and 95% CIs for SGA G1: WG < 0.25 kg/wk G2: WG 0.25-0.34 kg/wk G3: WG 0.35-0.44 kg/wk G4: ≥ 0.45 kg/wk (Reference)	G1: 3.0 (2.5-3.5) G2: 1.9 (1.6-2.2) G3: 1.3 (1.1-1.5) G4: 1.0	Maternal age, parity, pregravid BMI, height, education, mother living with father, smoking
Dawes and Grudzinskas, 1991 ¹¹⁹ UK, hospital 1,092 All weights/BMI Fair	Pregravid weight: Measured at first prenatal visit Total weight gain: Routine prenatal care or maternity records	Average weekly weight gain < 0.20 kg as a predictor of SGA G1: Sensitivity G2: Specificity	G1: 12.9% G2: 91.3%	Maternal age, parity, pregravid BMI, weight, smoking, gestational age
Kiel et al., 2007 ⁴ USA, birth certificate registry 120,251 Obese Fair	Pregravid weight: Medical records Total weight gain: Routine prenatal care or maternity records	G1: Odds of SGA for weight gain > 25lbs G2: OR of SGA for weight gain < 15 lbs G3: Reference Weight gain 15-25 lbs	G1: Odds of SGA are lower for women in this group G2: Odds of SGA are higher for women in this group Numerical value for ORs not reported in study	Maternal age, maternal race, maternal education, poverty, smoking, parity, chronic hypertension
Kramer et al., 1990 ¹²² Canada, university hospital 8,719 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	G1: OR and 95% CI, for SGA for each 5 kg decrease in net gestational WG	G1: 1.32 (1.20-1.44)	Pregravid weight, infant sex, smoking, parity, maternal diabetes, height, previous LBW infant, severe pregnancy- induced hypertension

Table 21. Gestational weight gain and SGA (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Muscati et al., 1996 ¹⁰⁵	Pregravid weight: Medical records	G1: OR for SGA per 1 kg increase in WG up to week 20	G1: 0.93 (<i>P</i> = NS) G2: 0.85 (<i>P</i> < 0.01) G3: 0.89 (<i>P</i> < 0.01)	Parity, pregravid standard weight, pregravid excess weight, birth length, infant sex
Canada, public health department 371	Total weight gain: Collected by study investigators	G2: OR for SGA per 1 kg increase in WG from weeks 21 to 30 G3: OR for SGA per 1 kg increase in WG from weeks 31 to term		
All weight/BMI Fair				
Steward and Moser, 2004 ¹¹⁴	Pregravid weight: Not stated	G1: OR and 95% CI, for SGA defined as FGR < 0.85	G1: 0.98 (0.97-0.98)	Maternal age, race, education, marital status, pregravid weight, adequacy of prenatal care, smoking, infant sex
USA, vital statistics data 2,933	Total weight gain: Self-report			
All weights/BMI Fair				
Takimoto et al., 2006 ¹¹¹	Pregravid weight: Medical records	ORs and 95% CI, for SGA	G1: 2.87 (2.56-3.21) G2: 1.49 (1.35-1.66) G3: 1.0	Maternal age, parity, pregravid weight, gestational age, infant sex
Japan, obstetric units 112,257	Total weight gain: Routine prenatal care or maternity records	G1: Total GWG < 25th percentile for GA G2: Total GWG 25-49th percentile for GA G3: Total GWG 50-74th percentile for GA (Reference) G4: Total GWG 75-89th percentile for GA G5: Total GWG ≥90th percentile for GA	G4: 0.55 (0.55-0.72) G5: 0.45 (0.45-0.63)	
All weights/BMI Fair				

Table 21. Gestational weight gain and SGA (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Wen et al., 1990 ⁸⁹ USA, hospital Cohort 17,149 Fair	Pregravid weight: Measured at first prenatal visit Total weight gain: Routine prenatal care or maternity records	ORs for SGA G1: GWG < 0.24 kg/wk G2: GWG 0.24- 0.57 kg/wk G3: GWG 0.58- 0.74 kg/wk (Reference) G4: GWG ≥ 0.75 kg/wk	G1: 2.24 (<i>P</i> < 0.05) G2: 1.55 (<i>P</i> < 0.05) G3: 1.0 G4: 1.25 (NS)	Maternal age, race, parity, marital status, education, previous preterm delivery, alcohol use, drug use, maternal height, maternal weight, smoking, infant sex
Bianco et al., 1998 ⁵⁴ USA, medical center 613 Morbidly obese (BMI > 35) Poor	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	% SGA for GWG: G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs	G1: 4 G2: 3.9 G3: 5.6 G4: 3.1 G5: 3.8	N/A
Cherry et al., 1993 ⁹⁵ USA, hospital 599 All weights/BMI Poor	Pregravid weight: Measured by study investigators Total weight gain: Routine prenatal care or maternity records	%SGA for each shifting of EW category. Light: < 90% EW Normal: 90 to 110% of EW Heavy: > 110% EW G1: Normal to Heavy G2: Light to Normal G3: Heavy to Heavy G4: Normal to Normal G5: Light to Light G6: Heavy to Normal G7: Normal to Light	G1: 22% G2: 39% G3: 38% G4: 41% G5: 62% G6: 60% G7: 65%	N/A

Table 21. Gestational weight gain and SGA (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Ekblad and Grenman, 1992 ⁶⁸	Pregravid weight: Medical records	Infant BW by group	G1: 1% G2: 6% G3: 35%	N/A
Finland, hospital 357	Total weight gain: Routine prenatal care or maternity records	Infant weight percentile for mothers with normal prepregnancy weight and normal weight gain	G4: 43% G5: 13% G6: 2% G7: 3% G8: 14% G9: 32%	
Prepregnancy weight 20% over or under ideal body weight for height and normal weight		G1: < 2.5% G2: 2.5-10% G3: 10-50% G4: 50-90% G5: 90-97.5% G6: > 97.5%	G10: 34% G11: 14% G12: 3%	
Poor		Infant weight percentile for mothers with weight gain ≤5 kg G7: < 2.5% G8: 2.5-10% G9: 10-50% G10: 50-90% G11: 90-97.5% G12: > 97.5%	G13: 0% G14: 2% G15: 42% G16: 29% G17: 20% G18: 7%	
		Infant weight percentile for mothers with weight gain ≥20 kg G13: < 2.5% G14: 2.5-10% G15: 10-50% G16: 50-90% G17: 90-97.5% G18: > 97.5%		
Jensen et al., 2005 ⁵⁹	Pregravid weight: Self-report	Rates of SGA	No significant difference in rates of SGA by maternal weight gain group. Numerical results not reported in article.	Maternal age, pregravid BMI, gestational age, 2 hour OGTT, parity, smoking, ethnicity, clinical center
Denmark, university hospitals 481	Total weight gain: Routine prenatal care or maternity records	G1: GWG < 5.0 kg (Reference) G2: GWG 5.0-9.9 kg G3: GWG 10.0- 14.9 kg G4: GWG ≥ 15.0 kg		
Obese Poor				

Table 21. Gestational weight gain and SGA (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Lang et al., 1996 ⁶⁶ USA, hospital 11,505 All weights/BMI Poor	Pregravid weight: Not stated Total weight gain: Not stated	ORs and 95% CIs for SGA G1: WG ≤ 0.40 lbs/wk G2: WG 0.40-0.65 lbs/wk G3: WG 0.65-0.90 lbs/wk (Reference) G4: WG > 0.90 lbs/wk	G1: 2.8 (2.2-3.6) G2: 1.6 (1.4-1.9) G3: 1.0 (Reference) G4: 0.6 (0.5-0.7)	Maternal age, race, parity, height, pregravid weight, maternal education, health insurance, planned pregnancy, previous induced abortion, previous spontaneous abortion, previous still birth, maternal morbidity, caffeine intake, marijuana, prenatal care, smoking, infant sex

Table 22. Gestational weight gain and SGA by BMI status

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Caulfield et al., 1998 ¹¹⁶ USA, hospital obstetric database 3,870 All weights/BMI Good	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	ORs and 95% CIs for SGA per 50g/wk increase in rate of weight gain by BMI G1: Underweight G2: Normal weight G3: Overweight	G1: 0.87 (0.78-0.97) G2: 0.90 (0.84-0.96) G3: 0.93 (0.86-1.01)	Maternal age, race, parity, pregravid BMI, height, hypertension, provider type, smoking, infant sex

BMI, body mass index; cat, category; CI, confidence interval; G, group; g, gram; kg, kilogram; kg/wk, kilogram per week; lbs, pounds; med, medium; OR, odds ratio; SD, standard deviation; SGA, small-for-gestational-age.

Table 22. Gestational weight gain and SGA by BMI status (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Cedergren, 2006 ⁵⁸ Sweden, Medical Birth Registry 245,526 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	ORs and 95% CIs for SGA (< 2 SD below the mean) Weight gain < 8 kg G1: BMI < 20 G2: BMI 20-24.9 G3: BMI 25-29.9 G4: BMI 30-34.9 G5: BMI ≥ 35 Weight gain > 16 kg G6: BMI < 20 G7: BMI 20-24.9 G8: BMI 25-29.9 G9: BMI 30-34.9 G10: BMI ≥ 35 Weight gain 8-16 kg (Reference)	G1: 2.35 (1.92-2.88) G2: 1.99 (1.77-2.23) G3: 1.75 (1.48-2.07) G4: 1.68 (1.26-2.25) G5: 1.71 (1.03-2.85) G6: 0.50 (0.41-0.61) G7: 0.50 (0.45-0.56) G8: 0.57 (0.47-0.68) G9: 0.61 (0.40-0.93) G10: 0.50 (0.20-1.24)	Maternal age, parity, smoking, year of birth
Cheng et al., 2004 ¹²⁴ USA, birth certificate registry 14,114 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Not stated	95% CIs of SGA for low weight gain (< 0.2 kg/wk) by BMI G1: Underweight G2: Normal weight G3: Overweight G4: Obese	G1: (1.2-2.4) G2: (1.9-2.7) G3: (1.6-2.9) G4: (1.4-2.1)	Maternal age, education, Medicaid status, pregravid BMI, smoking, previous SGA, adequacy of prenatal care, maternal cardiac disease, preeclampsia, year of birth of second infant
Zhou and Olsen, 1997 ¹⁰⁸ Denmark, two communities Cohort 7,122 Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	% Growth retardation (birthweight $< 3,000$ g and placental weight > 490 g) by weight gain category and BMI Weight gain < 11 kg G1: Underweight (Reference) G2: Normal G3: Overweight Weight gain 12-15 kg G4: Underweight G5: Normal G6: Overweight Weight gain > 16 kg G7: Underweight G8: Normal G9: Overweight	G1: 1.0 G2: 0.6 (0.4-0.8) G3: 0.6 (0.4-1.1) G4: 0.3 (0.2-0.5) G5: 0.4 (0.3-0.6) G6: 0.4 (0.1-1.0) G7: 0.3 (0.2-0.5) G8: 0.2 (0.1-0.3) G9: 0.2 (0.1-0.6)	Maternal age, parity, alcohol, diabetes, term delivery, smoking, gestational age, infant sex

Table 22. Gestational weight gain and SGA by BMI status (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Kabiru and Raynor, 2004 ⁵¹ USA, hospital 5,131 All weights/BMI Poor	Pregravid weight: Measured at first prenatal visit Total weight gain: Routine prenatal care or maternity records	% SGA G1: No change in BMI category G2: 1 category increase in BMI G3: > 1 category increase in BMI % SGA among overweight G4: No change in BMI category G5: 1 category increase in BMI G6: > 1 category increase in BMI	G1: 19.5% G2: 13.5% G3: 9.5% G4: 14.2% G5: 9.9% G6: 11.5%	N/A
Wataba et al., 2006 ⁶¹ Japan, academic medical center 21,718 All weights/BMI Poor	Pregravid weight: Not stated Total weight gain: Routine prenatal care or maternity records	ORs and 95% CIs for SGA Parous, Low BMI (< 18) G1: WG < 0.15 kg/wk G2: WG 0.15-0.20 kg/wk G3: WG 0.20-0.25 kg/wk G4: WG 0.25-0.30 kg/wk (Reference) Parous, Medium BMI (18- 23.9) G5: WG < 0.15 kg/wk G6: WG 0.15-0.20 kg/wk G7: WG 0.20-0.25 kg/wk (Reference) Parous, High BMI (> 24) G8: WG < 0.15 kg/wk G9: WG 0.15-0.20 kg/wk (Reference) Nulliparous, Low BMI (< 18) G10: WG < 0.15 kg/wk G11: WG 0.15-0.20 kg/wk G12: WG 0.20-0.25 kg/wk G13: WG 0.25-0.30 kg/wk (Reference) Nulliparous, Medium BMI (18-23.9) G14: WG < 0.15 kg/wk G15: WG 0.15-0.20 kg/wk G16: WG 0.20-0.25 kg/wk G17: WG 0.25-0.30 (Reference)	G1: 5.42 (2.86-10.27) G2: 2.78 (1.53-5.06) G3: 1.39 (0.82-2.42) G4: 1.0 G5: 2.21 (1.67-2.93) G6: 1.68 (1.23-2.07) G7: 1.0 G8: 2.82 (1.17-6.78) G9: 1.0 G10: 6.20 (2.72-14.09) G11: 2.58 (1.14-5.87) G12: 2.46 (1.19-5.08) G13: 1.0 G14: 2.64 (1.88-3.71) G15: 1.60 (1.15-2.23) G16: 1.39 (1.03-1.87) G17: 1.0 G18: 7.06 (2.11-23.61) G19: 1.0	Preeclampsia, C-section, 1- minute Apgar score < 4

Table 22. Gestational weight gain and SGA by BMI status (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Wataba et al., 2006 ⁶¹ (continued)		Nulliparous, High BMI (> 24) G18: WG < 0.05 kg/wk G19: WG $0.15-0.20$ kg/wk (Reference)		

Six fair-quality studies^{24,53,76,83,90,91} evaluated the ORs for SGA and found that the lowest weight gains (as compared to normal weight gains) were associated with ORs between 1.82 and 3.0. Among indigent US women,⁸⁹ the risk of SGA was highest for mothers in the lowest weight gain category (< 0.24 kg/week) when compared with women gaining 0.58 to 0.74 kg per week (OR 2.24; $P < 0.05$). A weaker association was observed for women gaining 0.24 to 0.57 kg per week (OR 1.55; $P < 0.05$). A US study noted earlier also found that women with the lowest weight gains had an OR for an SGA infant of 2.06 (95% CI, 1.62-2.63) when compared with women gaining between the 25th and 75th percentile, and an OR of 1.82 (95% CI, 1.35-2.47) when compared with women gaining between the 10th and 90th percentiles.¹¹⁸ A US study found that the OR of SGA in a second pregnancy was 1.9 (95% CI, 1.8-2.2) for weight gains less than 0.2 kg/wk as compared to weight gains greater than 0.2 kg/wk.¹²⁴ The study of Japanese women noted earlier defined SGA as birthweight < 1.5 SD below the mean and gestational weight gain according to percentiles.¹¹¹ Among women in the two lowest weight gain categories (very low and low) the ORs of SGA were 2.87 (95% CI, 2.56-3.21) and 1.49 (95% CI, 1.35-1.66), respectively, when compared with women in the moderate weight gain category. In addition, a significant protective effect was observed for the two highest weight gain categories. One study, using data from the Swedish Medical Birth Registry, observed higher rates of SGA (here defined as < 2 SD below the mean) among the lowest weight gain groups.¹²³ Specifically, women gaining < 0.25 kg per week had an OR of 3.0 (95% CI, 2.5-3.5) when compared with women gaining ≥ 0.45 kg per week. The ORs decreased as gestational weight gain category dropped. Similar results were found in a study of obese women.⁴

Among white nonsmokers in Canada (fair-quality study),¹⁰⁵ for each 1 kg increase in weight gain up to week 20, the OR of an SGA infant was 0.93 (not significant); for weight gain from weeks 21 to 30, it was 0.85 ($P < 0.01$); and for weight gain from week 31 to term, it was 0.89 ($P < 0.01$). In other words, increases in weight gain from weeks 21 to term lowered a woman's risk of an SGA infant. A fair-quality study of the predictors of SGA found that average weekly weight gain < 0.20 kg had 12.9 percent sensitivity and 91.3 percent specificity.¹¹⁹

Two fair-quality studies defined growth restriction using FGR, with SGA specified as an FGR < 0.85 .^{79,89} In general, increases in weight gain were associated with lower risks of SGA. Specifically, one study found an OR of 0.98 (95% CI, 0.97-0.98) for each 1 kg increase in total gestational weight gain.¹¹⁴ Another study found an OR of 1.32 (95% CI, 1.20-1.44) for each 5 kg decrease in net gestational weight gain (total gestational weight gain minus infant birthweight).¹²²

In a poor US study,⁶⁶ using women gaining 0.65 to 0.9 pounds per week as the reference group, women gaining ≤ 0.40 pounds per week had an OR for an SGA infant of 2.8 (95% CI, 2.2-3.6), and women gaining 0.4 to 0.65 pounds per week an OR of 1.6 (95% CI, 1.4-1.9). In this study, however, women gaining > 0.9 pounds per week also experienced a significant protective effect against SGA (OR, 0.6; 95% CI, 0.5-0.7).

The results from three^{14,20,31} poor-quality studies did not find statistically significant results. One study was among Finnish women,⁶⁸ one defined SGA as birthweight < 2 SD below the mean,⁵⁹ and one study was among morbidly obese women.⁵⁴ A study among adolescents (also rated poor) looked at the proportion of infants who gained less than the median weight (instead of the 10th percentile).⁹⁵ Mothers who shifted to higher weight classes had fewer infants who fell below the median for intrauterine growth; women who did not maintain their weight and shifted to lower weight classes were more likely to have infants below the median for intrauterine growth.

Six studies presented stratified analyses by BMI (Table 22).^{11,19,22,72,81,91} In general, the risk of SGA among women with low weight gain decreased as BMI increased.

A US database study (rated good quality) found that increasing rates of weight gain were associated with reduced risk of an SGA infant, with the risk decreasing with increasing BMI.¹¹⁶ Specifically, the ORs of SGA for each 50 g per week increase in maternal weight were as follows: 0.87 (95% CI, 0.78-0.97) for underweight mothers; 0.90 (95% CI, 0.84-0.96) for mothers of normal weight; and 0.93 (95% CI, 0.86-1.01) for overweight and obese women. In the Swedish birth registry study (rated fair quality), the risk of SGA was higher in the low weight gain group (< 8 kg), but the risk decreased with increasing BMI.⁵⁸ Using women gaining between 8 and 16 kg as the reference group, these researchers reported that the OR for delivering an SGA infant for women with low weight gain (< 8 kg) was 1.71 (95% CI, 1.03-2.85) among women with a BMI ≥ 35 ; it was 2.35 (95% CI, 1.92-2.88) among women with a BMI < 20 . Women gaining > 16 kg were at decreased risk for delivering an SGA infant, with the risk being similar between all BMI categories.

Among nondiabetic women in Denmark (fair-quality study) for whom SGA was defined as birthweight $< 3,000$ g despite placenta weight being above the 66th percentile (491 g), women who gained more than 16 kg were at lower risk of delivering an SGA infant; this risk was the same regardless of BMI status.¹⁰⁸ The risk of SGA decreased with increasing weight gain, and it also tended to decrease as BMI increased. In a US study, 95% CIs of the OR of SGA for low weight gain (< 0.2 kg/wk) compared to weight gain > 0.2 kg/wk, were similar across BMI categories: underweight (95% CI, 1.2-2.4), normal weight (95% CI, 1.9-2.7), overweight (95% CI, 1.6-2.9), obese (95% CI, 1.4-2.1).¹²⁴

A poor-quality study of the effect of changing BMI categories found that excessive weight gain (defined in various ways depending on BMI) was associated with lower rates of SGA for two groups of women: normal weight (excessive gain, > 35 pounds; $P = 0.016$) and overweight (excessive gain, > 25 pounds; $P = 0.003$); this association did not hold for obese women.⁵¹ A study among Japanese women (also poor quality) found high risks for SGA among nulliparous women with low BMI (< 18) and low rates of weight gain (< 0.15 kg/week).⁶¹

Sixteen of these studies adjusted for multiple confounding factors such as age, pregravid BMI, smoking, glucose levels, parity, race, gestational age, marital status, height, education, and sex of infant.^{19,20,22,24,29,53,69,72,76,79,81,83,85,89-91}

Apgar scores.

Study characteristics. Four studies, set in Sweden,⁵⁸ the United States,^{33,92} and Japan,⁶¹ examined the effect of gestational weight gain on Apgar scores (Evidence Table 23, Table 23). Apgar scores, calculated on the basis of five criteria (appearance, pulse, grimace, activity, respiration), range from 0 to 10. Three were cohort studies; the fourth was a case-control study examining outcomes of macrosomic infants ($\geq 4,000$ g) and normal-weight babies (2,500-3,999 g).¹²⁵

Overview of results. These four studies, three rated fair^{19,33,92} and one poor,⁶¹ did not provide consistent evidence on the direction or trend of effect. These studies inconsistently controlled for confounders. None controlled for a range of maternal pregnancy complications that could account for low Apgar scores.

Detailed results. Three studies examined 1-minute or 5-minute Apgar scores at two levels: > 7 or ≥ 7 . Two found no association between gestational weight gain and Apgar scores.^{19,92} The third found increased ORs for gestational weight gain, after adjusting for prepregnancy weight quartile, height (tertile), BMI category, race, parity, hypertension, and other variables entered by stepwise regression model, but the authors provided no further details on the magnitude of the effect.⁷⁰

One poor-quality study examined associations between 1-minute Apgar scores > 4 and rates of weekly weight gain (7 categories), categorized differently across different BMI groups (3 groups) and parity (2 categories), resulting in 42 comparisons.⁶¹ Two comparisons were statistically significant: (1) higher risk for low Apgar scores for nulliparous women with low BMI and lower-than-median weight gain for their peer group; and (2) higher risk for parous women with medium BMI with higher-than-median weight gain for their peer group.

Table 23. Gestational weight gain and Apgar scores

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Cedergren, 2006 ⁵⁸ Sweden, Medical Birth Registry 245,526 All weights/BMI Fair	Pregravid weight: Self report, if unknown, standardized measurement is made during first visit to maternity health care center Total weight gain: Measured when woman entered delivery unit	Weight gain < 8 kg, 8-16 kg, and >16 kg for each BMI class below G1: BMI < 20 G2: BMI 20-24.9 G3: BMI 25-29.9 G4: BMI 30-34.9 G5: BMI ≥35	No association between low weight gain and Apgar score (< 7), despite BMI of mother	BMI, maternal age, parity, smoking in early pregnancy, year of birth
Johnson et al., 1992 ⁷⁰ USA, prenatal clinics 3,191 All weights/BMI Fair	Pregravid weight: Self report collected at first antepartal visit Total weight gain: Last prenatal visit	G1: total weight gain < 16 lb G2: total weight gain 16-25 lb G3: total weight gain 26-35 lb G4: total weight gain > 35 lb	Increased OR for gestational weight gain on 1-minute and 5- minute Apgar score ≤ 7, persists after adjusting (no further details provided)	Prepregnancy weight quartile, height (tertile), BMI category, race, parity, hypertension, other variables entered by stepwise regression model

AOR, adjusted odds ratio; BMI, body mass index; kg/wk, kilogram per week.

Table 23. Gestational weight gain and Apgar scores (continued)

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Nixon et al., 1998 ¹²⁵ USA, county nurse- midwifery services 2,228 All weights (IOM) Fair	Pregravid weight: Routine data forms, self report collected at first prenatal visit Total weight gain: Routine data forms, prenatal care or maternity records prior to delivery	Continuous weight gain measure	Gestational weight gain was not a predictor of Apgar scores < 7	Age, parity, BMI
Wataba et al., 2006 ⁶¹ Japan, academic medical center 21,718 All weights/BMI Poor	Pregravid weight: Hospital database/ register Total weight gain: Hospital database/ record	Rate of weight gain, categorized differently across different BMI groups	AOR for 1 min Apgar scores < 4 for nulliparous women with low BMI, weekly weight gain < 15 kg/wk, compared with women gaining 0.25-0.3 kg/wk: 12.24 (2.04-73.43) AOR for 1 min Apgar scores < 4 for parous women with medium BMI, weekly weight gain 0.35-0.4 kg/wk compared with women gaining 0.2-0.25 kg/wk: 2.21 (1.08-4.53) No other relationships were significant	Parity, baseline BMI

Infant Outcomes

Perinatal mortality.

Study characteristics. Three studies, two set in the United States^{93,94} and one in Denmark,¹²⁶ looked at the association between maternal weight gain and mortality, defined in one study as stillbirth¹²⁶ and in two others as perinatal mortality (neonatal plus fetal deaths)^{93,94} (Table 24, Evidence Table 24). All three studies used different definitions of maternal weight gain:

- weight gain per week;¹²⁶
- optimal weight gain¹²⁷ defined as 36 to 40 pounds for underweight women, 31 to 40 pounds for women of ideal prepregnancy weight, and 26 to 30 pounds for overweight women, based on associations between maternal prepregnancy weight, height, weight gain, and adverse perinatal outcomes; and
- low weight gain (< 0.8 kg per week).¹²⁸

Overview of results. One of these studies was rated poor quality¹²⁸ and the others were rated fair. These studies suggest a protective effect of gestational weight gain on perinatal mortality but not on stillbirth.

Table 24. Gestational weight gain and perinatal mortality

Author, Date Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Bracero and Byrne, 1997 ¹²⁷ USA, hospital 20,971 All weights/BMI Fair	Pregravid weight: Self-report at first prenatal visit Total weight gain: Last prenatal assessment	G1: Suboptimal weight gain G2: Optimal weight gain	Perinatal mortality% G1: 0.6 G2: 0.2 <i>P</i> < 0.0001	NA
Nohr et al., 2005 ¹²⁶ Denmark, National Birth Cohort 54,505 All weights/BMI Fair	Pregravid weight: Self-report of pre- pregnancy weight at first telephone interview between 9 and 24 weeks weeks Total weight gain: Average weekly increase between self reported weights in first and second pregnancy interviews for women who provided a first interview between 9-24 weeks, those who provided a second interview between 26 and 38 completed weeks of gestation, and those who had at least 6 weeks between 2 interviews	Weight per week for BMI groups (underweight < 18.5; 18.5 ≤ normal weight < 25; 25 ≤ overweight < 30; and obese ≥ 30)	Weight gain in pregnancy was not significantly associated with the risk of stillbirth for any BMI groups.	AOR adjusted for age, height, parity, socio-occupational status, physical exercise, smoking, alcohol and coffee consumption
Naeye, 1990 ¹²⁸ USA, hospitals affiliated with medical schools 56,857 All weights/BMI Poor	Pregravid weight: Self-report at first antenatal care visit Total weight gain: Data from medical records after first trimester	Low weight gain defined as < 0.8 kg/week after the first trimester for pregravid BMI groups below: G1: BMI < 20 G2: BMI 20-24 G3: BMI 25-30 G4: BMI > 30	Attributable risk estimates for perinatal death for low pregnancy weight gain G1: 0.03 (95% CI, 0.02-0.05) G2: 0.02 (95% CI, 0.01-0.03) G3: 0.01 (95% CI, 0.00-0.02) G4: 0.00	Age 35-40, diabetes mellitus, hypertensive disorders, black, preterm birth, major congenital malformations, twins, neonatal respiratory distress syndrome

AOR, adjusted odds ratio; BMI, body mass index; G, group; kg, kilogram.

Results for categorical measures of weight gain. Both studies that focused on optimal or low weight gain found a protective effect of weight gain on infant mortality, but variations in the definition of maternal weight gain and the outcome do not allow quantification of the magnitude of the effect.^{93,94}

Results for rate of weight gain. The study that examined associations between weight gained per week and stillbirth found no effect of weight gain on stillbirth within groups defined by BMI.¹²⁶ It found increased risks of stillbirth with pregravid obesity and overweight status. This association between higher pregravid weight and stillbirth persisted after the investigators excluded women with obesity-related diseases (diabetes, preeclampsia, and other hypertensive disorders). Within this subset of women without obesity-related diseases (n = 39,187), the AOR for stillbirth related to an increased weight of 100 g per week was 0.94 (95% CI, 0.87-1.03).

Neonatal distress.

Study characteristics. A Swedish study examined the effects of gestational weight gain on fetal distress (equivalent to International Classification of Diseases [ICD] 9-codes 768.2-4; and ICD 10-codes P20.0, P20.1, and P20.9) using medical birth registry data from 245,526 singleton, term pregnancies over a 9-year period. (Evidence Table 25).⁵⁸ Women were grouped by BMI status into three gestational weight gain categories: < 8 kg (low), 8 to 16 kg, and >16 kg (high).

Overview of results. The results of this fair study show that after adjusting for maternal age, parity, smoking in early pregnancy, and year of birth, the authors reported that fetal distress was not significantly associated with low weight gain despite the BMI of the mother. Overweight and morbidly obese women with excessive weight gain did have an increased risk for fetal distress.

Detailed results. Compared with women with gestational weight gain of 8-16 kg, the OR for fetal distress among women gaining 16 kg or more was 2.15 (95% CI, 1.10-4.20) for women with BMI \geq 35 and 1.31 (95% CI, 1.05-1.53) for women with BMI 25-29.9.

Neonatal hypoglycemia.

Study characteristics. Two studies examined the effect of gestational weight gain on neonatal hypoglycemia (Evidence Table 26).^{75,96} One was a retrospective cohort study of 20,465 women;¹²⁹ the other¹¹⁰ was a retrospective case-control study using data from 45,245 singleton, live births from a US prepaid group practice health plan. The studies categorized gestational weight gain differently; one examined gestational weight gain as a dichotomous variable based on extremes of weight gain (< 7 kg and >18 kg),¹²⁹ and the other used maternal rate of weight gain (total pregnancy weight gain minus infant birthweight divided by weeks of gestation when the last weight was measured) in kg per week.¹¹⁰ Hypoglycemia was defined by ICD codes¹²⁹ or as at least one plasma glucose test result < 40 mg/dL.¹¹⁰

In the case-control study,¹¹⁰ babies were identified as cases if they had the following complications: macrosomia (birthweight > 4,500 g), hypoglycemia (at least one plasma glucose < 40 mg/dL), or hyperbilirubinemia (at least one total serum bilirubin of 20 mg/dL or more). In general, hypoglycemic cases tended to be infants whose mothers were younger, nonwhite, and less educated than mothers of controls. More women with a prepregnancy BMI >29.0 appeared among the cases (22.9 percent) than the controls (17.6 percent).

Overview of results. The results of these studies (1 good¹¹⁰ and 1 fair¹²⁹) suggest that gestational weight gain is associated with the risk of infant hypoglycemia.

Results. In the case-control study (rated good quality),¹¹⁰ after adjusting for age, race-ethnicity, parity, plasma screening value, and gestational age at last weight measured, the authors found that women who gained in the highest bracket of weight gain per week (more than 0.40 kg/week) had a increased risk of delivering an infant with hypoglycemia (AOR, 1.94; 95% CI, 1.33-2.82) than women gaining 0.22 to 0.31 kg per week.

Findings from the retrospective cohort study were similar.¹²⁹ After controlling for several confounders, the authors found that weight gain of more than 18 kg was associated with hypoglycemia (AOR, 1.67; 95% CI, 1.13-2.46) when compared with weight gain of 11.5 to 16.0 kg.

Hyperbilirubinemia.

Study characteristics. The retrospective case-control study described above also examined the effect of gestational weight gain on infant hyperbilirubinemia (Evidence Table 27).¹¹⁰

Overview of results. One good study¹¹⁰ suggested that increased gestational weight gain is associated with a higher risk of hyperbilirubinemia.

Detailed results. Compared with controls, the hyperbilirubinemia case group had more Asians (20.1 percent vs. 8.1 percent) and tended to be born at a gestational age < 37 weeks. Compared with women gaining 0.22 to 0.31 kg per week, women who gained in the highest bracket of weight gain/week (more than 0.40 kg/week) had an increased risk of delivering an infant with hyperbilirubinemia (AOR, 1.94; 95% CI, 1.33-2.82).

Neonatal hospitalization.

Study characteristics. One study investigated the influence of gestational weight gain on perinatal outcomes, including hospitalization of infant (Evidence Table 28).¹² Using a hospital-based, retrospective cohort study design, the authors studied 633 women who delivered live, singleton babies in Japan between 24 and 42 weeks' gestation. Mean age of the women was 29.1 and most were nulliparas. Most of the women gained between 8.5 and 12.5 kg (mean, 10.5 kg) during their pregnancy. Gestational weight gain was collected from maternity records and was based on last weight taken at the hospital prior to delivery.

Overview of results. One fair study suggested that infants of women who gained less than 8.5 kg during their pregnancy were 60 percent more likely to require hospitalization.¹²

Detailed results. Overall, 13.3 percent had babies with complications requiring hospitalization, excluding admissions for phototherapy necessitated by neonatal jaundice. After adjusting for maternal age, parity, smoking, prepregnancy BMI, and gestational age, the authors did not find a significant relationship between gestational weight gain of less than 8.5 kg (AOR, 1.60; 95% CI, 0.88-2.88) or weight gain greater than 12.5 kg (AOR, 0.93; 95% CI, 0.46-1.88) and hospitalization of infant.

Other infant morbidity.

Study characteristics. Two studies addressed other neonatal morbidity in association with gestational weight gain (Evidence Table 29); one was the large cohort study noted above,¹²⁹ and the other used a case-control design.¹³⁰ Both studies relied on self-reported prepregnancy weights. Total weight gained during pregnancy was ascertained from prenatal records¹²⁹ and women's self-report.¹³⁰ The studies differed on how gestational weight gain was categorized: the cohort study categorized gestational weight gain according to both the IOM recommendations (i.e., the woman was below, within, or above the IOM thresholds) and by extremes of weight gain (< 7 kg, > 15 kg); the case-control study defined gestational weight gain as a continuous variable.

Overview of results. One fair study reported that gestational weight gain less than 7 kg was associated with neonatal seizure.¹²⁹ Another fair study reported no significant association between infant leukemia and weight gain during pregnancy.¹³⁰

Detailed results. The cohort study looked at the relationship between gestational weight gain and several adverse neonatal outcomes (birth trauma, 5-minute Apgar score < 7, need for assisted ventilation, SGA, LGA, umbilical cord arterial pH < 7.1, umbilical cord arterial base excess < 10, admission to the neonatal intensive care unit [NICU], admission to the special-care nursery [a step-down unit], neonatal infection, seizure, hypoglycemia, polycythemia, jaundice, meconium aspiration syndrome, respiratory distress or tachypnea, anemia, birth asphyxia, and perinatal death).¹²⁹ The authors controlled for maternal age, race, parity, smoking, pregravid BMI, date of delivery, pregnancy-induced hypertension, mode of delivery, length of first stage of labor, length of second stage of labor, gestational age, and birthweight. Using weight gain of

11.5 to 16 kg as a reference, the authors reported that gestational weight gain less than 7 kg was associated with neonatal seizure (AOR, 10.66; 95% CI, 2.17-52.36). Gestational weight gain >18 kg was associated with assisted ventilation (AOR, 1.52; 95% CI, 1.16-2.00), seizure (AOR, 6.19; 95% CI, 1.32-28.96), polycythemia (AOR, 1.59; 95% CI, 1.13-2.22), and meconium aspiration syndrome (AOR, 1.86; 95% CI, 1.13-3.05).

The case-control study¹³⁰ examined the association between maternal reproductive history, including gestational weight gain, and the risk of infant leukemia in 240 cases, defined as infant leukemia diagnosed at < 1 year of age, and 255 controls matched to cases by year of birth. Infants with infant leukemia were significantly ($P < 0.003$) less likely to be white (79.5 percent vs. 85.5 percent) and more likely to be Hispanic (10.5 percent vs. 3.5 percent) than controls. After adjusting for sex, race or ethnicity, maternal education, and prepregnancy BMI, the authors found no significant association between infant leukemia and weight gain during pregnancy.

Infant BMI.

Study characteristics. Two older studies examined the influence of gestational weight gain on the offspring's BMI (Evidence Table 30). One cohort study comprised 8,719 singleton, live-born infants from a hospital in Montreal, Canada, from 1980 to 1986.¹²² Of these mothers, 48 percent were primiparas, 90 percent were married, and 87 percent had started prenatal care in the first trimester. The infant's weight and length at birth was used to calculate BMI. Weight gain was expressed as total weight gain minus the weight of the infant at birth. The second study enrolled 119 term GDM and 143 term control mother-infant dyads from a hospital in Rhode Island in 1982.¹³¹ The mothers were all screened for gestational diabetes using a universal screen approach between 24 and 28 weeks' gestation. Anthropometric measurements on the infants were done by study staff on the second day of life; weight and height was used to calculate infants' BMI. Total gestational weight gain was defined as measured weight at last prenatal visit (within one week of delivery) minus self-reported pregravid weight.

Results. The Canadian study reported that net gestational weight gain was weakly but significantly correlated with infant's BMI ($r = .04$, $P < 0.01$).¹²² In multivariate analysis, net gestational weight gain did not meet the criterion threshold for remaining in the stepwise regression.¹²²

In the US study, total gestational weight gain was significantly correlated with infant's BMI ($r = .22$, $P = 0.01$).¹³¹ In multivariable regression analysis done separately for mothers with GDM and controls, total gestational weight gain significantly predicted infant's BMI such that a 1 kg increase in weight gain was associated with a 0.06 and 0.05 increase in BMI for GDM and control infants, respectively, after controlling for pregravid BMI and glucose values. The difference between the results of these two studies lies in the fact that once the weight of the infant is removed from total weight gain, an important product of conception is missing from the measure of weight gain and thus the strength of the association is reduced.¹³¹

Other infant growth characteristics.

Study characteristics. Six studies examined the association between gestational weight gain and various other infant growth characteristics (Evidence Table 31, Table 25).^{31,56,57,62,82,89}

Table 25. Gestational Weight Gain and Other Infant Growth Measures

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Brown et al., 2002 ⁹⁸ USA, primary care clinics 389 All weight/BMI Good	Pregravid weight: Measured by study investigators Total weight gain: Collected by study investigators	G1: Increase in ponderal index per 1 kg increase in first trimester weight gain G2: Increase in ponderal index per 1 kg increase in second trimester weight gain G3: Increase in Ponderal Index per 1 kg increase in third trimester weight gain	G1: $\beta = 0.21$ ($P < 0.0003$) G2: $\beta = 0.05$ PI ($P < 0.4$) G3: $\beta = 0.12$ ($P < 0.03$)	Maternal age, parity, pregravid BMI, height, infant sex, gestational age
Guihard-Costa et al., 2004 ⁹² France, hospital database 13,972 All weights/BMI Fair	Pregravid weight: Routine prenatal care Total weight gain: Routine prenatal care or maternity records	G1: SC for effect of GWG on crown-heel length G2: SC for effect of GWG on head circumference G3: SC for effect of GWG on subscapular skinfold thickness SCs are regression coefficients calculated as if all of the independent variables had a variance of 1	G1: SC 0.142 G2: SC 0.120 G3: SC 0.146	Maternal age, parity, pregravid BMI, height
Kirchengast and Hartmann 2003 ⁹³ Austria, university hospital 8,011 All weights/BMI Fair	Pregravid weight: Estimated from measured weight at first prenatal visit Total weight gain: Routine prenatal care or maternity records	Change in infant size characteristics per 1 kg increase in GWG G1: Birth length (cm) G2: Head circumference (cm) G3: Acromial circumference (cm) G4: Diameter frontooccipitalis (cm)	G1: $\beta = 0.55$ (0.43-0.68) G2: $\beta = 0.33$ (0.23-0.42) G3: $\beta = 0.47$ (0.39-0.55) G4: $\beta = 0.12$ (0.07-0.18)	Maternal age, age at menarche, pregravid weight, height, distantia cristarum

β , unstandardized coefficient from multiple regression; BMI, body mass index; cm, centimeters; g, gram; GWG, gestational weight gain; kg, kilogram; SC, standardized coefficient; SGA, small-for-gestational-age.

Table 25. Gestational Weight Gain and Other Infant Growth Measures (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Kramer et al., 1990 ¹²² Canada, university hospital 8,719 All weights/BMI Fair	Pregravid weight: Self-report Total weight gain: Routine prenatal care or maternity records	Correlation coefficients between GWG and: G1: Length G2: Head circumference G3: BMI G4: Ponderal Index G5: Weight/Head circumference	G1: -0.04 ($P < 0.01$) G2: -0.01 G3: 0.04 ($P < 0.01$) G4: 0.04 ($P < 0.01$) G5: 0.01	Pregravid weight, infant sex, smoking, parity, maternal diabetes, height, previous LBW infant, severe pregnancy-induced hypertension
Net gestational weight gain was associated with correlation coefficients of -0.04 for length, -0.01 for head circumference, 0.04 for BMI, 0.04 for Ponderal Index, and 0.01 for weight/head circumference. Results were significant ($P < 0.01$) for length, BMI, and Ponderal Index				
Shepard et al., 1996 ¹¹⁷ Norway and Sweden, multicenter study 369 All weights/BMI Fair	Pregravid weight: Medical records Total weight gain: Measured at 3 study time periods	Increase in mean abdominal fetal growth rate (mm/day) per 5% increase in proportional weight gain in this period: G1: Weeks 17-25 G2: Weeks 25-33 G3: Weeks 33-37	G1: $\beta = 0.35$ ($P = 0.49$) G2: $\beta = 0.88$ ($P = 0.02$) G3: $\beta = 1.53$ ($P = 0.02$)	Maternal age, pregravid BMI, previous SGA, infant sex
Ekblad and Grenman, 1992 ⁶⁸ Finland, hospital 357 Prepregnancy weight 20% over or under ideal body weight for height and normal weight Poor	Pregravid weight: Medical records Total weight gain: Routine prenatal care or maternity records	Mean symphysis-fundus height: G1: Weight gain ≤ 5 kg G2: Weight gain 5-20 kg G3: Weight gain ≥ 20 kg	G1: 30.8 cm \pm 4.0 G2: 32.8 cm \pm 3.4 G3: 35.0 cm \pm 3.9	N/A

Overview of results. The evidence from one good,⁹⁸ three fair,^{14,56,57,82} and one poor study⁶⁸ suggest that gestational weight gain is associated with various measures of infant growth characteristics. A single fair study failed to find an association between gestational weight gain and infant proportionality.¹²²

Detailed results. One good-quality study analyzed the relationship between weight gain (total and by trimester) and ponderal index (PI, a way of characterizing the relationship of height to mass for an individual).⁹⁸ Each kilogram of weight gained in the first and third trimesters significantly increased the PI: first trimester, an estimated 0.21 units; third trimester, by 0.12 units. Second trimester weight gain was not associated with newborn PI. The authors adjusted their models for gestational age, sex, parity, maternal height, maternal age, and pregravid BMI.

A retrospective cohort study (rated fair quality) conducted in France examined predictors of various infant growth measures,⁹² using standardized coefficients (SC) from stepwise regression models. SCs are regression coefficients calculated as if all of the independent variables had a variance of 1. Pregnancy weight gain had a significant influence on birthweight (SC 0.199), crown-heel length (SC 0.142), head circumference (SC 0.120), and subscapular skinfold thickness (SC 0.146).

One fair-quality study examined proportional weight gain in relation to fetal growth rate in millimeters (mm) per day, calculated by averaging three ultrasound measurements of the sagittal and transverse diameters of the fetal abdomen in three study time periods.¹¹⁷ Increases in proportional weight gain during the second period (weeks 25 to 33) and third period (weeks 33 to 37), but not the first period (weeks 17 to 25) were significantly associated with significant increases in fetal growth. These results were adjusted for age, BMI, smoking, history of delivering an SGA infant, and infant sex.

Infant body proportionality was studied in a Canadian population (rated fair quality) with validated gestational ages.¹²² Proportionality was evaluated using z transformations of crown-heel length, head circumference, BMI, PI, and birthweight/head circumference. Net gestational weight gain was associated with correlation coefficients of -0.04 for length, 0.04 for BMI, and 0.04 for PI (all $P < 0.01$). ORs of low and high PI for each 5 kg decrease in net gestational weight gain were not significant.

A fair-quality study conducted in Austria found that for each 1 kg increase in total gestational weight gain, birth length increased by 0.55 cm (95% CI, 0.43-0.68), head circumference increased by 0.33 cm (95% CI, 0.23-0.42), acromial circumference increased by 0.47 cm (95% CI, 0.39-0.55), and diameter frontooccipitalis increased by 0.12 cm (95% CI, 0.07-0.18).⁹³ This study adjusted for maternal age, age at menarche, pregravid weight, height, and distantia cristarum.

Finally, a poor-quality retrospective cohort study conducted in Finland examined the relationship between weight gain and symphysis-fundus (SF) height.⁶⁸ SF height did not differ significantly between weight gain groups at 24 weeks, but higher gestational weight gains were associated with longer SF height.

Child Outcomes

Childhood weight status.

Study characteristics. Four studies, using different definitions of outcomes, examined the long-term effect of gestational weight gain on children's weight status (Evidence Table 32).⁹⁹⁻¹⁰² Three studies enrolled the subjects at birth and then followed them through various end points; up to 15 months postpartum,¹³² 3 years of age,²⁴ and 2 and 5 years for the Avon longitudinal study of pregnancy and childhood (ALSPAC) in England.¹³³ All three included only singleton births. One was conducted using a national representative sample from 1979 that followed the children of mothers who were born in 1984, 1986, 1988, and 1990 for up to 12 years.¹³⁴

Overview of results. Due to the different definitions of the outcomes, the results from three fair¹⁰⁰⁻¹⁰² and one poor^{99,102} studies are mixed for an association between gestational weight gain and childhood weight status.

Detailed results. In the ALSPAC study (rated fair), which used as its outcome “catch up growth” from birth to 2 years of age (for definition see Table 26), bivariate analysis suggested that children who showed catch-up growth were no different in the amount of weight that their mothers gained during pregnancy than children who showed no change or those who had catch-down growth. No adjustments were made for confounding.

In another fair study that reported on the effect of total weight gain and net weight gain (excluding infant birthweight),²⁴ child BMI percentiles at age 3 were grouped as follows: below 50th (referent category), 50th to 84th, 85th to 94th, and 95th or higher. Gestational weight gain was associated with a BMI of ≥ 95 percentile in both bivariate and multivariate analysis; a 5 kg increase in weight gain was associated with a 52 percent increase in risk of obesity in the offspring. Gestational weight gain was also associated with BMI z score. Similar associations were found when using net weight gain as the exposure.

Table 26. Gestational weight gain and childhood weight status

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Li et al., 2007 ¹³⁴ USA, National Longitudinal Survey of youth 1979 Child and Young Adult file 1,739	Pregravid weight: Self-report Total weight gain: Self-report	Maternal weight gain categories (kg): G1: < 15 lbs G2: 15-24 lbs G3: 25-34 lbs G4: 35-44 lbs G5: > 45 lbs	AOR (95% CI) for early onset overweight (early onset of overweight that persisted throughout childhood) compared with normal (low probability of overweight throughout childhood and was characterized as the never overweight class) G5: 1.7 (1.0-2.9) G3: 1.0 (reference)	Infant sex, race, birth order, gestational age, birthweight, breastfeeding, pregravid BMI, maternal age, maternal education, family income
All weight/BMI Fair			Other AOR for weight gain categories for early onset overweight not significant compared with weight gain 25-34 lbs No association between maternal weight gain and risk of late onset overweight (moderately high probability of overweight at age 2 years, low probability of overweight at age 4 and 6 years, but growing probability of overweight after age 8 years)	
Oken et al., 2007 ²⁴ USA, HMO 1,044	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain, 5 kg increments	AOR (95%CI) BMI \geq 95th percentile vs BMI<50th percentile associated with a 5 kg increase in gestational weight gain: 1.52 (1.19-1.94) Child BMI z-score at age 3 years for AOR listed above (95% CI): 0.11 (0.05, 0.17)	Smoking, race, household income, marital status, glucose tolerance, gestation length, breastfeeding duration, child's sex
All weight/BMI Fair				

AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; G, group; HMO, health maintenance organization; kg, kilogram; lbs, pounds; USA, United States of America; vs, versus.

Table 26. Gestational weight gain and childhood weight status (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Ong et al., 2000 ¹³³ UK, Avon longitudinal study of pregnancy and childhood 848 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Obstetric records	Maternal weight gain, continuous measure	Children were grouped into three growth categories (catch-up, no change, and catch-down) based on a gain in weight (SD score > 0.67 for catch-up; SD score < 0.67 for catch- down. Maternal weight gain was not a significant predictor of catch-up growth between 0 and 2 years	NA
Sowan et al., 2000 ¹³² USA, NIH-funded Infant Growth Study 630 All weight/BMI Poor	Pregravid weight: Self-report Total weight gain: Self-report	Maternal weight gain, 5 lb. increments	AOR (95%CI) for infant obesity (BMI> gender and age specific 84th percentile based on Infant Growth Study population norms) at 1, 4, 7, and 10 months: NS AOR (95%CI) for obesity at 14 months: .8 (0.7-1.0)	Maternal age, nonpregnant weight, smoking, marital status, father living in home, family stress, grandmother living in home, socioeconomic status, gender, race, infant BMI at birth, infant BMI from previous study month

The one poor study that examined BMI \geq 85th percentile at ages less than 14 months did not find any association with gestational weight gain.¹³² However, the nationally representative study did find an association for early onset of overweight associated with weight gains \geq 20.43 kg (\geq 45 lbs) but not later on in life.¹³⁴

The US study (rated poor quality) determined, using multivariable logistic regression models, that gestational weight gain was a significant predictor of infant obesity at 1 and 14 months of age.¹³² The odds of obesity rose 10 percent at 1 month for every 5-pound increase in weight gain adjusting for parental and household variables, sex of the infant, and ethnicity (OR, 1.1; 95% CI, 1.0-1.2). At 14 months the association was reversed; the odds of obesity was decreased by 20 percent for every 5-pound increase in gestational weight gain (OR, 0.8; 95% CI, 0.7-1.0), adjusting for several variables include birth BMI and BMI from the previous study month.

Childhood hospitalization.

Study characteristics. One study, a cohort of children (N = 11,980) born to mothers attending midwifery centers in Denmark from April 1984 to 1987, examined the effect of maternal prenatal lifestyle factors on children's hospitalizations with infectious diseases (Evidence Table 33).¹³⁵ After excluding stillbirths, multiple births, and children with congenital malformations, the authors followed 10,440 newborns from 6 months to 12 years. Information on prenatal factors was self-reported by the mother via a questionnaire. Weight gain, calculated as the difference between the self-reported pregravid weight and the weight measured at the time of delivery obtained from the medical records, was categorized as < 10, 10 to 12, 13 to 15, and \geq 16 kg. Outcome data on hospitalizations related to infections were obtained from registry information based on ICD codes.

Overview of results. One fair study suggested that weight gain > 13 kg only for women who were underweight before pregnancy (BMI < 18) was associated with an increased risk of childhood hospitalization for infectious diseases.¹³⁵

Detailed results. The crude incidence rate ratios (IRR) for the effect of weight gain on hospitalizations were nonsignificant compared with weight gains of 13 to 15 kg: < 10 kg, 0.99; 10 to 12 kg, 0.93; and > 16 kg, 1.01). When maternal pregravid weight status was stratified as BMI < 18 and BMI ≥ 18, weight gain greater than 13 kg among women with a pregravid BMI < 18 increased the risk of hospitalizations compared with women with higher BMI and gaining similar weight (IRR, 1.42; 95% CI, 1.09-1.86). This model adjusted for maternal and paternal age, social group, marital status, number of siblings, and maternal smoking during pregnancy.

Short- and Long-term Maternal Outcomes

Lactation. We found no evidence on the effect of gestational weight gain (not defined by IOM definitions) on lactation that accounted for pregravid weight. We present results for studies relying on IOM definitions of weight gain under KQ 3.

Postpartum weight retention.

Study characteristics. Twelve articles from 10 study populations examine the relationship between gestational weight gain and postpartum weight retention (Evidence Table 34, Table 27).^{105,136-146} Six articles used data collected within 1-year postpartum,^{105,140-143,145} four used long-term follow-up data of greater than 1 year postpartum,^{136,142,144,146} and three used interpregnancy interval data.¹³⁷⁻¹³⁹

Table 27. Gestational weight gain and postpartum weight retention

Author, Year	Country, Setting	Pregravid Weight (How Measured)	Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Callaway et al., 2007 ¹⁴⁶	Australia, University Hospital	Pregravid weight: Self report		G1: Gestational weight gain ≤ 15 kg	G1: Mean change (95% CI) in BMI at 21 years postpartum: 5.06 kg/m ² (4.85-5.27)	Baseline income, secondary school completion, ethnicity, maternal age at birth, parity, birthweight, gestational age, infant sex, maternal smoking during pregnancy, smoking at 21 years, sedentary lifestyle at 21 years, baseline maternal BMI, hypertensive disorders during pregnancy
		Total weight gain: Obstetric records/maternal questionnaires		G2: Gestational weight gain >15 kg	G2: Mean change (95% CI) in BMI at 21 years postpartum: 6.40 kg/m ² (6.19-6.61) P < 0.001	
					G2 was associated with a mean change in BMI over 21 years of 0.19 kg/m ² (95%CI: 0.16-0.22)	

AGA, average gestational age; ANCOVA, analyses of covariances; β, unstandardized regression coefficient; B, standardized regression coefficient; kg, kilogram; SD, standard deviation; SE, standard error; SEM, standard error of the mean; UK, United Kingdom.

Table 27. Gestational weight gain and postpartum weight retention (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Harris et al., 1999 ¹⁴⁴ UK, Antenatal Care Project 74 All weight/BMI Good	Pregravid weight: Measured at first trimester prenatal visit Total weight gain: Self report	Continuous maternal weight gain, kg	ANCOVA model with weight (kg) at 2.5 years postpartum as dependent variable and maternal weight gain (kg) as independent variable: B = -0.031 β = -0.029 SEM = 0.120 P = 0.796	Marital status, increased dissatisfaction with body, increased access to food, increased energy intake, decreased activity, smoking status, maternal age, duration of followup, pregravid BMI, parity, gestational age at booking, parental obesity, social support
Harris et al., 1997 ¹³⁷ UK, Hospital 523 All weight/BMI Fair	Pregravid weight: Measured within 13 weeks' gestation Total weight gain: Measured	Gestational weight gain during previous pregnancy (kg), continuous	ANCOVA model for interpregnancy weight change (kg), defined as the difference between weight at start of index pregnancy and weight at start of previous pregnancy: B = 0.262 β = 0.227 SEM = 0.52 P < 0.001	Marital status, smoking status, alcohol, parity, age, socioeconomic status, nulliparous BMI, birthweight, gestational age at start of previous pregnancy, gestational age at start of index pregnancy, gestational age at start of first pregnancy, interpregnancy interval, gestational age at delivery
Harris et al., 1997 ¹³⁸ UK, Hospital 243 All weight/BMI Fair	Pregravid weight: Measured within 13 weeks' gestation Total weight gain: Measured	Gestational weight gain during first pregnancy as a continuous measure (kg)	ANCOVA model for interpregnancy weight change (kg), defined as the difference between weight at start of first pregnancy and weight at start of the second pregnancy: B = 0.176 β = 0.169 SEM = 0.070 P < 0.013	Marital status, lactation, smoking status, alcohol, height, nulliparous BMI, birthweight, gestational age at start of previous pregnancy, terminations between pregnancy, interpregnancy interval

Table 27. Gestational weight gain and postpartum weight retention (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hunt et al., 1995 ¹³⁹ USA, population-based family history database (Utah) and participants of an obesity study 221 All weight/BMI Morbidly obese Fair	Pregravid weight: Self-report (validated by hospital records if available) Total weight gain: Self-report (validated by hospital records if available)	G1: Population-based sample G2: Morbidly obese women who were normal weight at age 20-24 years or prior to first pregnancy	Regression of current weight on total number of pregnancies showed a 1.3 kg/pregnancy increase in current weight ($P = 0.03$) with no difference between G1 and G2 ($P = 0.60$) Gestational weight gain was significantly greater in G2 than G1 for the first pregnancy only ($P < 0.05$) G2 had a net weight retention after the first pregnancy of 4.0 kg greater than G1 at 6 weeks postpartum G2 averaged 1.6 kg/pregnancy greater weight retention than G1 for additional pregnancies	Weight at ages 20 to 24, current age
Linne et al., 2004 ¹⁴² Sweden, Stockholm Pregnancy and Weight Development Study 563 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Medical Records	Gestational weight gain as a continuous variable (kg): G1: Pregravid BMI ≤ 25 G2: Pregravid BMI > 25	G2 had significantly greater weights at prepregnancy, delivery, 1 year postpartum, and 15 years postpartum compared to G1 ($P < 0.001$); however, G2 did not have a higher risk of postpartum retention than G1	Alcohol use, smoking, number of pregnancies since index child, employment area
Linne et al., 2003 ¹³⁶ Sweden, Stockholm Pregnancy and Women's Nutrition Study 563 Normal weight/overweight Fair	Pregravid weight: Self-report Total weight gain: Medical records	G1: Women with normal BMI (20-25) at prepregnancy and 15 years postpartum G2: Women with normal BMI at prepregnancy who had overweight BMI (> 25) at 15 years postpartum	G1: Mean (SD) maternal weight gain, 13.6 (3.7) kg G2: Mean (SD) maternal weight gain, 15.4 (4.4) kg t-Test: $P < 0.001$	None

Table 27. Gestational weight gain and postpartum weight retention (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Muscatti et al., 1996 ¹⁰⁵	Pregravid weight: Physicians' records	G1: Weight gain ≤ week 20 (kg)	Regression model of weight retention (kg) at 6 weeks postpartum as the dependent variable and G1-G5 as independent variables: G1: $\beta = 0.86$ (SE: 0.05) $P < 0.001$	Standard weight for height (based on 1983 Metropolitan Life Insurance Tables), pregravid weight above standard (difference between actual weight and standard weight), parity, gestational age, infant sex
Canada, Prenatal Nutrition Counseling Program 371	Total weight gain: Measured	G2: Weight gain weeks 21-30 (kg) G3: Weight gain weeks 31- term	G2: $\beta = 0.68$ (SE: 0.07) $P < 0.001$ G3: $\beta = 0.49$ (SE: 0.07) $P < 0.001$	
All weight/BMI		G4: Total weight gain ≤ 12 kg	G4: $\beta = 0.58$ (0.13) $P = \text{NR}$	
Fair		G5: Total weight gain > 12 kg	G5: $\beta = 0.77$ (0.04) $P = \text{NR}$	
			Among women with AGA infants, women with 6 week postpartum weights greater than the median value (6.2kg, underweight; 5.7kg, normal weight; 3.1kg, overweight) had significantly greater total weight gains and weight gains during the first 20 weeks' gestation compared to women with 6 week postpartum weights of the median value or lower	
Ohlin et al., 1990 ¹⁴⁵	Pregravid weight: Self-report	Gestational weight gain as a continuous variable (kg)	Regression model for weight change (kg), defined as the difference between prepregnancy and 1 year postpartum weights: B = 0.32 $P < 0.001$	Lactation score, age, prepregnancy BMI, parity
Sweden, maternity clinics 1423	Total weight gain: Maternity records			
All weight/BMI				
Fair				

Table 27. Gestational weight gain and postpartum weight retention (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Soltani et al., 2000 ¹⁴³ UK, Hospital 77 All weight/BMI Fair	Pregravid weight: Measured at 13 weeks' gestation Total weight gain: Measured	Pregravid weight G1: Normal weight G2: Underweight G3: Overweight G4: Obese	G1: Patterns of changes in body weight (kg) and fat mass follow a monotonous trend; body weight and fatness increased during gestation, decreased substantially at 6 weeks postpartum, and then stayed the same or slightly decreased until 6 months postpartum G2: Showed similar pattern to G1. G3: Divergent pattern of weight gains and losses; body fat mass changes show a very scattered pattern G4: Divergent pattern of both weight and fat mass gains and losses; heavier and greater fat masses at 6 months postpartum compared to 13 weeks gestation; significantly lower fat mass loss and greater skinfold thickness gain between 36 weeks gestation and 6 months postpartum compared to normal weight women ($P < 0.05$)	None
Walker et al., 2004 ¹⁴¹ USA, Austin New Mothers Study 382 All weight/BMI Fair	Pregravid weight: Self report Total weight gain: Self report	Continuous gestational weight gain (kg)	Each kg of gestational weight gain was associated with 0.314 kg/m ² of postpartum BMI ($P < 0.001$)	Ethnicity, time, interaction of ethnicity and time, pregravid BMI, weight-related distress, energy intake

Table 27. Gestational weight gain and postpartum weight retention (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Parham et al., 1990 ¹⁴⁰	Pregravid weight: Self report	Gestational weight gain for population in tertiles, mean (se):	Change in BMI category between prepregnancy and 1-3months postpartum:	None
USA, prenatal clinics serving low income women	Total weight gain: Measured	G1: 3.7 (2.9) G2: 9.4 (1.3) G3: 16.0 (3.7)	G1, G2: 83% No change; 7% Desirable change (i.e. underweight women becoming normal weight); 10% Undesirable change (~5% had an increase in BMI category and ~5% had a decrease in BMI category) G3: 42% no change; 19% desirable change; 39% undesirable change (all increases in BMI category)	
158				
All weight/BMI				
Poor				

Overview of results. The results of the two good^{144,147} and eight^{105,136-143,145} fair studies reviewed in this section suggest that gestational weight gain is positively associated with weight retention within 1 year postpartum^{105,141,145} and with interpregnancy weight gains.¹³⁷⁻¹³⁹ There is evidence to suggest that pattern of weight gain influences weight retention; a higher percentage of weight gained within the first 20 weeks of gestation is retained at 6 weeks postpartum compared to weight gains later in pregnancy.¹⁰⁵ Additionally, weight retention differs across pregravid BMI strata,^{138,143} with overweight and obese women retaining more weight compared to normal weight women. Postpartum weight retention seems to be especially problematic for obese women, who may be at risk for increases in fat mass and central adiposity in the postpartum period.¹⁴³ In the long term, the effect of gestational weight gain on weight retention is less conclusive; two studies^{144,146} found little to no association between gestational weight gain and weight at 2.5 and 21 years after the index pregnancy and one study¹³⁶ found that women who became overweight at 15 years follow-up had higher gestational weight gains compared to women who remained normal weight.

Results for less than 1-year postpartum. Three cohort studies, two rated^{105,143} and the other rated poor,¹⁴⁰ examined the association between weight gain and weight retention prior to 1-year postpartum.

One study used a population of low-income white women to examine the influence of total gestational weight gain and partial weight gains, categorized as weight gain \leq 20 weeks, 21-30 weeks, and 31 weeks to term, on postpartum weight retention at 6 weeks.¹⁰⁵ Each kilogram of gestational weight gain at \leq 20 weeks, 21-30 weeks, and 31 weeks to term was significantly ($P < 0.001$) associated with an increase of 0.86 (± 0.05), 0.68 (± 0.07), and 0.49 (± 0.07) kg at 6 weeks postpartum, respectively. Pregravid weight status, defined as underweight, normal weight, and overweight, was based on 1983 Metropolitan Life Insurance Table weight-for-height values. The mean gestational weight gains for women with $<$ median postpartum weight retention (median values of postpartum weight retention were 5.7 kg for underweight, 6.2 kg for normal weight, and 3.1 kg for overweight women) were 13.3, 13.2, and 9.6 kg for underweight, normal

weight, and overweight women, respectively. In contrast, the mean weight gains for women \geq median postpartum weight retention were 19.6, 20.2, and 19.1 kg, respectively ($P < 0.001$). Similar significant differences were seen for mean partial weight gains between women with postpartum weight retention $<$ median and \geq median values ($P < 0.05$ - $P < 0.001$), with the greatest weight gain differences seen within 20 weeks of gestation. Gestational weight gain of 12 kg was associated with 2.5 kg of postpartum weight retention; regression analyses for weight gains of ≤ 12 kg and > 12 kg were associated with 0.58 (SE: 0.13) and 0.77 (SE: 0.04) kg of postpartum weight retention per kg of weight gain, respectively.

Another study measured body weight, body fat mass (kg), and skinfold thickness (sum of five skinfold thicknesses) from 13 weeks of gestation through 6 months postpartum.¹⁴³ BMI categories at 13 weeks' gestation were defined using the IOM BMI classifications. Patterns in changes of body weight and fat mass across the study period were described for each BMI category. Among normal-weight women, the patterns of changes in both body weight and fat mass follow a monotonic trend; body weight and fatness increased during gestation, decreased substantially at 6 weeks postpartum, and then stayed the same or slightly decreased until 6 months postpartum. Overweight women show a divergent pattern of weight gains and losses; women with the highest weight gains and losses at 6 months postpartum were in this group. Body fat mass changes showed a very scattered pattern. Obese women also show a divergent pattern of both weight and fat mass gains and losses; however, the majority of obese women are heavier and have greater fat masses at 6 months postpartum compared to 13 weeks' gestation. Compared with normal-weight women, obese women have significant ($P < 0.05$) increases in total skinfold thickness between 36 weeks' gestation and 6 months postpartum and in waist to hip ratio between 6 weeks' and 6 months postpartum.

Results from the poor study were consistent.¹⁴⁰ Among the women within the upper tertile for gestational weight gains (mean 16.0 ± 3.7 kg), approximately 39 percent had an increase in BMI category at 1 to 3 months postpartum compared to only 5 percent among women within the lower and middle tertiles for gestational weight gains (mean 3.7 ± 2.9 kg and 9.4 ± 1.3 kg, respectively).

Postpartum weight retention at 1 year. Three publications (2 studies), all rated fair quality, measured weight retention at 1 year postpartum.^{141,142,145} One study using data from a low income, racially/ethnically diverse population reported that a 1 kg increase in gestational weight gain was associated with an increase of 0.314 kg/m^2 in BMI at 1 year postpartum.¹⁴¹ Two articles based on data from the Stockholm Pregnancy and Weight Development Study examined the association between gestational weight gain and weight retention at 1 year postpartum.^{142,145} In one article, a 1 kg increase in total gestational weight gain was associated with a 0.32 kg increase in weight at 1 year postpartum ($P < 0.001$), which explained 12.7 percent of the variation in the change in weight from prepregnancy to 1 year postpartum ($P < 0.001$).¹⁴⁵ The other article examined body weight at prepregnancy, delivery, 1 year followup, and 15 years followup in women with normal (BMI 20-25) and overweight (BMI > 25) pregravid BMI.¹⁴² Women who were overweight before pregnancy were significantly heavier at each time point ($P < 0.001$); however, there were no significant differences between normal-weight women and overweight women in the amount of weight retained from prepregnancy to 6 months and 1 year postpartum.

Postpartum weight retention in the medium term. One good-quality study¹⁴⁴ found no association between gestational weight gain and weight retention at two and half years postpartum in a small cohort of women with low antenatal risks enrolled in the Antenatal Care Project (United Kingdom).

Long-term postpartum weight retention. Three publications (2 studies) measured long-term weight retention. One good-quality study in a cohort of Australian women examined the

association between gestational weight gain, dichotomized as ≤ 15 kg and > 15 kg, and weight retention at 21 years after the index pregnancy.¹⁴⁶ Excessive weight gain during pregnancy (> 15 kg) was associated with a mean change in BMI of 0.19 kg/m^2 (95% CI, 0.16-0.22).

Two articles, both rated fair, from the Stockholm Pregnancy and Weight Development Study examined the effects of gestational weight gain on weight retention at 15 years postpartum.^{136,142} At 15 years follow-up, women who had been overweight (BMI > 25) before pregnancy were heavier than women who had been of normal weight (BMI 20-25) before pregnancy.¹⁴² The difference in the weight increases from prepregnancy to 15 years follow-up between overweight and normal-weight women were not significant (7.7 ± 7.0 kg and 6.2 ± 12.1 kg, respectively; $P = 0.36$).¹⁴² Among women with normal pregravid weight, those who remained at a normal weight at 15 years follow-up had significantly lower gestational weight gains than women who were overweight at 15 years follow-up (13.6 ± 3.7 kg and 15.4 ± 4.4 kg, respectively; $P < 0.001$).¹³⁶

Interpregnancy weight retention. Three studies, all rated fair quality, examined the association between gestational weight gain and interpregnancy weight retention.¹³⁷⁻¹³⁹ Two cohort studies used data collected from women attending a city hospital in England.^{137,138} In one, gestational weight gain during a previous pregnancy was associated with a 0.262 kg increase (standard error of the mean [SEM], 0.052; $P < 0.001$) in weight between the index pregnancy and the previous pregnancy.¹³⁷ In the other, gestational weight gain was associated with a 0.176 kg increase (SEM, 0.074; $P = 0.001$) in weight from the beginning of the index pregnancy to the beginning of the second pregnancy.¹³⁸ Prepregnancy BMI and interpregnancy weight gain were independently associated, suggesting that women who had gained the most weight between pregnancies were more likely to have been overweight before their first pregnancy than women who gained less between pregnancies.

A cross-sectional study examined the effect of weight gain (self-reported) from multiple pregnancies on the development of morbid obesity in a group of morbidly obese women, who were not morbidly obese prior to their first pregnancy, and population-based controls.¹³⁹ The mean gestational weight gain and net weight retention for all pregnancies was 14.2 kg and 5.7 kg, respectively, for women who became morbidly obese, and 12.5 kg and 3.4 kg, respectively, for the controls. Women who became morbidly obese gained significantly more weight during their first pregnancy than controls (16.4 kg vs. 12.6 kg, respectively; $P < 0.05$), and they retained significantly more weight after their first and second pregnancies than controls (7.1 kg and 5.9 kg vs. 3.1 kg and 2.9 kg, respectively; $P < 0.05$). After adjusting for pregravid weight at ages 20 to 24 years, the authors determined that each pregnancy was associated with a 1.3 kg increase in current weight ($P = 0.03$), with no significant difference between the slopes of women who became obese and controls (1.6 kg/pregnancy and 1.0 kg/pregnancy, respectively; $P = 0.6$).

Premenopausal breast cancer.

Study characteristics. One study examined the effect of pregnancy weight gain on a woman's risk of developing premenopausal breast cancer (Evidence Table 35).¹⁴⁸ The study was a nested case-control study within a cohort of 22,610 Finnish women with a mean age of 40 during 1990 and 1993. Women self-reported their breast cancer status, and their current weight, highest nonpregnancy weight, weight at age 20, and weight gain during any pregnancy in one of four categories (< 10 , 10-15, 16-20, and > 20 kg). A total of 114 women had identified themselves as having premenopausal breast cancer; of these, 98 women had provided information on year of birth, had been pregnant, and had their cancer diagnosed after a pregnancy. Four controls for each case from the cohort were selected matched by age and type of intrauterine device.

Overview of results. The fair study suggested that gestational weight gain and premenopausal breast cancer are not associated.¹⁴⁸

Detailed results. ORs for breast cancer by gestational weight gain category were close to null and nonsignificant in both crude and adjusted models (age, education, family history of breast cancer, and change in BMI) using the < 10 kg category as the reference: ORs were 0.8 (0.44, 1.47), 1.0 (0.47, 2.04), and 0.8 (0.27, 2.13) for weight categories 10-15 kg, 16-20 kg, and > 20 kg, respectively.

KQ 3: Outcomes of Weight Gain Within or Outside IOM Recommendations

Although the KQ 3 issues are similar to those addressed in KQ 1, the focus here is on analyses that directly apply the categories of weight gain during pregnancy that the IOM laid out in its 1990 document.¹ The recommendations specific to BMI weight status groups and certain sociodemographic or physical characteristics are as follows:

- 28 to 40 pounds for women with low BMI (<19.8);
- 25 to 35 pounds for women with normal BMI (19.8-26);
- 15 to 25 pounds for women high BMI (> 26.0-29.0);
- weight gain of at least 15 pounds for obese women (BMI > 29);
- weight gain in the upper end of the recommended range for adolescents and black women; and
- weight gain in the lower end of the recommended range for short women (< 157 centimeters, or approximately 62 inches).

We present KQ 3 results similar to the presentation for KQ 1. We examine, first, maternal antenatal outcomes and then intrapartum outcomes; we then consider birth outcomes, infant outcomes, and child outcomes; and, finally, we cover maternal short- and long-term outcomes. When we have three or more studies dealing with the same topic (i.e., outcome), we present information in summary tables; otherwise, detailed information on these articles will be found in the relevant evidence tables in Appendix E.[†] For all outcomes, we first describe the studies (main study characteristics only); we then provide an overview of the results (for topics with more than one study), followed by a more detailed discussion of relevant studies.

We rated studies for quality as good, fair, or poor (as explained in Chapter 2). All studies are reported in summary tables (including quality grades), and they are presented in order by quality rating. The text focuses on studies of good and fair quality, in that order; the vast majority are fair quality, so studies for which no quality grade is specified can be assumed to be of fair quality. We only briefly summarize poor studies. Generally, if studies deal with more than one outcome, we describe the study once and refer back as needed.

Maternal Antepartum Outcomes

Gestational diabetes mellitus.

Study characteristics. Four studies examined the relationship between weight gain according to the IOM guidelines and GDM (Evidence Table 36, Table 28).^{3,53-55} Two studies were done

[†] Appendixes and evidence tables cited in this report are provided electronically at <http://www.ahrq.gov/downloads/pub/evidence/pdf/admaternal/admaternalapp.pdf>.

specifically among obese women;^{54,55} two included women of normal weight,^{53,55} and one included women of various pregravid weight categories.³

Table 28. Weight change relative to IOM thresholds and gestational diabetes mellitus

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Saldana et al., 2006 ³ USA, hospital 952 All weight/BMI Good	Pregravid weight: Self-report Total weight gain: Measured	G1: Normal glucose tolerance G2: Impaired glucose tolerance G3: Gestational diabetes mellitus BMI IOM	Mean (SE) weight gain ratio (defined as observed weight gain/IOM recommended weight gain): G1: 1.43 (0.04) G2: 1.48 (0.21) G3: 1.88 (0.15) <i>P</i> < 0.05 AOR (95% CI) for weight gain ratio: G1: 1.0 (reference) G3: 1.2 (0.9-1.4)	Race, age, gestational age
Edwards et al., 1996 ⁵⁵ USA, Hospital 1,443 Normal/obese weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Obese BMI > 29 (kg): G1: Lost weight/no change G2: 0.5-6.5 G3: 7-11.5 G4: 12-16 G5: > 16 Normal weight BMI 19.8-26 G6: < 11.5 G7: 11.5-16 G8: > 16	Gestational diabetes, % G1: 13.3 G2: 24.3 G3: 11.9 G4: 16.7 G5: 17.3 <i>P</i> for linear trend (G1-G5) = 0.554 G6: 2.3 G7: 3.3 G8: 2.9 <i>P</i> for linear trend (G6-G8) = 0.759	None
Thorsdottir 2002 ⁵³ Iceland, hospital records 614 Normal weight/BMI 19.5-25.5 Fair	Pregravid weight: Self-report Total weight gain: Maternity records	Maternal weight gain categories (kg): G1: < 11.5 G2: 11.5-16.0 G3: 16.1-20.0 G4: > 20.0	Gestational diabetes, % G1: 2.9 G2: 0 G3: 0 G4: 0 <i>P</i> for trend < 0.015	None

AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; g, gram; GDM, gestational diabetes mellitus; IOM, Institute of Medicine; kg, kilogram; NS, not sufficient; SE, standard error; USA, United States of America.

Table 28. Weight change relative to IOM thresholds and gestational diabetes mellitus (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Bianco et al., 1998 ⁵⁴ USA, medical center 11,926 Nonobese (BMI 19-27) and morbidly obese (BMI > 35) Poor	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories among morbidly obese (BMI > 35): G1: Weight loss/no change G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs	Distribution of GDM, %: G1: 15.7 G2: 15.0 G3: 14.4 G4: 13.4 G5: 12.5 <i>P</i> = NS	Race, parity, clinic service, substance abuse, preexisting medical condition

Overview of results. No definitive evidence from four studies (1 good,³ 2 fair,^{53,55} 1 poor⁵⁴) exists of an association between high weight gain and risk of developing GDM because of methodological problems with most studies addressing this topic.

Detailed results. Obese women, independent of weight gain, had increased risks of developing GDM in three studies (1 of good quality,³ 1 of poor quality⁵⁴). Overweight women in the one good study that included them also had an increased risk for GDM.³ All studies used weight gain at the time of delivery, which included the weight gained after the diagnosis of GDM. This measure of weight gain is biased since, once the diagnosis of GDM is made, weight gain is closely monitored and controlled through treatment.

One good study evaluated weight gain up to the time of GDM diagnosis in both white and black women.³ The authors calculated the ratio of weight gain that expressed the amount of weight a woman gained to the amount she was expected to gain according to the IOM guidelines until the time of diabetes testing (that is, accounting for gestational length). Women who developed GDM had higher weight gain ratios than did women with normal glucose tolerance. In multivariable analysis, weight gain ratio was not significantly associated with developing GDM. However, among overweight women, a higher weight gain ratio was predictive of impaired glucose tolerance and this effect was stronger for white women (data not shown in table).

Two studies (1 poor-quality⁵⁴) examined total weight gain and GDM risk in obese women; neither found any association (using bivariate analyses) with weight gains either above or below the IOM guidelines.^{54,55}

Two studies reported findings for women of normal weight.^{53,55} One had too few women who developed GDM across the weight gain groups to permit analyses,⁵³ and the other found no association.⁵⁵

Hypertension.

Study characteristics. One poor study compared the effect of total weight gain on the risk of developing pregnancy-induced hypertension among morbidly obese women and nonobese women using data from Mount Sinai Medical Center from 1988 to 1995 (Evidence Table 37).⁵⁴

Results. In bivariate analysis, this study found no association between weight gains below or above the IOM guidelines and pregnancy-induced hypertension.

Preeclampsia.

Study characteristics. The association between gestational weight gain and preeclampsia was examined in four articles (2 from the same database) of fair quality (Evidence Table 38, Table 29).^{4,25,53,55} Two studies included obese women,^{4,55} three included women of normal weight.^{25,53,55}

Table 29. Weight change relative to IOM thresholds and preeclampsia

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Devader et al., 2007 ²⁵ USA, birth certificate data 94,696 Normal weight/BMI 19.8-26 Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories (lbs): G1: < 25 G2: 25-35 G3: > 35	AOR (95% CI) for preeclampsia: G1: 0.56 (0.49-0.64) G2: 1.00 (reference) G3: 1.88 (1.74-2.04)	Age, race, education, income, alcohol use, height, prior pregnancy, inadequate prenatal care use, smoking, child's gender, birth year
Edwards et al., 1996 ⁵⁵ USA, Hospital 1,443 Normal/ Obese weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Obese BMI > 29 (kg): G1: Lost weight/ no change G2: 0.5-6.5 G3: 7-11.5 G4: 12-16 G5: > 16 Normal weight BMI 19.8-26: G6: < 11.5 G7: 11.5-16.0 G8: > 16.0	Preeclampsia G1: 10.7 G2: 7.7 G3: 8.3 G4: 7.9 G5: 16.5 <i>P</i> for linear trend (for G1- G5) = 0.076 G6: 2.8 G7: 2.9 G8: 6.6 <i>P</i> for linear trend (for G6- G8) = 0.048	None

AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; g, gram; kg, kilogram; lbs, pounds; USA, United States of America.

Table 29. Weight change relative to IOM thresholds and preeclampsia (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Kiel et al., 2007 ⁴ USA, Hospital 120,170 Obese BMI Fair	Pregravid weight: Self-report Total weight gain: Medical record	Maternal weight gain categories stratified by prepregnancy obesity status, Obese Class I (BMI 30–34.9), Obese Class II (BMI 35–39.9), Obese Class III (BMI ≥ 40): G1: ≤ -10lbs G2: -2 to -9 lbs G3: No change G4: 2-9 lbs G5: 10-14 lbs G6: 15-25 lbs G7: 26-35 lbs G8: > 35 lbs	For Obese Class I: OR (95% CI) for preeclampsia were significantly lower (< 1.00, G6 was reference) for G2-G5 and significantly higher for G7-G8. For Obese Class II: OR (95% CI) for preeclampsia were significantly greater (> 1.00, G6 was reference) for G1 and G3-G5 and significantly lower for G8. For Obese Class III: OR (95% CI) for preeclampsia were significantly greater (> 1.00, G6 was reference) for G1-G3 and G5 and significantly lower for G7-G8	Age, race, parity, education, poverty (enrollment in Medicaid, WIC, food stamp programs), tobacco use, chronic hypertension
Thorsdottir et al., 2002 ⁵³ Iceland, hospital records 614 Normal weight/BMI 19.5-25.5 Fair	Pregravid weight: Self-report Total weight gain: Maternity record	Maternal weight gain categories (kg): G1: < 11.5 G2: 11.5-16.0 G3: 16.1-20.0 G4: > 20.0	Preeclampsia,% G1: 1.4 G2: 2.3 G3: 5.4 G4: 4.4 P for trend = 0.262	None

Overview of results. The evidence of an association between high weight gains and increased risk of preeclampsia is inconclusive.

Detailed results. Among obese women, preeclampsia risk increased with gains greater than 25 pounds and decreased with gains lower than 15 pounds in one study.⁴ Another study reported no association, but it had not conducted multivariate analyses for this outcome.⁵⁵

Among women of normal weight, one study found no association between preeclampsia and gains either below or above the IOM levels.⁵³ In two other studies, the risk of preeclampsia rose as weight gains above the IOM recommendations increased;^{25,55} it dropped with weight gains below IOM thresholds in one of these studies.²⁵

Maternal Intrapartum Outcomes

Cesarean delivery.

Study characteristics. Nine articles examined the effect on cesarean delivery of weight gain classified according to the IOM guidelines (Evidence Table 39, Table 30).^{4,25,53-55,77,118,149,150} These studies were all rated fair except for one poor study.⁵⁴ Two articles were based on the same birth certificate data from Missouri,^{4,25} three used US hospital databases;^{55,118,149} one used data from a US midwifery practice;¹⁵⁰ one used a random selection of normal-weight pregnant women in Iceland;⁵³ and one used data from the US Pregnancy Risk Assessment Monitoring System (PRAMS).⁷⁷

Overview of results. For underweight and normal-weight women, some evidence may suggest an increased risk of cesarean delivery for weight gains above IOM recommendations; evidence for obese or morbidly obese women is inconsistent.

Detailed results. Two studies that examined women across a range of BMI categories found increased risks of cesarean delivery for weight gains exceeding IOM guidelines and these results were consistent in all pregravid weight categories (AORs of 1.6 and 2.0).^{149,150}

Table 30. Weight change relative to IOM thresholds and cesarean delivery

Author, Year	Country, Setting	Pregravid Weight (How Measured)	Sample Size	Baseline BMI	Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Devader et al., 2007 ²⁵	USA-Missouri, birth certificate data	Pregravid weight: Self-Report	94,696	Normal weight BMI 19.8-26	Total weight gain: As reported on birth certificate	G1: Gained less than 25 lbs G2: Gained 25-35 lbs G3: Gained more than 35 lbs	AOR for cesarean delivery (additionally controlled for LGA and cephalopelvic disproportion) G1: 0.82 (0.78–0.87) G2: 1.0 G3: 1.35 (1.29–1.40)	Age, race, education, income, alcohol use, height, prior pregnancy, inadequate prenatal care use, smoking, child's gender, birth year
Fair								

AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; G, group; GDM, gestational diabetes mellitus; IOM, Institute of Medicine; lb(s), pound(s); LGA, large for gestational age; OR, odds ratio; PRAMS, Pregnancy Risk Assessment Monitoring System; USA, United States of America; WIC, The Special Supplemental Nutrition Program for Women, Infants, and Children.

Table 30. Weight change relative to IOM thresholds and cesarean delivery (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Edwards et al., 1996 ⁵⁵ USA, hospital 1,443 Normal BMI 19.8- 26 Obese BMI > 29 Fair	Pregravid weight: Self-reported Total weight gain: Prenatal records	Obese G1: wt loss or 0 lbs G2: 1-14 lbs G3: 15-25 lbs G4: 26-35 lbs G5: > 35 lbs Normal weight G1: < 25 lbs G2: 25-35 lbs G3: > 35 lbs	Obese G1: 30.7% G2: 21.6% G3: 23.8% G4: 26.2% G5: 30.1% Normal wt G1: 5.7% G2: 12.1% G3: 8.6% No significant difference in rates of cesarean delivery by IOM weight gain categories for normal weight or obese women Obese women AOR = 3.2 (2.3- 4.4) for cesarean delivery	Age, parity, pregravid BMI, GDM, pregnancy- induced hypertension, prenatal adequacy, alcohol use, drug use, smoking, gestational age
Jain et al., 2007 ⁷⁷ USA, PRAMS 7,661 All weight/BMIs (using IOM definitions) Fair	Pregravid weight: Self-reported Total weight gain: Self-reported	G1: ≤ 15 lbs G2: 16 - < 25 lbs G3: 25 - < 35 lbs G4: ≥ 35 lbs G5: interaction term overwt/obese and gaining 25-35	Primipara (AOR, 95% CI) G5: 0.71 (0.43-1.19) Multipara G5: 0.77 (1.37-1.59)	Pregravid BMI, parity
Kaiser and Kirby, 2001 ¹⁵⁰ USA, university nurse-midwifery system 1,881 All wt/BMI (using IOM definitions) Fair	Pregravid BMI: Self-reported Total weight gain: Measured at last prenatal visit	G1: Below IOM G2: Within IOM G3: Above IOM	Crude OR 95% CI G1: 0.82 (0.49-1.36) G3: 1.0 (0.62-1.63) AOR for weight gain above IOM recommendations: 2.04 (95% CI 1.02-4.05)	Age, race, pregravid BMI, preeclampsia, height, previous live births, failure to progress, breech presentation, placental abruption, fetal bradycardia, primigravidity, birthweight
Kiel et al., 2007 ⁴ USA-Missouri, birth certificate 120,170 Obese BMI > 30 Fair	Pregravid BMI: Self-reported Total weight gain: Birth certificate	G1: Wt loss > 10 lbs G2: Wt loss 2-9 lbs G3: No change G4: 2-9 lbs G5: 10-14 lbs G6: 15-25 lbs G7: 26-35 lbs G8: > 35 lbs	For all three classes of obese women, risks of cesarean delivery rise above an OR of 1 when weight gain exceeds 25 pounds	Age, race, parity, education, poverty (enrollment in medicaid, WIC, food stamp programs), tobacco use, chronic hypertension

Table 30. Weight change relative to IOM thresholds and cesarean delivery (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Parker and Abrams, 1992 ¹¹⁸ USA, hospital data base 6,690 All wt/BMI (using IOM definitions) Fair	Pregravid weight: Self reported Total weight gain: Measured weight in prenatal record	G1: Below IOM G2: Above IOM	AOR for all women weight gain > IOM (G2) = 1.48 (1.25-1.76) For overweight women, there was no significant association between cesarean delivery and weight gain (AOR = 0.71 (0.40-1.26) For nonoverweight women, the association between cesarean delivery and weight gain was 1.45 (1.21- 1.73)	Age, race, parity, pregravid BMI, height, maternal high and low weight gain, smoking, gestational age, birthweight
Stotland et al., 2004 ¹⁴⁹ USA, university hospital 9,788 All wt/BMI Fair	Pregravid weight: No details reported Total weight gain: No details reported, possibly measured weight in prenatal records	G1: Below IOM G2: Above IOM	AOR with birthweight in model G1: 0.99 (0.82-1.19) G2 :1.40 (1.22-1.59) BMI < 19.8 G1 = 0.96 (0.67-1.37); G2 = 1.93 (1.45-2.53) BMI 19.8-26 G1 = 1.04 (0.81-1.33); G2 = 1.26 (1.06-1.50) BMI > 26 G1 = 0.74 (0.38- 1.44); G2 = 1.21 (0.83-1.78)	Age, race, pregravid BMI, year of delivery, smoking, gestational age, birthweight, infant sex
Thorsdottir et al., 2002 ⁵³ Iceland, hospital records 614 Normal wt/BMI 19.5-25.5 Fair	Pregravid weight: Self-reported Total weight gain: Measured weight in prenatal records	G1 < 11.5 kg G2 11.5-16 kg G3 16.1-20 kg G4 > 20 kg	G1: 17.4% G2: 9.5% G3: 12.9% G4: 13.1% No significant differences in cesarean delivery rates by IOM weight gain categories in normal weight women	Age, parity, height, gestational age, birthweight
Bianco et al., 1998 ⁵⁴ USA, hospital 11,926 Nonobese BMI 19 to 27 /morbidly obese BMI > 35 Poor	Pregravid weight: Perinatal data base Total weight gain: Perinatal data base	G1: wt loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs	G1: 25.5% G2: 26.8% G3: 28.8% G4: 35.0% G5: 33.8% No significant difference among morbidly obese women by weight gain categories OR for cesarean comparing morbidly to nonobese = 2.3 (1.9-2.8)	Macrosomia

The six studies stratified by pregravid weight status produced mixed results. Of the articles in this category, five considered women of normal weight.^{25,53,55,118,149} Of these five studies, two^{53,55} reported no association with weight gains above the IOM guidelines and three found a moderate association between cesarean delivery and weight gain above IOM recommendations^{25,118,149}. Four studies (1 of poor quality⁵⁴) examined these issues among overweight and obese women.^{54,55,118,149} They reported no association between weight gain and risk of cesarean delivery. For underweight women, two studies reported a moderate to strong association between weight gain above IOM recommendations and risk for cesarean delivery;^{118,149} for nonobese women, one of these studies reported a moderate association.¹¹⁸ Three studies reported that the risk of cesarean delivery was higher for obese or morbidly obese women than for nonobese women.^{54,55,150} One study suggested that these risks increase within classes of obesity with gains greater than 25 pounds.⁴

The one study that examined the interaction between weight gain of 25-34 pounds and pregravid overweight or obese status did find a significant effect for multiparous women but not primiparous.⁷⁷

Birth Outcomes

Preterm birth.

Study characteristics. Four studies, all rated fair, reported on the association between weight gain according to the IOM guidelines and preterm birth defined as < 37 completed weeks of gestation (Evidence Table 40, Table 31).^{22,85,151,152} One study reported on total weight gain.²² All four reported on the rate of weight gain or pattern.^{22,85,151,152}

Table 31. Weight change relative to IOM thresholds and preterm birth (< 37 weeks)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hickey et al., 1995 ¹⁵¹	Pregravid weight: Self-reported	G1: Low rate of weight gain in first trimester-underweight (BMI < 19.8) & < 2.3 kg and normal weight (BMI 19.8-26) & < 1.6 kg	OR (95% CI) for spontaneous preterm G1: 1.27 (0.7-2.3) G2: 1.23 (0.7-2.18) G3: 2.46 (1.53-3.92)	Age, race, pregravid BMI, height, alcohol use, history of previous infant less than 2,750 g, number of days between last weight observation and delivery, smoking, infant sex
USA, university prenatal clinics 1,518 Under/normal wt Fair	Total weight gain: Prenatal records	G2: Low rate of weight gain in second trimester (Underwt & < 0.38 kg/wk or normal wt & < 0.37 kg/wk) G3: Low rate of weight gain in third trimester (Underwt & < 0.38 kg/wk or normal wt & < 0.37 kg/wk)	Pattern of weight gain G1 only: 2.94 (0.73-11.98) G2 only: 1.08 (0.1-11.23) G3 only: 11.54 (2.93-45.28) G1 & G2: 4.89 (0.85-28.14) G1 & G3: 4.49 (0.96-20.96) G2 & G3: 7.37 (1.66-32.76) All trimesters: 4.18 (0.75-23.35)	

Af Am, African American; AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; DOB, date of birth; G, group; IOM, Institute of Medicine; kg/wk, kilograms per week; OR, odds ratio; wt: weight; PTB, pre-term birth; USA, United States of America; wk, week; wt, weight.

Table 31. Weight change relative to IOM thresholds and preterm birth (< 37 weeks) (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Schieve et al., 2000 ¹⁵² USA, nationally representative 1988 births 3,511 All wt/BMI Low BMI < 19.8 Average BMI 19.8-26 High BMI > 26 Fair	Pregravid weight: Self-reported baseline Weight gain: Rate of measured weight between 14 and 28 wks gestation	G1: Low < 0.5 less/week; G2: Average 0.5-1.5 lb/week G3: High > 1.5 lb/week	AOR for preterm birth Low BMI: G1 = 6.7 (1.1-40.6) Low BMI: G2 = 0.8 (0.4-1.4) Low BMI: G3 = 1.0 (0.4-2.6) Average BMI: G1 = 3.6 (1.6-8.0) Average BMI: G2 (Reference) Average BMI: G3 = 1.0 (0.6-1.9) High BMI: G1 = 1.6 (0.7-3.5) High BMI: G2 = 1.1 (0.6-2.1) High BMI: G3 = 0.1 (0.03-0.6)	Age, race, parity, marital status, education, smoking
Siega-Riz et al., 1994 ²² USA, public health clinics 5,854 All wt/BMI (using IOM definitions) Fair	Pregravid weight: self reported Total weight Gain: Prenatal records	Total weight gain expressed as a ratio of observed: expected based on the IOM recommen- dation for a given gestational age.	Adequacy of weight gain in the third trimester was predictive of preterm birth - the data suggested a threshold effect for all weight status groups with a marked decrease in risk at 90-110% of the IOM recommendation With the rate of weight gain less than 60% of the IOM value, women in all four groups had more than double the risk of delivering preterm, which was statistically significant for all but the obese category. Excessive rate of weight gain was significantly associated with a preterm birth only for women of normal pregnancy weight status at a value greater than 200% of the IOM value	Pregravid BMI, gestational age

Table 31. Weight change relative to IOM thresholds and preterm birth (< 37 weeks) (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Stotland et al., 2006 ⁸⁵	Pregravid weight: Self-reported	G1: low rate of weight gain < .27 kg/wk	Crude OR of spontaneous preterm birth G1: 2.6 (95% CI 2.1–3.2) G3: 1.0 (95% CI 0.8–1.2)	Age, race, parity, pregravid BMI, history of previous PTB, year of delivery, number of days between last weighing and DOB, smoking
USA, academic medical center	Total weight gain: prenatal records	G2: ref 0.27- 0.52 kg/wk G3: high rate of weight gain > 0.52 kg/wk	AOR of spontaneous preterm birth G1: 2.5 (95% CI 2.0–3.1) G3: 1.0 (95% CI 0.8–1.3)	
15,101			No differences in results by parity combined with history of preterm birth	
Underweight BMI < 19.8 and normal weight BMI 19.8- 26			Slightly higher risks for Af Am and high wt gain close to sign for Af Am	
Fair				

Overview of results. Despite inconsistencies in the definitions of rate of weight gain and the timing of its calculation, the four studies are consistent in showing increased risks of preterm birth for underweight and normal-weight women, thereby providing evidence of some association between weight gain below IOM recommendations and preterm birth. Evidence about any association between weight gain above IOM recommendations and preterm birth is inconclusive.

Detailed results on total weight gain. The single study on total weight gain, set in the United States, included only singleton live births with no pregnancy complications among predominantly Hispanic women (80 percent) using information reported on the medical record.²² Total weight gain was defined as weight at last prenatal visit minus self-reported pregravid weight (which was checked for biological plausibility). To analyze observed weight gains in light of the IOM recommendations, the authors created an “expected total weight gain” variable using the amount of weight gain a woman was supposed to gain according to the IOM guidelines when her last weight was measured and then calculated a ratio of observed to expected weight gain. Ratios greater than 1 indicate that the women gained more weight than expected; ratios less than 1 indicate that they gained less weight than expected. For all but obese women, the pattern of risk of preterm birth was U-shaped. The lowest risk of preterm birth was observed for all women with weight gain ratios between 1.10 and 1.40.

Results on rate of weight gain for all women. In the two studies that examined rate of weight gain among women in all BMI groupings,^{22,152} the US study described above found that inadequate or excessive weight gain in the first or second trimester using the IOM definitions was not associated with preterm birth.²² By contrast, adequacy in the third trimester was predictive of risk of preterm birth; ratios of observed/expected between .90 and 1.10 were associated with decreased risk. A ratio of < 0.60 was significantly associated with a doubling of the risk of preterm birth for women of all but the obese weight groups. Among normal-weight women, a ratio > 2.0 was significantly associated with a preterm birth.

The other study was conducted in a nationally represented sample of all singleton live births in the US from 1988.¹⁵² This study used common definitions of rate of weight gain (mapping to IOM categories for underweight women): low (< 0.5 lb/week), average (0.5 to 1.5 lb/week), and

high > 1.5 lb/week) for all BMI groups. The authors calculated rate of weight gain in a regression model using measured prenatal weights from 14 to 28 weeks of gestation. Among women of normal weight, low weight gain was statistically significantly associated with an increased risk (approximately fourfold) of preterm delivery compared with women in this same category who had average weight gain. This finding held true when medically indicated preterm deliveries were excluded, when women with pregnancy complications were excluded, and when models were adjusted for confounders listed in Table 31. Among underweight women, a low rate of weight gain was statistically significantly associated with the risk of preterm birth when the same exclusions and model adjustments were made. In models with these same exclusions and adjustments, however, for women with a BMI \leq 26, high weight gain was not associated with significant changes in the risk of preterm birth and for women with a BMI > 26, high weight gain was associated with *lower* risk of preterm birth.

Detailed results on rate of weight gain for normal or underweight women. Two studies examined the effect of rate of weight gain on spontaneous preterm birth among only underweight and normal-weight women.^{85,151} In one US study, the authors calculated the rate of weight gain over the entire pregnancy using weight at time of delivery minus self-reported pregravid weight divided by gestational age at delivery (minus 2 weeks because gestational age was based on last menstrual period).⁸⁵ Low rate of weight gain during pregnancy, defined as < 0.27 kg per week, was statistically significantly associated with spontaneous preterm birth in both crude and adjusted analyses. High rate of weight gain, defined as > 0.52 kg per week, was not associated with risk of preterm birth. These findings were similar when the models were stratified by ethnicity, parity, and history of preterm birth, and adjusted for the confounders listed.

In another US study, total weight gain in the first trimester was defined as measured weight at 10 to 13 weeks minus self-reported pregravid weight; second and third trimester rates of weight gain were based on measured weights during the trimester.¹⁵¹ Low weight gain in the first or second trimester alone was not associated with spontaneous preterm birth. By contrast, low third-trimester weight gain was statistically significantly associated with spontaneous preterm birth. The combination of low second- and third-trimester rate of weight gain was also statistically significantly associated with spontaneous preterm birth. All analyses controlled for several confounders listed in Table 31.

Birthweight.

Study characteristics. Ten studies from nine databases examined the association between weight gain defined by IOM guidelines and birthweight (Evidence Table 41, Table 32).^{20,54,60,104,153-158} Three studies were done in only black women,^{60,153,154} two stratified by race;^{20,155,156} two were done in adolescents;^{153,154} one came from a cohort of 233 women enrolled in the WIC program in Iowa;¹⁵⁷ and one used a perinatal database from a medical center in New York.⁵⁴

Table 32. Weight change relative to IOM thresholds and birthweight

Author, Year	Country, Setting	Pregravid Weight (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Nielsen 2006 ¹⁵³	USA, prenatal clinics	Pregravid weight: Self-reported	G1: < IOM G2: lower half IOM range G3: Upper half IOM range G4: > IOM	Adjusted birthweight BMI < 19.8 G1: 2,986 g G2: 3,167 g G3: 3,198 g G4: 3,277 g All significantly different from each other except G2 & G3	Parity, pregravid BMI, preeclampsia, time between last weight measure and delivery, height, smoking, infant sex
	African-Americans only	Total weight gain: Prenatal records, measured		BMI 19.8-26 G1: 3,018 g G2: 3,166 g G3: 3,255 g G4: 3,318 g All significantly different from each other	
	815			BMI > 26 G1: 3,127 g G2: 3,351 g G3: 3,384 g G4: 3,434 g G1 significantly different from the others, G2, G3 & G4 not significantly different from each other	
	All weight/BMIs				
	Good				

&, and; AOR, adjusted odds ratio; birthwt, birthweight; BMI, body mass index; G, group; g, gram; GDM, gestational diabetes mellitus; IOM, Institute of Medicine; kg/wk, kilogram per week; NR, not/none reported; OR, odds ratio; underwt, underweight; USA, United States of America; WIC, The Special Supplemental Nutrition Program for Women, Infants, and Children.

Table 32. Weight change relative to IOM thresholds and birthweight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hickey et al., 1997 ²⁰	Pregravid weight: Self-reported	G1: Below IOM range	BMI < 19.8 G1: Black: 2,840 White: 3,002	Age, education, height, street drugs, alcohol use, time between last prenatal weight observation and delivery, smoking, gestational age, infant sex
USA, public health programs	Total weight gain: Measured weights- prenatal records	G2: Lower end of IOM range G3: Upper end of IOM range G4: Gain above IOM range	G2: Black: 2,995 White: 3,151	
5,198			G3: Black: 3,017 White: 3,200	
All wt/BMI (using IOM definitions)			G4: Black: 3,163 White: 3,353	
Fair			BMI 19.8-26.0 G1: Black: 3,052 White: 3,176	
			G2: Black: 3,105 White: 3,199	
			G3: Black: 3,180 White: 3,307	
			G4: Black: 3,228 White: 3,389	
			BMI > 26.0 G1: Black: 3,126 White: 3,385	
			G2: Black: 3,192 White: 3,376	
			G3: Black: 3,312 White: 3,402	
			G4: Black: 3,300 White: 3,504	

Table 32. Weight change relative to IOM thresholds and birthweight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hickey et al., 1996 ¹⁵⁵ USA, prenatal clinics 415 Under & Normal weight Fair	Pregravid BMI: Self-reported Total weight gain: Prenatal records	G1: First trimester < 2.6 kg for underwt (BMI < 19.8) & < 1.6 kg for normal wt (BMI 19.8-26) G2: Second trimester < 0.38 kg/wk for underwt & < 0.37 kg/wk for normal wt G3: < 0.38 kg/wk for underwt & < 0.37 kg/wk for normal wt	Association of low trimester gain with birthwt G1: all women -18 g <i>P</i> = .65 Black -15 g <i>P</i> = .76 White -42 g <i>P</i> = .53 G2: All women -166g <i>P</i> = < .001 Black -164 g <i>P</i> = .005 White -158 g <i>P</i> = .05 G3: All women -111g <i>P</i> = .008 Black -77 g <i>P</i> = .14 White -194 g <i>P</i> = .004 No association with low weight gain in only the first or second trimester. G3: All -164 g <i>P</i> = .01 Black -80 g <i>P</i> = .38 White -300 g <i>P</i> = .005 Association with low weight gain during more than one trimester G1 & G2: All -236 g <i>P</i> = .01 Black -265 g <i>P</i> = .04 White -169 g <i>P</i> = .25 G1 & G3: No significant diff G2 & G3: All -206 g <i>P</i> = .01 Black -178 g <i>P</i> = .08 White -268 g <i>P</i> = .06 G1, G2 & G3: All -284 g <i>P</i> = .002 Black -252 g <i>P</i> = .03 White -379 g <i>P</i> = .008	Age, race, pregravid BMI, height, alcohol use, third trimester number of weeks between last weight observation and delivery, history of previous infant < 2,750 g, smoking, gestational age, infant sex
Hickey et al., 1993 ¹⁵⁶ USA, prenatal clinics 1,168 All weight/BMIs Fair	Pregravid BMI: Self-reported Total weight gain: Prenatal records	BMI ≤ 29 G1: gain < range G2: gain in the range G3: gain > range BMI > 29 G4: gain < 6.0 kg G5: gain > 6.0 kg	Adjusted Birthwt BMI ≤ 29 G1: Black: 3,027 White: 3,246 G2: Black: 3,177 White: 3,233 G3: Black: 3,293 White: 3,523	Maternal height, education, parity, marital status, smoking, alcohol use, hypertension, GDM, gestational age at delivery, socioeconomic status, time between last weight and delivery

Table 32. Weight change relative to IOM thresholds and birthweight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hickey et al., 1993 ¹⁵⁶ (continued)			BMI > 29 G4: Black: 3,214 White: 3,500 G5: Black: 3,553 White: 3,596	
Luke et al., 1996 ¹⁰⁴ USA, clinic 487 All weight/BMIs Fair	Pregravid weight: Self-reported Total weight gain: Prenatal records, measured	G1: Gain < IOM G2: gain equal to IOM G3: gain > IOM	Adjusted birthweight G1: BMI < 19.8 2,873 g* BMI 19.8-26.0 3,157 g* BMI > 26 3,138 g G2: BMI < 19.8 3,190 g BMI 19.8-26 3,298 g BMI > 26 3,338 g G3: BMI < 19.8 3,489 g* BMI 19.8-26 3,494 g* BMI > 26 3,347 g * significantly different from gains within range within each BMI grouping	Maternal age, parity, black ethnicity, smoking, gestational duration, fetal sex
May, 2007 ¹⁵⁷ USA, WIC clinic 233 All weight/BMI Fair	Pregravid weight: Self reported Total gestational weight gain: Self-reported	G1: Below IOM G2: Greater IOM	Betas from multiple linear regression G1: -162 g G2: -153 g	Maternal BMI, smoking, gestational age at delivery
Ogunyemi et al., 1998 ⁶⁰ USA, Hospital 582 All weight/BMIs (using IOM definitions) Fair	Pregravid weight: Self-reported Total gestational weight gain: Prenatal records, measured	G1: Low < IOM G2: Normal = IOM G3: High > IOM	Birthweight G1: 3,029 G2: 3,210 G3: 3,283 (<i>P</i> < 0.01)	NR

Table 32. Weight change relative to IOM thresholds and birthweight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Scholl et al., 1995 ¹⁵⁸	Pregravid weight: Self-reported	Rate between 20- 36 wks G1: low rate < 0.34 kg/wk	Birthweight (g): G1: 3,049 (56.94) <i>P</i> < 0.05, low vs. moderate plus excessive weight gain	NR
USA Camden Study 274 Normal weight BMI 19.8-26 Fair	Total weight gain: Prenatal records, measured	G2: moderate rate 0.34-0.68 kg/wk G3: Excessive rate > 0.68 kg/wk	G2: 3,208 (36.33) G3: 3,191 (49.46)	
Stevens-Simon and McAnarney, 1992 ¹⁵⁴	Pregravid weight: Self-reported	G1: slow < 0.23 kg/wk	Birthweight (g): G1: 2,745 (694) G2: 3,097 (457)	NR
USA African- American adolescent maternity program 141 All BMI Fair	Total weight gain: Prenatal records, measured	G2: average 0.23-4 kg/wk G3: rapid > 0.4 kg/wk	G3: 3,351 (482) <i>P</i> < 0.0001 No difference in pregravid by weight gain groups	
Bianco et al., 1998 ⁵⁴	Pregravid weight: Self-report	Maternal weight gain categories among morbidly obese :	G1: 3,302 g G2: 3,192 g G3: 3,337 g G4: 3,506 g G5: 3,453 g <i>P</i> = < 0.05	NR
USA, medical center 11,926 Nonobese (BMI 19-27) and morbidly obese (BMI > 35) Poor	Total weight gain: Measured	G1: Weight loss/no change G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs		

Overview of results. Overall, these studies (1 good,¹⁵³ 8 fair,^{20,60,104,154-157} and 1 poor⁵⁴) support an association between weight gains less than the IOM guidelines and lower birthweight; such an association appears to be stronger when the *rate* of weight gain is the relevant factor. There is also evidence of an association for gains above the guidelines and higher birthweight but less so when rate of weight gain is the relevant factor.

Detailed results for total weight gain. Seven articles examined total weight gain; one was good,¹⁵³ one was poor quality,⁵⁴ and the remainder were fair.^{20,60,104,156,157} The study of women in the WIC program found that weight gains both below and above the IOM guidelines were associated with lower birthweights (162 g and 153 g, respectively).¹⁵⁷ One study found that women who were underweight or normal weight and who gained above the IOM guidelines had

higher birthweights; women who gained below the guidelines had lower birthweights than those who gained within them.¹⁰⁴ The association of higher birthweight with higher weight gain was also found among morbidly obese women in one poor study that failed to adjust for any confounders.⁵⁴

Studies that stratified by race^{20,156} or that included only one race^{60,153} found, overall, that black women gaining above the IOM guidelines experienced significantly higher birthweights (a range of 73 g to 330 g) than those who gained less weight.^{20,60,153,156} Among white women,^{20,156} weight gain above the IOM guidelines was also associated with higher birthweights for those with a BMI ≤ 29 ^{20,156} but not > 29 in one study.¹⁵⁶ This increase in birthweight was close to 200 g.^{20,156} In three of these studies,^{20,153,156} the analyses were adjusted for multiple confounders listed in Table 32.

One good study conducted among black adolescents that examined total weight gain found infant birthweights to be lower among those who gained less than the IOM recommendations than among those who gained within or above the guidelines;¹⁵³ infant birthweights did not differ between those who gained within and those who gained above the thresholds.

Detailed results for rate of weight gain. Three fair-quality studies examined rate of weight gain as the exposure of interest with respect to birthweight.^{154,155,158} The one including only adolescents found that mothers who gained < 0.23 kg per week had infants with a mean birthweight of 2,745 g; this birthweight was lower than for infants of mothers who gained 0.23 to 0.4 kg per week (3,097 g) and for those who gained > 0.4 kg per week (3,351 g).¹⁵⁴

One study examined rate of weight gain only among normal-weight women from the ages of 12 to 29 from black, white, and Hispanic groups.¹⁵⁸ The authors used a rate of weight gain between 20 to 36 weeks and defined low as < 0.34 kg per week, moderate as 0.34 to 0.68 kg per week, and excessive as > 0.68 kg per week. Controlling for several confounders, the investigators found that women with low rates of weight gain had infants of statistically significantly lower birthweights than did women with higher rates of weight gain. Birthweights did not differ between those who gained at excessive and moderate rates.

The other rate of weight gain study involved both white and black women with a BMI ≤ 26 and a mean age of 25.¹⁵⁵ Their analyses used mothers who gained more than the IOM guidelines as the reference group. Mothers who gained low levels of weight (< 0.38 kg per week for underweight or < 0.37 kg per week for normal weight) in the second trimester had infants who weighed 166 g less than infants from the reference group; mothers who gained low levels of weight in the third trimester had infants who weighed 111 g less than those in the reference group. When all women were included in the analyses, the effect seen in the third trimester was statistically significant; however, when analyses were stratified by race, it was significant only for white women.

In addition, this study showed that pattern of weight gain was important. Low total weight gain in the first trimester combined with low rate of gain in the second was associated with an infant who weighed 236 g less than those whose mothers gained more weight. This finding appeared to be statistically significant for all women and for black women when analyses were stratified by race. Low rate of weight gain in the second and third trimesters was associated with a 206 g deficit in weight of the infant. Low rate of weight gain in all three trimesters was associated with the greatest deficit, 284 g.

Low birthweight.

Study characteristics. Twelve articles (from 10 databases) examined low birthweight (LBW, defined as $< 2,500$ g) (Evidence Table 42, Table 33).^{2,20,54,55,60,127,154,159-163} Two articles reported on data from the Pregnancy Nutrition Surveillance System (PNSS) from either eight² or nine states;¹⁶⁰ two used a single hospital database.^{55,159} Two studies used PRAMS data.^{162,163}

Table 33. Weight change relative to IOM thresholds and low birthweight (< 2,500 g)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hellerstedt et al., 1997 ¹⁵⁹ USA, hospital 1,343 Normal/obese BMI Good	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories stratified by pregravid BMI and smoking status: Obese (BMI > 29.0): G1: Smokers, < IOM G2: Smokers, within IOM G3: Smokers, > IOM G4: Nonsmokers, < IOM G5: Nonsmokers, within IOM G6: Nonsmokers, > IOM Normal weight (BMI 19.8- 26.0): G7: Smokers, < IOM G8: Smokers, within IOM G9: Smokers, > IOM G10: Nonsmokers, < IOM G11: Nonsmokers, within IOM G12: Nonsmokers, > IOM Obese: G13: Lost/no gain G14: 0.5-6.5 kg G15: 7-11.5 kg G16: 12-16 kg G17: > 16 kg Normal weight: G18: < 11.5 kg G19: 11.5-16 kg G20: > 16 kg	G1: 17.3% G2: 10.0% G3: 12.3% G4: 10.5% G5: 7.8% G6: 2.6% G7: 17.5% G8: 3.5% G9: 3.6% G10: 12.4% G11: 6.0% G12: 5.3% G13: 16.0% G14: 11.1% G15: 8.3% G16: 4.0% G17: 6.0% P = 0.003 for G13-G17 G18: 14.2% G19: 5.4% G20: 4.9% P = 0.001 for G18-G20 For obese women, compared to nonsmokers who gained 7-11.5 kg, smokers who gained < 7 kg were at significantly higher risk of LBW: AOR: 7.7 (95% CI, 1.5- 40.0)	Maternal age, pregravid BMI, infant sex, race, parity, prenatal alcohol use, prenatal illicit drug use, adequacy of prenatal care, gestational hypertension, GDM, gestational age
Schieve et al., 1998 ¹⁶⁰ USA, Pregnancy Nutrition Surveillance System (WIC clinics)	Pregravid weight: Self-report Total weight gain: Self report	Maternal weight gain categories stratified by pregravid BMI (IOM underweight, normal weight, overweight, and obese) and race (non-Hispanic white, non-Hispanic black, and Hispanic)	Within every BMI-race ethnicity stratum, the odds of delivering a LBW infant tended to decrease as weight gain increased. This trend was statistically significant for all strata; however, the	Age, height, education, trimester of the special supplemental nutrition program for WIC

AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; G, group; g, gram; GDM, gestational diabetes; IOM, Institute of Medicine; kg, kilogram; lbs, pounds; LBW, low birthweight; MLBW, moderately low birthweight; NICU, neonatal intensive care unit; USA, United States of America; VLWB, very low birthweight; WIC, The Special Supplemental Nutrition Program for Women, Infants, and Children.

Table 33. Weight change relative to IOM thresholds and low birthweight (< 2,500 g) (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Schieve et al., 1998 ¹⁶⁰ (continued) 173,006 All weight/BMI Good		G1: ≥ 10 lbs below IOM G2: 1-9 lbs below IOM G3: Lower half of IOM G4: Upper half of IOM G5: 1-9 lbs above IOM G6: ≥ 10 lbs above IOM	trend diminished with increasing BMI. Women with underweight and normal weight BMI in G2 were 1.1–2.8 times more likely to deliver a LBW infant than women in G3; women in G1 were 1.8 – 3.2 times more likely to deliver a LBW infant compared to G3.	
Bracero and Byrne, 1998 ¹²⁷ USA, hospital, Brooklyn, NY 20,971 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories: G1: Maternal weight gain under the IOM guidelines G2: Maternal weight gain within the IOM guidelines G3: Maternal weight gain over the IOM guidelines G4: Optimal weight gain (36-40 lbs for BMI < 19.8; 31-40 lbs for BMI 19.8-26.0; 26-30 lbs for BMI > 26.0) G5: Suboptimal weight gain (< 36 lbs for BMI < 19.8; < 31 lbs for BMI 19.8-26.0; < 26 lbs for BMI > 26.0)	G1: 10.1% G2: 3.3% G3: 2.5% (<i>P</i> < 0.001 comparing G1-G3) G4: 4.9% G5: 1.8% (<i>P</i> < 0.001 vs. G4)	Not applicable
Cogswell et al., 1995 ² USA, Pregnancy Nutrition Surveillance System 53,541 Normal/ Overweight/Obese Fair	Pregravid weight: Self-report Total weight gain: Self-report	Maternal weight gain categories (lbs) stratified by pregravid BMI: Normal weight (BMI 19.8-26.0): G1: < 15 G2: 15-19 G3: 20-24 G4: 25-29 G5: 30-34 G6: 35-39 G7: ≥ 40	AOR (95% CI) for low birthweight: G1: 2.1 (1.6-2.6) G2: 1.4 (1.1-1.8) G3: 1.0 (0.8-1.3) G4: 1.0 (reference) G5: 0.8 (0.6-1.0) G6: 0.6 (0.5-0.8) G7: 0.5 (0.4-0.6) G8: 1.1 (0.7-1.9) G9: 1.0 (reference) G10: 0.7 (0.4-1.2) G11: 0.8 (0.5-1.4) G12: 0.5 (0.3-0.8) G13: 0.6 (0.3-1.1) G14: 0.4 (0.3-0.7)	Age, race, height, smoking, gestational age, infant sex

Table 33. Weight change relative to IOM thresholds and low birthweight (< 2,500 g) (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Cogswell et al., 1994 ² (continued)		Overweight (BMI > 26.0-29.0): G8: < 15 G9: 15-19 G10: 20-24 G11: 25-29 G12: 30-34 G13: 35-39 G14: ≥ 40 Obese (BMI > 29.0): G15: < 15 G16: 15-19 G17: 20-24 G18: 25-29 G19: 30-34 G20: 35-39 G21: ≥ 40	G15: 1.5 (0.9-2.4) G16: 1.0 (reference) G17: 0.9 (0.5-1.6) G18: 1.3 (0.8-2.3) G19: 0.9 (0.5-1.7) G20: 1.0 (0.5-1.8) G21: 0.9 (0.5-1.5)	
Edwards et al., 1996 ⁵⁵ USA, Hospital 1,443 Normal/Obese weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories (kg) Obese BMI > 29: G1: Lost weight/no change G2: 0.5-6.5 G3: 7-11.5 G4: 12-16 G5: > 16 Normal BMI 19.8-26: G6: < 11.5 kg G7: 11.5-16 G8: > 16 kg	G1: 12.8% G2: 8.9% G3: 7.9% G4: 6.8% G5: 8.7% <i>P</i> (for G1-G5) = 0.405 G6: 8.5% G7: 5.6% G8: 8.9% <i>P</i> (for G6-G8) = 0.183 AOR (95% CI) for birthweight < 2,500 g among obese women (BMI > 29.0): G3: 1.0 (reference) G1: 4.2 (0.9-19.6)	Age, parity, pregravid BMI, GDM, pregnancy- induced hypertension, prenatal adequacy, alcohol use, drug use, smoking, gestational age
Hickey et al., 1997 ²⁰ USA, public health programs 5,198 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories stratified by race: Black Women: G1: Below range (< 12.5kg for BMI < 19.8; < 13.9kg for BMI 19.8-26.0; < 7.0kg for BMI > 26.0) G2: In lower range (12.5- 15.2kg for BMI < 19.8; 11.5- 13.8kg for BMI 19.8-26.0; 7.0-9.2kg for BMI > 26.0) G3: In upper range (15.3- 18kg for BMI < 19.8; 13.9- 16.0kg for BMI 19.8-26.0; 9.3-11.5kg for BMI > 26.0)	AOR (95% CI) G1: 2.6 (1.2-5.6) G2: 1.0 (reference) G3: 1.2 (0.4-3.3) G4: 1.4 (0.6-3.6) G5: 1.5 (0.8-2.6) G6: 1.0 (reference) G7: 0.4 (0.2-0.9) G8: 0.7 (0.3-1.2)	Age, education, height, drug use, alcohol use, time between last prenatal weight observation and delivery, smoking, gestational age, infant sex

Table 33. Weight change relative to IOM thresholds and low birthweight (< 2,500 g) (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hickey et al., 1997 ²⁰ (continued)		G4: Above range (> 18kg for BMI < 19.8; > 16.0kg for BMI 19.8-26.0; > 11.5kg for BMI > 26.0) White Women: G5: Below range G6: In lower range G7: In upper range G8: Above range		
Ogunyemi et al., 1999 ⁶⁰ USA, Hospital 582 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM BMI IOM	AOR (95% CI) for very low birthweight: G1: 1.8 (0.6-4.7) G2: 1.1 (0.4-4.7) G3: 1.0 (Reference)	Age, parity, pregravid BMI, preeclampsia, cesarean delivery, previous cesarean, tobacco use, previous fetal death, hypertension, asthma, previous LBW, vomiting, NICU
Stevens-Simon and McAnarney, 1992 ¹⁵⁴ USA, adolescent maternity program 141 Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories (kg/wk): G1: < 0.23 G2: 0.23-0.40 G3: > 0.40	Distribution of LBW, %: G1: 21.4 G2: 10.6 G3: 4.3 P = NS	Not applicable
Strauss and Dietz, 1999 ¹⁶¹ USA, National Collaborative Perinatal Project and the Child Health and Development Study 10,756 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories stratified by pregravid BMI: BMI < 20.0: G1: Low 1st trimester gain (< 0.1kg/wk) G2: Low 2nd trimester gain (< 0.3kg/wk) G3: Low 3rd trimester gain (< 0.3kg/wk) BMI 20.0-25.0: G4: Low 1st trimester gain G5: Low 2nd trimester gain G6: Low 3rd trimester gain BMI > 25.0: G7: Low 1st trimester gain G8: Low 2nd trimester gain G9: Low 3rd trimester gain	AOR (95% CI) for < 2,500g: G1: 0.88 (0.50-1.57) G2: 2.68 (1.46-4.94) G3: 2.07 (1.22-3.51) G4: 1.31 (0.88-1.95) G5: 1.92 (1.29-2.87) G6: 2.12 (1.48-3.04) G7: 1.02 (0.50-2.08) G8: 1.88 (1.03-3.43) G9: 1.53 (0.86-2.74) Reference group-normal rate of weight gain in the trimester	Race, GDM, toxemia, smoking

Table 33. Weight change relative to IOM thresholds and low birthweight (< 2,500 g) (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Bianco et al., 1998 ⁵⁴	Pregravid weight: Self-report	Maternal weight gain categories among morbidly obese (BMI > 35):	Distribution of LBW,%: G1: 2.0 G2: 11.1 G3: 8.3 G4: 5.2 G5: 3.8 P = NS	Race, parity, clinic service, substance abuse, preexisting medical condition
USA, medical center	Total weight gain: Measured	G1: Weight loss/no change G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs		
11,926				
Nonobese (BMI 19- 27) and morbidly obese (BMI > 35)				
Poor				
Hulsey et al., 2005 ¹⁶²	Pregravid weight: Self-report	Pregravid BMI and gestational weight gain categories:	AOR (95% CI) for very low birthweight (500- 1,499g): G1: 2.06 (1.26-2.87) G2: 1.82 (1.22-2.29) G3: 1.00 (reference) G4: 2.05 (0.90-4.44) G5: 1.25 (0.61-1.61) G6: 1.74 (1.23-2.42)	Ethnicity, intendedness of pregnancy, Medicaid status, WIC status, prenatal care, diabetes, hypertension
USA, birth certificates linked to PRAMS data	Total weight gain: Birth certificate	G1: BMI < 19.8 and < IOM G2: BMI 19.8-26.0 and < IOM G3: BMI 19.8-26.0 and within IOM G4: BMI 26.1-29.0 and < IOM G5: BMI > 29.0 and < IOM G6: BMI > 29.0 and within IOM	AOR (95% CI) for moderately low birthweight (1500-2499 g): G1: 4.83 (2.98-7.83) G2: 1.77 (1.23-2.60) G3: 1.00 (reference) G4: 0.28 (0.11-1.83) G5: 1.09 (0.67-2.13)	
87,293				
All weight/BMI				
Poor				
Nida et al., 1996 ¹⁶³	Pregravid weight: Self-report	G1: < IOM G2: within IOM G3: > IOM	BMI < 19.8 G1: 10.2% G2: 6% G3: 4.7	Pregravid BMI
USA PRAMS	Total weight gain: Self-report			
No sample size				
All weight/BMI			BMI 19.8-25 G1: 8.4% G2: 3.9% G3: 4.5%	
Poor			BMI > 26 G1: 6.1% G2: 3.8% G3: 5.1% No statistical testing was performed	

Overview of results. Evidence from twelve articles (2 good,^{159,160} 7 fair,^{2,20,55,60,77,127,154,161} and 3 poor^{54,162,163}) supports an association between weight gain less than the IOM guidelines and LBW for both underweight and normal-weight women; evidence is less conclusive about any association for women with higher body weight.

Detailed results for total weight gain. In the nine-state PNSS study,¹⁶⁰ analyses for normal and overweight women stratified by race showed a statistically significant decreased risk of LBW with higher gains. Among underweight women, a protective effect against LBW was seen with higher gains in whites and Hispanic and an increased risk was associated with low weight gains (>10 lbs <IOM threshold) across all the race groups. Similarly, among obese women of all race groups, low weight gains (> 10 pounds below the IOM threshold) were associated with higher risk of LBW.¹⁶⁰

In the eight-state PNNS study,² for women of normal weight, the odds for LBW were elevated and statistically significant when their weight gains were below 19 pounds compared with women whose weight gains were in the recommended range. For overweight and obese women, weight gains below the IOM guidelines were not associated with LBW infants. This was also shown in the study by Edwards et al.⁵⁵

Weight gains above the IOM guidelines starting at > 35 pounds were protective against having a LBW infant for normal-weight women,² and starting at \geq 40 pounds for overweight women, but higher weight gains were not protective for obese women.

Two studies showed almost double the odds of LBW among black women who delivered at term but had weight gain below the IOM range;^{20,60} this finding was statistically significant in only one (good) study.²⁰ The OR among white women was 1.5 (not significant).²⁰

The only association seen among obese women was among smokers who gained less than the IOM guidelines.¹⁵⁹ These women had an eightfold increased risk of having an LBW infant compared with obese nonsmokers who gained adequately.¹⁵⁹

One study performed bivariate analysis between the IOM categories of weight gain and LBW infants.¹²⁷ It demonstrated a statistically higher prevalence of LBW among mothers who gained less than the IOM guidelines than among mothers who gained within or more than the guidelines.

Detailed results for rate of weight gain. Two studies examined the effect of the rate of weight gain on LBW.^{154,161} One among black adolescents found no differences in the prevalence of LBW by rate-of-weight-gain group.¹⁵⁴ The other included only term births, used data from the National Collaborative Perinatal Project and the Child Health and Development Study, and examined total weight gain in the first trimester and rates in the second and third trimesters.¹⁶¹ Low rate of weight gain in the second and third trimesters was associated with an increased risk of term LBW or intrauterine growth restriction (IUGR) in both data sets. This association held for all weight status groups except women with a BMI > 25 when the analysis was stratified by pregravid BMI and adjusted for multiple confounders.

Fetal growth (large for gestational age or macrosomia).

Study characteristics. We identified 15 studies that examined the association between weight gain categorized according to the IOM guidelines on LGA^{4,25,54,116,118,129,154,159} or macrosomia^{2,53,55,110,160,164,165} (Evidence Tables 43 and 44, Table 34). Five studies used data from a hospital database;^{54,55,116,118,129,159} three were cohort studies.^{53,154,164} One study used data from a health maintenance organization;¹¹⁰ one used a prenatal clinic database;¹⁵³ one used state birth certificate data;^{4,25} one used the Pregnancy Nutrition Surveillance System;^{2,160} and one used controls from a multicenter study of birth defects.¹⁶⁵

Table 34. Weight change relative to IOM thresholds and large-for-gestational-age infant weight

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
LGA as > 90th percentile of birthweight for gestational age				
Caulfield et al., 1998 ¹¹⁶ USA, university hospital 3,870 All weight/BMI Good	Pregravid weight: Self report Total weight gain: Measured	G1: Underweight, BMI < 19.8 G2: Normal weight, BMI 19.8-26.0 G3: Overweight, BMI > 26.0 Black women: G4: No weight gain < IOM G5: No weight gain > IOM White women: G6: No weight gain < IOM G7: No weight gain > IOM	AOR (95% CI) for LGA and rate of weight gain (per 50 g/wk): G1: 1.25 (1.11-1.41) G2: 1.14 (1.08-1.20) G3: 1.13 (1.07-1.20) Expected absolute change (as % of baseline) in incidence of LGA associated with modifiable risk factor (G4-G7): G4: +1.28 (+26) G5: -0.77 (-16) G6: +2.58 (+17) G7: -2.87 (-19)	Age, race, parity, pregravid BMI, height, hypertension, provider type, smoking, female infant
Hellerstedt et al., 1997 ¹⁵⁹ USA, medical center 1,343 Normal/obese BMI Good	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories stratified by pregravid BMI and smoking status: Obese (BMI > 29.0): G1: Smokers, < IOM G2: Smokers, within IOM G3: Smokers, > IOM G4: Nonsmokers, < IOM G5: Nonsmokers, within IOM G6: Nonsmokers, > IOM Normal weight (BMI 19.8-26.0): G7: Smokers, < IOM G8: Smokers within IOM G9: Smokers, > IOM G10: Nonsmokers < IOM G11: Nonsmokers, within IOM G12: Nonsmokers, > IOM Obese: G13: Lost/no gain G14: 0.5-6.5 kg G15: 7-11.5 kg G16: 12-16 kg G17: > 16 kg Normal weight: G18: < 11.5 kg G19: 11.5-16 kg G20: > 16 kg	Frequencies of LGA, %: G1: 5.3 G2: 10.0 G3: 12.3 G4: 12.2 G5: 11.7 G6: 22.2 G7: 0 G8: 1.8 G9: 9.1 G10: 4.4 G11: 8.1 G12: 14.3 G13: 9.3 G14: 10.5 G15: 11.3 G16: 17.5 G17: 21.8 <i>P</i> = 0.001 for G13-G17 G18: 2.8 G19: 6.7 G20: 13.1 <i>P</i> < 0.001 for G18-G20 Compared with infants of obese nonsmokers who gained 7- 11.5kg, the only group at significantly higher risk of LGA was non smokers who gained > 11.5kg: AOR: 2.3 (95% CI, 1.2- 4.5)	Maternal age, pregravid BMI, infant sex, race, parity, prenatal alcohol use, prenatal illicit drug use, adequacy of prenatal care, gestational hypertension, GDM, gestational age

AOR: adjusted odds ratio; BMI, body mass index; CI, confidence interval; G, group; g, gram; GDM: gestational diabetes; IOM, Institute of Medicine; kg/wk, kilogram per week; lbs, pounds; LBW, low birthweight; NICU, neonatal intensive care unit; PRAMS, Pregnancy Risk Assessment Monitoring System; USA, United States of America; WIC, The Special Supplemental Nutrition Program for Women, Infants, and Children.

Table 34. Weight change relative to IOM thresholds and large-for-gestational-age infant weight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Devader et al., 2007 ²⁵ USA, birth certificate data 94,696 Normal weight/BMI 19.8-26 Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories: G1: < 25 lbs G2: 25-35 lbs G3: > 35 lbs	AOR (95% CI) for LGA: G1: 0.40 (0.37-0.44) G2: 1.00 (reference) G3: 2.43 (2.30-2.56)	Age, race, education, income, alcohol use, height, prior pregnancy, inadequate prenatal care use, smoking, child's gender, birth year
Kiel et al., 2007 ⁴ USA, birth registry 120,170 Obese BMI > 30 Fair	Pregravid weight: Self-report Total weight gain: Medical record	Maternal weight gain categories stratified by prepregnancy obesity status, Obese Class I(BMI 30–34.9), Obese Class II (BMI 35–39.9), Obese Class III (> = BMI 40): G1: ≤ -10 lbs G2: -2 to -9 lbs G3: No change G4: 2-9 lbs G5: 10-14 lbs G6: 15-25 lbs G7: 26-35 lbs G8: > 35 lbs	For Obese Class I: OR (95% CI) for LGA were significantly lower (< 1.00, G6 was reference) for G1- G5 and significantly higher for G7- G8. For Obese Class II: OR (95% CI) for LGA were significantly lower (< 1.00, G6 was reference) for G1- G5 and significantly higher for G7- G8. For Obese Class III:OR (95% CI) for LGA were significantly lower (< 1.00, G6 was reference) for G1- G4 and significantly higher for G7-G8	Age, race, parity, education, poverty (enrollment in Medicaid, WIC, food stamp programs), tobacco use, chronic hypertension
Parker and Abrams, 1992 ¹¹⁸ USA, hospital USA, Hospital database (California) 6,690 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories: G1: < IOM range G2: Within IOM range G3: > IOM BMI IOM	AOR (95% CI) for LGA: G3: 1.92 (1.52-2.43) G2: 1.00 (reference) Incidence of LGA in nonobese women,%: G1: 3.25 G2: 6.14 G3: 13.11 Incidence of LGA in obese women,%: G1: 5.88 G2: 17.53	Age, race, parity, pregravid BMI, height, maternal high and low weight gain, smoking, gestational age, birthweight

Table 34. Weight change relative to IOM thresholds and large-for-gestational-age infant weight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Stevens-Simon and McAnarney, 1992 ¹⁵⁴ USA, adolescent maternity program 141 Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories (kg/wk): G1: < 0.23 G2: 0.23-0.40 G3: > 0.40	Distribution of LGA, %: G1: 3.6 G2: 4.5 G3: 12.8 <i>P</i> = NS	NA
Stotland et al., 2006 ¹²⁹ USA, university hospital 20,465 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Prenatal record	Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM G4: weight gain < 7kg G5: weight gain > 18kg BMI IOM	Unadjusted Rates of LGA: G1: 3.85 <i>P</i> < 0.001 vs. G2 G2: 6.62 G3: 13.76 <i>P</i> < 0.001 vs. G2 G4: 5.26 G5: 14.60 <i>P</i> < 0.05 vs. G2 AOR (95% CI) for LGA: G1: 0.58 (0.47-0.72) G2: 1.00 (reference) G3: 1.98 (1.74-2.25) G4: 0.50 (0.33-0.78) G5: 2.28 (2.00-2.62)	Age, race, parity, pregravid BMI, pregnancy- induced hypertension, date of delivery, mode of delivery, length of first and second stage of labor, smoking, gestational age, birthweight
Bianco et al., 1998 ⁵⁴ USA, Medical Center 11,926 Nonobese (BMI 19-27) and morbidly obese (BMI > 35) Poor	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories among morbidly obese (BMI > 35): G1: Weight loss/no change G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs	Distribution of LGA, %: G1: 12.0 G2: 11.8 G3: 18.8 G4: 25.8 G5: 23.8 <i>P</i> < 0.01	Race, parity, clinic service, substance abuse, preexisting medical condition

Table 34. Weight change relative to IOM thresholds and large-for-gestational-age infant weight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
LGA as birthweight > 4,500 gm 275				
Hedderson et al., 2006 ¹¹⁰	Pregravid weight: Self-report	Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM	% Distribution of maternal weight gain categories among women with macrosomia: G1: 4.0 G2: 16.3 G3: 79.7 <i>P</i> < 0.05 (compared to controls)	Age, race, parity, pregravid BMI, screening glucose value from 1 hour after the 50g oral glucose challenge test, difference between age at delivery and gestational age at last weight measured
USA, Kaiser Permanente Medical Care Program	Total weight gain: Measured	BMI IOM	AOR (95% CI) for macrosomia: G1: 0.38 (0.20-0.70) G2: 1.00 reference G3: 3.05 (2.19-4.26)	
45,245			OR (95% CI) for macrosomia: Underweight women (BMI < 19.8) G2: 1.00 (reference) G3: 2.70 (0.83-8.61)	
All weight/BMI			Normal weight women(BMI 19.8-26.0) G2: 1.00 (reference) G3: 3.60 (2.27-5.83)	
Good			Overweight/obese women (BMI > 26.0) G2: 1.00 (reference) G3: 2.00 (1.14-3.47)	
Schieve et al., 1998 ¹⁶⁰	Pregravid weight: Self-report	Maternal weight gain categories stratified by pregravid BMI (IOM-underweight, normal weight, overweight, and obese) and race (non-Hispanic white, non-Hispanic black, and Hispanic): G1: ≥ 10 lbs below IOM G2: 1-9 lbs below IOM G3: Lower half of IOM G4: Upper half of IOM G5: 1-9 lbs above IOM G6: ≥ 10 lbs above IOM	Within every BMI-race ethnicity stratum, the odds of delivering a > 4,500g infant tended to increase as weight gain increased. This trend was statistically significant for all strata; however, the trend diminished with decreasing BMI. Women in G6 were 2.2–10.8 times more likely to deliver a > 4,500 g infant compared to women in G3, irrespective of BMI status.	Age, height, education, trimester of the Special Supplemental Nutrition Program for WIC
USA Pregnancy Nutrition Surveillance System - data from WIC clinics	Total weight gain: Self report			
173,006				
All weight/BMI				
Good				

Table 34. Weight change relative to IOM thresholds and large-for-gestational-age infant weight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Cogswell et al., 1995 ² USA, Pregnancy Nutrition Surveillance System 53,541 Normal/ Overweight/ Obese Fair	Pregravid weight: Self-report Total weight gain: Self-report	Maternal weight gain categories (lbs) stratified by pregravid BMI: Normal weight (BMI 19.8-26.0): G1: < 15 G2: 15-19 G3: 20-24 G4: 25-29 G5: 30-34 G6: 35-39 G7: ≥ 40 Overweight (BMI > 26.0-29.0): G8: < 15 G9: 15-19 G10: 20-24 G11: 25-29 G12: 30-34 G13: 35-39 G14: ≥ 40 Obese (BMI > 29.0): G15: < 15 G16: 15-19 G17: 20-24 G18: 25-29 G19: 30-34 G20: 35-39 G21: ≥ 40	AOR (95% CI) for high birthweight: G1: 1.0 (0.5-2.0) G2: 0.4 (0.2-1.0) G3: 0.6 (0.3-1.1) G4: 1.0 (reference) G5: 1.1 (0.7-1.8) G6: 1.5 (1.0-2.3) G7: 3.3 (2.3-4.7) G8: 0.8 (0.2-2.6) G9: 1.0 (reference) G10: 1.1 (0.4-3.5) G11: 2.1 (0.8-5.7) G12: 2.4 (0.9-6.4) G13: 1.6 (0.6-4.6) G14: 4.0 (1.6-10.1) G15: 0.7 (0.5-1.1) G16: 1.0 (reference) G17: 1.1 (0.7-1.7) G18: 1.3 (0.8-2.0) G19: 1.9 (1.3-2.9) G20: 2.1 (1.3-3.2) G21: 2.3 (1.6-3.3)	Age, race, height, smoking, gestational age, sex of infant
Thorsdottir 2002 ⁵³ Iceland, Hospital records 614 Normal weight/BMI 19.5-25.5 Fair	Pregravid weight: Self-report Total weight gain: Maternity records	Maternal weight gain categories: G1: < 11.5 kg G2: 11.5-16.0 kg G3: 16.1-20.0 kg G4: > 20.0 kg G5: 12.5-15.5 kg G6: > 17.8-20.8 kg	Birthweight > 4,500g, % G1: 4.3 G2: 4.1 (<i>P</i> < 0.05 between groups) G3: 9.1 (<i>P</i> < 0.05 between groups) G4: 10.2 (<i>P</i> < 0.05 between groups) <i>P</i> for trend < 0.015 RR (95% CI) for > 4,500g: G5: 1.00 (reference) G6: 3.54 (1.26-9.97)	Age, parity, height, gestational age, birthweight

Table 34. Weight change relative to IOM thresholds and large-for-gestational-age infant weight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis	
LGA as birthweight > 4,000 gm					
Edwards et al., 1996 ⁵⁵	Pregravid weight: Self-report	Maternal weight gain categories (kg) Obese > 29:	Birthweight ≥ 4,000g, %:	Age, parity, pregravid BMI, GDM, pregnancy- induced hypertension, prenatal adequacy, alcohol use, drug use, smoking, gestational age	
USA, Hospital	Total weight gain: Measured	G1: Lost weight/no change G2: 0.5-6.5 G3: 7-11.5 G4: 12-16 G5: > 16	G1: 12.0 G2: 12.5 G3: 13.3 G4: 15.4 G5: 24.4		
1,443		Normal BMI 19.8-26	P (for G1-G5) = 0.026		
Normal/Obese weight/BMI		G6: < 11.5kg G7: 11.5-16 G8: > 16kg	G6: 5.7 G7: 6.6 G8: 16.9 P (for G6-G8) < 0.001		
Fair			AOR (95% CI) for birthweight ≥ 4,000 g among obese women (BMI > 29.0): G3: 1.0 (reference) G8: 2.8 (1.4-5.6)		
			AOR (95% CI) for birthweight ≥ 4,000g among normal weight women (BMI 19.8-26.0): G7: 1.0 (reference) G8: 2.4 (1.3-4.7)		
Rode et al., 2007 ¹⁶⁴	Pregravid weight: Self report	Maternal weight gain categories stratified by pregravid BMI status:	AOR (95% CI) for birthweight ≥ 4,000g:		Preeclampsia, caffeine consumption, gestational age, smoking
Denmark Smoke- free Newborn Study, University Hospital	Total weight gain: Self report	BMI less than 19.8 G1: < IOM G2: Within IOM G3: > IOM	G1: 0.8 (0.4-1.6) G2: 1.0 (reference) G3: 1.7 (0.8-3.6)		
2,248		BMI 19.8–26.0 G4: < IOM G5: Within IOM G6: > IOM	G4: 0.7 (0.5-0.999) G5: 1.0 (reference) G6: 1.9 (1.5-2.5)		
All weight/BMI		BMI 26.1–29.0 G7: < IOM G8: Within IOM G9: > IOM	G7: 0.6 (0.1-3.1) G8: 1.0 (reference) G9: 1.8 (0.8-3.9)		
Fair			G10: 0.8 (0.4-1.7) G11: 1.0 (reference) G12: 0.9 (0.4-2.0)		

Table 34. Weight change relative to IOM thresholds and large-for-gestational-age infant weight (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Rode et al., 2007 ¹⁶⁴ (continued)		BMI greater than 29.0 G10: < IOM G11: Within IOM G12: > IOM		
Kabali et al., 2007 ¹⁶⁵	Pregravid weight: Self-report	G1: < IOM G2: within IOM G3: > IOM	AOR G1: 1.0 (0.4, 1.9) G2: ref G3: 1.5 (0.7, 2.5)	Maternal age, marital status, race/ethnicity, family income, years of education, smoking, alcohol, sex of child, parity, gestational age
USA./Canada, Pediatric practice 815	Total weight: Self-report	BMI IOM	Combined effect with BMI OR (AOR similar but not all could be calculated)	
All weight/BMI			Underweight/G1: 0.7 (0.2, 3.3) Underweight/G2: 1.0 (0.3, 3.5) Underweight/ G3: 1.7 (0.4, 6.4)	
Poor			Normal/G1: 0.7 (0.3, 1.8) Normal/G2 Ref Normal/ G3: 1.1 (0.5, 2.3)	
			Overweight/G1: 1.2 (0.4, 3.8) Overweight/G2: 0.8 (0.2, 2.7) Overweight/G3: 2.4 (1.2, 4.8)	

Overview of results for LGA infant weight. Eight studies defined LGA as > 90 percentile of birthweight for gestational age (Table 34).^{4,25,54,116,118,129,154,159} The majority of these studies, of which two were rated good,^{116,159} one poor⁵⁴ and the remainder fair,^{4,25,118,129,154} showed a consistent association between weight gains above the IOM guidelines and LGA for women of all weight status groups. Four articles examined LGA defined as > 4,500 g;^{2,53,110,160} two were good quality,^{110,160} two were fair.^{2,53} They also showed a consistent association. When macrosomia or high birthweight was the outcome, results were less consistent (1 poor quality,¹⁶⁵ 2 fair-rated studies^{55,164}).

Detailed results for LGA infant weight. One study reported the risk of LGA among women of all weight status groups¹²⁹ and another among nonobese women (BMI < 30).¹¹⁸ In both studies, the risk for LGA was nearly doubled for women who gained above the IOM guidelines. For women who gained below the IOM guidelines, the risk for LGA was decreased by close to 40 percent.¹²⁹

For women of normal pregravid weight, the odds of LGA estimated from an adjusted model found a nonsignificant increased risk of having an LGA infant.⁵⁵ In another study, the risk was twofold higher and statistically significant for women gaining more than IOM recommendations.²⁵ This same study found that the odds of LGA was decreased by more than 60 percent with gains below the IOM guidelines for normal-weight women.

Among obese women, the risk of LGA was 2.3 times greater for nonsmokers gaining in excess of the IOM guidelines, but this was not true among obese smokers.^{55,159} In a study that grouped women into classes of obesity,⁴ the odds of LGA increased with weight gains above 25 pounds for all classes of obesity.

Two studies examined the impact of *rate* of weight gain according to the IOM guidelines on having an LGA infant.^{116,154} One good study defined the rate of weight gain in increments of 50 g per week.¹¹⁶ The AORs associated with having an LGA infant for each increment were as follows: 1.25 for normal-weight women, 1.14 for overweight women, and 1.13 for obese women. Using these AORs, the authors calculated the expected change in the incidence of LGA if weight gains remained within the IOM guidelines. These changes were -0.77 percent for black women and -2.87 percent for white women; baseline LGA incidence rates were 4.8 percent and 14.8 percent, respectively. The other study investigated rate of weight gain among black adolescents with no difference in pregravid weight status.¹⁵⁴ In bivariate analysis the prevalence of LGA did not differ between mothers who were slow weight gainers (< 0.23 kg/week) or rapid weight gainers (> 0.4 kg/week) and mothers who were average weight gainers (0.23 to 0.4 kg/week).

With respect to LGA defined as > 4,500 g, the one study reporting risk estimates for women of all weight groups found that weight gain above the IOM guidelines was associated with a threefold increased risk of LGA after adjustment for various confounders.¹¹⁰ Women who gained less than the recommendation were 62 percent less likely to have an LGA infant than women who gained within the recommended range.

Analyses for normal-weight women showed a threefold increased risk of LGA with weight gains above the IOM guidelines¹¹⁰ or at > 40 pounds^{2,53} after adjusting for multiple confounders. Overweight and obese women who gained more than the IOM guidelines had twice the risk of having an LGA infant in one study,¹¹⁰ and in another study,² they did not have a significantly increased risk until weight gains exceeded 40 pounds for overweight women (AOR, 4.0; 95% CI, 1.6-10.1) and 30 pounds for obese women (AOR ranged from 1.9 to 2.3).

Low weight gains were not significantly associated with LGA risk in any of these studies.^{2,53,110,160} In one study that stratified results by weight status and race across all BMI and racial groups,¹⁶⁰ the risk of LGA was significantly higher with total weight gains 10 pounds more than the IOM recommendation. Weight gains below the IOM guidelines were protective only among white women across all BMI weight status groups.

Detailed results for high birthweight or macrosomia. Three studies (1 poor-quality¹⁶⁵) defined high birthweight or macrosomia as > 4,000 g.^{55,164} All stratified results by pregravid weight status. For normal-weight women, those who gained more than the IOM guidelines were at a statistically significant increased risk in the two studies of fair quality.^{55,164} Normal-weight women who gained below the guidelines were at decreased risk in one study.¹⁶⁴ For obese women, one study found no difference in the risk of macrosomia with weight gains either above or below the IOM guidelines;¹⁶⁴ the other found that those who gained above the IOM guidelines had 2.8 times the risk for a macrosomic infant relative to those who gained within the recommended range.⁵⁵ For underweight and overweight women, weight gains above or below the IOM guidelines were not associated with delivering a macrosomic infant,¹⁶⁴ although women with weight gains above the guidelines appeared to have a slightly increased risk.

Fetal growth (small for gestational age).

Study characteristics. Ten articles examined the association of gaining weight according to the IOM guidelines and having an SGA infant (Evidence Table 45, Table 35).^{4,25,54,55,116,118,129,153,154,159} Two studies were conducted among black adolescents.^{153,154} The majority used hospital databases^{54,55,116,118,129,153,159} or clinic databases¹⁵³ as the source of their information; one study (2 articles) used birth certificate information,^{4,25} and one was a cohort study.¹⁵⁴ All studies used a definition of < 10th percentile to define SGA, but reference populations differed across these studies.

Table 35. Weight change relative to IOM thresholds and small-for-gestational-age

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Caulfield et al., 1998 ¹¹⁶ USA, University Hospital 3,870 All weight/BMI Good	Pregravid weight: Self report Total weight gain: Measured	G1: Underweight, BMI < 19.8 G2: Normal weight, BMI 19.8-26.0 G3: Overweight, BMI > 26.0 Black women: G4: No weight gain < IOM G5: No weight gain > IOM White women: G6: No weight gain < IOM G7: No weight gain > IOM	AOR (95% CI) for SGA and rate of weight gain (per 50 g/wk): G1: 0.87 (0.78-0.97) G2: 0.90 (0.84-0.96) G3: 0.93 (0.86-1.01) Expected absolute change (as % of baseline) in incidence of SGA associated with modifiable risk factors (G4- G7): G4: -1.17 (-16) G5: +0.97 (+13) G6: -0.44 (-11) G7: +0.60 (+15)	Age, race, parity, pregravid BMI, height, hypertension, provider type, smoking, female infant
Hellerstedt et al., 1997 ¹⁵⁹ USA, medical center 1,343 Normal/obese BMI Good	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories stratified by pregravid BMI and smoking status: Obese (BMI > 29.0): G1: Smokers, < IOM G2: Smokers, within IOM G3: Smokers, > IOM G4: Nonsmokers, < IOM G5: Nonsmokers, within IOM G6: Nonsmokers, > IOM Normal weight (BMI 19.8- 26.0): G7: Smokers, < IOM G8: Smokers, within IOM G9: Smokers, > IOM G10: Nonsmokers, < IOM G11: Nonsmokers, within IOM G12: Nonsmokers, > IOM	Frequencies of SGA,%: G1: 13.3 G2: 10.0 G3: 7.7 G4: 5.5 G5: 4.7 G6: 3.6 G7: 28.6 G8: 10.9 G9: 3.6 G10: 8.9 G11: 6.5 G12: 6.4 G13: 10.7 G14: 6.6 G15: 6.0 G16: 4.0 G17: 5.3 <i>P</i> = 0.115 for G13-G17 G18: 15.9 G19: 7.5 G20: 5.7 <i>P</i> = 0.001 for G18-G20	Maternal age, pregravid BMI, infant sex, race, parity, prenatal alcohol use, prenatal illicit drug use, adequacy of prenatal care, gestational hypertension, GDM, gestational age

AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; G, group; GDM, gestational diabetes mellitus; kg, kilogram; IOM, Institute of Medicine; NS, not sufficient; OR, odds ratio; PIH, pregnancy-induced hypertension; SGA, small for gestational age; USA, United States of America; WIC, The Special Supplemental Nutrition Program for Women, Infants, and Children.

Table 35. Weight change relative to IOM thresholds and small-for-gestational-age (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Hellerstedt et al., 1997 ¹⁵⁹ (continued)		Obese: G13: Lost/no gain G14: 0.5-6.5 kg G15: 7-11.5 kg G16: 12-16 kg G17: > 16 kg Normal weight: G18: < 11.5 kg G19: 11.5-16 kg G20: > 16 kg	For obese women, compared to nonsmokers who gained 7-11.5 kg, smokers who gained < 7 kg were at significantly higher risk of SGA OR: 3.2 (95% CI, 1.1-10.1) For normal weight women, compared to nonsmokers who gained 11.5-16 kg, smokers who gained < 11.5 kg were at significantly higher risk of SGA OR: 4.3 (95% CI, 1.8-10.3)	
Nielsen et al., 2006 ¹⁵³	Pregravid weight: Self-report	G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI > 26.0	SGA, %: G1: 22.3 G2: 15.6 G3: 11.5 <i>P</i> < 0.01 for G1-G3	Parity, pregravid BMI, time between last weight measure and delivery, height
USA, hospitals (African American adolescents) 815 All weight/BMI Good	Total weight gain: Measured	G4: < IOM G5: Lower half of IOM G6: Upper half of IOM G7: > IOM	AOR (95% CI) for SGA: G4: 2.31 (1.22-4.37) G5: 1.00 (reference) G6: 0.88 (0.41-1.89) G7: 0.68 (0.34-1.35) <i>P</i> < 0.01 for G4-G7	
Devader et al., 2007 ²⁵	Pregravid weight: Self-report	Maternal weight gain categories (lbs): G1: < 25 G2: 25-35 G3: > 35	AOR (95% CI) for SGA: G1: 2.14 (2.01-2.27) G2: 1.0 (reference) G3: 0.48 (0.45-0.50)	Age, race, education, income, alcohol use, height, prior pregnancy, inadequate prenatal care use, smoking, child's gender, birth year
USA, birth certificate data 94,696 Normal weight/BMI 19.8-26 Fair	Total weight gain: Measured			

Table 35. Weight change relative to IOM thresholds and small-for-gestational-age (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Edwards et al., 1996 ⁵⁵ USA, hospital 1,443 Normal/Obese weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Obese BMI > 29 (kg): G1: Lost weight/no change G2: 0.5-6.5 G3: 7-11.5 G4: 12-16 G5: > 16 Normal weight 19.8-26 G6: < 11.5 G7: 11.5-16 G8: > 16	% SGA for obese: G1: 10.7% G2: 6.6% G3: 6.0% G4: 4.0% G5: 5.3% <i>P</i> = 0.11 For normal weight: G6: 15.9% G7: 7.5% G8: 5.7% <i>P</i> = 0.001 AOR (95% CI) Obese: G1 vs. G3 2.9 (1.1-8.4) Normal weight: G6 vs. G7 1.7 (0.9-3.4)	Age, parity, pregravid BMI, GDM, PIH, prenatal adequacy, alcohol use, drug use, smoking, gestational age
Kiel et al., 2007 ⁴ USA, birth registry 120,170 Obese BMI > 30 Fair	Pregravid weight: Self-report Total weight gain: Medical record	Maternal weight gain categories stratified by prepregnancy obesity status, Obese Class I (BMI 30–34.9), Obese Class II (BMI 35–39.9), Obese Class III (BMI ≥ 40): G1: ≤ -10 lbs G2: -2 to -9 lbs G3: No change G4: 2-9 lbs G5: 10-14 lbs G6: 15-25 lbs G7: 26-35 lbs G8: > 35 lbs	For Obese Class I: AOR (95% CI) for SGA were significantly greater (> 1.00, G6 was reference) for G1- G5 and significantly lower for G7-G8. For Obese Class II: AOR (95% CI) for SGA were significantly greater (> 1.00, G6 was reference) for G1- G5 and significantly lower for G7- G8 For Obese Class III: AOR (95% CI) for SGA were significantly greater (> 1.00, G6 was reference) for G1 and G3 and significantly lower for G7-G8	Age, race, parity, education, poverty (enrollment in Medicaid, WIC, food stamp programs), tobacco use, chronic hypertension
Parker and Abrams, 1992 ¹¹⁸ USA, hospital (California) 6,690 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM BMI IOM	AOR (95% CI) for SGA: G1: 1.78 (1.39-2.27) G2: 1.00 (reference) Incidence of SGA in nonobese women, %: G1: 3.25 G2: 6.14 G3: 13.11 Incidence of SGA in obese women, %: G1: 11.76 G2: 3.09	Age, race, parity, pregravid BMI, height, maternal high and low weight gain, smoking, gestational age, birthweight

Table 35. Weight change relative to IOM thresholds and small-for-gestational-age (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Stevens-Simon and McAnarney, 1992 ¹⁵⁴	Pregravid weight: Self-report	Maternal weight gain categories (kg/wk):	Distribution of SGA, %: G1: 7.1 G2: 9.1 G3: 2.1 P = NS	None
USA, adolescent maternity program	Total weight gain: Measured	G1: < 0.23 G2: 0.23-0.40 G3: > 0.40		
141				
All weight/BMI				
Fair				
Stotland et al., 2006 ¹²⁹	Pregravid weight: Self-report	Maternal weight gain categories:	Unadjusted rates of SGA: G1: 11.74 P< 0.001 vs. G2 G2: 7.05 G3: 3.70 P< 0.001 vs. G2 G4: 13.99 P< 0.05 vs. G2 G5: 3.87 P< 0.05 vs. G2	Age, race, parity, pregravid BMI, PIH, date of delivery, mode of delivery, length of first and second stages of labor, smoking, gestational age, birthweight
USA, university hospital	Total weight gain: Prenatal record	G1: < IOM G2: Within IOM G3: > IOM G4: < 7 kg G5: > 18 kg	AOR (95% CI) for SGA: G1: 1.66 (1.44-1.92) G2: 1.00 (reference) G3: 0.51 (0.44-0.59) G4: 2.26 (1.76-2.90) G5: 0.50 (0.42-0.60)	
20,465				
All weight/BMI				
Fair				
Bianco et al., 1998 ⁵⁴	Pregravid weight: Self-report	Maternal weight gain categories among morbidly obese (BMI > 35):	Distribution of SGA, %: G1: 4.0 G2: 3.9 G3: 5.6 G4: 3.1 G5: 3.8 P = No testing due to small numbers in each cell	Race, parity, clinic service, substance abuse, preexisting medical condition
USA, medical center	Total weight gain: Measured	G1: Weight loss/no change G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs		
11,926				
Nonobese (BMI 19-27) and morbidly obese (BMI > 35)				
Poor				

Overview of results for SGA infant weight. Evidence from 10 studies (3 good,^{116,153,159} 6 fair,^{4,25,55,118,129,154} one poor⁵⁴) supports an association between weight gains below the recommended IOM guidelines and the risk of having an SGA infant.

Detailed results of SGA infant weight. With respect to gaining less than the IOM guidelines, two studies found statistically significant higher odds for women giving birth to an SGA infant across all pregravid BMI categories.^{118,129} One of these studies also examined the odds for excessive weight gain, which was statistically significantly protective.¹²⁹

Among normal-weight women, two studies found that excessive weight gain decreased the SGA risk by half, whereas inadequate weight gain doubled the SGA risk.^{25,55} Among obese women, those who gained below the IOM guidelines were at nearly three times the risk of

having an SGA infant^{55,118,159} compared with those who gained within the recommended range. In the one study that was able to examine classes of obesity (Class I, BMI 30.0–34.9; Class II, BMI 35.0–39; and Class III, BMI ≥ 40), the risk of SGA increased for all classes in a linear fashion as weight gain fell below the IOM recommendation of at least 15 to 25 pounds.⁴

The good study conducted among black adolescents that examined total weight gain¹⁵³ found an increased odds for SGA associated with gaining less than the IOM guidelines compared with gaining at the lower half of the guidelines (AOR, 2.31; 95% CI, 1.22–4.37) and no significantly protective effect with weight gains in the upper half or greater than the IOM.

Two studies examined the *rate* of weight gain.^{116,154} One, among black adolescents,¹⁵⁴ found no difference in the prevalence of SGA among rate of weight gain categories (slow, < 0.23 kg/week; average, 0.23 to 0.40 kg/week; and rapid, > 0.4 kg/week). In the other study, after adjustment for multiple confounders, increasing rates of weight gain were associated with a reduced risk of SGA.¹¹⁶ This study calculated the expected change in the incidence of SGA by preventing inadequate weight gain to be -1.17 percent and -0.44 percent for black and white women, respectively.

Apgar Scores.

Study characteristics. Three studies, all rated fair quality, dealt with Apgar scores (Evidence Table 46; Table 36).^{125,129,154}

Table 36. Weight change relative to IOM thresholds and Apgar scores

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Nixon et al., 1998 ¹²⁵ USA, county nurse- midwifery services 2,228 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Data records	Gestational weight gain categorized by IOM recommendations BMI IOM	Maternal weight gain by IOM guidelines was not a significant predictor of Apgar scores (details- none reported)	None
Stevens-Simon and McAnarney, 1992 ¹⁵⁴ USA, adolescent maternity program 141 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories (kg/wk): G1: < 0.23 G2: 0.23-0.40 G3: > 0.40	Distribution of 1-minute Apgar score ≤ 4, %: G1: 25.0 G2: 4.5 G3: 14.9 P = 0.02 for G1 vs. G2 or G3 Distribution of 5-minute Apgar score ≤ 4, %: G1: 3.5 G2: 0 G3: 0 P = NS	None

BMI, body mass index; G, group; IOM, Institute of Medicine; kg/wk, kilogram per week; NS, not significant; USA, United States of America.

Table 36. Weight change relative to IOM thresholds and Apgar scores (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Stotland et al., 2006 ¹²⁹	Pregravid weight: Self-report	Maternal weight gain categories:	Unadjusted rates of 5-minute Apgar score < 7: G1: 1.94 G2: 1.58 G3: 2.14 (<i>P</i> < 0.05, G3 vs. G2)	Age, race, parity, pregravid BMI, pregnancy-induced hypertension, date of delivery, mode of delivery, length of first and second stage of labor, smoking, gestational age, birthweight
USA, university hospital	Total weight gain: Prenatal records	G1: < IOM G2: Within IOM G3: > IOM G4: < 7 kg G5: > 18 kg	G4: 2.39 G5: 2.16 (<i>P</i> < 0.05, G5 vs. G2)	
20,465			AOR (95% CI) for 5-minute Apgar score < 7: G1: 1.18 (0.84-1.66) G2: 1.00 (reference) G3: 1.33 (1.01-1.76) G4: 1.29 (0.70-2.39) G5: 1.30 (0.95-1.77)	
All weight/BMI (using IOM definitions)				
Fair				

Overview of results. Three fair studies provide insufficient evidence to support an association between weight gain and low Apgar scores.

Detailed Results on Apgar Scores. Three studies included investigation of Apgar scores and adherence to the IOM recommendations.^{125,129,154} In one study,¹²⁹ total weight gain above the IOM guidelines increased the risk of having a 5-minute Apgar score of < 7 by 33 percent (AOR, 1.33; 95% CI, 1.01- 1.76), whereas a weight gain below the IOM guidelines was not associated with a low 5-minute Apgar score (AOR, 1.18; 95% CI, 0.84-1.66). Another study¹²⁵ found no effect of maternal weight gain with the outcome defined as a 1-minute Apgar score of < 7. The third study¹⁵⁴ was conducted among black adolescents and found a slow rate of weight gain (< 0.23 kg/week) to be associated with a 1-minute Apgar score of ≤ 4 compared to higher rates of weight gain (> 0.23 kg/week).

Infant Outcomes

Perinatal mortality.

Study characteristics. One US study of a hospital database examined perinatal mortality (Evidence Table 47).¹²⁷ The study included overall perinatal mortality and adverse perinatal outcome, which was defined as an infant death between delivery and discharge, delivery before 37 completed weeks of gestation, LBW, or stillbirth.¹²⁷

Overview of results. One fair study did not conduct multivariable modeling using the IOM cutpoints, and therefore provides weak evidence on the association between weight gain and perinatal mortality.¹²⁷

Detailed results. The authors reported, using only bivariate analysis, that infants of mothers who gained below the IOM recommendations had a significantly higher proportion of adverse perinatal outcomes (14 percent) and perinatal mortality (1.1 percent) than the infants whose mothers gained within or above the recommendations (8.5 percent and 0.4 percent respectively; *P* < 0.001 for all comparisons).

Infant hypoglycemia.

Study characteristics. Two studies from hospital databases examined hypoglycemia in the infant (Evidence Table 48).^{110,129} One study had many other outcomes such as birth trauma, admission to the special care nursery, neonatal infection, seizure, polycythemia, meconium aspiration syndrome, respiratory distress syndrome, and a hospital stay of 5 and 10 days.¹²⁹

Overview of results. Two studies, of good¹¹⁰ and fair quality,¹²⁹ respectively, found moderate evidence that high maternal weight gain is associated with an increased risk of neonatal hypoglycemia for weight gain above IOM recommendations and were consistent in demonstrating a lack of association between weight gain below IOM recommendations and neonatal hypoglycemia.

Detailed results. Two studies included infant hypoglycemia as an outcome of interest.^{110,129} The good study used a case-control design for women who delivered singletons at Kaiser Permanente Medical Center from 1996 to 1998.¹¹⁰ Cases (N = 328) were defined as infants with plasma glucose < 40 mg/dl; controls were infants born to women with no GDM. Cases had a significantly higher odds of having mothers who gained more than the IOM guidelines (AOR, 1.38; 95% CI, 1.01-1.89); weight gains below the IOM were not associated with infant hypoglycemia.

Stratification by race (in the good study) showed that among infants born to non-Hispanic white women, a pregnancy weight gain below the IOM guidelines was significantly associated with a decreased odds of hypoglycemia (OR, 0.39; 95% CI, 0.18-0.84); among infants born to women of minority groups (undefined), weight gain below the IOM guidelines was significantly associated with an increased risk of hypoglycemia (OR, 1.69; 95% CI, 1.08-2.64).¹¹⁰ This study also stratified by pregravid BMI and did not find any significant effect that suggested the effect of weight gain varied by pregravid BMI.

The second study reported that women who gained above the IOM guidelines were significantly more likely to have an infant with hypoglycemia (AOR, 1.52; 95% CI, 1.06-2.16)¹²⁹ but that women with weight gain below the guidelines had no such association. This study found significant associations only for weight gains above the IOM and the following outcomes: infant seizure (AOR, 6.5; 95% CI, 1.43-29.65), polycythemia (AOR, 1.44; 95% CI, 1.06-1.94), and meconium aspiration (AOR; 1.79, 95% CI, 1.12-2.86). Data were adjusted for maternal race, prepregnancy BMI, parity, age, gestational hypertension, smoking, gestational age at delivery, model of delivery, length of each stage of labor, and birthweight.

NICU admissions.

Study characteristics. Two studies, rated fair, dealt with admission to the neonatal intensive care unit (NICU); (Evidence Table 49).^{129,154} One study was a cohort of black adolescents.¹⁵⁴

Overview of results. Two fair studies using different measures of weight gain provided weak inconsistent evidence on neonatal hospitalization.

Detailed results on admission to NICU. One study found that decreased risk of NICU admission was significantly associated with weight gain below IOM guidelines (AOR, 0.66; 95% CI, 0.46-0.96) but not with weight gains above the IOM guidelines (AOR, 1.03; 95% CI, 0.79-1.35).¹²⁹ In the other study, among black adolescents a slow rate of weight gain (< 0.23 kg/week) was significantly associated with NICU admission ($P = 0.01$).¹⁵⁴

Child Outcomes

Childhood weight status. *Study characteristics.* Only one study of fair quality was found²⁴ that examined weight gain according to the IOM and childhood weight status (Evidence Table 50). This study involved 1,585 women from a single HMO in Boston who were part of

pregnancy study and then enrolled in a follow-up study. A total of 1,110 children completed a visit at age 3, at which time study staff measured their weight and height; maternal weight and pregravid weight status were obtained via questionnaire. This study did not specify singleton-only births, but it did note that preterm births and infants weighing < 2,500 kg were excluded because of their different growth trajectories in the first year of life. Maternal weight gain was calculated as the difference between weight measured near delivery obtained from the prenatal record and self-reported pregravid weight. The study reported on the effect of total weight gain, net weight gain (excluding infant birthweight) and weight gain classified by IOM guidelines. Child BMI percentiles were grouped as follows: below 50th (referent category), 50th to 84th, 85th to 94th, and 95th or higher.

Results. Using children born to women who gained inadequately as the referent, children born to women who gained adequately or excessively had higher odds of being in higher percentile categories. The AORs for children born to women who gained adequately were as follows: 50th to 84th percentile, 1.85 (1.17-2.92); 85th to 94th percentile, 2.09 (1.12-3.92), and 95th percentile and above, 3.77 (1.38-10.27). AORs for children born to mothers who gained excessively were similar: respectively, 1.84 (1.17-2.88), 2.03 (1.11-3.72) and 4.35 (1.69-11.24). Both models adjusted for maternal pregravid BMI, prenatal smoking, race/ethnicity, household income, marital status, glucose tolerance, paternal BMI, gestational length, and child's sex.

Short- and Long-term Maternal Outcomes

Lactation performance.

Study characteristics. Three studies (four articles) reported on the effects of weight gain on lactation performance (Evidence Table 51, Table 37).¹⁶⁶⁻¹⁶⁹ One study was done using the Danish National Birth Cohort;¹⁶⁶ another study (2 articles) used a US hospital database for years 1988 to 1997;^{168,169} and the third used data from the US Pediatric Nutrition Surveillance System and the Pregnancy Nutrition Surveillance System.¹⁶⁷ Lactation performance was defined as initiated breastfeeding,^{167,168} duration of any breastfeeding,¹⁶⁶⁻¹⁶⁸ and exclusive breastfeeding.^{166,168,169} Weight gain was defined as the difference between weight at delivery and self-reported pregravid weight^{168,169} or was based simply on self-reported total weight gain.^{166,167} The two US studies used total weight gain as categorical variables corresponding to the IOM guidelines;¹⁶⁷⁻¹⁶⁹ the Danish study used categories corresponding to the following cutpoints: < 8 kg, 8 to 15.9 kg (the reference group), and ≥ 16 kg.¹⁶⁶

Table 37. Weight change relative to IOM thresholds and breastfeeding

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Baker et al., 2007 ¹⁶⁶ Denmark-National Birth 37,459 All wt/BMI Under wt BMI < 18.5 Normal BMI 18.5- 24.9 Overweight BMI 25-29 Obese BMI ≥ 30 Fair	Pregravid weight: Prepregnant weight Self reported Total weight gain: Self-reported	G1: < 8 kg G2: 8-15.9 kg G3: ≥ 16 kg	Overall higher risk of terminating full or any breastfeeding with higher pregravid BMI. Unadjusted RR full BF G1: 1.13 (95% 1.08-1.18) G3: 1.05 (1.03-1.08). Any BF G1: RR 1.16 (1.11-1.22) G3: 1.05 (1.03-1.08). GWG not a predictor of full or any when BMI was in the model.	BMI
Li et al., 2003 ¹⁶⁷ USA WIC clinics 51,329 All wt/BMI (using IOM definitions) Fair	Pregravid weight: Prepregnant weight Self reported Total weight gain: Self-reported	G1: < IOM G2: within IOM G3: > IOM	Adjusted OR for failure to initiate BF by BMI: Under, normal and overweight G1: groups had a significant increased odds of failure to initiate BF compared to G2: within BMI strata. Obese women regardless of weight gain had increased odds of failure to initiate compared to normal wt G2. Adjusted mean duration of BF (<i>P</i> < 0.01)* G1: 12.9 wk* G2: 13.6 wk (ref) G3: 12.8 wk*	Age, race, parity, pregravid BMI, maternal education, marital status, prenatal care, poverty-income ratio, gestational weight gain, smoking, gestational age, birthweight

BF, breastfeeding; BMI, body mass index; G, group; IOM, Institute of Medicine; OR, odds ratio; overwt, over weight; PCAP, Prenatal Care Assistance Program; RR, relative risk; wt, weight; WIC, The Special Supplemental Nutrition Program for Women, Infants, and Children.

Table 37. Weight change relative to IOM thresholds and breastfeeding (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Rasmussen et al., 2002 ¹⁶⁸ Hilson et al., 2006 ¹⁶⁹ USA, hospital 2,494 All wt/BMI (using IOM definitions) Fair	Pregravid weight: Prepregnant weight Self reported Total weight gain: Prenatal records	G1: < IOM G2: within IOM G3: > IOM	OR unsuccessful initiation of BF (normal wt G2: ref) Underwt no significant diff Normal wt G3: 1.66 (1.05- 2.63) Overwt no significant diff Obese G3: 2.89 (1.78-4.69) Hazard OR discontinuing exclusive BF (normal wt G2: ref) Underwt G3: 1.39 (1.01-1.92) Normal wt-no signif differences Overwt G3: 1.27 (1.03-1.56) Obese G1: 1.37 (1.01-1.84) G2: 1.50 (1.11-2.03) G3: 1.78 (1.48-2.14) Hazard OR discontinuing any BF (normal wt G2: ref) Underwt-no sign difference Normal wt-no sign difference Overwt- no sign difference Obese G2: 1.57 (1.14-2.18), G3: 1.99 (1.64-2.43)	Age, parity, participation in WIC/PCAP, type of delivery, mother attended college, smoking

Overview of results. These studies (all fair quality) support an association between weight gains below the IOM guidelines and lower likelihood of breastfeeding initiation; they also suggest a shorter duration of exclusive breastfeeding among obese women. They provide only inconsistent evidence of an association between weight gain in relation to the IOM guidelines and initiation of breastfeeding.

Detailed results on breastfeeding initiation. Obese women, regardless of weight gain, had higher odds of never initiating breastfeeding than women of normal weight in one US study.¹⁶⁷ For women who were underweight or of normal weight, greater weight gain was associated with a lower odds of never initiating breastfeeding; for overweight and obese women, there was no such association.¹⁶⁷ Finally, for all three categories of women classified by BMI, weight gain below the IOM guidelines (as compared with weight gain within the guidelines) was associated with higher odds of never initiating breastfeeding.

The second study (2 articles) examined initiation of breastfeeding at 4 days postpartum among women who intended to breastfeed.^{168,169} Compared with normal-weight women who gained within the IOM guidelines, normal-weight women who gained more than the IOM guidelines and obese women regardless of weight gain had significantly higher odds of not breastfeeding.¹⁶⁸ Among obese women, unsuccessful initiation of breastfeeding was limited to those who gained more than IOM guidelines¹⁶⁹ compared with normal-weight women who

gained within the guidelines. This study also reported a nonsignificant tendency of failing to initiate breastfeeding successfully with weight gain less than the IOM guidelines.

Detailed results on duration of exclusive breastfeeding. The two studies (three articles) examining the length of exclusive breastfeeding all showed statistically significant shorter durations among obese women.^{166,168,169} The association between weight gain and duration of full breastfeeding did not differ by BMI status in two studies.^{166,169}

US women who gained above the IOM guidelines had a statistically significant shorter median duration of exclusive breastfeeding than women who gained within the guidelines according to multivariate models.¹⁶⁹ For those who gained above the guidelines, the median duration of exclusive breastfeeding was 1 week shorter for underweight and overweight women and 3 weeks shorter for obese women.

In the Danish study,¹⁶⁶ weight gain was a statistically significant predictor of full breastfeeding at 1, 16, and 20 weeks postpartum. In unadjusted models, both low weight gain (< 8 kg) and high weight gain (≥ 16 kg) were associated with early termination of full breastfeeding. Once the authors adjusted for pregravid BMI, however, this association was no longer significant.

Detailed results on duration of any breastfeeding. Shorter duration of any breastfeeding was associated with maternal obesity.^{166,167,169}

In the two US studies, gaining weight above the IOM guidelines was associated with shorter duration of any breastfeeding (in the range of 1 to 2.5 weeks less) in bivariate and multivariate analysis.^{167,169} In one study, gaining weight below the IOM guidelines was also associated with shorter length of any breastfeeding (~1 week).¹⁶⁷

In the Danish study, weight gain was a statistically significant predictor of terminating any breastfeeding at 16 and 20 weeks postpartum but not at 1 week.¹⁶⁶ In unadjusted models, both low and high weight gains were associated with early termination of any breastfeeding. Once models were adjusted for pregravid BMI, this finding was no longer significant.

Fat retention.

Study characteristics. Two studies in the United States examined differences in the amount of fat retained in the postpartum period by IOM categories of weight gain (Evidence Table 52).^{16,97} One study reported on 63 pregnant women (17 underweight, 34 normal weight, 12 overweight/obese) from a convenience sample of 124 nonsmoking women ages 18 to 40.⁹⁷ The study conducted body composition measurements using dual-energy x-ray absorptiometry both before and after pregnancy and weighed the women before, during, and after pregnancy. The second study was conducted among a convenience sample of 196 nonsmoking women between 19 and 36 years recruited from three prenatal clinics. These investigators used self-reported pregravid weight and conducted body composition measurements starting at 12 to 16 weeks of gestation, at 37 weeks, and/or at 2 to 4 weeks postpartum with hydrodensitometry (underwater weighing) and deuterium dilution volume.¹⁶ Total body bone mineral was measured at 2 to 4 weeks postpartum using dual-energy absorptiometry. They applied a four-compartment model (incorporating measurements of total body water, body density, body weight, and bone mineral content) to estimate total body fat.

Overview of results. Evidence from two fair studies suggests that fat retention was higher among women whose weight gains exceeded IOM guidelines.

Detailed results. In one study, fat retention was significantly higher among women who gained above the IOM guidelines (5.3 kg) than among women who gained within (2.3 kg) or below (-0.5kg).⁹⁷ In the second study, changes in body fat from 14 to 37 weeks of gestation stratified by pregravid BMI showed that women who gained below the IOM guidelines had the lowest amount of fat gain; those within an intermediate level and those above had the highest fat

gain.¹⁶ The investigators did not report significance tests. Among obese women who gained within the IOM guidelines, the percentage of body fat change (-0.6 kg) was significantly lower than among other BMI groups who also gained within the recommendations (6.0 kg for underweight, 3.8 kg for normal weight, and 2.8 kg for overweight women).

Short-term weight retention.

Study characteristics. Four studies examined weight gain and weight retention in the short term^{104,154,158,170} (Evidence Table 53, Table 38). Three studies reported on results at 6 weeks postpartum.^{154,158,170} All used a cohort design involving mostly low-income women; two included Hispanic, black, and white women,^{158,170} and the third included only black adolescents.¹⁵⁴ One study used total weight gain as the exposure;¹⁷⁰ two examined the rate of weight gain.^{154,158} A fourth study examined the possible association 2 days after term delivery (37 to 43 weeks' gestation).¹⁰⁴

Table 38. Weight change relative to IOM thresholds and short-term weight retention

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Luke et al., 1996 ¹⁰⁴ USA, clinic 487 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain < IOM recommendations: G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI > 26.0 Maternal weight gain within IOM recommendations: G4: BMI < 19.8 G5: BMI 19.8-26.0 G6: BMI > 26.0 Maternal weight gain > IOM recommendations: G7: BMI < 19.8 G8: BMI 19.8-26.0 G9: BMI > 26.0	Mean (SEM) retained weight (defined as 2-day postpartum weight minus pregravid weight, kg): G1: 3.2 (0.5) <i>P</i> < 0.05 compared to G4 G2: 0.8 (0.4) <i>P</i> < 0.05 compared to G5 G3: -5.0 (0.7) <i>P</i> < 0.05 compared to G6 G4: 8.2 (0.7) G5: 7.0 (0.4) G6: 1.4 (0.8) G7: 15.5 (0.9) <i>P</i> < 0.05 compared to G4 G8: 12.9 (0.4) <i>P</i> < 0.05 compared to G5 G9: 9.5 (0.5) <i>P</i> < 0.05 compared to G6	Age, parity, race, smoking, gestation duration, fetal sex
Scholl et al., 1995 ¹⁵⁸ USA Camden Study 274 Normal weight/BMI 19.8-26 Fair	Pregravid weight: Self report Total weight gain: Measured	Maternal weight gain categories (kg/wk): G1: ≤ 0.34 G2: > 0.34-0.68 G3: > 0.68	Mean (SEM) change in weight (kg) from pregravid to 6 weeks postpartum: G1: 3.1 (0.80) G2: 3.9 (0.51) G3: 9.4 (0.70) <i>P</i> < 0.001, G3 vs. G1,G2	Age, parity, race, height, lactation status, smoking

B, beta; BMI, body mass index; CI, confidence interval; G, group; IOM, Institute of Medicine; kg, kilogram; kg/wk, kilogram per week; SD, standard deviation; SE, standard error; SEM, standard error of mean.

Table 38. Weight change relative to IOM thresholds and short-term weight retention (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Stevens-Simon and McAnarney, 1992 ¹⁵⁴ USA, adolescent maternity program 141 All weight/BMI Fair	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories (kg/wk): G1: < 0.23 G2: 0.23-0.40 G3: > 0.40	Short term weight retention (2-11 weeks postpartum), total kg: G1: -1.7 (SD 2.9) G2: 2.9 (SD 2.9) G3: 9.6 (SD 5.6) P < 0.0001 AOR (95% CI) for subsequent maternal obesity (> 120% ideal weight for height): G3: 190.94 (7.55-4,779.02)	Age, pregravid BMI, level of physical activity, timing of first prenatal and postpartum visits substance use, body habitus
Walker et al., 2004 ¹⁷⁰ USA, Austin New Mothers Study 419 All weight/BMI (using IOM definitions) Fair	Pregravid weight: Self-report Total weight gain: Self-report	Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM	Mean (SD) weight (kg) retained at 6 weeks postpartum: G1: -0.34 (3.44) G2: 3.86 (3.45) G3: 10.55 (6.14) P = 0.000 % Women who attained pregravid weight at 6 weeks postpartum: G1: 48.8 G2: 14.3 G3: 2.3 Correlation of gestational weight gain, excluding infant weight, (continuous variable) and weight retained at 6 weeks postpartum: r = 0.90 P = 0.000 Multiple regression analysis predicted a mean increase in retained weight of 0.88 kg for each 1 kg increase in maternal weight gain (B = 0.88, SE = 0.02, P = 0.000)	Race, parity, pregravid BMI, gestational weight gain, gestational age

Overview of results. Evidence from four fair studies supports an association between weight gain in excess of the IOM recommendations and higher weight retention in the immediate postpartum period.^{104,154,158,170}

Detailed results. In one study, women who gained more than recommended levels retained, at 6 weeks, statistically significantly more weight than women who gained within or below IOM guidelines.¹⁷⁰ The 2-day post-delivery analyses, stratified by pregravid BMI, showed that for each BMI grouping, women who gained above the IOM guidelines retained statistically significantly more weight than women who gained within the guidelines; women who gained below the IOM guidelines retained significantly less than those who gained within them.¹⁰⁴

Two studies examined the *rate* of weight gain. One defined < 0.23 kg per week as slow weight gain and > 0.4 kg per week as rapid,¹⁵⁴ and the other defined low as < 0.34 kg per week and excessive as > 0.68 kg week.¹⁵⁸ In both studies, the amount of weight retained was highest among women who had an excessive rate of weight gain compared with women who had lower rates.^{154,158}

Weight retention during the first year postpartum.

Study characteristics. Six studies examined the effect of weight gain according to IOM classifications on weight retained during the first year postpartum (Evidence Table 54, Table 39).^{158,171-175} Five studies were from the United States, and one was from Sweden.¹⁷¹ Five used a cohort design,^{158,171,172,174,175} one US study was done in a representative sample of births.¹⁷³

Table 39. Weight change relative to IOM thresholds and weight retention during the first year postpartum

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Amorim et al., 2007 ¹⁷¹	Pregravid weight: Self-report	Maternal weight gain categories: < IOM	A mixed ANOVA with one repeated measures factor (weight before pregnancy, 6 months, 1, and 15 years) and one between-subjects factor (< IOM, within IOM, > IOM) showed a main effect of time [F (9.024) = 113.7, P = 0.000] and a significant time group interaction [F(6,12) = 77.23, P = 0.000]	Pregravid BMI
Sweden, hospital 483	Total weight gain: Obstetric records	Within IOM > IOM		
All weight/BMI Fair			The weight of women who gained excessive during pregnancy was significantly greater at each time-point [main effect of group: F (10.55) = 870.0, P = 0.000]	
Rooney et al., 2002 ¹⁷⁴	Pregravid weight: Measured at first visit	Maternal weight gain categories:	Average weight change between prepregnancy and 6 months postpartum (kg):	Duration of breastfeeding, postpartum aerobic exercise, weight loss by 6 months
USA, hospital 540	Total weight gain: Measured	G1: < IOM G2: Within IOM G3: > IOM	G1: -0.61 G2: 1.8 G3: 4.2 P = 0.01	
All weight/BMI Fair		BMI IOM	Regression coefficient (95% CI) for weight at 6 months postpartum: G1: -1.53 (-3.36–0.30) G2: Reference G3: 1.24 (-0.63–3.11)	

ANOVA, analysis of variance; BMI, body mass index; CI, confidence interval; G, group; kg, kilogram; kg/wk, kilogram per week; SE, standard error.

Table 39. Weight change relative to IOM thresholds and weight retention during the first year postpartum (continued)

Author, Year	Country, Setting	Pregravid Weight (How Measured)	Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Scholl et al., 1995 ¹⁵⁸	USA, Camden Study	Pregravid weight: Self report	Total weight gain: Measured	Maternal weight gain categories (kg/wk): G1: ≤ 0.34 G2: > 0.34-0.68 G3: > 0.68	Mean (SEM) change in weight (kg) from pregravid to 6 months postpartum: G1: 3.2 (0.95) G2: 3.8 (0.61) G3: 7.9 (0.83) <i>P</i> < 0.001, G3 vs. G1, G2 Mean (SEM) change in weight (kg) from 6 weeks to 6 months postpartum: G1: 0.13 (0.64) G2: -0.05 (0.41) G3: -1.48 (0.56) <i>P</i> < 0.05, G3 vs. G1, G2 AOR (95% CI) for becoming overweight (BMI > 26.0) at 6 months postpartum: G1, G2: 1.0 (reference) G3: 2.89 (1.36-6.00)	Age, race, parity, pregravid BMI, lactation, height, smoking
274						
Normal weight/BMI 19.8-26						
Fair						
Walker, 1996 ¹⁷²	USA, mail survey	Pregravid weight: Self report	Total weight gain: Self report	Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM	Mean weight retention at 6 months postpartum, lbs: G1: 0.4 G2: 3.7 G3: 13.5 <i>P</i> < 0.001 Maternal weight gain was significantly related to weight at 6 months postpartum: <i>r</i> = 0.60, <i>P</i> < 0.001 Mean weight retention at 18 months postpartum, lbs: G1, G2: 0.7 G3: 11.0 <i>P</i> < 0.01 Maternal weight gain was significantly related to weight at 18 months postpartum: <i>r</i> = 0.49, <i>P</i> < 0.001	Mode of delivery, infant sex, breastfeeding, infant birthweight, pregravid BMI
88						
Underweight/Normal/Overweight (using IOM definitions)						
Fair						

Table 39. Weight change relative to IOM thresholds and weight retention during the first year postpartum (continued)

Author, Year	Country, Setting	Pregravid Weight (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Olson 2002 ¹⁷⁵	USA, hospital and primary care clinic system	Pregravid weight: Measured during first trimester Total weight gain: Measured	Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM G4: Interaction for > IOM and income ≤ 185% federal poverty line	Regression coefficient (SE) for weight change from early pregnancy to 1 year postpartum (kg): G1: -1.50 (0.62) <i>P</i> = 0.016 G2: reference G3: 0.32 (0.65) <i>P</i> = 0.621 G4: 3.41 (0.91) <i>P</i> < 0.001 AOR (95% CI) for major weight gain (≥ 10 lbs) at 1 year postpartum: G1: 0.33 (0.13-0.83) G2: 1.00 (reference) G3: 1.47 (0.73-2.94) G4: 3.23 (1.25-9.08) Compared to normal-weight women (BMI 19.8-26.0) in G2, normal weight, overweight (BMI 26.1-29.0) and obese (BMI > 29.0) women in G3 retained significantly more weight at 1 year postpartum (all <i>P</i> < 0.01)	Exercise, food intake, breastfeeding, pregravid BMI, age, marital status, income, postpartum month that weight was measured
Keppel 1993 ¹⁷³	USA, 1988 National Maternal and Infant Health Survey	Pregravid weight: Self-report Total weight gain: Self-report	Categories of amount of weight retained (lbs) at 10-18 months postpartum: G1: Lost weight G2: 0-3 G3: 4-8 G4: 9-13 G5: ≥ 14	The percent distribution of women in G1-G5 stratified by maternal weight gain categories showed that both black and white women who gained < IOM or within the IOM guidelines retained less weight (10-18 months postpartum) than women who gained > IOM recommendations. Irrespective of maternal weight gain, black women retained more weight than white women	None
					Poor

Overview of results. The evidence from five fair studies^{158,171,172,174,175} and one poor study¹⁷³ supports an association between excessive weight gain and weight retention within the first year postpartum.

Detailed results. Regardless of when postpartum weight was measured—at 6^{158,171,172,174} or at 10 to 18 months^{171,173,175}—women who gained above the IOM recommendations retained more weight than those who gained within them. Women who gained below recommendations did not always retain less weight than those who gained within them, according to one fair¹⁵⁸ and one poor study.¹⁷³ In the poor study, which stratified results by race, this pattern of weight retention by weight gain held true for white and black women.¹⁷³ One study calculated women had statistically significant odds of becoming overweight at 6 months given rates of weight gain above IOM guidelines.¹⁵⁸

Another study used a mixed ANOVA with a one-repeated-measure factor (time of the weight measurement: before pregnancy, 6 months, 1 year, and 15 years after) and one between-subject factor (below, within, above the IOM guidelines).¹⁷¹ The weight of women who gained

excessively during pregnancy was statistically significantly higher at each time point adjusted for pregravid BMI.

Long-term weight retention.

Study characteristics. Four articles from three databases examined weight retention after several years^{171,174,176} or until the second pregnancy¹⁷⁷ (Evidence Table 55, Table 40). One study (2 articles) was in a US medical center in Wisconsin,^{174,176} one was done in another US hospital;¹⁷⁷ and one was conducted in Sweden.¹⁷¹ Three studies were rated fair quality; one was rated good.¹⁷⁷

Table 40. Weight change relative to IOM thresholds and long-term weight retention

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Gunderson, 2000 ¹⁷⁷ USA, hospital 1,300 All weight/BMI (using IOM definitions) Good	Pregravid weight: Self-report Total weight gain: Measured	Maternal weight gain categories: G1: < IOM/ within IOM G2: > IOM	AOR (95% CI) for becoming overweight between baseline (pregravid weight at start of index pregnancy) and start of second study pregnancy (median interval time = 1.5 years): G1: Reference G2: 2.95 (1.67-5.24)	Smoking, PIH, education, parity, marital status, age at menarche, interval to first birth
Rooney, 2005 ¹⁷⁶ USA, hospital 484 All weight/BMI Fair	Pregravid weight: Measured at first prenatal visit Total weight gain: Measured	Categories of maternal weight gain: G1: < IOM G2: within IOM G3: > IOM	Multivariable regression coefficient (95% CI) for BMI at 15 years postpartum: G1: -0.57 (-0.57-1.21) G2: reference G3: 1.69 (0.79-2.58) Multivariable regression coefficient (95% CI) for change in weight between baseline and 15 years postpartum: G1: 0.43 (-1.87-2.73) G2: reference G3: 4.19 (1.88-6.51)	Marital status at delivery, change in marital status, current parity, insurance status at delivery, current insurance status, baseline BMI, weight gain at index pregnancy, retained weight at 6 months postpartum, participation in postpartum aerobic exercise, duration of breastfeeding
Amorim et al., 2007 ¹⁷¹ Sweden, hospital 483	Pregravid weight: Self-report Total weight gain: Obstetric records	Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM	Mean (SD) change in weight at 15 years postpartum, kg: G1: 6.2 (6.8) G2: 6.7 (6.8) G3: 10.3 (8.5) P = 0.000	Education, lactation, weight retention at 6 months postpartum, weight gain between 6 months and 1 year postpartum, pregravid BMI

AOR, adjusted odds ratio; B, beta; BMI, body mass index; CI, confidence interval; G, group; IOM, Institute of Medicine; PIH, pregnancy-induced hypertension; SD, standard deviation; USA, United States of America.

Table 40. Weight change relative to IOM thresholds and long-term weight retention (continued)

Author, Year Country, Setting Sample Size Baseline BMI Quality	Pregravid Weight (How Measured) Total Weight Gain (How Measured)	Definition of Groups	Results	Confounders and Effect Modifiers Included in Analysis
Amorim et al., 2007 ¹⁷¹ (continued)			Mean (SD) BMI at 15 years postpartum: G1: 23.5 (3.7) G2: 23.6 (3.0) G3: 25.9 (3.9) <i>P</i> = 0.000	
All weight/BMI (using IOM definitions)			Multiple regression coefficient, B (95% CI) for 15 year BMI status: G1: 0.01 (-0.56-0.59) G2: Reference G3: 0.72 (0.15-1.30) <i>P</i> = 0.033	
Fair			Multiple regression coefficient (95% CI) for change in BMI status between pregravid and 15 years postpartum: G1: 0.02 (-0.56-0.59) G2: Reference G3: 0.68 (0.11-1.24) <i>P</i> = 0.042	
Rooney et al., 2002 ¹⁷⁴	Pregravid weight: Measured at first visit	Maternal weight gain categories:	Average weight change between prepregnancy and ~8.5 years postpartum (kg): G1: 4.1 G2: 6.5 G3: 8.4 <i>P</i> = 0.01	Duration of breastfeeding, postpartum aerobic exercise, weight loss by 6 months
USA, hospital 540	Total weight gain: Measured	G1: < IOM G2: Within IOM G3: > IOM	Regression coefficients (95% CI) for BMI at ~8.5 years postpartum: G1: -3.86 (-5.56 - -2.16) G2: Reference G3: -0.70 (-2.13-0.74)	
All weight/BMI (using IOM definitions)				
Fair				

Overview of results. Evidence from one good article¹⁷⁷ and three fair articles^{171,174,176} supports an association between excessive weight gain and higher weights later in life.

Detailed results. The results for the Sweden study were reported above.¹⁷¹ In the Wisconsin study, the average amount of weight retained at a mean of 8.5 years later was statistically significantly higher among women who gained more than recommended guidelines than among women who gained within or below guidelines.^{174,176} In the regression model predicting long-term weight (at 8.5 years and 14.7 years), weight gain during pregnancy was a significant predictor of weight retention.

In the other US study, the incidence of overweight at the second pregnancy was statistically significantly higher among women who had gained above the IOM in the prior pregnancy than among those who gained within or below IOM recommendations.¹⁷⁷ The adjusted odds of becoming overweight between baseline and the start of the second pregnancy was nearly threefold for women gaining above recommendations.

KQ 5: Anthropometrics of Weight Measurement

Nearly all of the 150 studies included in this review estimated adiposity using body weight or BMI. Ten studies collected data from other anthropometric measurements and incorporated them into varying body composition equations or models to estimate body fat (Evidence Table 56).^{16,97,102,115,143,178-182} These measurements included bioelectrical impedance analysis (BIA),¹⁷⁸ dual energy X-ray absorptiometry (DEXA, formerly referred to as DXA),^{16,97,180} skinfold thicknesses,^{102,143,180} circumferences (arm, thigh, radius, upper chest, chest, elbow, waist, upper iliac, wrist, knee, calf, and ankle),^{102,115,143,178,180} total body water,^{16,97,178,180} total body nitrogen,⁹⁷ total body potassium,⁹⁷ magnetic resonance imaging (MRI),^{179,181} and underwater weighing.^{16,97,180} Studies that used DEXA or MRI methods^{16,97,179,180} recorded measurements only during the postpartum period.

Collectively, these studies do not provide sufficient evidence to judge whether alternate methods of weight measurement are more informative or predictive of infant and maternal outcomes than standard body weight and height measurements.

Chapter 4. Discussion

This chapter discusses our findings for five key questions (KQs) relating to outcomes of gestational weight gain, modifiers and confounders of outcomes of weight gain, outcomes of weight gain within or outside Institute of Medicine (IOM) recommendations, risks and benefits of recommendations, and anthropometric measures of weight gain.

We note in this discussion both the quality of individual studies (good, fair, or poor, as explained in Chapter 2) and the strength of the evidence for each question or subquestion (also described in Chapter 2) and defined below. As noted in Chapter 2, the quality of each study is based on the summary assessment of quality on nine key domains: background, sample selection, specification of exposure, specification of outcome, soundness of information, followup, analysis comparability, analysis of outcome, and interpretation.

The strength of evidence for each outcome incorporates the quality of the studies and the consistency and volume of the evidence. To reiterate, the levels of strength of evidence are as follows:

- I. **Strong:** The evidence is from studies of strong design; results are both clinically important and consistent with minor exceptions at most; results are free from serious doubts about generalizability, bias, or flaws in research design. Studies with negative results have sufficiently large samples to have adequate statistical power.
- II. **Moderate:** The evidence is from studies of strong design, but some uncertainty remains because of inconsistencies or concern about generalizability, bias, research design flaws, or adequate sample size. Alternatively, the evidence is consistent but derives from studies of weaker design.
- III. **Weak:** The evidence is from a limited number of studies of weaker design. Studies with strong design either have not been done or are inconclusive.
- IV. **No evidence:** No published literature.

In this first part of this chapter, we discuss chiefly the outcomes with strong or moderate strength of evidence. The tables present outcomes in the order of strength of evidence and then by the outcomes as presented in Chapter 3. We caution that the levels of evidence assigned to the outcomes below reflect associations, not causality, given the preponderance of observational studies in this literature.

For greater synthesis, we first combine our discussion of outcomes for KQ 1 (outcomes of gestational weight gain, broadly defined) and KQ 3 (outcomes of gestational weight defined by IOM cutpoints). We then take up KQ 2 (modifiers and confounders of gestational weight gain), KQ 4 (risks and benefits of gestational weight gain recommendations), and KQ 5 (anthropometrics of weight measurement during pregnancy). When results are described as significant, we mean statistically significant. We conclude the chapter by examining the limitations of this review and the evidence base and then presenting our recommendations for future research.

Outcomes of Maternal Weight Gain (KQ 1 and KQ 3)

KQ 1 asks about outcomes of gestational weight gain for infants and for mothers; we had specified more than 30 outcomes as being of interest. We present outcomes of gestational weight gain for each of these categories of outcomes, classified in six categories: maternal antepartum outcomes, maternal intrapartum outcomes, birth outcomes, infant outcomes, child outcomes, and short- and long-term maternal outcomes. We focus chiefly on outcomes for which the evidence is either strong or moderate.

KQ 1 also asks what evidence exists to demonstrate causality. Nearly all the studies in this review are observational studies; therefore, generally this evidence base cannot demonstrate a causal link between gestational weight gain and outcomes. Moreover, observational studies that do not control for confounding or possible explanatory factors cannot be used to comment on causality. These research questions thus require the inclusion and assessment of observational studies for making policy decisions, and decisionmakers will need to take into account the limitations of the evidence base.

Our analysis of outcomes related to weight gains in relationship to recommendations of the Institute of Medicine (KQ 3) classified outcomes into six categories as with KQ 1. KQ 3 also asks about the outcomes of weight loss. Weight loss is not considered appropriate during pregnancy for any weight status. Few studies collected or analyzed these data in a manner that allowed compilation and synthesis.

To enable synthesis and help identify gaps in the evidence, we have combined the discussion of the findings for KQ 1 and KQ3, by outcomes. The levels of evidence assigned below account for consistency, directionality, and quality for associations between gestational weight gain and the outcome. The following tables provide a summary assessment of the outcome and its strength of evidence for KQ 1 and KQ3: maternal antepartum outcomes, Table 41; maternal intrapartum outcomes, Table 42; birth outcomes, Table 43; infant outcomes, Table 44; child outcomes, Table 45; and maternal short- and long-term outcomes, Table 46.

Across all 36 outcomes that we examined for KQ 1, only eight outcomes had strong or moderate strength of evidence. Specifically, we found

- no strong or moderate evidence for maternal antepartum outcomes;
- moderate evidence only for cesarean delivery among maternal intrapartum outcomes;
- moderate or strong evidence for several birth outcomes: preterm birth, birthweight, low birthweight, macrosomia, large-for-gestational-age (LGA), and small-for-gestational-age (SGA);
- no strong or moderate evidence for infant outcomes;
- no strong or moderate evidence for child outcomes; and
- moderate evidence for intermediate-term postpartum weight retention among short- and long-term maternal outcomes.

For KQ 3, we found strong or moderate strength of evidence for 11 outcomes: the 8 identified for KQ 1 and moderate evidence for breastfeeding, short-term postpartum weight retention, and long-term postpartum weight retention.

Maternal Antepartum Outcomes

We examined the literature for five maternal antepartum outcomes (Table 41). For all, evidence was weak.

Table 41. Strength of evidence: maternal antepartum outcomes of gestational weight gain

Outcome	Source of evidence	Strength of evidence	Number and quality of studies
Maternal discomforts of pregnancy	KQ 1	Weak	2 fair ^{41,42} and 3 poor studies ⁴³⁻⁴⁵
	KQ 3	No evidence	
Hyperemesis	KQ 1	Weak	1 poor ⁴⁷
	KQ 3	No evidence	
Abnormal glucose metabolism	KQ 1	Weak	2 good, ^{3,48} 5 fair ^{52,57,55,56,53} , 4 poor ^{49-51,54}
	KQ 3	Weak	1 good, ³ 2 fair, ^{53,55} 1 poor ⁵⁴
Hypertensive disorders	KQ 1	Weak	8 fair, ^{4,25,52,53,55,58-60} 4 poor, ^{49,51,54,61}
	KQ 3	Weak	4 fair, ^{4,25,53,55} 1 poor ⁵⁴
Gallstones	KQ 1	Weak	1 fair, 1 poor ^{62,63}
	KQ 3	No evidence	

Maternal discomforts of pregnancy.

Results from KQ 1. Five studies (2 fair^{41,42} and 3 poor studies⁴³⁻⁴⁵) provided weak evidence on a variety of discomforts of pregnancy: heartburn,⁴⁵ physical symptoms or level of physical energy,⁴² stretch marks,^{43,44} and overall symptoms.⁴¹ A study on physical symptoms and level of physical energy found no differences for women who gained an excessive amount of weight compared to those who did not, irrespective of BMI group.⁴² A study on overall symptoms found that total weight gain was associated with a higher frequency of symptoms from mid-pregnancy through the 36th week of gestation.⁴¹ Both studies of development of striae gravidarum^{43,44} and the heartburn study⁴⁵ were rated poor quality, so no conclusions can be drawn about any relationship between gestational weight gain and these outcomes.

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Hyperemesis.

Results from KQ 1. One study of poor quality provided weak evidence that total gestational weight gain of < 7 kg is associated with an antepartum admission related to hyperemesis.⁴⁷ This study had a high number of cases with missing values on gestational weight gain (17 percent of the cohort).

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Abnormal glucose metabolism.

Results from KQ 1. Eleven studies (2 good,^{3,48} 5 fair,^{52,53,55-57} and 4 poor^{49-51,54}) provided weak evidence on the relationship between weight gain in pregnancy and the development of abnormal glucose metabolism.^{3,48-57} Although 11 studies is a sizeable number of articles, the inconsistencies in methodology and definition across them (i.e., lack of standardization) are too substantial to permit clear summation of the research or to warrant any stronger grading than weak. The major shortcoming was inconsistent diagnostic criteria.

Four studies found that greater weight gains in pregnancy were positively associated with abnormal glucose tolerance,^{3,51,55,56} three (2 good, 1 poor) found that women having lower-than-average weight gains had a higher likelihood of gestational diabetes mellitus (GDM),^{48,49,53} and four articles found no significant association.^{50,52,54,57} Family history of diabetes,^{50,56} maternal age,^{3,50,56} parity,⁵⁰ and body mass index (BMI)^{3,50,56,57} were more predictive of abnormal glucose metabolism than gestational weight gain in the research we reviewed.

Results from KQ 3. Four studies (1 good,³ 2 fair,^{53,55} and 1 poor⁵⁴) examined the relationship of the IOM guidelines and abnormal glucose metabolism. These studies offered weak evidence of an association largely because all except one used total gestational weight gain as the exposure variable rather than weight gain until the time of diagnosis. Because treating women with GDM includes dietary counseling and efforts to control weight gain, the use of total weight gain as a predictor of GDM is likely to be a biased indicator.

Synthesis of results. Inconsistent diagnostic criteria and biases in the definition of weight gain result in a weak body of evidence from which we cannot draw conclusions about the association between gestational weight gain and GDM.

Maternal hypertensive disorders.

Results from KQ 1. Twelve studies (2 fair,^{4,25,52,53,55,58-60} 4 poor,^{49,51,54,61}) provided weak evidence on the association between prenatal weight gain and the development of pregnancy-induced hypertension.^{4,25,49,51-55,58-61} Of these 12 studies, 10 reported a relationship between increasing weight and the likelihood of pregnancy-induced hypertension,^{4,25,49,51,53,55,58-61} 2 found no effect. One potential explanation for the relationship between weight and gestational hypertension, particularly preeclampsia, is that the condition is marked by edema, which often presents as rapidly increasing weight before delivery. Consequently, the association observed in the majority of the studies may represent the disease state itself, rather than any marker of implied causation.

Results from KQ 3. When we examined maternal hypertensive disorders by IOM guidelines, three fair studies (4 articles)^{4,25,53,55} and one poor study⁵⁴ provided weak evidence of an association relating to pregnancy-induced hypertension.

Synthesis of results. In summary, largely because weight gain is a marker of edema, which is a hallmark of preeclampsia, and because of analytical flaws, the available evidence provides only weak evidence of a relationship between gestational weight gain and the development of pregnancy-induced hypertension.

Gallstones.

Results from KQ 1. Two studies (2 poor⁶² and 1 fair⁶³) provided weak evidence suggesting a potential relationship between weight gain and cholelithiasis.

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Maternal Intrapartum Outcomes

In all, we examined the literature for 11 maternal and intrapartum outcomes (Table 42). For one of these—cesarean delivery—the evidence was of moderate strength. For all other outcomes, evidence was weak.

Table 42. Strength of evidence: maternal intrapartum outcomes of gestational weight gain

Outcome	Source of evidence	Strength of Evidence	Number and Quality of Studies
Premature rupture of membranes	KQ 1	Weak	2 Fair ^{64,65}
	KQ 3	No evidence	
Preterm labor	KQ 1	Weak	1 Poor ⁶⁶
	KQ 3	No evidence	
Postterm pregnancy	KQ 1	Weak	1 Fair ⁵⁸
	KQ 1	Weak	1 Fair ⁵⁸
	KQ 3	No evidence	
Induction of labor	KQ 1	Weak	2 Fair, ^{25,67} 3 Poor ^{51,59,68}
	KQ 3	No evidence	
Length of labor	KQ 1	Weak	2 Fair, ^{69,70} 1 Poor ⁶⁸
	KQ 3	No evidence	
Mode of delivery	KQ 1	Moderate for cesarean delivery; Weak for instrumental delivery	14 Fair, ^{4,25,52,58,67,69-73,75-78} 7 Poor ^{49,51,54,59,61,68,74}
	KQ 3	Moderate evidence for increased risk of cesarean for weight gain above IOM recommendations for underweight and normal weight women Weak inconsistent evidence for weight gain above IOM recommendations for obese or morbidly obese women	8 Fair, ^{4,25,53,55,77,118,149,150} 1 Poor ⁵⁴
Vaginal birth after cesarean	KQ 1	Weak	1 Poor ⁷⁹
	KQ 3	No evidence	
Vaginal lacerations	KQ 1	Weak	2 Poor ^{51,68}
	KQ 3	No evidence	
Shoulder dystocia	KQ 1	Weak	3 Poor ^{51,68,80}
	KQ 3	No evidence	
Cephalopelvic disproportion	KQ 1	Weak	1 Fair, ²⁵ 1 Poor ⁷⁴
	KQ 3	No evidence	
Complications of labor and delivery	KQ 1	Weak	1 Fair, ⁵³ 1 Poor ⁸¹
	KQ 3	No evidence	

Premature rupture of membrane.

Results from KQ 1. Two fair studies provided weak evidence that low weight gain (< 21 pounds) or low rate of weight gain (< 275 g per week) is associated with a higher risk of premature rupture of membrane for full-term pregnancies and preterm pregnancies.^{64,65} One study provided weak evidence that high weight gain (> 40 pounds) is also associated with a higher risk of premature rupture of membranes of full-term pregnancies.⁶⁴

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Preterm labor.

Results from KQ 1. One poor study yielded weak evidence that weight gain below 0.65 to 0.9 pounds per week significantly increased the risk of premature labor.⁶⁶ Compared with the risk for premature labor for women gaining 0.66 to 0.9 pounds per week, the risk was nearly doubled for women gaining 0.41 to 0.65 pounds per week and nearly tripled for women gaining 0.4 pounds per week or less. Weight gain above 0.9 pounds per week had no significant effect on premature labor.

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Postterm pregnancy.

Results from KQ 1. One fair study (weak evidence) showed no effect of either low or high gestational weight gain on postterm pregnancy.⁵⁸

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Induction of labor. Five studies (2 fair,^{25,67} 3 poor^{51,59,68}) examined the association of increased gestational weight gain and labor induction^{59,67,68} or failure of labor induction.^{25,51} These studies provided weak evidence of an association between higher risk of labor induction or failure of induction and higher weight gain. We cannot summarize the magnitude of the effect because of differences in the definition of weight gain and in the nature of confounders controlled for in the analyses; however, the association was statistically significant in different pregravid BMI categories. No study controlled for maternal health characteristics that might lead to labor induction.

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Length of labor.

Results from KQ 1. Three studies (2 fair,^{69,70} 1 poor⁶⁸) provided weak evidence on the association between gestational weight gain and length of labor; two studies yielded weak evidence that higher weight gain among women of normal weight was associated with longer labor.^{68,69} These studies inconsistently controlled for confounding factors. A single study that controlled for a subset of confounders provided weak evidence that increased weight gain was associated with labor abnormalities.¹⁸³

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Mode of delivery.

Results from KQ 1. Of the 21 studies (14 fair,^{4,25,52,58,67,69-73,75-78} 7 poor^{49,51,54,59,61,68,74}) that examined mode of delivery, all but 4 showed some degree of association between higher weight gain and cesarean delivery; the strength of evidence was moderate.^{4,25,49,51,52,54,58,59,61,67-76} Only four studies^{49,52,54,67} failed to show any relationship between gestational weight gain and mode of delivery, specifically cesarean delivery.

Ten studies controlled for route of previous delivery. Of these, five controlled for comorbidities that could have been significant confounders for route of delivery; all found an increased risk of cesarean delivery with increased weight gain.^{71,72,75,76,78} The association appeared to be stronger among overweight and obese women. The evidence is limited by variations in the definition of gestational weight gain and in the definition of cesarean delivery

and by the failure in many studies to account for previous route of delivery or underlying health risks. As other reviews suggest, indications for cesarean delivery are driven by underlying maternal health risks¹⁸⁴ that may be associated with pregravid BMI and weight gain.

Of the five studies that examined risks of instrumental delivery,^{25,51,58,68,69} three suggested a higher risk of instrumental delivery with increasing weight.^{25,68,69} This evidence base was graded weak because it is limited by variations in definition of the outcome and lack of control for confounding.

Results from KQ 3. Nine studies (8 fair,^{4,25,53,55,118,148,149} 1 poor⁵⁴) examined the association between gestational weight gain classified by the IOM guidelines and cesarean delivery. These studies yielded moderate evidence for increased risk of cesarean delivery for weight gain above IOM recommendations for underweight and normal-weight women; they offered weak, inconsistent evidence for obese or morbidly obese women.

The various studies showed the following main findings with respect to cesarean delivery: higher risk with weight gains in excess of IOM recommendations across all pregravid weight groups (2 studies);^{149,150} higher risk with weight gain in excess of IOM recommendations among nonobese women as a group (1 study);¹¹⁸ higher risk with weight gain above IOM recommendations for normal-weight women (3^{25,118,149} of 5 studies^{25,53,55,118,149}); and higher risk with weight gain above IOM recommendations for underweight women (2 studies).^{118,149}

Studies on obese or morbidly obese women were inconsistent. Two suggested no higher risk with weight gain above IOM recommendations,^{54,55} one suggested a higher risk,¹⁴⁹ and a fourth suggested higher risks with weight gain in excess of 25 pounds.⁴ One study examining the interaction between pregravid overweight or obese status and weight gain above IOM recommendations failed to find a significant effect for either primiparous or multiparous women when the interaction term was defined as pregravid overweight or obese status and weight gain of 25-34 pounds.⁷⁷ When the interaction term was redefined as pregravid overweight or obese status and weight gain greater than 25 pounds, the study found a significant effect only for multiparous women.

Synthesis of results. The majority of studies suggested an association between gestational weight gain and cesarean delivery. This association appeared to be stronger for overweight and obese women. When studies examined the risk of cesarean delivery with respect to IOM recommendations, they were relatively more consistent in demonstrating higher risks for weight gain above IOM recommendations for underweight and normal-weight women, but they were inconsistent in demonstrating increased risks of cesarean delivery for weight gain above IOM recommendations for obese and morbidly obese women. Our findings of a higher risk of cesarean for overweight and obese women, coupled with the lack of significance of weight gain above IOM recommendations for obese and morbidly obese women, suggest that underlying health risks (such as increased risks of abnormal glucose tolerance) associated with high pregravid weight are likely confounders in the relationship between gestational weight gain and cesarean delivery.

Vaginal birth after cesarean.

Results from KQ 1. One poor study provided weak evidence that gestational weight gain of 40 pounds or more increased the risk of vaginal birth after cesarean (VBAC) failure.⁷⁹

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Vaginal lacerations.

Results from KQ 1. Two studies, both rated poor quality, provided weak, inconsistent evidence on the effect of weight gain and vaginal lacerations (incidence of third- or fourth-degree vaginal lacerations or the need for repairs).^{51,68}

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Shoulder dystocia.

Results from KQ 1. Evidence from three poor studies provided weak evidence on the association of gestational weight gain and shoulder dystocia.^{51,68,80} One study suggested a positive association, but the positive predictive value of high weight gain on shoulder dystocia was only 1 percent. A model of shoulder dystocia that included other predictors, such as multiparity and previous heavy baby, had a total positive predictive value of less than 3 percent. Thus, shoulder dystocia is largely an unpredictable outcome.

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Cephalopelvic disproportion.

Results from KQ 1. Two studies (1 fair,²⁵ 1 poor⁷⁴) provided weak evidence of an association between higher gestational weight gain and cephalopelvic disproportion (CPD) among normal-weight women. Variability in the definition of CPD and the failure to account for underlying maternal health characteristics weaken the reported association. The poor study failed to identify an association between weight gain and CPD at higher pregravid BMI levels.⁷⁴

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Other complications of labor and delivery.

Results from KQ 1. Two studies (1 fair,⁵³ 1 poor⁸¹) provided weak, conflicting evidence on labor and delivery complications. One study failed to find statistically significant results; the other reported that weight gain of more than 40 pounds increased the risk for complications by 40 percent.

The degree of impact was difficult to assess because the studies defined the outcome broadly and differently and used different cutpoints to assign weight gain categories. The outcome, complications, was treated as a dichotomous variable, and analyses were not specific to any one intrapartum or neonatal problem; thus, making meaningful clinical recommendations is impossible.

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Birth Outcomes

The knowledge base about the association between gestational weight gain and birth outcomes is, on the whole, stronger than the knowledge base for any other set of outcomes. The relative strength of this body of evidence is unsurprising because the IOM committee based its recommendations on optimizing birthweight and fetal growth; the body of research thereafter was focused on testing these outcomes.

Five outcomes—preterm birth, birthweight, low birthweight, and large-for-gestational-age (LGA) and small-for-gestational-age (SGA) birthweights—all have strong bodies of evidence (Table 43). The outcome of macrosomia was graded moderate strength of evidence; Apgar scores had only weak strength of evidence.

Table 43. Strength of evidence: birth outcomes of gestational weight gain

Outcome	Source of Evidence	Strength of Evidence	Number and Quality of Studies
Preterm birth	KQ 1	Strong	2 Good, ^{84,88} 7 Fair, ^{23,65,71,82,85,86,89} 3 Poor ^{59,83,87}
	KQ 3	Strong for association with weight gain below IOM recommendations; Weak inconsistent for association with weight gain above IOM recommendations	4 Fair ^{22,85,151,152}
Birthweight	KQ 1	Strong	4 Good, ^{48,98,103,106} 12 Fair, ^{55,70,75,92,93,97,99-102,104,105} 9 Poor ^{54,59,68,83,90,91,94-96}
	KQ 3	Strong for association between low gains and low birthweight Moderate for association between high gains and high birthweight only for underweight and normal-weight women	1 Good, ¹⁵³ 8 Fair, ^{20,60,104,154-158} 1 Poor ⁵⁴
Low birthweight	KQ 1	Strong	1 Good, ¹⁰⁶ 9 Fair, ^{2,4,52,70,71,75,93,107,108} 3 Poor ^{54,95,109}
	KQ 3	Strong for association between low gains and low birthweight for underweight and normal weight mothers; weak for lack of association between low gain and low birthweight for overweight and obese women	2 Good, ^{159,160} 7 Fair, ^{2,20,55,60,127,154,161} 3 Poor ^{54,162,163}
Macrosomia	KQ 1	Strong	1 Good, ¹¹⁰ 9 Fair, ^{2,4,70,77,93,108,111-113} 2 Poor ^{49,59}
	KQ 3	Moderate only for overweight and obese women	2 Good, ^{110,160} 4 Fair, ^{2,53,55,164} 1 Poor ¹⁶⁵
Large-for-gestational-age	KQ 1	Strong	1 Good, ¹¹⁶ 8 Fair, ^{4,58,100,105,115,118,121,122} 5 Poor ^{54,59,61,68,120}
	KQ 3	Strong for association between high gains and LGA infants, and moderate for protective effect of low gains and LGA infants	2 Good, ^{116,159} 5 Fair, ^{4,25,118,129,154} 1 Poor ⁵⁴
Small-for-gestational-age	KQ 1	Strong	1 Good, ¹¹⁶ 12 Fair, ^{4,58,89,105,108,111,114,118,119,122-124} 7 Poor ^{51,54,59,61,66,68,95}
	KQ 3	Strong for the association between low gains and SGA infants	3 Good, ^{116,153,159} 6 fair, ^{4,25,55,118,129,154} 1 Poor ⁵⁴
Apgar scores	KQ 1	Weak	3 Fair, 1 Poor ^{58,61,70,125}
	KQ 3	Weak	3 Fair ^{125,129,154}

Preterm birth.

Results from KQ 1. Strong evidence from 12 studies (2 good,^{84,88} 7 fair,^{23,65,71,82,85,86,89} 3 poor^{59,83,87}) suggested that weight gains at either end of the spectrum result in a higher risk of premature birth. Overall, the majority of studies adjusted for sociodemographic characteristics

and risk factors of preterm birth, including maternal age, smoking status, alcohol consumption, race, marital status, socioeconomic status, and education. Not all studies measured maternal history of obstetric complications. These studies displayed little consistency in terms of adjustment for covariates, inclusion/exclusion of different types of preterm births, and the methods used to define and categorize gestational weight gain. Nevertheless, the results collectively suggested that weight gain is associated with length of gestation^{82,83} and that low weight gain^{71,82} and low rate of weight gain^{23,65,82,84-87,89} predict preterm birth.

Among the nine studies that categorized gestational weight gain and reported effect estimates,^{23,65,71,84-89} eight reported at least one significant association between low gestational weight gain (as defined in the study) and preterm birth.^{23,65,71,84-87,89} Of five studies focused on high gestational weight gain (as defined in the study),^{23,65,85,86,89} four reported at least one significant association between gestational weight gain and preterm birth.^{23,65,86,89}

Across the eight studies that considered low rate of weight gain,^{23,65,84-89} the rates varied below a cutpoint of 0.37 kg per week; nonetheless, seven consistently showed a higher risk of preterm birth with a low rate of weight gain.^{23,65,84-87,89} Across the five studies that considered high rate of weight gain,^{23,65,85,86,89} high rates varied above a cutpoint of 0.52 kg per week; four studies consistently showed a higher risk of preterm birth with a high rate of weight gain.^{23,65,86,89}

The association between risk of preterm birth and gestational weight gain may differ by maternal pregravid weight status. In three studies that stratified by pregravid BMI status,^{23,86,87} underweight women tended to have higher risks of preterm birth at low rates of weight gain,^{23,86,87} but obese women tended to have higher risks of preterm birth at high rates of weight gain.^{23,86} One study found no association between the risk of preterm birth and gestational weight gain.⁸⁵

Results from KQ 3. Four studies, all of fair quality, reported on the association between rate of gestational weight gain according to the IOM guidelines and preterm birth.^{22,85,151,152} Despite inconsistencies in the definitions of rate of weight gain and the timing of its calculation, the four studies are consistent in showing increased risks of preterm birth for underweight and normal-weight women, thereby providing strong evidence of an association between weight gain below IOM recommendations and preterm birth. Specifically, two studies found that weight gain below IOM recommendations is associated with a higher risk of preterm birth across all pregravid BMI categories,^{22,85} two studies found this effect for normal-weight women and underweight women.^{151,152} Two studies, one including all pregravid weight status,²² and another limited to normal-weight and underweight women,¹⁵¹ reported an association only for low weight gain during the third trimester and preterm birth.^{22,151}

These studies also provided weak, inconsistent evidence of the association between weight gain above IOM recommendations and preterm birth. One study suggested increased risks of preterm birth with high weight gain for normal-weight women²² one suggested no increased risk for underweight and normal-weight women, but a protective effect of high weight gain for high BMI women;¹⁵² and one suggested no increased risks at all.⁸⁵

Synthesis of results. The majority of studies found an effect of low gestational weight gain on preterm birth. High gestational weight gain was less consistently associated with this outcome. The association for low weight gain held whether investigators used total weight gain or rate of weight gain as the relevant exposure of interest; it also held despite differences in confounders that were controlled for across the studies. Evidence also supported a stronger association between low gestational weight gain and preterm birth for underweight women than for any other category of pregravid weight status.

Birthweight.

Results from KQ 1. Evidence from 25 studies (4 good,^{48,98,103,106} 12 fair,^{55,70,75,92,93,97,99-102,104,105} 9 poor^{54,59,68,83,90,91,94-96}) provided strong evidence that gestational weight gain is associated with infant birthweight. This relationship held true for various measures of gestational weight gain (categorical measures, total weight gain, net weight gain, proportional weight gain, and weight gain by trimester).

Seven studies^{48,93,98,101-103,105} reported that birthweight increased between 16.7 g and 22.6 g for every 1-kg increase in gestational weight gain. Two studies^{55,104} reported values by BMI status,^{55,104} suggesting that the effect of increased gestational weight gain on infant birthweight was more pronounced at lower BMI levels.

Three studies examined the effect of weight gain by trimester on infant birthweight.^{98,101,105} They were consistent in demonstrating that weight gain in the third trimester had the least effect. Two studies that used similar definitions of trimester found that a 1-kg increase in gestational weight gain during the first trimester was associated with 18- to 31-g increases in birthweight. By contrast, a 1-kg increase during the second trimester or during the third trimester was associated with, respectively, 26- to 32.8-g and 7- to 17-g increases in infant birthweight.^{98,101}

Results from KQ 3. 10 articles from nine databases (1 good,¹⁵³ 8 fair,^{20,60,104,154-158} and 1 poor⁵⁴) examined the association between gestational weight gain defined by IOM guidelines and birthweight. Overall, these articles provided strong evidence that weight gain below IOM recommendations is associated with lower birthweights. All the studies found an association between low weight gain and lower birthweight despite various methods of characterizing gestational weight gain (total, rate, or by trimester).

The evidence that higher weight gains were associated with higher birthweights is moderate because of the inconsistency across the studies. All but one study examined this association.¹⁵⁵ Seven found an association between high weight gains and higher birthweights,^{20,54,60,104,153,154,156} and two found no association;^{157,158} however, the study populations differed by race and pregravid weight status. We found moderate evidence for three findings: infants of black women had significantly higher birthweights (73 to 330 g);^{20,60,153,156} infants of white women with a BMI less than 29 had higher birthweights (~200 g);¹⁵⁶ and infants of underweight and normal-weight women had higher birthweights with higher weight gains, but this was not true for overweight and obese women.^{104,153}

Synthesis of results. We found strong evidence in support of an association between gestational weight gain and birthweight. Low gestational weight gain is associated with lower birthweights across all pregravid weight status groups. High gestational weight gain resulting in higher birthweight appears to be limited to underweight and normal-weight women.

Low birthweight (< 2,500 grams).

Results from KQ1. Thirteen studies (1 good,¹⁰⁶ 9 fair,^{2,4,52,70,71,75,93,107,108} 3 poor^{54,95,109}) provided strong evidence that low weight gain increases the risks of low birthweight (LBW).^{2,4,52,54,71,93,106-109} Only two fair studies did not find a statistically significant association between total gestational weight gain and LBW, although their point estimates were in the expected direction.^{52,107} Variations in the definition of gestational weight gain and specification of weight increase category make it challenging to infer the magnitude of risk at different levels of gestational weight gain.

Results from KQ 3. Twelve articles from 10 databases articles (2 good,^{159,160} 7 fair,^{2,20,55,60,127,154,161} and 3 poor^{54,162,163}) examined the association between weight gain and low birthweight. These studies provided strong, consistent evidence of an association between weight

gain below the IOM guidelines and LBW for underweight and normal-weight women. They suggest no association between weight gain below IOM recommendations and LBW for overweight and obese women, but the strength of evidence is weak.^{2,55}

Synthesis of results. Overall, we found strong evidence for an association between low gestational weight gain and low birthweight. The evidence appears to be stronger among women who, before pregnancy, had been underweight or of normal weight than among women who had been overweight or obese; this is especially true when gestational weight gain is a categorical variable (low, medium, high). Despite variations in controlling for confounding and the definition of gestational weight gain, studies were consistent in defining low birthweight as < 2,500 g and in their direction of the outcome.

Macrosomia.

Results from KQ1. Eleven of 12 studies (1 good,¹¹⁰ 9 fair,^{2,4,70,77,93,108,111-113} 1 poor⁵⁹) provided strong evidence that high gestational weight gain is associated with greater risks of macrosomia.^{2,4,59,70,77,93,108,110-113} One poor study did not support the association.⁴⁹ The relationship between high gestational weight gain and macrosomia held despite variations in definition of macrosomia (> 4,500 g^{2,108,110,113} or > 4,000 g^{4,59,70,77,93,111,112}). Generally, the highest weight gains were associated with the highest risks of macrosomia.

Results from KQ3. Seven studies examined the association between gestational weight gain categorized according to the IOM and macrosomia defined as either > 4,000 g or > 4,500 g (2 good,^{110,160} 1 poor,¹⁶⁵ and the remaining fair^{2,53,55,164}). These studies yielded moderate evidence of an association between weight gains above the IOM recommendations and macrosomia. The association differed by pregravid weight status and how weight categories above the IOM recommendations were defined. We found a consistent effect of weight gains above IOM recommendations among normal-weight women on macrosomia in five of seven studies.^{53,55,110,160,164} By contrast, no significant effect was seen among underweight women in three of four studies, although the point estimates were elevated suggesting an increased risk of macrosomia with excessive weight gains.^{110,164,165} Among overweight women and obese women, five out of seven studies found an association,^{53,55,110,160,165} one found the association only with very high weight gains well above the IOM recommendations,² and one found no association.¹⁶⁴

Synthesis of results. Moderate to strong evidence suggests that high weight gains are associated with macrosomia. This evidence has some inconsistencies in the findings attributable to variations in definitions of both macrosomia and gestational weight gain categories. The evidence suggests no effect of high gestational weight gain for underweight women on macrosomia.

Size based on gestational age: large for gestational age (LGA).

Results from KQ1. Fourteen studies (1 good,¹¹⁶ 8 fair,^{4,58,100,105,115,118,121,122} 5 poor^{54,59,61,68,120}) with varying definitions of weight gain and LGA were consistent in demonstrating an association between high gestational weight gain and LGA; we graded the evidence for this association as strong. This association held whether LGA was defined as birthweight greater than the 90th percentile or as birthweight more than two standard deviations above the mean. Whether BMI modifies this relationship is unclear.

Results from KQ3. Eight articles examined gestational weight gain according to IOM guidelines and LGA (2 good,^{116,159} 5 fair,^{4,25,118,129,154} and 1 poor⁵⁴). These studies provided strong evidence that high weight gains are associated with an increased risk of LGA infants. Only one study failed to find an association.¹⁵⁴ Weight gains below IOM guidelines, by contrast, were protective against LGA in only four studies (moderate evidence).^{4,25,129,159}

Synthesis of results. The increased risk of LGA was consistently seen in women with higher absolute weight gains and in women with gains in excess of the IOM recommendations. The body of literature is large and the evidence is strong for this association despite differences in the definition of LGA and factors that were controlled for confounding.

Size based on gestational age: small for gestational age (SGA).

Results from KQ1. Twenty publications (1 good,¹¹⁶ 12 fair,^{4,58,89,105,108,111,114,118,119,122-124} and 7 poor^{51,54,59,61,66,68,95}) provided strong evidence that women in the lowest weight gain categories had higher percentages of SGA infants and were at increased risk of delivering an SGA infant, despite differences across studies in the definition of weight gain and SGA. In general, the risk of SGA among women with low weight gain decreased as BMI increased.

Results from KQ3. Ten articles examined the association between weight gain categorized according to the IOM guidelines and SGA (3 good,^{116,153,159} 1 poor,⁵⁴ and the rest fair^{4,25,55,118,129,154}) and yielded strong evidence of an association between SGA and weight gains below IOM guidelines. Only two studies did not find any evidence of an association.^{54,154} Weight gains above the IOM were protective of SGA in four studies^{4,25,129,159} of six, suggesting a moderate degree of evidence; two did not find an effect.^{116,153}

Synthesis of results. Overall, a large body of literature yielded strong evidence for an association between low gestational weight gain and the risk of having an SGA infant. This association is seen whether weight gain is examined in categories or in absolute terms and despite some inconsistencies in what variables were controlled for in the analysis.

Apgar scores.

Results from KQ 1. Four studies (3 fair,^{58,70,125} 1 poor study⁶¹) provided weak evidence on the effect of gestational weight gain on Apgar scores. Two studies (1 fair, 1 poor) suggested some association between weight gain and Apgar scores, but the results were not consistent in the direction or trend of effect; the other two did not report any such association.

Results from KQ 3. Three fair studies provided weak evidence on any association between weight gain according to IOM guidelines and Apgar scores.^{125,129,154}

Synthesis of results. Together these studies do not provide consistent evidence on the association between gestational weight gain and Apgar scores.

Infant Outcomes

We reviewed eight infant outcomes and found weak evidence for all outcomes (Table 44).

Table 44. Strength of evidence: infant outcomes of gestational weight gain

Outcome	Source of Evidence	Strength of Evidence	Number and Quality of Studies
Perinatal mortality	KQ 1	Weak	2 fair, ^{126,127} 1 poor ¹²⁸
	KQ 3	Weak	1 fair ¹²⁷
Neonatal hypoglycemia	KQ 1	Weak	1 good, ¹¹⁰ 1 fair ¹²⁹
	KQ 3	Weak	1 good, ¹¹⁰ 1 fair ¹²⁹
Neonatal distress	KQ 1	Weak	1 fair ⁵⁸
	KQ 3	No evidence	
Hyperbilirubinemia	KQ 1	Weak	1 good ¹¹⁰
	KQ 3	No evidence	
Neonatal hospitalization	KQ 1	Weak	1 fair ⁵²
	KQ 3	Weak	2 fair ^{129,154}
Other infant morbidity	KQ 1	Weak	2 fair ^{129,130}
	KQ 3	No evidence	
Infant BMI	KQ 1	Weak	2 fair ^{122,131}
	KQ 3	No evidence	
Other infant growth characteristics	KQ 1	Weak	1 good, ⁹⁸ 4 fair, ^{92,93,117,122} 1 poor ⁶⁸
	KQ 3	No evidence	

Perinatal mortality.

Results from KQ 1. Three studies (2 fair,^{126,127} 1 poor¹²⁸) with samples ranging from 20,000 to 50,000 women provide weak evidence that low gestational weight gain is associated with a higher risk of perinatal mortality or stillbirth.¹²⁶⁻¹²⁸ The poor study reported that higher BMI is associated with a higher risk of stillbirth, suggesting a nonlinear relationship between weight gain and stillbirth.¹²⁸ No study controlled for maternal health characteristics that might lead to perinatal mortality.

Results from KQ 3. One fair study on overall perinatal mortality reported a significantly higher proportion of perinatal mortality (1.1 percent) among infants of mothers who gained below the IOM recommendations than the infants whose mothers gained within or above the recommendations. This work, however, did no multivariable modeling using the IOM cutpoints, so it yielded only weak evidence.¹²⁷

Synthesis of results. Together, these results provided weak evidence of an association between low gestational weight gain and perinatal mortality.

Neonatal hypoglycemia.

Results from KQ 1. Two studies (1 good,¹¹⁰ 1 fair¹²⁹) suggested that high gestational weight gain (> 18 kg) or a high rate of weight gain (> 0.4 kg/week) is associated with an increased risk of infant hypoglycemia. The two studies only incompletely adjusted for confounding variables, however.

Results from KQ 3. The same two studies found that high gestational weight gain is associated with an increased risk of neonatal hypoglycemia for weight gain above IOM recommendations. They were consistent in demonstrating a lack of association between weight gain below IOM recommendations and neonatal hypoglycemia.

Synthesis of results. Together, these results provided weak evidence of an association between low gestational weight gain and neonatal hypoglycemia

Neonatal distress.

Results from KQ 1. One fair study provided weak evidence of a lack of association between low weight gain and fetal distress.⁵⁸

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Hyperbilirubinemia.

Results from KQ 1. One good study yielded weak evidence that women who gained in the highest bracket of weight gain per week (more than 0.40 kg/week) during pregnancy had a nearly doubled odds ratio of delivering an infant with hyperbilirubinemia when compared with women gaining between 0.22 kg and 0.31 kg per week.¹¹⁰

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Hospitalization. One fair study provided weak evidence that infants of women who gained less than 8.5 kg during their pregnancy were more likely to require hospitalization than infants born to women who gained the reference amount of 8.5 to 12.5 kg during pregnancy.⁵² The study controlled for maternal age, parity, smoking, prepregnancy BMI, and gestational age but not for other maternal health characteristics.

Results from KQ 3. Two fair studies using different measures of weight gain provided weak, inconsistent evidence on neonatal hospitalization. In one, decreased risk of admission to a neonatal intensive care unit (NICU) was significantly associated with weight gain below IOM guidelines but not with weight gains above the IOM guidelines.¹²⁹ In the other study among black adolescents, risk of NICU admission was significantly associated with a slow rate of weight gain (< 0.23 kg/week).¹⁵⁴

Synthesis of results. Together, these studies provide weak, inconsistent evidence on the relationship between gestational weight gain and neonatal hospitalization.

Other infant morbidity.

Results from KQ 1. Two fair studies provided weak evidence on other neonatal and infant morbidity outcomes.^{129,130} In one study, weight gain less than 7 kg was significantly associated with neonatal seizure.¹²⁹ In addition, gestational weight gain greater than 18 kg was significantly associated with assisted ventilation, seizure, polycythemia, and meconium aspiration syndrome. Another study found no significant association between infant leukemia and weight gain during pregnancy after adjusting for sex, race, maternal education, and prepregnancy BMI.¹³⁰

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Infant BMI.

Results from KQ 1. Two fair studies provide weak, inconsistent evidence on the influence of weight gain on infant BMI.^{122,131} Any possible association may be attenuated, however, when the weight of the infant is removed from total weight gain.

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Other infant growth characteristics.

Results from KQ 1. Five of six studies (1 good,⁹⁸ 4 fair,^{92,93,117,122} 1 poor⁶⁸) provided weak evidence that gestational weight gain is associated with various other infant growth characteristics. Gestational weight gain increased birth length, head circumference, acromial

circumference, and diameter frontoccipitalis⁹³ and crown-heel length and subscapular skinfold thickness.⁹² Proportional weight gain after 25 weeks of gestation increased fetal growth;¹¹⁷ higher gestational weight gains were associated with longer symphysis-fundus height.⁶⁸ Weight gained in the first and third trimester, but not the second trimester, was associated with ponderal index.⁹⁸ A fair study on infant body proportionality failed to find any association between gestational weight gain and the outcome.¹²²

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Child Outcomes

Only two child outcomes were covered by literature included in this review: childhood weight status and childhood hospitalization (Table 45). The strength of evidence is weak for both.

Table 45. Strength of evidence: child outcomes of gestational weight gain

Outcomes		Source of evidence	Strength of Evidence	Number and Quality of Studies
Childhood weight status	KQ 1	Weak		3 fair, ^{24,133,134} 1 poor ¹³²
	KQ 3	Weak		1 fair ²⁴
Childhood hospitalization for infectious diseases	KQ 1	Weak		1 fair ¹³⁵
	KQ 3	No evidence		

Childhood weight status.

Results from KQ 1. Four studies (3 fair^{24,133,134} and 1 poor¹³²) examined the long-term effect of gestational weight gain on the offspring's weight status, but they differed in definitions of the outcomes and timing of measurements. They provided weak, inconsistent evidence of this possible association: three studies showed no effect for childhood weight status at 14 or 24 months^{132,133} or much later in life;¹³⁴ one reported an increased risk early in infancy;¹³⁴ and one reported an increased risk at 3 years.²⁴

Results from KQ 3. One fair study examined weight gain according to the IOM recommendations and childhood weight status.²⁴ Children born to women who gained adequately or excessively had higher odds of being in 50th to 84th, 85th to 94th, and 95th or higher BMI percentile categories than did children born to women who gained inadequately.

Synthesis of results. The evidence of an association between gestational weight gain and childhood weight status is weak because of the limited number of studies and variations in definition of gestational weight gain during pregnancy. Additionally, variations in the age at which child outcomes were measured make comparisons across studies challenging. Studies do not adequately address the potentially lessening role of gestational weight gain on childhood weight status as the importance of child's dietary behavior and physical activity rises.

Childhood hospitalization for infectious diseases.

Results from KQ 1. One fair study examined the effect of gestational weight gain on childhood hospitalization for infectious diseases.¹³⁵ It provided weak evidence of an effect of weight gains greater than 13 kg only among women who had been underweight before pregnancy (BMI < 18).

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

Short- and Long-term Maternal Outcomes

The literature covered eight maternal outcomes (Table 46). Of these, evidence for both KQ 1 and KQ 3 is moderate for intermediate-term postpartum weight retention. In addition, we found moderate strength of evidence to support the association between weight gain and breastfeeding initiation, short-term postpartum weight retention, and long-term postpartum weight retention. The evidence for every other outcome (breastfeeding duration, fat accrual, interpregnancy weight retention, and premenopausal breast cancer) was weak.

Table 46. Strength of evidence: maternal outcomes of gestational weight gain

Outcomes	Source of Evidence	Strength of Evidence	Number and Quality of Studies
Lactation	KQ 1	No evidence	
	KQ 3	Breastfeeding initiation: Moderate for gains below guidelines Exclusive breastfeeding duration: Weak Any breastfeeding duration: Weak	3 fair studies (4 articles), 3 fair ¹⁶⁶⁻¹⁶⁹
Fat accrual	KQ 1	No evidence	
	KQ 3	Weak	2 fair ^{16,97}
Short-term weight retention (11 weeks or less)	KQ 1	Weak	1 fair ¹⁰⁵
	KQ 3	Moderate	4 fair ^{104,154,158,170}
Intermediate term weight retention (3 months to 3 years)	KQ 1	Moderate	1 good, ¹⁴⁴ 3 fair, ^{141,143,145} 1 poor ¹⁴⁰
	KQ 3	Moderate for weight retention for gains within or above guidelines Weak for weight retention for gains below guidelines	2 fair, ^{171,172,174} 2 poor ^{158,173}
Inter-pregnancy weight retention	KQ 1	Weak	3 fair ¹³⁷⁻¹³⁹
	KQ 3	Weak	1 good ¹⁷⁷
Long-term weight retention (>3 years)	KQ 1	Weak	1 good, ¹⁴⁶ 1 fair (2 articles) ^{136,142}
	KQ 3	Moderate	3 fair, ^{171,174,176}
Premenopausal breast cancer	KQ 1	Weak	1 fair ¹⁴⁸
	KQ 3	No evidence	

Lactation.

Results from KQ 1. We found no evidence on the effect of weight gain (total or rate of weight gain as a continuous variable) on lactation that accounted for pregravid weight.

Results from KQ 3. Three fair studies, published in four articles,¹⁶⁶⁻¹⁶⁹ examined the association of weight gain in relation to the IOM guidelines and breastfeeding. Evidence for an association between weight gains below the guidelines and lower likelihood of breastfeeding initiation is moderate.

For duration of exclusive breastfeeding, the studies offered moderate evidence of a shorter duration of exclusive breastfeeding for women with pregravid obese status.^{166,168,169} They offered only weak evidence for associations with weight gain; one reported shorter duration with higher gains¹⁶⁹ and another reported no association.¹⁸⁵

Three studies provide moderate evidence that suggests the length of any breastfeeding among obese women.^{166,168,169} The studies provided only weak evidence that gestational weight gain is associated with the duration of any breastfeeding. Two studies reported that gaining weight above the IOM guidelines was associated with shorter duration,^{167,169} but another reported no association after adjustments for confounding by BMI.¹⁶⁶

Overall, few studies examined the relationship between gestational weight gain and lactation. Comparison across studies is problematic because of the various definitions of breastfeeding. There appears to be a moderate association between pregravid weight status and breastfeeding; obese women appear to have a lower likelihood of initiating and continuing breastfeeding, regardless of weight gain.

Maternal fat accrual and retention postpartum.

Results from KQ 1. We found no evidence on the effect of gestational weight gain on maternal fat accrual and retention postpartum that accounted for pregravid weight.

Results from KQ 3. Two fair studies examined differences in the amount of fat retained in the postpartum period by categories of IOM weight gain.^{16,97} Both suggested that higher weight gains were associated with more fat accrual postpartum, but the evidence is weak because of the low number of studies, their limited generalizability, and small sample sizes.

Short-term (≤ 11 weeks postpartum) postpartum weight retention.

Results from KQ1. One fair study provided weak evidence for an association between gestational weight gain and short-term postpartum weight retention (measured at 6 weeks postpartum).¹⁰⁵

Results from KQ3. Four studies (all fair^{104,154,158,170}) provided moderate, consistent evidence that weight gains (defined as total weight gain or rate of weight gain) exceeding IOM guidelines were associated with greater weight retention measured at or before 11 weeks postpartum.

Synthesis of results. Overall, the studies on weight retention measured within 11 weeks postpartum all showed a consistent effect that higher gestational weight gains are associated with higher weight retention.

Intermediate-term (3 months up to 3 years postpartum) postpartum weight retention.

Results from KQ1. Five studies (1 good,¹⁴⁴ 3 fair,^{141,143,145} and 1 poor¹⁴⁰) provide moderate evidence for an association between gestational weight gain and weight retention between 3 months and 3 years postpartum.

Results from KQ3. Six studies (5 fair^{158,171,172,174,175} and 1 poor¹⁷³) examined the association between weight gain categorized according to IOM guidelines and weight retention within 3 years postpartum. They yielded moderate, consistent evidence that women who gained above the IOM recommendations retained more weight than those who gained within them. They provided only weak evidence about any association when weight gains were below IOM guidelines.

Synthesis of results. Overall, the evidence is moderate for an association between high gestational weight gains (despite variations in definitions) and weight retention in the

intermediate term. However, the lack of consistent adjustment for covariates, particularly for factors influencing weight development over time such as physical activity and diet, means that this summary assessment must be interpreted cautiously.

Long-term (> 3 years postpartum) postpartum weight retention.

Results from KQ1. Two studies (1 good¹⁴⁶ and 1 fair [2 articles]^{136,142}) provided weak evidence on the association between gestational weight gain and long-term postpartum weight retention. The one good study found no association for higher weight gains at 21 years after delivery.¹⁴⁶

Results from KQ3. Three fair studies examined the association between gestational weight gain according to the IOM guidelines and weight retention several years after delivery.^{171,174,176} They yielded moderate, consistent evidence that higher weight gains were associated with weight retention later in life, but the magnitude of weight retained was small.

Synthesis of results. Overall, the evidence is weak to moderate for an association between high gestational weight gains and long-term weight retention. Once again, the lack of consistent adjustment for covariates, particularly on factors influencing weight development over time such as physical activity and diet, make a summary assessment of the influence of gestational weight gain on long-term postpartum weight retention challenging; our results must be interpreted with caution.

Interpregnancy weight retention.

Results from KQ1. Three studies, all rated fair quality, provide weak evidence for an association between gestational weight gain and interpregnancy weight retention.¹³⁷⁻¹³⁹ Two studies reported positive associations between gestational weight gain in an index pregnancy and an increase in weight from the beginning of the index pregnancy to the beginning of the following pregnancy.^{137,138} Another study found no evidence for an association between gestational weight gain across multiple pregnancies and the development of morbid obesity;¹³⁹ however, women who became morbidly obese gained significantly more weight during their first pregnancy and retained significantly more weight after their first and second pregnancies than did controls.

Results from KQ3. One good study examined gestational weight gain according to the IOM guidelines and weight retention until the second pregnancy.¹⁷⁷ The incidence of overweight at the second pregnancy was significantly higher among women who had gained above IOM recommendations in the prior pregnancy than among those who gained within or below IOM recommendations.¹⁷⁷ The adjusted odds of becoming overweight between baseline and the start of the second pregnancy was nearly threefold for women gaining above recommendations. We rate this evidence as weak due to the limited number of studies conducted.

Synthesis of results. Overall, evidence for an association between gestational weight gain and interpartum weight retention up to the next pregnancy is weak.

Premenopausal breast cancer.

Results from KQ 1. One fair study provided weak evidence that gestational weight gain and premenopausal breast cancer are not associated.¹⁴⁸

Results from KQ 3. We found no evidence from studies examining outcomes of weight gain categorized by IOM recommendations.

KQ 2: Confounders and Effect Modifiers of Outcomes of Maternal Weight Gain

KQ 2 asks about the confounders and effect modifiers relevant for examining any associations between weight gain (overall and patterns) and birth outcomes; it also asks about the extent to which these confounders and effect modifiers themselves contribute to outcomes. As reported in our results and discussion for KQ 1, the types of confounders and effect modifiers vary considerably by the type of outcome being considered. Moreover, as demonstrated in our summary tables for KQ 1, little consistency exists within the body of evidence for each outcome on which confounders are to be included, and even less consistency exists on their definition.

Given the large variations in the overall body of evidence on the confounders and effect modifiers, our discussion on KQ 2 is limited to outcomes with either moderate or strong evidence of association with weight gain (as identified for KQ 1). These are preterm birth, cesarean delivery, birthweight, low birthweight, macrosomia, LGA infants, SGA infants, and intermediate postpartum weight retention (3 months to 3 years).

Because age, race and ethnicity, and pregravid weight status are key considerations in the 1990 IOM weight gain recommendations, we limit our discussion of KQ 2 to the consideration of these three key variables. In addition, we consider the independent effect of parity on health outcomes. All four variables are defined in highly variable fashion across the included studies. The discussion below represents general trends for these variables.

Finally, because KQ 2 asks about the *independent* association between confounders and effect modifiers, we consider results only from multivariate analyses for confounders and effect modifiers that included weight gain during pregnancy as a predictor of the outcome. Several studies controlled for age, race and ethnicity, pregravid weight status, and parity, but they did not have abstractable results; the summary findings below are therefore a subset of relevant evidence. These studies together provide strong evidence of the independent association of pregravid weight status on outcomes, moderate evidence on the effects of age and parity, and weak evidence, largely because of insufficient data, on the effect of race.

Age

Several studies controlled for age in multivariate analysis but did not present their results in the published data. In general, the studies that presented findings for age suggested increasing risks for cesarean delivery and preterm birth as age rises. Key highlights of the evidence are presented below; Table 47 offers further details.

- Of five studies of preterm birth,^{82,87-89} three (2 fair,^{82,89} 1 poor⁸⁷) suggested higher risks of preterm birth with increased age; two (1 good,⁸⁸ 1 poor⁸³) suggested no effect of age.
- Five fair studies on cesarean delivery^{72,73,76-78} suggested a higher risk of cesarean delivery with increased age. The risk was generally true for both primary and repeat cesareans,^{77,78} except for repeat labored cesareans, in the only study that examined the association for that particular subgroup.⁷⁸
- Of six studies concerning birthweight,^{83,93,98,99,101,102} three (1 good,⁹⁸ 2 fair^{93,99}) suggested that higher ages are associated with increased birthweight; three (2 fair,^{101,102} 1 poor⁸³) suggested no effect of age.

- Two studies were available on low birthweight defined as < 2500 g.^{107,109} One fair study reported no effect of mothers' being adolescents,¹⁰⁷ and one poor study reported a higher risk for women ages 40 years and older than for women ages 20 to 29 years.¹⁰⁹
- Two fair studies reported no association between age and macrosomia;^{70,77} two fair studies reported an increased risk of macrosomia with increased maternal age.^{93,112}
- Three studies were available on SGA.^{66,89,124} One fair study reported higher risks of intrauterine growth retardation (IUGR) for women older than 25 years⁸⁹ than for women 20 to 25 years; the other two (1 fair,¹²⁴ 1 poor⁶⁶) reported no association between age and SGA.
- Of three studies about intermediate weight retention,^{141,144,145} two fair studies reported higher risk with increased age,^{141,145} one good study reported no increased risk.¹⁴⁴

Table 47. Age, gestational weight gain, and outcomes

Outcome	Citations Addressing Effect of Age	Effect of Age
Preterm birth	5 ^{82,83,87-89} of 12 ^{23,59,65,66,71,82-89}	Higher risks of preterm birth with increased age ⁸² Among women with prepregnancy weight < 48 kg, higher risk of preterm birth for women < 21 years than for women ≥ 21 years ⁸⁷ Higher risks of preterm delivery for women < 17 and > 25 than for 20-25 ⁸⁹ No significant association between gestational age and age categories (16-19, 20-24, 25-29, 30-34, 35-45) ⁸³ No significant association between preterm birth and age categories (< 20, 21-35, ≥35 years) ⁸⁸
Cesarean delivery	5 ^{72,73,76-78} of 21 ^{4,25,49,51,52,54,58,59,61,67-78}	Higher risk of primary cesarean for women > 30 years than for women 20-29 years; lower risk for women < 20 years than for women 20-29 years ⁷² Increased risk of cesarean delivery with increased age ^{73,76} Increased risk of cesarean delivery with age ≥ 30 years compared with 20-24 years for primiparous and multiparous cesarean delivery; no significant association for other age groups ⁷⁷ Higher risk of primary cesarean delivery, with or without labor, for women ≥ 35 years than for women 20-34 years; higher risk of repeat cesarean without labor for women ≥ 35 years than for women < 35 years; no increased risk of repeat cesarean with labor for women age ≥ 35 compared with women < 35; lower risk of primary cesarean with labor for women < 20 years than for women 20-34 years ⁷⁸
Birthweight	6 ^{83,93,98,99,101,102} of 25 ^{48,54,55,59,68,70,75,83,90-106}	Increased birthweight associated with higher age ^{93,98} Lower birthweight for women < 25 years than for women 25-29 years, no significant association for age > 29 years ⁹⁹ No significant association between birthweight and age ^{83,101,102}
Low birthweight (specifically < 2,500 g)	2 ^{107,109} of 13 ^{2,4,52,54,70,71,75,93,95,106-109}	Higher risk of LBW for women ≥40 than for women 20-29, no significant association for women 30-29 years compared with women 20-29 years ¹⁰⁹ No significant association between LBW and adolescence ¹⁰⁷
Macrosomia	4 ^{70,77,93,112} of 12 ^{2,4,49,59,70,77,93,108,110-113}	Increased risk of macrosomia with higher age ^{93,112} No significant association by age ^{70,77}
Large-for-gestational-age (LGA)	0 of 14 ^{4,54,58,59,61,68,100,105,115,116,118,120-122}	No abstractable data
Small-for-gestational-age (SGA)	3 ^{66,89,124} of 20 ^{4,51,54,58,59,61,66,68,89,95,105,108,111,114,116,118,119,122-124}	Higher risks of IUGR for women > 25 than for women 20-25 ⁸⁹ No significant association between SGA birth and age ^{66,124}
Intermediate postpartum weight retention (PPWR)	3 ^{141,144,145} of 5 ^{140,141,143-145}	Higher PPWR with higher age ^{141,145} No significant association between postpartum weight retention and age ¹⁴⁴

IUGR, intrauterine growth retardation; kg, kilogram; LBW, low birthweight; PPWR, postpartum weight retention; SGA, small-for-gestational-age.

Race and Ethnicity

Studies from relatively homogenous populations did not examine the effect of race or ethnicity, so the body of evidence on the independent effect of these variables was limited. These studies suggested that black women, in comparison with white women, have higher risks of

preterm birth and SGA and lower risks of LGA and macrosomia. Highlights of the evidence are presented below, with details in Table 48.

Table 48. Race and ethnicity, gestational weight gain, and outcomes

Outcome	Citations Addressing Effect of Race and Ethnicity	Effect of Race and Ethnicity
Preterm birth	2 ^{82,85} of 12 ^{23,59,65,71,82-89}	Significantly higher risks of preterm birth for blacks compared with whites, significantly lower risks of preterm birth for Asians compared with whites, no differences for Hispanics compared with whites ^{82,106} Among blacks, both low and high gain were associated with spontaneous preterm birth, although for high gain the statistical significance was borderline; among Asians, there was a nonstatistically significant inverse association between high gain and spontaneous preterm birth; among whites and Latinas, low gain was associated with a significantly higher risk of preterm birth but not high gain ⁸⁵
Cesarean delivery	1 ⁷⁷ of 21 ^{4,25,49,51,52,54,58,59,61,67-78}	No significant association between race/ethnicity and primiparous or multiparous cesarean delivery ⁷⁷
Birthweight	3 ^{94,102,106} of 25 ^{48,54,55,59,68,70,75,83,90-106}	Lower birthweight for infants of black women than for infants of white women; no significant association for Puerto Rican ancestry compared with white ancestry ¹⁰² No effect of race and ethnicity on birthweight ^{94,106}
LBW	2 ^{106,109} of 13 ^{2,4,52,54,70,71,75,93,95,106-109}	LBW babies more likely among black than Hispanic women ¹⁰⁶ LBW babies more likely among black women and Hispanic women than white women ¹⁰⁹
Macrosomia	2 ^{70,77} of 12 ^{2,4,49,59,70,77,93,108,110-113}	Lower risk of macrosomia for black women than for white women ⁷⁰ Lower risk of macrosomia for foreign-born Asian non-Hispanic women than for native-born white non-Hispanic women; lower risk of macrosomia for Hispanic women, whether native or foreign-born, than for native-born white non-Hispanics; lower risk of macrosomia for Hispanic women, whether native or foreign-born, than for native-born white non-Hispanics; lower risk of macrosomia for native-born black non-Hispanic women than for native-born white non-Hispanic women; no significant associations for foreign-born white or black non-Hispanic women or native-born Asian non-Hispanic women ⁷⁷
LGA	1 ¹¹⁶ of 14 ^{4,54,58,59,61,68,100,105,115,116,118,120-122}	Lower risk of LGA for black women with BMI 19.8-26 or BMI > 26 than white women at the same BMI levels; no significant association for race at BMI < 19.8 ¹¹⁶
SGA	3 ^{66,114,116} of 20 ^{4,51,54,58,59,61,66,68,89,95,105,108,111,114,116,118,119,122-124}	Lower risk of SGA for black women with BMI 19.8-26 than white women at the same BMI level; no significant associations for race at BMI < 19.8 or BMI > 26 ¹¹⁶ Higher risk of SGA infants among black women and women of other races than white women ⁶⁶ Higher risk of IUGR among black women than white women; lower risk of IUGR among Asian women than white women ¹¹⁴
Intermediate PPWR	1 ¹⁴¹ of 5 ^{140,141,143-145}	Risk of weight retention higher for black and Hispanic than white women ¹⁴¹

BMI, body mass index; IUGR, intra-uterine growth retardation; LBW, low birthweight; LGA, large-for-gestational-age; PPWR, postpartum weight retention; SGA, small-for-gestational-age.

- Two fair studies suggested higher risks of preterm birth for black women than for white women.^{82,85} One study suggested that among blacks, both high weight gain and low weight gain predicted preterm birth, but that among women of other races and ethnicities, low weight gain alone increased the risk of preterm birth.⁸⁵

- One fair study showed no significant association between race or ethnicity and primiparous or multiparous cesarean delivery.⁷⁷
- One fair study reported an effect of race and ethnicity showing lower infant birthweight for black women than white women; it reported no significant association for women of Puerto Rican ancestry.¹⁰² Two other studies (1 good,¹⁰⁶ 1 poor⁹⁴) showed no effect of race and ethnicity.
- Two studies (1 good,¹⁶⁶ 1 poor¹⁰⁹) reported a higher risk of LBW infants among black women than among white women.^{106,109} One reported a higher risk of LBW babies among Hispanic women than among white women.¹⁰⁹
- Two fair studies showed a lower risk of macrosomia for black women than for white women;^{70,77} one reported a lower risk for Hispanic women than for white women.⁷⁷
- One good study reported that black women of normal weight were less likely to have LGA babies than white women of normal weight.¹¹⁶
- Three studies (1 good,¹¹⁶ 1 fair,¹¹⁴ 1 poor⁶⁶) showed higher risks for either SGA^{66,116} or IUGR¹¹⁴ for black women than for white women; one study showed lower risks for Asian women than white women.¹¹⁴
- One study fair reported that black and Hispanic women retained more weight than white women.¹⁴¹

Pregravid Weight or Body Mass Index

Our search strategy required that included studies have controlled for pregravid weight status; as a result, the evidence on pregravid weight status is strongest. These studies generally demonstrated a strong independent effect of pregravid weight status on all but one of the outcomes for which we found moderate or strong evidence (preterm birth, cesarean delivery, birthweight, low birthweight, macrosomia, LGA infants, SGA infants, and intermediate postpartum weight retention [3 months to 3 years]). The exception was postpartum weight retention, for which the studies showed inconsistent results. Key highlights are presented below, with more details in Table 49:

- Seven studies (2 good,^{84,88} and 5 fair^{65,71,82,86,89}) reported a higher risk of preterm birth with lower pregravid weight status; one poor study showed no statistically significant relationship between pregravid weight and gestational age.⁸³
- Ten fair studies reported showing a higher risk of cesarean delivery with higher pregravid weight status.^{52,67,70-73,75-78}

Table 49. Pre gravid body mass index, gestational weight gain, and outcomes

Outcome	Citations Addressing Effect of Body Mass Index	Effect of Body Mass Index
Preterm birth	8 ^{65,71,82-84,86,88,89} of 12 ^{23,59,65,71,82-89}	Higher risks of preterm birth with baseline weight lower than reference pregravid weight of 100-149 pounds; no increased risks with higher than reference weight ⁷¹ Lower risks with increased BMI ⁸² Higher risks with decreased BMI ⁸⁶ Higher risks with BMI less than normal range (< 19.8-26) ^{84,88} Higher risks with pregravid weight < 73 kg than with ≥ 85 kg ⁸⁹ Higher risks of preterm birth with obesity (pregravid BMI > 30) ⁶⁵ No significant association between pregravid weight and gestational age
Cesarean delivery	10 ^{52,67,70-73,75-78} of 21 ^{4,25,49,51,52,54,58,59,61,67-78}	Higher risk of cesarean delivery with higher BMI ^{70,73,76} Higher risks of cesarean delivery with higher pregravid weight ⁷⁵ Higher risks of primary cesarean with pregravid weight higher than 100–149 pounds; no increased risks with lower than reference weight ⁷¹ Higher risks of unplanned cesarean with obesity than nonobese weight categories ⁶⁷ Higher risk of cesarean with pregravid BMI > 25 than with BMI 18.5-25; no increased risk for BMI < 18.5 ⁵² Higher risk of primary cesarean delivery for pregravid weight ≥ 70 kg than with 60-69 kg; no significant association with other pregravid weights ⁷² Higher risks of primiparous cesarean delivery with pregravid overweight and obese status than with normal weight; higher risk of multiparous cesarean delivery with obese status than with normal weight; no significant association for overweight women compared with normal-weight women for multiparous cesarean delivery ⁷⁷ Higher risk of primary cesarean, with or without labor, and repeat cesarean, with or without labor, for pregravid overweight or obese status than for normal weight; lower risk of primary cesarean with labor for underweight women than for normal weight women; no significant association between underweight status and either primary cesarean without labor or repeat cesarean with or without labor ⁷⁸
Birthweight	12 ^{48,83,91,93,94,96,98-102,105} of 25 ^{48,54,55,59,68,70,75,83,90-106}	Higher birthweight associated with higher pregravid weight ^{48,83,91,93,96,98,101} Birthweight lower for prepregnancy weight < 55 kg than for prepregnancy weight 56-66 kg; birthweight higher with prepregnancy weight > 66 kg ⁹⁹ Higher birthweight with higher pregravid weight-for-height (using Metropolitan Life Insurance tables) ¹⁰⁵ No significant association between birthweight and obesity ¹⁰⁰ No difference in birthweight by pregravid BMI groups ⁹⁴ No significant association between birthweight and low pregravid BMI ¹⁰²
LBW	8 ^{2,52,70,71,93,107-109} of 13 ^{2,4,52,54,70,71,75,93,95,106-109}	Higher risks of LBW with pregravid weight less than 100–149 pounds, significantly decreased risks with higher than reference weight ⁷¹ Higher risk of LBW with pregravid BMI < 18.5 than with BMI 18.5-25; no significant association for BMI > 25 ⁵² Lower risk of LBW with increasing pregravid weight ^{2,93} Lower risk of LBW with increasing BMI ⁷⁰ Lower risk of LBW with BMI > 30 than with BMI 25-29, no significant association for women with BMI < 25 ¹⁰⁹ No significant association between LBW and BMI for women gaining < 11 kg (no direct comparisons for other weight gain categories) ¹⁰⁸ No significant association between LBW and pregravid underweight status ¹⁰⁷

BMI, body mass index; IUGR, intra-uterine growth retardation; kg, kilogram; LBW, low birthweight; PPWR, postpartum weight retention; SGA, small for gestational age.

Table 49. Pregravid body mass index, gestational weight gain, and outcomes (continued)

Outcome	Citations Addressing Effect of Body Mass Index	Effect of Body Mass Index
Macrosomia	7 ^{2,70,83,93,108,112,113} of 12 ^{2,4,49,59,70,77,93,108,110-113}	Increased risk of macrosomia with higher pregravid weight ^{93,112} Increased risk of macrosomia with pregravid BMI 19.8-26 compared with BMI < 19.8 ⁷⁰ Higher risk of macrosomia with first trimester BMI > 25 than with < 20; no higher risk with BMI 20-25 compared with BMI < 20 ¹¹³ Higher risk of macrosomia with pregravid BMI > 26 than with BMI < 19.8 for women gaining < 11 kg; no higher risk for women with BMI 19.8-26 (no direct comparisons for other weight gain categories) ¹⁰⁸ Higher rates of macrosomia with higher pregravid weight ² Higher risk of macrosomia with pregravid overweight or obese status than with normal weight ⁷⁷
LGA	4 ^{100,105,121,122} of 14 ^{4,54,58,59,61,68,100,105,115,116,118,120-122}	Higher rates of LGA with higher pregravid BMI ¹⁰⁰ Higher rates of LGA with higher pregravid weight-for-height (using Metropolitan Life Insurance tables) ¹⁰⁵ Lower risk of LGA with lower prepregnancy weight ¹²² No significant association between pregravid BMI (per 1 kg/meter ² increment) and LGA ¹²¹
SGA	9 ^{66,89,105,108,114,119,122-124} of 20 ^{4,51,54,58,59,61,66,68,89,95,105,108,111,114,116,118,119,122-124}	Higher risks of SGA with pregravid weight < 73 kg than with ≥ 85 kg ⁸⁹ Higher risk of growth retardation with BMI < 19.8 than with BMI 19.8-26 for women gaining < 11 kg; no significantly increased risk of growth retardation with BMI > 26 compared with BMI < 19.8 for women gaining < 11 kg (no direct comparisons for other weight gain categories) ¹⁰⁸ Lower risk of SGA with higher pregravid weight-for-height (using Metropolitan Life Insurance tables) ¹⁰⁵ Lower risk of SGA with pregravid BMI higher than 19.9 compared with BMI ≤ 19.9 ¹²³ Higher risk of SGA with pregravid BMI < 20 than with BMI ≥ 20 ¹¹⁹ Higher risks of SGA with pregravid weight < 100 pounds than with pregravid weight 126-160 pounds, lower risk of SGA with pregravid weight 160 pounds than with pregravid weight 126-160 pounds ⁶⁶ Higher risks of SGA with pregravid underweight status than with normal weight; lower risks of SGA with pregravid overweight or obese status than with normal weight ¹²⁴ Higher risk of IUGR with lower prepregnancy weight ¹²² Lower risk of IUGR with higher pregravid weight ¹¹⁴
PPWR	3 ^{141,144,145} of 5 ^{140,141,143-145}	Increased risk of PPWR with higher pregravid weight ^{141,144,145} No significant association between pregravid weight and PPWR ^{144,145}

- Of 12 studies,^{48,83,91,93,94,96,98-102,105} nine (2 good,^{48,98} 4 fair,^{93,99,101,105} 3 poor^{83,91,96}) demonstrated higher birthweight with higher pregravid weight status; three (2 fair,^{100,102} 1 poor⁹⁴) suggested no association.
- Of eight studies,^{2,52,70,71,93,107-109} six (5 fair,^{2,52,70,71,93} 1 poor¹⁰⁹) reported lower risks of LBW with higher pregravid weight status; two fair studies suggested no association.^{107,108}
- Seven (6 fair,^{2,70,93,108,112,113} 1 poor⁸³) studies reported a higher risk of macrosomia with higher pregravid weight (overweight or obese compared with normal weight).
- Of four studies,^{100,105,121,122} three fair studies reported a higher risk of LGA with higher pregravid weight status;^{100,105,122} one fair study found no significant association.¹²¹
- Nine studies reported lower risks of either SGA (5 fair,^{89,105,119,123,124} 1 poor⁶⁶) or IUGR (3 fair studies)^{108,114,122} with higher pregravid weight status.

- Of three studies,^{141,144,145} one fair study suggested a higher risk of postpartum weight retention with higher pregravid weight status,¹⁴¹ two (1 good,¹⁴⁴ 1 fair¹⁴⁵) showed no association.

Parity

Studies did not always examine or report on the independent effect of parity on health outcomes, but the few that did showed consistent effects of increased risks of cesarean delivery and SGA with nulliparity and reduced risks of weight retention for primiparous women. Multiparous women have larger (heavier) babies, lower risks of low birthweight babies, and higher risks of LGA or macrosomia. Key highlights are presented below, with more details in Table 50:

- Five (1 good,⁸⁸ 2 fair,^{82,89} 2 poor^{83,87}) studies suggested no association between parity and preterm birth.
- Four fair studies suggested higher risks of cesarean delivery with nulliparity.^{67,70,72,76}
- Eight (2 good,^{48,98} 5 fair,^{70,92,101,102,105} 1 poor⁸³) studies reported a higher birthweight with higher parity.
- Two studies (1 fair,⁷⁰ 1 poor¹⁰⁹) reported lower risks of low birthweight with higher parity.
- Three fair studies suggested a higher risk of macrosomia with higher parity.^{70,77,112}
- Two of three studies (1 good,¹¹⁶ 1 fair¹²²) suggested a higher risk of LGA with higher parity;^{116,122} one fair study suggested no association between LGA and parity.¹¹⁵
- Three studies (1 good,¹¹⁶ 1 fair,⁸⁹ 1 poor⁶⁶) suggested greater risks of SGA^{66,116} or IUGR with nulliparity.⁸⁹
- One fair study reported that primiparous women were more likely to retain weight at 1 year postpartum than multiparous women.¹⁴¹

Table 50. Parity, gestational weight gain and outcomes

Outcome	Citations Addressing Effect of Parity	Effect of Parity
Preterm birth	5 ^{82,83,87-89} of 12 ^{23,59,65,71,72,82-89}	Lower gestational age with parity ≥ 5 compared with nulliparous; no significant association for other parities ⁸³ No significant association between preterm birth and parity ^{82,87-89}
Cesarean delivery	4 ^{67,70,72,76} of 21 ^{4,25,49,51,52,54,58,59,61,67-78}	Higher risk of cesarean delivery with nulliparity ^{67,70} Higher risk of cesarean delivery for nulliparity compared with parity = 1; no increased risk of cesarean with parity > 1 compared with parity = 1 ⁷² Lower risk of cesarean with having had at least one viable pregnancy ⁷⁶

BMI, body mass index; IUGR, intra-uterine growth retardation; kg, kilogram; LBW, low birthweight; LGA, large-for-gestational-age; PPWR, postpartum weight retention; SGA, small for gestational age.

Table 50. Parity, gestational weight gain and outcomes (continued)

Outcome	Citations Addressing Effect of Parity	Effect of parity
Birthweight	8 ^{48,70,83,92,98,101,102,105} of 25 ^{48,54,55,59,68,70,75,83,90-106}	Higher birthweight associated with higher parity ^{48,70,83,92,98,101,102,105}
Low birthweight	2 ^{70,109} of 13 ^{2,4,49,54,70,71,75,93,95,106-109}	Lower risk of LBW with increased parity ⁷⁰ Lower risk of LBW with 3 or more term live births than with 1 or 2 live births; higher risk of LBW with no term live births than with 1 or 2 ¹⁰⁹
Macrosomia	3 ^{70,77,112} of 12 ^{2,4,49,59,70,77,93,108,110-113}	Higher risk of macrosomia with multiparity than with nulliparity ^{70,112} Higher risk of macrosomia with nulliparity compared with parity ≥ 2, no significant risks of macrosomia with parity = 1 compared with parity ≥ 2 ⁷⁷
LGA	3 ^{115,116,122} of 14 ^{4,54,58,59,61,68,100,105,115,116,118,120-122}	Higher risks of LGA with multiparity for all BMI categories ¹¹⁶ Higher risks of LGA with multiparity ¹²² No significant association between LGA and parity ¹¹⁵
SGA	3 ^{66,89,116} of 20 ^{4,51,54,58,59,61,66,68,89,95,105,108,111,114,116,118,119,122-124}	Increased risk of IUGR for parity = 1 than with parity = 2; no increased risk of IUGR for parity ≥ 3 than with parity = 2 ⁸⁹ Lower risk of SGA with multiparity for normal BMI women; no significant association between SGA and multiparity for underweight and overweight women ¹¹⁶ Higher risk of SGA with nulliparity than multiparity ⁶⁶
Intermediate PPWR	1 ¹⁴¹ of 5 ^{140,141,143-145}	Lower risk of PPWR for primiparous women than multiparous women ¹⁴¹

KQ 4: Risks and Benefits of Gestational Weight Gain Recommendations

Despite conducting a systematic review of 150 studies identified by numerous search strategies, we did not uncover any clear exposition of the harms and benefits of offering the same weight gain recommendations to all women, irrespective of race or ethnicity, age, or pregravid BMI.

Although most studies controlled for various demographics variables in their analyses, few were specifically undertaken to understand the impact of the IOM recommendations on subpopulations. We did uncover a few studies that specifically investigated differential response to weight gain by pregravid BMI relative to numerous outcomes, but generally this evidence was not conclusive. Outcomes differentially affected by weight gain included the following:

- Labor induction (2 fair studies;^{3,67} 2 poor studies^{59,68})
- Cesarean delivery (9 fair studies;^{4,25,58,69-73,75,76} 5 poor studies^{51,59,61,68,74})
- Preterm birth (2 fair studies;^{23,86} 1 poor study⁸⁷)
- Low birthweight(1 fair;² 1 poor¹⁶² study)
- Large-for-gestational age(2 fair studies^{25,129})
- Macrosomia (2 fair studies^{55,164}) and
- Postpartum weight retention (3 fair studies^{138,140,143}).

This differential response suggests that one recommendation for all women, irrespective of BMI, cannot be justified by the studies we reviewed. This conclusion is not as robust as it might

seem, however, because nearly the entire database comprises observational studies; this fact renders the findings suggestive but not definitive. Further undermining our ability to state clearly whether any harms or benefits accrue to having a single recommendation for all women is that the quality ratings assigned to the studies were rarely “good” and that a nontrivial share of the articles were of poor quality and should be discounted in terms of arriving at overall grades of the strength of evidence. A common deficiency was that investigators did not control adequately for potential confounders and effect modifiers in their analyses. As noted throughout Chapter 3, inadequate attention to confounders undermines our ability to interpret the findings of much of the research we reviewed.

The IOM recommendations state that black women and teenagers should gain at the upper end of the recommendations; several researchers aimed to investigate whether weight gains differentially affect the outcomes for adolescents and black women. Assessing this research is important in determining the harms and benefits of one recommendation for all women.

Findings Relative to Benefits and Harms of Different Recommendations Based on Race

The IOM guidelines recommended that black women gain at the upper end of recommended ranges; the aim was to influence differences in mean birthweights between blacks and whites and decrease the risks of low or suboptimal birthweights among black infants. Five studies, four good,^{20,116,156,160} and one fair,⁸⁵ specifically aimed to compare the impact of the IOM guidelines on infants born to black and white women.

Three of these studies^{20,116,160} did not produce evidence supporting benefits of black women gaining at the upper limit of the IOM recommendations. In one of the good studies,¹¹⁶ researchers studied 3,870 women who gave birth to singleton infants at 28 or more weeks of gestation between 1987 and 1989. They found that the relationship between weight gain and either SGA infants or LGA infants did not differ by maternal race for any BMI category. Although racial differences seemed to arise in the occurrence of SGA and LGA infants, these differences were mediated by pregravid BMI rather than weight gain during pregnancy. The researchers concluded that encouraging black women to gain at the upper end of the recommended range is unlikely to produce measurable reductions in SGA births; they noted, however, that benefits may accrue from recommending lowered weight gain recommendations for average and overweight white women with respect to the prevalence of LGA infants.

In another good study,¹⁶⁰ investigators reported on data from the Pregnancy Nutrition Surveillance System for nine states. The study involved self-reported pregravid weight, total weight gain, and infant birthweight data on 173,066 women who delivered between 39 and 41 weeks’ gestational age. Adjusted odds ratios (ORs) showed that both black and white women who entered pregnancy with a low BMI had a statistically greater likelihood of having an LBW infant if they gained 10 pounds or less than the IOM recommendations than did women who gained within the lower half of the recommendations. The investigators did not control for maternal complications and underlying diseases. Within all of the BMI-race strata, mean birthweight rose as weight gain increased. The study was unable to find consistent evidence to support benefits of counseling black women to gain at a rate different than that for other women; the researchers concluded that their analysis did not support the IOM recommendation that black women gain at the upper ends of the ranges.

The third study, which yielded no support for differential recommendations based on race, examined outcomes for 5,918 low-income women.²⁰ The researchers revealed that adjusted mean birthweights were higher for white women with normal pregravid BMIs gaining in the upper half of the recommended ranges but not for black women with normal pregravid BMIs. They also found through logistic regression analyses that prenatal weight gain in the upper compared with the lower half of the recommended ranges was significantly associated with a decreased OR for low birthweight among white women but not for black women. In addition to its large size, the study has several strengths that included the exclusion of women with a variety of confounding characteristics, such as adolescents less than 18 years old and maternal risk factors for poor pregnancy outcomes. The researchers also excluded all women whose last prenatal weight assessment was greater than 3 weeks before delivery. The study lacked data on parity, however, and gestational age was not based on ultrasound verifications. Additionally, fewer black women than white women were included in the analyses, which may have limited the researchers' ability to detect the impact of weight gain on outcomes. Findings from the study led the researchers to conclude that their data do not support differential recommendations.

An earlier study by the same lead author had concluded that the IOM recommendation that black women gain at the upper end of the recommended ranges is valid.¹⁵⁶ In this study, they analyzed birth outcomes for 1,168 multiparous low-income women who were at risk for delivering an SGA infant. When weight gain was less than 6 kg, black women with a pregravid BMI > 29 delivered twice as many growth-restricted infants as did white women with comparable BMIs; when, however, weight gain exceeded 6 kg, obese black women delivered one-third as many growth-restricted infants as obese white women. After adjusting for numerous potentially confounding and intervening variables, black women in each pregravid category delivered increasingly larger infants if they met or exceeded the IOM recommendations; this relationship effect was absent in white women. The authors concluded, therefore, that their findings supported the IOM recommendations regarding weight gain guidance for black women. This study lacked generalizability to all black women, however, because the study population was specifically chosen based on its risks for giving birth to growth-restricted infants.

The fifth study that specifically aimed to explore the interaction of weight gain and race on infant outcomes analyzed data from 15,101 births to white, black, Latina, and Asian women who entered pregnancy with normal or underweight BMIs.⁸⁵ For most subgroups, weight gain beyond 0.27 kg per week was not associated with decreasing risks for spontaneous preterm births. However, both low and high weight gains were associated with significantly increased risks of spontaneous preterm birth in black women who had experienced a previous preterm birth and who entered pregnancy with a low or normal BMI. The authors concluded that determining whether race or ethnicity modifies the relationship between weight gain and prematurity requires further exploration.

In summary, the harms and benefits of providing women of all racial and ethnic subgroups with the same weight gain recommendations cannot be determined from existing research. Undoubtedly, various factors in addition to weight gain are likely to be responsible for differences between white and black women in both mean birthweights and the prevalence of low birthweight infants.²⁰ As Hickey and colleagues note, more important than race may be social, economic, environmental, nutritional, cultural, lifestyle, medical and other factors for which race is a surrogate.²⁰

Findings Relative to Benefits and Harms of Different Recommendations Based on Age

Few studies specifically aimed to understand differences in the impact of weight gain recommendations on women in various age categories. Four studies purposefully investigated adolescents (1 good,¹⁵³ 2 fair,^{154,186} and 1 poor⁹⁵); according to the IOM, they should gain at the upper ranges of the BMI-specific recommendations.

Researchers for the one study rated good analyzed data for 815 black adolescents who, at the time of conceiving their infants, were less than 18 years old.¹⁵³ Birthweight outcomes markedly improved in teens from all BMI groups when their weight gain increased from below to within the lower half of the IOM recommended range; additional benefits from gains in the upper half of the recommended ranges were modest or equivocal. A limitation of this study was that prepregnancy weight was self-reported; whether the reliability of self-reported weights in teens is equivalent to self-reported weights in older women is not known.

One fair study also reported results that question whether encouraging adolescents to gain in the upper ranges of the recommendations confers any advantages.¹⁸⁶ This study specifically examined whether adolescents require greater prenatal weight gains than nonadolescents to deliver infants of comparable weight. The study population was 423 women between the ages of 14 and 25 who received care in a health maintenance organization. The study, published in 1991, did not specifically reference the IOM recommendations but, rather, used a weight gain of 11 to 12 kg as the optimal level. Both the adolescents and the young adults had a total weight gain of approximately 3 kg over the optimal level and delivered similar weight infants. Despite the relatively high weight gains, 28 percent of the adolescents and 31 percent of the nonadolescents had infants determined to be in the optimal weight range of 3,500 to 3,999 g. Maternal weight gain, gestational age, parity, and cigarette use during pregnancy were significant predictors of infant birthweight in the regression analysis. Analysis of subjects who were primiparous, nonsmokers, had a gestational age greater than 37 weeks at delivery, and who entered prenatal care in the first trimester revealed that mean monthly weight gain, total pregnancy weight gain, and infant birthweights were similar between the young adult and adolescent mothers. The authors concluded that pregnant adolescents are not at biological risk of delivering underweight infants and that adolescents do not appear to require a greater weight gain than young adults to deliver similar weight babies.

Another fair study undertook a prospective, longitudinal assessment to investigate the advantages and disadvantages of large weight gain among pregnant adolescents. The study involved 141 low-income black women ages 12 through 19. The subjects were classified according to their average rate of weekly weight gain as either slow, average, or rapid gainers. The rate of weight gain did not influence the prevalence of maternal glucose intolerance, pregnancy-induced hypertension, or cesarean delivery; larger weight gains were associated with larger infants.

One study did not meet inclusion criteria but we note it because it provides a provocative argument that weight gain recommendations based on adult BMI categories may not be sufficiently specific to yield optimal maternal and neonatal outcomes for childbearing adolescents.¹⁸⁷ This study, which included only descriptive statistics and no multivariate analyses, compared the pregnancy experience of adolescents when assigned to IOM categories for BMI status with the experience when they were assigned to BMI growth curve percentiles set forth by the Centers for Disease Control and Prevention (CDC). Fewer adolescents were

classified as underweight by the CDC BMI percentiles than by the IOM categories; thus, the CDC percentiles mean that fewer adolescents will be encouraged to gain extra pounds in pregnancy to compensate for low BMI. The author postulated that application of the IOM recommendations to teens results in recommendations for weight gain that are higher than necessary for healthy pregnancy outcomes and sets young women up for excess weight retention.

Findings Relative to Benefits and Harms of Different Recommendations from the IOM

Options to the IOM weight gain recommendations were specifically explored in three studies (1 good;¹⁸⁸ 2 fair^{4,127}). These studies offered optimal weight gain ranges, based on their findings that differ from the IOM recommendations.

In a fair study, one research team set out to determine optimal weight gain in a singleton pregnancy.¹²⁷ Using a retrospective cohort of 20,971 singleton pregnancies delivered in a primarily low-risk population between 1987 and 1993, the researchers reported that the best perinatal outcomes for all women, except those with BMIs in the obese range, occurred with higher weight gains than current IOM recommendations. The optimal gain was determined to be between 36 and 40 pounds; among obese women, the best outcomes occurred when women gained less than 36 pounds. These conclusions considered outcomes only for the infant without balancing the potential impact of such recommendations on prenatal and intrapartum complications for the mother or her long-term obesity risks.

Another study offered specific suggestions for women by obesity class defined by the National Institutes of Health (NIH).⁴ The authors, investigating the relationship between weight gain and preeclampsia, cesarean delivery, and LGA and SGA infants, reported that the following weight gains were associated with minimal risks for these outcomes: (a) class I obese women, weight gain of 10 to 25 pounds; (b) class II obese women, weight gain of 0 to 9 pounds; and (c) class III, obese women weight loss of 0 to 9 pounds. As noted earlier, this study failed to account for confounders and effect modifiers. A recent good study analyzed data from 298,648 singleton pregnancies registered in the Swedish Medical Birth Registry to recommend optimal weight gains by BMI class.¹⁸⁸ Analyzing the ORs of various adverse maternal and perinatal outcomes, the researchers determined that the optimal weight gains were as follows: (a) for women entering pregnancy with a BMI < 20, 9 to 22 pounds (4-10 kg); (b) for women with a BMI of 20 to 24.9, 5 to 22 pounds (2-10 kg); for women with BMIs of 25 to 29.9, less than 20 pounds (< 9 kg); and (d) for women with a BMI ≥ 30, less than 13 pounds (< 6 kg). Like most studies in this review, it limited its exploration to short-term outcomes related to the pregnancy, the intrapartum, and the neonatal period.

The most compelling evidence to determine the harms and benefits of the IOM recommendations compared with those of other recommendations would come from experimental studies. The IOM recommendations have become the *de facto* standard of care, however, and so investigators have neither an incentive nor an ethically strong position to test alternatives.

Conclusions Regarding the Harms and Benefits of Uniform Recommendations for All Women

In conclusion, existing research is inadequate to assess objectively the range of harms and benefits of providing all women, irrespective of age, race or ethnicity, or pregravid BMI with the same recommendation for weight gain in pregnancy. The majority of the studies presented evidence suggesting that one recommendation for all women would be disadvantageous, but findings were not consistent; moreover, these studies typically did not fully explore harms. Most of the studies in this review limited their analyses to short-term outcomes related to the pregnancy, the intrapartum, and the neonatal period. A full examination of harms would require longitudinal cohorts to determine long-term and unexpected consequences of specific recommendations.

A major impediment in understanding the harms or benefits of offering the same weight gain recommendations to all women is the lack of any information about how that advice might have been proffered. That is, the research we included did not reveal studies that investigated the processes of offering advice or the behavioral determinants for women acting on advice that is offered.

KQ 5: Anthropometrics of Weight Measurement During Pregnancy

Clinicians and researchers can use several anthropometric tools to determine adiposity (body fat). They include height and weight (to derive BMI); skinfold thicknesses, measured with calipers at various regions of the body, such as the arms, legs, and abdomen; circumferences, measured with measuring tape at various regions of the body, such as the arms, hips, and waist; bioelectrical impedance analysis (BIA); ultrasound; isotope dilution (to assess total body water); total body potassium; dual energy x-ray absorptiometry (DEXA); underwater or hydrostatic weighing (to measure body density); computerized tomography (CT); and magnetic resonance imaging (MRI).

The majority of these tools are appropriate for measuring adiposity in the pregnancy state (Table 51). The exceptions are CT and DEXA, which involve x-ray energies, and BIA, which has been used in pregnant women; however, its appropriateness is questionable because it involves sending a weak electrical current through the body.

Because body fat cannot be measured directly, researchers can incorporate values obtained from these tools into various equations to estimate percent body fat or body fat mass. These methods have been evaluated in two fair-quality studies.^{16,180} The equations and models, such as the four-compartment model, are based on assumptions of the relationships between aspects of body composition that can and cannot be measured. The more assumptions that a model relies on, the less likely it is to be accurate, especially when those assumptions are for large body components, such as water and bone.¹⁸⁰ The four-compartment model, which incorporates measurements of total body water, body density, body weight, and bone mineral content, has been shown to be a more accurate approach to estimating body fat^{16,180} than other equations using skinfolds and circumferences.

Table 51. Adiposity measurements and use in pregnancy

Adiposity Measurement	Used During Pregnancy?
Weight	Yes
Body mass index (BMI)	Yes
Skinfold thicknesses	Yes
Circumferences	Yes
Hydrostatic weighing	Yes
Dual energy x-ray absorptiometry (DEXA)	No
Bioelectrical impedance analysis (BIA)	Yes
Isotope dilution	Yes
Total body potassium	Yes
Total body nitrogen	Yes
Computed tomography (CT)	No
Magnetic resonance imaging (MRI)	Yes
Ultrasound	Yes

An obstacle in trying to assess body composition during pregnancy is that body components (e.g., water, lean mass, fat) are constantly changing throughout gestation; moreover, some measurements may not be able to distinguish individual components. For example, increased fluid retention and subcutaneous fat deposition during pregnancy may result in greater skinfold thickness estimates. If body fat or body density estimates are derived from equations using skinfold thicknesses, then body fat will be overestimated.¹⁸⁰ Additionally, anthropometric equations may be based on reference data collected in nonpregnant women or in those who are in early pregnancy and therefore involve inaccurate assumptions of changes occurring throughout pregnancy.

The lack of research on anthropometric changes throughout pregnancy and the postpartum period using measurements other than body weight and BMI is notable. Furthermore, only limited information is available about the methodology, validity, comparability, and, in some cases, safety of these measurements during pregnancy. Although ultrasound techniques are used throughout pregnancy and have been validated for measuring visceral fat, they are seldom used for measuring maternal adiposity. Similarly, MRI may be an effective tool to estimate adiposity; however, machinery is not readily available and is expensive to operate, therefore limiting its use in research settings. In contrast, measurements such as skinfold thicknesses or circumferences are inexpensive and easy to collect in the clinical setting, but whether they are as or more informative or predictive of infant and maternal outcomes than standard body weight and height measurements remains unclear. These types of measurements also require training and standardized methods (e.g., where tape measures or calipers are placed and how measurements are made); these requirements, especially if not met, may yield less precise and reproducible measurements than more expensive and sophisticated methods.

Limitations

Limitations of the Evidence Base

Source of information on weight gain. The lack of attention to the validity of self-reported weight and weight gain is a key limitation of this evidence base. Studies typically relied on self-report for pregravid weight; a substantial proportion relied on self-report for weight gain as well. Women often misreport their weight, and this bias varies by weight status. One study found underreporting of BMI (kg/m^2) by 0.8 and an understated prevalence of overweight or obesity ($\text{BMI} > 25$) in the range of 3 percent to 5 percent for non-Hispanic black and white women and up to 16 percent for Mexican-American women.³⁹ Among obese women of reproductive age, 50 percent underreported their weight by more than 5 pounds.³⁸ When studies use self-reports for both pregravid weight and weight gain during pregnancy, the bias is likely compounded.

Timing of measurement of gestational weight gain. Related to the issue of estimating the measurement error in the calculation of gestational weight gain is the timing of weight measurement during pregnancy relative to gestational age. Few women are weighed at the time of delivery; thus, their weight at the last prenatal visit varies by gestational age. Adjusting for the timing in gestation is critical in assessing adequacy of weight gain.

Studies fail to account for gestational age for other outcomes of interest as well. GDM is customarily diagnosed at about 26 to 28 weeks' gestation; for that reason, weight gain up to the time of the GDM diagnosis is the critical exposure period, not total weight gain during pregnancy. With outcomes such as preeclampsia, the timing of measurement is critical because increased weight gain that may be attributable to edema may be related to the disease process itself.

Studies that examine the effect of weight gain by trimesters of pregnancy but that fail to account for gestational age at the first weight measurement also suffer from likely misestimation of the true amount of weight gained early in pregnancy. Results from such studies may be biased as a result.

Appropriate adjustment for confounding. The evidence base is also limited by variations in the specific confounders and effect modifiers that investigators included or controlled for in their analyses. Omission of important confounders and effect modifiers, especially complications of pregnancy that are associated with changes in maternal weight postpartum, intrapartum complications, or birthweight, limit the interpretability and utility of the evidence. Furthermore, using the studies that did account for confounders and effect modifiers is hampered by the lack of consistent definition and inclusion of key variables.

These deficiencies together appreciably limit the consistency and validity of the evidence. As a result, we found very few outcomes for which we were able to attribute at least a moderate strength of association, despite the relatively large body of evidence that we examined.

Limitations of the Review

We limited our search to articles published in English, primarily for reasons of time and resources. We also excluded case reports and case series with fewer than 100 women. Given the deficiencies of much of the work we did include, however, we do not believe that these exclusions would have provided much, if any, additional useful information. We did examine

work from numerous developed countries, so our review does reach beyond the United States and potentially beyond English-speaking countries.

For similar time and resource reasons, we did not conduct dual independent, blinded review of articles for inclusion or abstraction of information into evidence tables. Instead, one reviewer performed the initial review, and a second reviewer examined that input and recommended changes or corrections when needed. These two reviewers reconciled any differences by consensus discussion. These procedures are generally in accord with the usual procedures for the RTI-UNC Evidence-based Practice Center. To enable us to address any systematic bias in our work that the above approach may have introduced, however, we did apply dual independent review for assessing the quality of individual articles and grading the strength of evidence.

The paucity of “similar” articles, for populations, patient characteristics, settings, and outcomes measured, precluded any efforts to pool findings statistically.

Future Research Directions

The gold standard of a randomized controlled trial will never be appropriate to determine the impact of different levels of weight gain by women of varying pregravid weights relative to their own health, the health of their pregnancy, and the health of the offspring. Therefore, observational studies are necessary to determine associations. Although our systematic review included large numbers of studies that took advantage of large databases and longitudinal data that allowed investigation of the influence of weight gain on short- and long-term outcomes, it yielded very little in the way of consistent findings because the body of research lacks methodological rigor, precision, and directionality.

Major shortcomings in the existing research include the lack of uniformity in definitions of the exposure and outcomes, lack of structured and transparent approaches for assessing confounders and effect modification, lack of power to detect meaningful differences, and inadequate approaches for assessing multiple outcomes related to gestational weight gain for the mother and child. Many studies also failed to provide a conceptual model that accounted for physiological processes. A comprehensive conceptual model with biological underpinnings would have allowed for the identification of preexisting maternal conditions that could confound the relationship between weight gain during pregnancy and outcomes such as gestational diabetes, pregnancy-induced hypertension, and newborn weight.

Another major shortcoming of the existing research is that many of the retrospective cohorts reported on populations preceding the obesity epidemic in this country. In addition, the IOM recommendations are imprecise with respect to overweight and obese women. The obese population deserves special attention because they are likely to enter pregnancy with numerous coexisting conditions or problems; they are also more likely to develop complications in pregnancy such as gestational diabetes, pregnancy-induced hypertension, preeclampsia, and delivery by cesarean section.

To address methodological issues future studies should:

- State when and how baseline pregravid weight and height are determined;
- When weight is self-reported, check for biological plausibility;
- State when and how weight gain is determined;
- Specify when and how postpartum weight is determined;

- Report on how outliers in pregravid weight, gestational weight gain, postpartum weight, and maternal height are handled;
- Standardize definitions regarding rates of weight gain, adequacy of rate of weight gain, and total weight gain;
- Standardize definitions of key confounders and effect modifiers, with more attention directed to disease states that affect both weight gain and pregnancy and neonatal outcomes; and
- Use more specific categories of BMI status for women categorized as obese (for example, using NIH categories such as obese class I, II, and III).

Most of the reviewed studies relied on self-reported pregravid weight and argued that this is an acceptable surrogate for prepregnancy measurement because it has been demonstrated in some populations to be reliable. That reliability needs to be studied for women of varying pregravid weights; it also needs to be studied relative to when it is asked in gestation (e.g., early first trimester, second trimester, or at delivery). Without a thorough understanding of the reliability of self-reported weights in and beyond pregnancy for all women and for subpopulations of women by age, BMI, and race or ethnicity, calculations for total weight gain may well lead researchers to conclusions supported by the data but not by actual weight changes. Such errors in calculations could easily lead to erroneous or missed associations. Thus, studies that assess the magnitude of this error are urgently needed.

We identified the following areas for further studies:

- Exploration of whether women receive accurate weight gain guidance by their prenatal clinicians; whether clinicians have the knowledge, attitudes, and skills necessary to provide appropriate weight gain guidance
- The knowledge, attitudes, and self-efficacy of women regarding gestational weight gain
- The impact of weight gain on lactation performance in order to differentiate biologic and psychologic reasons for discontinuation of breastfeeding
- The impact of age (younger and older) on the relationship of weight gain and pregnancy outcomes
- The impact of menarchal age on the relationship of weight gain and pregnancy outcomes
- The impact of parity on the relationship of weight gain and pregnancy outcomes
- Genetic influences of the relationship between weight gain and pregnancy outcomes
- The effect, over time, of gestational weight gain on women's health status
- The interaction of stature and weight gain
- Tests of the reliability of self-reported weights in pregnancy by age, parity, and BMI
- The impact of total weight gain vs. rate of weight gain vs. timing of weight gain on pregnancy outcomes
- Tests of the use of direct measurements of body fat prior to and during pregnancy as well as in the postpartum period
- Preferred anthropometric measurements for predicting outcomes of interest
- The effect of gestational weight gain on infant (beyond birthweight) and childhood outcomes
- Determination of optimal weight gains for obese women

In addition, more research is needed to evaluate the *long-term* impact of specific amounts of weight gain. This research will require significant funding because following longitudinal cohorts is crucial. Scandinavian countries report on longitudinal cohorts, but findings from these studies lack reasonable generalizability to the United States, which has a far more diverse population, a different prevalence of obesity, possibly different norms about the acceptability of obesity, and a different structure for health care delivery.

Finally, we emphasize the need for the use of far better research methods than the existing body of evidence reflects. Clearly the field has improved over time in the use of analytical approaches; more recent studies have taken into consideration some of the flaws in previous work. Investigators should make use of checklists to improve the quality of reporting of observational studies, such as STROBE,¹⁸⁹ to ensure that the design and conduct of their work meets contemporary standards for publication.

References

1. Institute of Medicine. Nutrition during pregnancy. Part I, weight gain. Washington, DC: National Academy Press 1990.
2. Cogswell ME, Serdula MK, Hungerford DW, Yip R. Gestational weight gain among average-weight and overweight women--what is excessive? *Am J Obstet Gynecol.* 1995 Feb;172(2 Pt 1):705-12.
3. Saldana TM, Siega-Riz AM, Adair LS, Suchindran C. The relationship between pregnancy weight gain and glucose tolerance status among black and white women in central North Carolina. *Am J Obstet Gynecol.* 2006 12;195(6):1629-35.
4. Kiel DW, Dodson EA, Artal R, Boehmer TK, Leet TL. Gestational weight gain and pregnancy outcomes in obese women: how much is enough? *Obstet Gynecol.* 2007 Oct;110(4):752-8.
5. Finkelstein EA, Fiebelkorn IC, Wang G. National medical expenditures attributable to overweight and obesity: how much and who's paying. *Health Affairs.* 2003;(Web exclusive): W3-219-W3-226.
6. Finkelstein EA, Ruhm CJ, Kosa KM. Economic causes and consequences of obesity. *Annual Review of Public Health.* Palo Alto, CA: Annual Reviews 2004.
7. Hedley AA, Ogden CL, Johnson CL, Carroll MD, Curtin LR, Flegal KM. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002. *J Am Med Assoc.* 2004 Jun 16;291(23):2847-50.
8. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999-2004. *J Am Med Assoc.* 2006 Apr 5;295(13):1549-55.
9. Institute of Medicine. Influence of Pregnancy Weight on Maternal and Child Health: Workshop Report Committee on the Impact of Pregnancy Weight on Maternal and Child Health. Washington, DC: National Academy Press 2007.
10. Kramer MS, Morin I, Yang H, Platt RW, Usher R, McNamara H, et al. Why are babies getting bigger? Temporal trends in fetal growth and its determinants. *J Pediatr.* 2002 Oct;141(4):538-42.
11. Martin JA, Hamilton BE, Menacker F, Sutton PD, Mathews TJ. Preliminary births for 2004: Infant and maternal health. Health E-stats. Hyattsville, MD: National Center for Health Statistics. Released November 15, 2005.
12. Eastman NJ, Jackson E. Weight relationships in pregnancy. I. The bearing of maternal weight gain and pre-pregnancy weight on birth weight in full term pregnancies. *Obstet Gynecol Surv.* 1968 Nov;23(11):1003-25.
13. Abrams B. Prenatal weight gain and postpartum weight retention: a delicate balance. *Am J Pub Health.* 1993;83(8):1082-4.
14. Suitor CW. Maternal weight gain: a report of an expert work group PDF Full Text. Rockville, MD: United States Department of Health and Human Services Public Health Service 1997.
15. Schieve LA, Cogswell ME, Scanlon KS. Trends in pregnancy weight gain within and outside ranges recommended by the Institute of Medicine in a WIC population. *Matern Child Health J.* 1998 Jun;2(2):111-6.
16. Lederman SA, Paxton A, Heymsfield SB, Wang J, Thornton J, Pierson RN, Jr. Body fat and water changes during pregnancy in women with different body weight and weight gain. *Obstet Gynecol.* 1997 Oct;90(4 Pt 1):483-8.
17. Carmichael S, Abrams B, Selvin S. The pattern of maternal weight gain in women with good pregnancy outcomes. *Am J Public Health.* 1997 Dec;87(12):1984-8.
18. Caulfield LE, Witter FR, Stoltzfus RJ. Determinants of gestational weight gain outside the recommended ranges among black and white women. *Obstet Gynecol.* 1996 May;87(5 Pt 1):760-6.

19. Pregnancy-related behaviors among migrant farm workers--four states, 1989-1993. *MMWR Morb Mortal Wkly Rep.* 1997 Apr 4;46(13):283-6.
20. Hickey CA, McNeal SF, Menefee L, Ivey S. Prenatal weight gain within upper and lower recommended ranges: effect on birth weight of black and white infants. *Obstet Gynecol.* 1997 Oct;90(4 Pt 1):489-94.
21. Siega-Riz AM, Hobel CJ. Predictors of poor maternal weight gain from baseline anthropometric, psychosocial, and demographic information in a Hispanic population. *J Am Diet Assoc.* 1997 Nov;97(11):1264-8.
22. Siega-Riz AM, Adair LS, Hobel CJ. Institute of Medicine maternal weight gain recommendations and pregnancy outcome in a predominantly Hispanic population. *Obstet Gynecol.* 1994 Oct;84(4):565-73.
23. Dietz PM, Callaghan WM, Cogswell ME, Morrow B, Ferre C, Schieve LA. Combined effects of prepregnancy body mass index and weight gain during pregnancy on the risk of preterm delivery. *Epidemiology.* 2006 Mar;17(2):170-7.
24. Oken E, Taveras EM, Kleinman KP, Rich-Edwards JW, Gillman MW. Gestational weight gain and child adiposity at age 3 years. *Am J Obstet Gynecol.* 2007 Apr;196(4):322 e1-8.
25. Devader SR, Neeley HL, Myles TD, Leet TL. Evaluation of gestational weight gain guidelines for women with normal prepregnancy body mass index. *Obstet Gynecol.* 2007 Oct;110(4):745-51.
26. Stotland NE, Haas JS, Brawarsky P, Jackson RA, Fuentes-Afflick E, Escobar GJ. Body mass index, provider advice, and target gestational weight gain. *Obstet Gynecol.* 2005 Mar;105(3):633-8.
27. Olson CM, Strawderman MS. Modifiable behavioral factors in a biopsychosocial model predict inadequate and excessive gestational weight gain. *J Am Diet Assoc.* 2003 Jan;103(1):48-54.
28. Cogswell ME, Scanlon KS, Fein SB, Schieve LA. Medically advised, mother's personal target, and actual weight gain during pregnancy. *Obstet Gynecol.* 1999 Oct;94(4):616-22.
29. Taffel SM, Keppel KG, Jones GK. Medical advice on maternal weight gain and actual weight gain. Results from the 1988 National Maternal and Infant Health Survey. *Ann N Y Acad Sci.* 1993 Mar 15;678:293-305.
30. Brawarsky P, Stotland NE, Jackson RA, Fuentes-Afflick E, Escobar GJ, Rubashkin N, et al. Pre-pregnancy and pregnancy-related factors and the risk of excessive or inadequate gestational weight gain. *Int J Gynaecol Obstet.* 2005 Nov;91(2):125-31.
31. Hickey CA, Cliver SP, Goldenberg RL, McNeal SF, Hoffman HJ. Relationship of psychosocial status to low prenatal weight gain among nonobese black and white women delivering at term. *Obstet Gynecol.* 1995 Aug;86(2):177-83.
32. Hickey CA. Sociocultural and behavioral influences on weight gain during pregnancy. *Am J Clin Nutr.* 2000 May;71(5 Suppl):1364S-70S.
33. Walker LO, Kim M. Psychosocial thriving during late pregnancy: relationship to ethnicity, gestational weight gain, and birth weight. *J Obstet Gynecol Neonatal Nurs.* 2002 May-Jun;31(3):263-74.
34. King JC. Maternal obesity, glucose intolerance, and inflammation in pregnancy. In: Packer L, Sies H, eds. *Oxidative Stress and Inflammatory Mechanisms in Obesity, Diabetes, and the Metabolic Syndrome*. Taylor & Francis CRC Press 2007:93-106.
35. Berkman N, Viswanathan M. Model Form for the Evaluation of Observational Studies Included in Systematic Literature Reviews. Durham, NC: RTI International 2007.
36. Deeks JJ, Dinnes J, D'Amico R, Sowden AJ, Sakarovitch C, Song F, et al. Evaluating non-randomised intervention studies. *Health Technol Assess.* 2003;7:iii-x. [PMID: 14499048].

37. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health*. 1998;52:377-84.
38. Brunner Huber LR. Validity of self-reported height and weight in women of reproductive age. *Matern Child Health J*. 2007;11:137-44.
39. Gillum RF, Sempos CT. Ethnic variation in validity of classification of overweight and obesity using self-reported weight and height in American women and men: the Third National Health and Nutrition Examination Survey. *Nutr J*. 2005;4:27.
40. West SL, King V, Carey TS, McKoy JN, Lohr K, Sutton SF, et al. Systems to rate the strength of scientific evidence. Evidence Report, Technology Assessment No. 47. Rockville, Md.: Agency for Healthcare Research and Quality. AHRQ Publication No. 02-E016 2002.
41. Rodriguez A, Bohlin G, Lindmark G. Symptoms across pregnancy in relation to psychosocial and biomedical factors. *Acta Obstet Gynecol Scand*. 2001 Mar;80(3):213-23.
42. Tulman L, Morin KH, Fawcett J. Prepregnant weight and weight gain during pregnancy: relationship to functional status, symptoms, and energy. *J Obstet Gynecol Neonatal Nurs*. 1998 Nov-Dec;27(6):629-34.
43. Madlon-Kay DJ. Striae gravidarum. Folklore and fact. *Arch Fam Med*. 1993 May;2(5):507-11.
44. Atwal GS, Manku LK, Griffiths CE, Polson DW. Striae gravidarum in primiparae. *Br J Dermatol*. 2006 Nov;155(5):965-9.
45. Marrero JM, Goggin PM, de Caestecker JS, Pearce JM, Maxwell JD. Determinants of pregnancy heartburn. *Br J Obstet Gynaecol*. 1992 Sep;99(9):731-4.
46. Vallianatos H, Brennand EA, Raine K, Stephen Q, Petawabano B, Dannenbaum D, et al. Beliefs and practices of First Nation women about weight gain during pregnancy and lactation: implications for women's health. *Can J Nurs Res*. 2006 Mar;38(1):102-19.
47. Dodds L, Fell DB, Joseph KS, Allen VM, Butler B. Outcomes of pregnancies complicated by hyperemesis gravidarum. *Obstet Gynecol*. 2006 Feb;107(2 Pt 1):285-92.
48. Kieffer EC, Tabaei BP, Carman WJ, Nolan GH, Guzman JR, Herman WH. The influence of maternal weight and glucose tolerance on infant birthweight in Latino mother-infant pairs. *Am J Public Health*. 2006 Dec;96(12):2201-8.
49. Brennand EA, Dannenbaum D, Willows ND. Pregnancy outcomes of First Nations women in relation to pregravid weight and pregnancy weight gain. *J Obstet Gynaecol Can*. 2005 Oct;27(10):936-44.
50. Seghieri G, De Bellis A, Anichini R, Alviggi L, Franconi F, Breschi MC. Does parity increase insulin resistance during pregnancy? *Diabet Med*. 2005 Nov;22(11):1574-80.
51. Kabiru W, Raynor BD. Obstetric outcomes associated with increase in BMI category during pregnancy. *Am J Obstet Gynecol*. 2004 Sep;191(3):928-32.
52. Murakami M, Ohmichi M, Takahashi T, Shibata A, Fukao A, Morisaki N, et al. Prepregnancy body mass index as an important predictor of perinatal outcomes in Japanese. *Arch Gynecol Obstet*. 2005 Apr;271(4):311-5.
53. Thorsdottir I, Torfadottir JE, Birgisdottir BE, Geirsson RT. Weight gain in women of normal weight before pregnancy: complications in pregnancy or delivery and birth outcome. *Obstet Gynecol*. 2002 May;99(5 Pt 1):799-806.
54. Bianco AT, Smilen SW, Davis Y, Lopez S, Lapinski R, Lockwood CJ. Pregnancy outcome and weight gain recommendations for the morbidly obese woman. *Obstet Gynecol*. 1998 Jan;91(1):97-102.

55. Edwards LE, Hellerstedt WL, Alton IR, Story M, Himes JH. Pregnancy complications and birth outcomes in obese and normal-weight women: effects of gestational weight change. *Obstet Gynecol.* 1996 Mar;87(3):389-94.
56. Kieffer EC, Carman WJ, Gillespie BW, Nolan GH, Worley SE, Guzman JR. Obesity and gestational diabetes among African-American women and Latinas in Detroit: implications for disparities in women's health. *J Am Med Womens Assoc.* 2001 Fall;56(4):181-7, 96.
57. Hackmon R, James R, O'Reilly Green C, Ferber A, Barnhard Y, Divon M. The impact of maternal age, body mass index and maternal weight gain on the glucose challenge test in pregnancy. *J Matern Fetal Neonatal Med.* 2007 Mar;20(3):253-7.
58. Cedergren M. Effects of gestational weight gain and body mass index on obstetric outcome in Sweden. *Int J Gynaecol Obstet.* 2006 Jun;93(3):269-74.
59. Jensen DM, Ovesen P, Beck-Nielsen H, Molsted-Pedersen L, Sorensen B, Vinter C, et al. Gestational weight gain and pregnancy outcomes in 481 obese glucose-tolerant women. *Diabet Care.* 2005 Sep;28(9):2118-22.
60. Ogunyemi D, Hullett S, Leeper J, Risk A. Prepregnancy body mass index, weight gain during pregnancy, and perinatal outcome in a rural black population. *J Matern Fetal Med.* 1998 Jul-Aug;7(4):190-3.
61. Wataba K, Mizutani T, Wasada K, Morine M, Sugiyama T, Suehara N. Impact of prepregnant body mass index and maternal weight gain on the risk of pregnancy complications in Japanese women. *Acta Obstet Gynecol Scand.* 2006;85(3):269-76.
62. Ko CW. Risk factors for gallstone-related hospitalization during pregnancy and the postpartum. *Am J Gastroenterol.* 2006 Oct;101(10):2263-8.
63. Lindseth G, Bird-Baker MY. Risk factors for cholelithiasis in pregnancy. *Res Nurs Health.* 2004;27(6):382-91.
64. Gosselink CA, Ekwo EE, Woolson RF, Moawad A, Long CR. Dietary habits, prepregnancy weight, and weight gain during pregnancy. Risk of pre term rupture of amniotic sac membranes. *Acta Obstet Gynecol Scand.* 1992 Aug;71(6):425-38.
65. Nohr EA, Bech BH, Vaeth M, Rasmussen KM, Henriksen TB, Olsen J. Obesity, gestational weight gain and preterm birth: a study within the Danish National Birth Cohort. *Paediatr Perinat Epidemiol.* 2007 Jan;21(1):5-14.
66. Lang JM, Lieberman E, Cohen A. A comparison of risk factors for preterm labor and term small-for-gestational-age birth. *Epidemiology.* 1996 Jul;7(4):369-76.
67. Graves BW, DeJoy SA, Heath A, Pekow P. Maternal body mass index, delivery route, and induction of labor in a midwifery caseload. *J Midwifery Womens Health.* 2006 Jul-Aug;51(4):254-9.
68. Ekblad U, Grenman S. Maternal weight, weight gain during pregnancy and pregnancy outcome. *Int J Gynaecol Obstet.* 1992 Dec;39(4):277-83.
69. Purfield P, Morin K. Excessive weight gain in primigravidas with low-risk pregnancy: selected obstetric consequences. *J Obstet Gynecol Neonatal Nurs.* 1995 Jun;24(5):434-9.
70. Johnson JW, Longmate JA, Frentzen B. Excessive maternal weight and pregnancy outcome. *Am J Obstet Gynecol.* 1992 Aug;167(2):353-70; discussion 70-2.
71. Rosenberg TJ, Garbers S, Lipkind H, Chiasson MA. Maternal obesity and diabetes as risk factors for adverse pregnancy outcomes: differences among 4 racial/ethnic groups. *Am J Public Health.* 2005 Sep;95(9):1545-51.
72. Joseph KS, Young DC, Dodds L, O'Connell CM, Allen VM, Chandra S, et al. Changes in maternal characteristics and obstetric practice and recent increases in primary cesarean delivery. *Obstet Gynecol.* 2003 Oct;102(4):791-800.

73. Chen G, Uryasev S, Young TK. On prediction of the cesarean delivery risk in a large private practice. *Am J Obstet Gynecol.* 2004 Aug;191(2):616-24; discussion 24-5.
74. Young TK, Woodmansee B. Factors that are associated with cesarean delivery in a large private practice: the importance of prepregnancy body mass index and weight gain. *Am J Obstet Gynecol.* 2002 Aug;187(2):312-8; discussion 8-20.
75. Shepard MJ, Saftlas AF, Leo-Summers L, Bracken MB. Maternal anthropometric factors and risk of primary cesarean delivery. *Am J Public Health.* 1998 Oct;88(10):1534-8.
76. Witter FR, Caulfield LE, Stoltzfus RJ. Influence of maternal anthropometric status and birth weight on the risk of cesarean delivery. *Obstet Gynecol.* 1995 Jun;85(6):947-51.
77. Jain NJ, Denk CE, Kruse LK, Dandolu V. Maternal obesity: can pregnancy weight gain modify risk of selected adverse pregnancy outcomes? *Am J Perinatol.* 2007 May;24(5):291-8.
78. Sherrard A, Platt RW, Vallerand D, Usher RH, Zhang X, Kramer MS. Maternal anthropometric risk factors for caesarean delivery before or after onset of labour. *BJOG.* 2007 Sep;114(9):1088-96.
79. Juhasz G, Gyamfi C, Gyamfi P, Tocce K, Stone JL. Effect of body mass index and excessive weight gain on success of vaginal birth after cesarean delivery. *Obstet Gynecol.* 2005 Oct;106(4):741-6.
80. Geary M, McParland P, Johnson H, Stronge J. Shoulder dystocia--is it predictable? *Eur J Obstet Gynecol Reprod Biol.* 1995 Sep;62(1):15-8.
81. Marshall VA. Maternal health practices and complications of term labor. *J Nurse-Midwifery.* 1991;36(3):168-73.
82. Carmichael S, Abrams B, Selvin S. The association of pattern of maternal weight gain with length of gestation and risk of spontaneous preterm delivery. *Paediatr Perinat Epidemiol.* 1997 Oct;11(4):392-406.
83. Velonakis EG, Maghiorakos P, Tzonou A, Barrat J, Proteau J, Ladopoulos I. The relation of birth weight and gestational age to biological, occupational and socioeconomic factors. *Clin Exp Obstet Gynecol.* 1997;24(4):232-6.
84. Siega-Riz AM, Adair LS, Hobel CJ. Maternal underweight status and inadequate rate of weight gain during the third trimester of pregnancy increases the risk of preterm delivery. *J Nutr.* 1996 Jan;126(1):146-53.
85. Stotland NE, Caughey AB, Lahiff M, Abrams B. Weight gain and spontaneous preterm birth: the role of race or ethnicity and previous preterm birth. *Obstet Gynecol.* 2006 Dec;108(6):1448-55.
86. Schieve LA, Cogswell ME, Scanlon KS. Maternal weight gain and preterm delivery: differential effects by body mass index. *Epidemiology.* 1999 Mar;10(2):141-7.
87. Spinillo A, Capuzzo E, Piazzini G, Ferrari A, Morales V, Di Mario M. Risk for spontaneous preterm delivery by combined body mass index and gestational weight gain patterns. *Acta Obstet Gynecol Scand.* 1998 Jan;77(1):32-6.
88. Kramer MS, Coates AL, Michoud MC, Dagenais S, Hamilton EF, Papageorgiou A. Maternal anthropometry and idiopathic preterm labor. *Obstet Gynecol.* 1995 Nov;86(5):744-8.
89. Wen SW, Goldenberg RL, Cutter GR, Hoffman HJ, Cliver SP. Intrauterine growth retardation and preterm delivery: prenatal risk factors in an indigent population. *Am J Obstet Gynecol.* 1990 Jan;162(1):213-8.
90. Paauw JD, Bierling S, Cook CR, Davis AT. Hyperemesis gravidarum and fetal outcome. *J Parenter Enteral Nutr.* 2005 Mar-Apr;29(2):93-6.
91. Di Cianni G, Miccoli R, Volpe L, Lencioni C, Ghio A, Giovannitti MG, et al. Maternal triglyceride levels and newborn weight in pregnant women with normal glucose tolerance. *Diabet Med.* 2005 Jan;22(1):21-5.

92. Guihard-Costa AM, Papiernik E, Kolb S. Maternal predictors of subcutaneous fat in the term newborn. *Acta Paediatr.* 2004 Mar;93(3):346-9.
93. Kirchengast S, Hartmann B. Impact of maternal age and maternal somatic characteristics on newborn size. *Am J Hum Biol.* 2003 Mar-Apr;15(2):220-8.
94. Shapiro C, Sutija VG, Bush J. Effect of maternal weight gain on infant birth weight. *J Perinat Med.* 2000;28(6):428-31.
95. Cherry FF, Sandstead HH, Wickremasinghe AR. Adolescent pregnancy. Weight and zinc supplementation effects. *Ann N Y Acad Sci.* 1993 Mar 15;678:334-7.
96. Springer NS, Bischooping K, Sampsel CM, Mayes FL, Petersen BA. Using early weight gain and other nutrition-related risk factors to predict pregnancy outcomes. *J Am Diet Assoc.* 1992 Feb;92(2):217-9.
97. Butte NF, Ellis KJ, Wong WW, Hopkinson JM, Smith EO. Composition of gestational weight gain impacts maternal fat retention and infant birth weight. *Am J Obstet Gynecol.* 2003 Nov;189(5):1423-32.
98. Brown JE, Murtaugh MA, Jacobs DR, Jr., Margellos HC. Variation in newborn size according to pregnancy weight change by trimester. *Am J Clin Nutr.* 2002 Jul;76(1):205-9.
99. Zaren B, Cnattingius S, Lindmark G. Fetal growth impairment from smoking--is it influenced by maternal anthropometry? *Acta Obstet Gynecol Scand Suppl.* 1997;165:30-4.
100. Pezzarossa A, Orlandi N, Baggi V, Dazzi D, Ricciarelli E, Coppola F. Effects of maternal weight variations and gestational diabetes mellitus on neonatal birth weight. *J Diabetes Complications.* 1996 Mar-Apr;10(2):78-83.
101. Abrams B, Selvin S. Maternal weight gain pattern and birth weight. *Obstet Gynecol.* 1995 Aug;86(2):163-9.
102. Hediger ML, Scholl TO, Schall JI, Healey MF, Fischer RL. Changes in maternal upper arm fat stores are predictors of variation in infant birth weight. *J Nutr.* 1994 Jan;124(1):24-30.
103. Groff JY, Mullen PD, Mongoven M, Bureau K. Prenatal weight gain patterns and infant birthweight associated with maternal smoking. *Birth: Issues in Perinatal Care.* 1997;24(4):234-9.
104. Luke B, Hediger ML, Scholl TO. Point of diminishing returns: when does gestational weight gain cease benefiting birthweight and begin adding to maternal obesity? *J Maternal-Fetal Med.* 1996;5(4):168-73.
105. Muscati SK, Gray-Donald K, Koski KG. Timing of weight gain during pregnancy: promoting fetal growth and minimizing maternal weight retention. *Int J Obes Relat Metab Disord.* 1996 Jun;20(6):526-32.
106. Hickey CA, Uauy R, Rodriguez LM, Jennings LW. Maternal weight gain in low-income black and Hispanic women: evaluation by use of weight-for-height near term. *Am J Clin Nutr.* 1990 Nov;52(5):938-43.
107. Desjardins E, Hardwick D. How many visits by health professionals are needed to make a difference in low birthweight? A dose-response study of the Toronto Healthiest Babies Possible program. *Can J Public Health.* 1999 Jul-Aug;90(4):224-8.
108. Zhou W, Olsen J. Gestational weight gain as a predictor of birth and placenta weight according to pre-pregnancy body mass index. *Acta Obstet Gynecol Scand.* 1997 Apr;76(4):300-7.
109. Lasker JN, Coyle B, Li K, Ortynsky M. Assessment of risk factors for low birth weight deliveries. *Health Care for Women International.* 2005;26(3):262-80.
110. Hedderson MM, Weiss NS, Sacks DA, Pettitt DJ, Selby JV, Quesenberry CP, et al. Pregnancy weight gain and risk of neonatal complications: macrosomia, hypoglycemia, and hyperbilirubinemia. *Obstet Gynecol.* 2006 Nov;108(5):1153-61.

111. Takimoto H, Sugiyama T, Fukuoka H, Kato N, Yoshiike N. Maternal weight gain ranges for optimal fetal growth in Japanese women. *Int J Gynaecol Obstet*. 2006 Mar;92(3):272-8.
112. Bergmann RL, Richter R, Bergmann KE, Plagemann A, Brauer M, Dudenhausen JW. Secular trends in neonatal macrosomia in Berlin: influences of potential determinants. *Paediatr Perinat Epidemiol*. 2003 Jul;17(3):244-9.
113. Clausen T, Burski TK, Oyen N, Godang K, Bollerslev J, Henriksen T. Maternal anthropometric and metabolic factors in the first half of pregnancy and risk of neonatal macrosomia in term pregnancies. A prospective study. *Eur J Endocrinol*. 2005 Dec;153(6):887-94.
114. Steward DK, Moser DK. Intrauterine growth retardation in full-term newborn infants with birth weights greater than 2,500 g. *Res Nurs Health*. 2004 Dec;27(6):403-12.
115. Bo S, Menato G, Signorile A, Bardelli C, Lezo A, Gallo ML, et al. Obesity or diabetes: what is worse for the mother and for the baby? *Diabet Metab*. 2003 Apr;29(2 Pt 1):175-8.
116. Caulfield LE, Stoltzfus RJ, Witter FR. Implications of the Institute of Medicine weight gain recommendations for preventing adverse pregnancy outcomes in black and white women. *Am J Public Health*. 1998 Aug;88(8):1168-74.
117. Shepard MJ, Bakketeig LS, Jacobsen G, O'Connor T, Bracken MB. Maternal body mass, proportional weight gain, and fetal growth in parous women. *Paediatr Perinat Epidemiol*. 1996 Apr;10(2):207-19.
118. Parker JD, Abrams B. Prenatal weight gain advice: an examination of the recent prenatal weight gain recommendations of the Institute of Medicine. *Obstet Gynecol*. 1992 May;79(5 (Pt 1)):664-9.
119. Dawes MG, Grudzinskas JG. Repeated measurement of maternal weight during pregnancy. Is this a useful practice? *Br J Obstet Gynaecol*. 1991 Feb;98(2):189-94.
120. Sunehag A, Berne C, Lindmark G, Ewald U. Gestational diabetes-perinatal outcome with a policy of liberal and intensive insulin therapy. *Ups J Med Sci*. 1991;96(3):185-98.
121. Kitajima M, Oka S, Yasuhi I, Fukuda M, Rii Y, Ishimaru T. Maternal serum triglyceride at 24-32 weeks' gestation and newborn weight in nondiabetic women with positive diabetic screens. *Obstet Gynecol*. 2001 May;97(5 Pt 1):776-80.
122. Kramer MS, Olivier M, McLean FH, Dougherty GE, Willis DM, Usher RH. Determinants of fetal growth and body proportionality. *Pediatrics*. 1990 Jul;86(1):18-26.
123. Cnattingius S, Bergstrom R, Lipworth L, Kramer MS. Prepregnancy weight and the risk of adverse pregnancy outcomes. *N Eng J Med*. 1998;338(3):147-52.
124. Cheng CJ, Bommarito K, Noguchi A, Holcomb W, Leet T. Body mass index change between pregnancies and small for gestational age births. *Obstet Gynecol*. 2004 Aug;104(2):286-92.
125. Nixon SA, Avery MD, Savik K. Outcomes of macrosomic infants in a nurse-midwifery service. *J Nurse Midwifery*. 1998 Jul-Aug;43(4):280-6.
126. Nohr EA, Bech BH, Davies MJ, Frydenberg M, Henriksen TB, Olsen J. Prepregnancy obesity and fetal death: a study within the Danish National Birth Cohort. *Obstet Gynecol*. 2005 Aug;106(2):250-9.
127. Bracero LA, Byrne DW. Optimal maternal weight gain during singleton pregnancy. *Gynecol Obstet Invest*. 1998;46(1):9-16.
128. Naeye RL. Maternal body weight and pregnancy outcome. *Am J Clin Nutr*. 1990 Aug;52(2):273-9.
129. Stotland NE, Cheng YW, Hopkins LM, Caughey AB. Gestational weight gain and adverse neonatal outcome among term infants. *Obstet Gynecol*. 2006 Sep;108(3 Pt 1):635-43.

130. Spector LG, Davies SM, Robison LL, Hilden JM, Roesler M, Ross JA. Birth characteristics, maternal reproductive history, and the risk of infant leukemia: a report from the Children's Oncology Group. *Cancer Epidemiol Biomarkers Prev.* 2007 Jan;16(1):128-34.
131. Vohr BR, McGarvey ST, Coll CG. Effects of maternal gestational diabetes and adiposity on neonatal adiposity and blood pressure. *Diabet Care.* 1995 Apr;18(4):467-75.
132. Sowan NA, Stemmer ML. Parental risk factors for infant obesity. *Am J Matern Child Nurs.* 2000;25(5):234-41.
133. Ong KK, Ahmed ML, Emmett PM, Preece MA, Dunger DB. Association between postnatal catch-up growth and obesity in childhood: prospective cohort study. *Br Med J.* 2000 Apr 8;320(7240):967-71.
134. Li C, Goran MI, Kaur H, Nollen N, Ahluwalia JS. Developmental trajectories of overweight during childhood: role of early life factors. *Obesity (Silver Spring).* 2007 Mar;15(3):760-71.
135. Yuan W, Basso O, Sorensen HT, Olsen J. Maternal prenatal lifestyle factors and infectious disease in early childhood: a follow-up study of hospitalization within a Danish birth cohort. *Pediatrics.* 2001 Feb;107(2):357-62.
136. Linne Y, Dye L, Barkeling B, Rossner S. Weight development over time in parous women--the SPAWN study--15 years follow-up. *Int J Obes Relat Metab Disord.* 2003 Dec;27(12):1516-22.
137. Harris HE, Ellison GT, Holliday M. Is there an independent association between parity and maternal weight gain? *Ann Hum Biol.* 1997 Nov-Dec;24(6):507-19.
138. Harris HE, Ellison GT, Holliday M, Lucassen E. The impact of pregnancy on the long-term weight gain of primiparous women in England. *Int J Obes Relat Metab Disord.* 1997 Sep;21(9):747-55.
139. Hunt SC, Daines MM, Adams TD, Heath EM, Williams RR. Pregnancy weight retention in morbid obesity. *Obes Res.* 1995 Mar;3(2):121-30.
140. Parham ES, Astrom MF, King SH. The association of pregnancy weight gain with the mother's postpartum weight. *J Am Diet Assoc.* 1990 Apr;90(4):550-4.
141. Walker L, Freeland-Graves JH, Milani T, George G, Hanss-Nuss H, Kim M, et al. Weight and behavioral and psychosocial factors among ethnically diverse, low-income women after childbirth: II. Trends and correlates. *Women Health.* 2004;40(2):19-34.
142. Linne Y, Dye L, Barkeling B, Rossner S. Long-term weight development in women: a 15-year follow-up of the effects of pregnancy. *Obes Res.* 2004 Jul;12(7):1166-78.
143. Soltani H, Fraser RB. A longitudinal study of maternal anthropometric changes in normal weight, overweight and obese women during pregnancy and postpartum. *Br J Nutr.* 2000 Jul;84(1):95-101.
144. Harris HE, Ellison GT, Clement S. Relative importance of heritable characteristics and lifestyle in the development of maternal obesity. *J Epidemiol Community Health.* 1999 Feb;53(2):66-74.
145. Ohlin A, Rossner S. Maternal body weight development after pregnancy. *Int J Obes.* 1990 Feb;14(2):159-73.
146. Callaway LK, McIntyre HD, O'Callaghan M, Williams GM, Najman JM, Lawlor DA. The association of hypertensive disorders of pregnancy with weight gain over the subsequent 21 years: findings from a prospective cohort study. *Am J Epidemiol.* 2007 Aug 15;166(4):421-8.
147. Kaiser LL, Allen L. Position of the American Dietetic Association: nutrition and lifestyle for a healthy pregnancy outcome. *J Am Diet Assoc.* 2002 Oct;102(10):1479-90.
148. Hilakivi-Clarke L, Luoto R, Huttunen T, Koskenvuo M. Pregnancy weight gain and premenopausal breast cancer risk. *J Reprod Med.* 2005 Nov;50(11):811-6.

149. Stotland NE, Hopkins LM, Caughey AB. Gestational weight gain, macrosomia, and risk of cesarean birth in nondiabetic nulliparas. *Obstet Gynecol.* 2004 Oct;104(4):671-7.
150. Kaiser PS, Kirby RS. Obesity as a risk factor for cesarean in a low-risk population. *Obstet Gynecol.* 2001 Jan;97(1):39-43.
151. Hickey CA, Cliver SP, McNeal SF, Hoffman HJ, Goldenberg RL. Prenatal weight gain patterns and spontaneous preterm birth among nonobese black and white women. *Obstet Gynecol.* 1995 Jun;85(6):909-14.
152. Schieve LA, Cogswell ME, Scanlon KS, Perry G, Ferre C, Blackmore-Prince C, et al. Prepregnancy body mass index and pregnancy weight gain: associations with preterm delivery. The NMIHS Collaborative Study Group. *Obstet Gynecol.* 2000 Aug;96(2):194-200.
153. Nielsen JN, O'Brien KO, Witter FR, Chang SC, Mancini J, Nathanson MS, et al. High gestational weight gain does not improve birth weight in a cohort of African American adolescents. *Am J Clin Nutr.* 2006 Jul;84(1):183-9.
154. Stevens-Simon C, McAnarney ER. Adolescent pregnancy. Gestational weight gain and maternal and infant outcomes. *Am J Dis Child.* 1992 Nov;146(11):1359-64.
155. Hickey CA, Cliver SP, McNeal SF, Hoffman HJ, Goldenberg RL. Prenatal weight gain patterns and birth weight among nonobese black and white women. *Obstet Gynecol.* 1996 Oct;88(4 Pt 1):490-6.
156. Hickey CA, Cliver SP, Goldenberg RL, Kohatsu J, Hoffman HJ. Prenatal weight gain, term birth weight, and fetal growth retardation among high-risk multiparous black and white women. *Obstet Gynecol.* 1993 Apr;81(4):529-35.
157. May R. Prepregnancy weight, inappropriate gestational weight gain, and smoking: Relationships to birth weight. *Am J Hum Biol.* 2007 May-Jun;19(3):305-10.
158. Scholl TO, Hediger ML, Schall JI, Ances IG, Smith WK. Gestational weight gain, pregnancy outcome, and postpartum weight retention. *Obstet Gynecol.* 1995 Sep;86(3):423-7.
159. Hellerstedt WL, Himes JH, Story M, Alton IR, Edwards LE. The effects of cigarette smoking and gestational weight change on birth outcomes in obese and normal-weight women. *Am J Public Health.* 1997 Apr;87(4):591-6.
160. Schieve LA, Cogswell ME, Scanlon KS. An empiric evaluation of the Institute of Medicine's pregnancy weight gain guidelines by race. *Obstet Gynecol.* 1998 Jun;91(6):878-84.
161. Strauss RS, Dietz WH. Low maternal weight gain in the second or third trimester increases the risk for intrauterine growth retardation. *J Nutr.* 1999 May;129(5):988-93.
162. Hulsey TC, Neal D, Bondo SC, Hulsey T, Newman R. Maternal prepregnant body mass index and weight gain related to low birth weight in South Carolina. *South Med J.* 2005 Apr;98(4):411-5.
163. Prenatal weight gain and birth weight among Oklahoma mothers. *J Okla State Med Assoc.* 1996 Dec;89(12):435-8.
164. Rode L, Hegaard HK, Kjaergaard H, Moller LF, Tabor A, Ottesen B. Association between maternal weight gain and birth weight. *Obstet Gynecol.* 2007 Jun;109(6):1309-15.
165. Kabali C, Werler MM. Pre-pregnant body mass index, weight gain and the risk of delivering large babies among non-diabetic mothers. *Int J Gynaecol Obstet.* 2007 May;97(2):100-4.
166. Baker JL, Michaelsen KF, Sorensen TI, Rasmussen KM. High prepregnant body mass index is associated with early termination of full and any breastfeeding in Danish women. *Am J Clin Nutr.* 2007 Aug;86(2):404-11.
167. Li R, Jewell S, Grummer-Strawn L. Maternal obesity and breast-feeding practices. *Am J Clin Nutr.* 2003 Apr;77(4):931-6.

168. Rasmussen KM, Hilson JA, Kjolhede CL. Obesity as a risk factor for failure to initiate and sustain lactation. *Adv Exp Med Biol.* 2002;503:217-22.
169. Hilson JA, Rasmussen KM, Kjolhede CL. Excessive weight gain during pregnancy is associated with earlier termination of breast-feeding among White women. *J Nutr.* 2006 Jan;136(1):140-6.
170. Walker LO, Timmerman GM, Sterling BS, Kim M, Dickson P. Do low-income women attain their pre-pregnant weight by the 6th week of postpartum? *Ethn Dis.* 2004 Winter;14(1):119-26.
171. Amorim AR, Rossner S, Neovius M, Lourenco PM, Linne Y. Does excess pregnancy weight gain constitute a major risk for increasing long-term BMI? *Obesity (Silver Spring).* 2007 May;15(5):1278-86.
172. Walker LO. Predictors of weight gain at 6 and 18 months after childbirth: a pilot study. *J Obstet Gynecol Neonat Nurs.* 1996;25(1):39-48.
173. Keppel KG, Taffel SM. Pregnancy-related weight gain and retention: implications of the 1990 Institute of Medicine guidelines. *Am J Pub Health.* 83(8):1100-3.
174. Rooney BL, Schauburger CW. Excess pregnancy weight gain and long-term obesity: one decade later. *Obstet Gynecol.* 2002 Aug;100(2):245-52.
175. Olson CM, Strawderman MS, Hinton PS, Pearson TA. Gestational weight gain and postpartum behaviors associated with weight change from early pregnancy to 1 y postpartum. *Int J Obes Relat Metab Disord.* 2003 Jan;27(1):117-27.
176. Rooney BL, Schauburger CW, Mathiason MA. Impact of perinatal weight change on long-term obesity and obesity-related illnesses. *Obstet Gynecol.* 2005;106(6):1349-56.
177. Gunderson EP, Abrams B, Selvin S. The relative importance of gestational gain and maternal characteristics associated with the risk of becoming overweight after pregnancy. *Int J Obes Relat Metab Disord.* 2000 Dec;24(12):1660-8.
178. Larciprete G, Valensise H, Vasapollo B, Altomare F, Sorge R, Casalino B, et al. Body composition during normal pregnancy: reference ranges. *Acta Diabetol.* 2003 Oct;40 Suppl 1:S225-32.
179. Sohlstrom A, Wahlund LO, Forsum E. Total body fat and its distribution during human reproduction as assessed by magnetic resonance imaging. *Basic Life Sci.* 1993;60:181-4.
180. Paxton A, Lederman SA, Heymsfield SB, Wang J, Thornton JC, Pierson RN, Jr. Anthropometric equations for studying body fat in pregnant women. *Am J Clin Nutr.* 1998 Jan;67(1):104-10.
181. Jovanovic-Peterson L, Crues J, Durak E, Peterson CM. Magnetic resonance imaging in pregnancies complicated by gestational diabetes predicts infant birthweight ratio and neonatal morbidity. *Am J Perinatol.* 1993 Nov;10(6):432-7.
182. Bartha JL, Marin-Segura P, Gonzalez-Gonzalez NL, Wagner F, Aguilar-Diosdado M, Hervias-Vivancos B. Ultrasound evaluation of visceral fat and metabolic risk factors during early pregnancy. *Obesity (Silver Spring).* 2007 Sep;15(9):2233-9.
183. Williamson DF, Madans J, Anda RF, Kleinman JC, Giovino GA, Byers T. Smoking cessation and severity of weight gain in a national cohort. *N Engl J Med.* 1991 Mar 14;324(11):739-45.
184. Viswanathan M, Visco AG, Hartmann K, Wechter ME, Gartlehner G, Wu JM, et al. Cesarean delivery on maternal request. *Evid Rep Technol Assess (Full Rep).* 2006 Mar(133):1-138.
185. Carpenter MW, Sady SP, Sady MA, Haydon B, Coustan DR, Thompson PD. Effect of maternal weight gain during pregnancy on exercise performance. *J Appl Physiol.* 1990 Mar;68(3):1173-6.

186. Johnston CS, Christopher FS, Kandell LA. Pregnancy weight gain in adolescents and young adults. *J Am Coll Nutr.* 1991 Jun;10(3):185-9.
187. Groth S. Are the Institute of Medicine recommendations for gestational weight gain appropriate for adolescents? *J Obstet Gynecol Neonatal Nurs.* 2007 Jan-Feb;36(1):21-7.
188. Cedergren MI. Optimal gestational weight gain for body mass index categories. *Obstet Gynecol.* 2007 Oct;110(4):759-64.
189. von Elm E, Altman DG, Egger M, Pocock SJ, Gotsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol.* 2008 Apr;61(4):344-9.

Appendixes

Search Strategy

Focused Search 1: November 2006

<u>#3</u>	Search "Weight Gain"[MeSH]	<u>12977</u>
<u>#7</u>	Search "Pregnancy"[MeSH] OR "Postpartum Period"[MeSH]	<u>583182</u>
<u>#9</u>	Search #3 AND #7	<u>1939</u>
<u>#10</u>	Search gestational weight gain	<u>1694</u>
<u>#11</u>	Search #9 OR #10	<u>3130</u>
<u>#12</u>	Search #9 OR #10 Limits: English, Humans	<u>1681</u>
<u>#15</u>	Search ("Outcome Assessment (Health Care)"[MeSH] OR "Pregnancy Outcome"[MeSH]) OR "Outcome and Process Assessment (Health Care)"[MeSH] Limits: English, Humans	<u>287919</u>
<u>#16</u>	Search #12 AND #15 Limits: English, Humans	<u>297</u>
<u>#17</u>	Search "Pregnancy Outcome"[MeSH] Limits: English, Humans	<u>19056</u>
<u>#18</u>	Search #12 AND #17 Limits: English, Humans	<u>255</u>
<u>#19</u>	Search ("Weight Gain/ethnology"[MeSH] OR "Weight Gain/genetics"[MeSH]) Limits: English, Humans	<u>97</u>
<u>#20</u>	Search #12 AND #19 Limits: English, Humans	<u>21</u>
<u>#22</u>	Search "Socioeconomic Factors"[MeSH] Limits: English, Humans	<u>154168</u>
<u>#23</u>	Search #12 AND #22 Limits: English, Humans	<u>183</u>
<u>#27</u>	Search "Body Weight"[MeSH] OR "Body Mass Index"[MeSH] Limits: English, Humans	<u>125469</u>
<u>#28</u>	Search #12 AND #27 Limits: English, Humans	<u>1438</u>
<u>#29</u>	Search #28 AND #15 Limits: English, Humans	<u>257</u>
<u>#31</u>	Search "Obesity"[MeSH] Limits: English, Humans	<u>49340</u>
<u>#32</u>	Search "Obesity"[MeSH] Limits: All Adult: 19+ years, English, Female, Humans	<u>22784</u>
<u>#33</u>	Search #32 AND #12 Limits: All Adult: 19+ years, English, Female, Humans	<u>131</u>
<u>#36</u>	Search #9 OR #10 Limits: English, Publication Date from 1990, Humans	<u>1453</u>
<u>#38</u>	Search "United States"[MeSH] Limits: English, Publication Date from 1990, Humans	<u>364130</u>
<u>#39</u>	Search #38 AND #36 Limits: English, Publication Date from 1990, Humans	<u>135</u>

#42	Search iom	<u>682</u>
#43	Search #42 AND #12	<u>19</u>
#45	Search #43 OR #39 Limits: English, Publication Date from 1990, Humans	<u>150</u>
#47	Search ("Counseling"[MeSH] OR "Directive Counseling"[MeSH]) Limits: English, Publication Date from 1990, Humans	<u>11733</u>
#48	Search #47 AND #12 Limits: English, Publication Date from 1990, Humans	<u>13</u>
#53	Search "Body Weights and Measures/instrumentation"[MeSH] Limits: English, Publication Date from 1990, Humans	<u>13</u>
#54	Search Body Weights and Measures[MeSH]	<u>275772</u>
#55	Search #12 AND #54	<u>1030</u>
#66	Search Anthropometry [mh]	<u>70445</u>
#67	Search #55 AND #66	<u>350</u>

KQ1: OUTCOMES

#3	Search "Weight Gain"[MeSH]	<u>12977</u>
#7	Search "Pregnancy"[MeSH] OR "Postpartum Period"[MeSH]	<u>583182</u>
#9	Search #3 AND #7	<u>1939</u>
#10	Search gestational weight gain	<u>1694</u>
#11	Search #9 OR #10	<u>3130</u>
#12	Search #9 OR #10 Limits: English, Humans	<u>1681</u>
#15	Search ("Outcome Assessment (Health Care)"[MeSH] OR "Pregnancy Outcome"[MeSH]) OR "Outcome and Process Assessment (Health Care)"[MeSH] Limits: English, Humans	<u>287919</u>
#16	Search #12 AND #15 Limits: English, Humans	<u>297</u>
#17	Search "Pregnancy Outcome"[MeSH] Limits: English, Humans	<u>19056</u>
#18	Search #12 AND #17 Limits: English, Humans	<u>255</u>

KQ2: SES

#19	Search ("Weight Gain/ethnology"[MeSH] OR "Weight Gain/genetics"[MeSH]) Limits: English, Humans	<u>97</u>
#20	Search #12 AND #19 Limits: English, Humans	<u>21</u>
#22	Search "Socioeconomic Factors"[MeSH] Limits: English, Humans	<u>154168</u>
#23	Search #12 AND #22 Limits: English, Humans	<u>183</u>

KQ3: IOM Guidelines

<u>#27</u>	Search "Body Weight"[MeSH] OR "Body Mass Index"[MeSH] Limits: English, Humans	<u>125469</u>
<u>#28</u>	Search #12 AND #27 Limits: English, Humans	<u>1438</u>
<u>#29</u>	Search #28 AND #15 Limits: English, Humans	<u>257</u>
<u>#31</u>	Search "Obesity"[MeSH] Limits: English, Humans	<u>49340</u>
<u>#32</u>	Search "Obesity"[MeSH] Limits: All Adult: 19+ years, English, Female, Humans	<u>22784</u>
<u>#33</u>	Search #32 AND #12 Limits: All Adult: 19+ years, English, Female, Humans	<u>131</u>
<u>#36</u>	Search #9 OR #10 Limits: English, Publication Date from 1990, Humans	<u>1453</u>
<u>#38</u>	Search "United States"[MeSH] Limits: English, Publication Date from 1990, Humans	<u>364130</u>
<u>#39</u>	Search #38 AND #36 Limits: English, Publication Date from 1990, Humans	<u>135</u>
<u>#42</u>	Search iom	<u>682</u>
<u>#43</u>	Search #42 AND #12	<u>19</u>
<u>#45</u>	Search #43 OR #39 Limits: English, Publication Date from 1990, Humans	<u>150</u>

KQ4: Recommendations

<u>#47</u>	Search ("Counseling"[MeSH] OR "Directive Counseling"[MeSH]) Limits: English, Publication Date from 1990, Humans	<u>11733</u>
<u>#48</u>	Search #47 AND #12 Limits: English, Publication Date from 1990, Humans	<u>13</u>

KQ5: Tools

<u>#53</u>	Search "Body Weights and Measures/instrumentation"[MeSH] Limits: English, Publication Date from 1990, Humans	<u>13</u>
<u>#54</u>	Search Body Weights and Measures[MeSH]	<u>275772</u>
<u>#55</u>	Search #12 AND #54	<u>1030</u>
<u>#66</u>	Search Anthropometry [mh]	<u>70445</u>
<u>#67</u>	Search #55 AND #66	<u>350</u>

Focused Search 2: February 2007

#2 Search "Weight Gain"[MeSH] = 13220

#5 Search pregnancy [mesh] = 577647

#6 Search #2 AND #5 = 1808

#7 Search gestational weight gain = 1725

#8 Search #6 OR #7 = 3023

#9 Search #6 OR #7 Limits: English, Humans = 1696

#15 Search ("Outcome Assessment (Health Care)"[MeSH] OR "Outcome and Process Assessment (Health Care)"[MeSH] OR "Pregnancy Outcome"[MeSH]) OR "Reproductive History"[MeSH] OR "birth outcomes" OR "infant health outcomes" OR "maternal health outcomes Limits: English, Humans = 332914

#16 Search #9 AND #15 Limits: English, Humans = 474

#19 Search ("Counseling"[MeSH] OR "Directive Counseling"[MeSH]) = 23091

#20 Search #9 AND #19 = 12

#25 Search "Body Weights and Measures"[MeSH] = 279399

#26 Search #9 AND #25 = 1044

#29 Search "Anthropometry"[MeSH] = 71849

#30 Search #26 AND #29 = 359

CINAHL

DE= Weight gain - in pregnancy = 253

63 duplicates

190 new records

COCHRANE = 4 records, already in database

EMBASE = 18 records, 8 new

Total unduplicated database = 913

Focused Search 3: March 2007

Same search as Focused Search 1 using Cochrane, CINAHL

Focused Search 4: June 2007

#1 Search pregnancy	620141
#2 Search height OR weight OR BMI OR "body mass index" OR skinfolds OR circumferences OR BIA OR "body impedance analyzer" OR ultrasound OR DEXA OR UWW OR "underwater weighing" OR "BOD POD" OR CT OR MRI	1369412
#3 Search #1 AND #2	103432
#4 Search #1 AND #2 Limits: Humans, English	66133
#5 Search #1 AND #2 Limits: Publication Date from 1990, Humans, English, All Adult: 19+ years	24044
#6 Search BMI OR "body mass index" OR skinfolds OR circumferences OR BIA OR "body impedance analyzer" OR ultrasound OR DEXA OR UWW OR "underwater weighing" OR "BOD POD" OR CT OR MRI Limits: Publication Date from 1990, Humans, English, All Adult: 19+ years	247723
#7 Search #5 AND #6 Limits: Publication Date from 1990, Humans, English, All Adult: 19+ years	15336
<hr/>	
#4 Search ("Pregnancy/physiology"[Majr]) AND ("Weight Gain"[Mesh])	379
#7 Search ("Adipose Tissue/anatomy and histology"[Mesh])	14707
#8 Search #4 AND #7	14
#9 Search ("Pregnancy/physiology"[Majr]) AND ("Weight Gain"[Mesh]) Limits: Publication Date from 1990, Humans, English, All Adult: 19+ years	148

Focused Search 5: October 2007

#1 Search "Weight Gain"[MeSH] AND pregnancy [mesh]	1889
#2 Search gestational weight gain	1812
#3 Search #1 OR #2	3160
#4 Search #1 OR #2 Limits: added to PubMed in the last 1 year, Humans, English	98
#5 Search ("Outcome Assessment (Health Care)"[MeSH] OR "Outcome and Process Assessment (Health Care)"[MeSH] OR "Pregnancy Outcome"[MeSH]) OR "Reproductive History"[MeSH] OR "birth outcomes" OR "infant health outcomes" OR "maternal health outcomes"	395351
#6 Search #4 AND #5	26
#7 Search ("Counseling"[MeSH] OR "Directive Counseling"[MeSH])	23918
#8 Search #4 AND #7	1
#9 Search "Body Weights and Measures"[MeSH] AND "Anthropometry"[MeSH]	42873
#10 Search #4 AND #9	34
#11 Search ("Pregnancy/physiology"[Majr]) AND ("Weight Gain"[Mesh]) AND ("Adipose Tissue/anatomy and histology"[Mesh])	14
#12 Search ("Pregnancy/physiology"[Majr]) AND ("Weight Gain"[Mesh]) AND ("Adipose Tissue/anatomy and histology"[Mesh]) Limits: added to PubMed in the last 1 year, Humans, English	0

CINAHL

DE= Weight gain - in pregnancy = 36

Duplicates = 18

new records = 18

COCHRANE = 1 records

EMBASE = 5 records

Duplicates = 1

New records = 4

58 new records

Total unduplicated database = 1024

Appendix B. Sample Data Collection Forms

Systematic Review of Maternal Weight Gain

Abstract Review Form

First Author, Year: _____

Endnote: _____

Abstractor Initials: _____

Primary Inclusion/Exclusion Criteria			
1. Original research (Exclude editorials, commentaries, letters to editor, reviews, etc.)	Yes	No	Cannot Determine
2. Study published between January 1990 and February 2007	Yes	No	Cannot Determine
3. Study published in English	Yes	No	Cannot Determine
4. Is this study located in a developed nation? (US, Canada, Western Europe, Japan, New Zealand, Australia)	Yes	No	Cannot Determine
5. Eligible Study type (Include RCTs, cohorts with comparisons, and case-controls with N≥40, case-series with N≥100) a. ___ RCT (N = ___) b. ___ Cohorts with comparison (N = ___) c. ___ Case-control (N = ___) d. ___ Case series (N = ___)	Yes	No	Cannot Determine
6. Applies to research topic (if not select one of the following reasons): a. ___ Basic science b. ___ Not "maternal weight gain"	Yes	No	Cannot Determine
7. Entirely or mostly singleton births	Yes	No (100% multi-fetal)	Cannot Determine

Retain for (include meta-analyses and systematic reviews here as appropriate):

- ___ **BACKGROUND/DISCUSSION**
- ___ **REVIEW OF REFERENCES**
- ___ **Other**

COMMENTS:

Reviewing



Reviewing at Level 1

SRS has detected that you may not need to fill this form out. It has already been completed by 2 users and is currently being worked on by 0 other users. It only needs to be reviewed by 2 users therefore your input may be redundant.

Click [here](#) to skip to the next one

Refid: 1, Birenbaum, H. J., M. A. Pane, S. M. Helou and K. P. Starr, Comparison of a restricted transfusion schedule with erythropoietin therapy versus a restricted transfusion schedule alone in very low birth weight premature infants, *South Med J*, 99(10), 2006, p. 1059-62
State: Excluded, Level: 1

Abstract Review

<p>Keywords: Anemia, Neonatal/blood/ prevention & control</p> <p>Increase Font Size</p> <p>Decrease Font Size</p> <p>Abstract: OBJECTIVE: Erythropoietin (EPO) is commonly used in very low birth weight neonates to minimize blood transfusions during hospitalization. Data are limited comparing the use of EPO along with a restricted transfusion schedule versus a restricted transfusion schedule alone. We compared the effects of a restricted transfusion schedule with EPO versus a restricted transfusion schedule alone during two consecutive 6-month periods. METHODS: In period I, infants born at <30 weeks gestational age (GA) or <1,500 g birth weight (BW) were treated prophylactically for six weeks with EPO 1,000 U/kg/wk in three divided doses and blood transfusions were given using a restricted transfusion schedule. This was called the EPO Group. In period II, a restricted transfusion schedule was utilized, but EPO was not administered. This constituted the No EPO Group. No other changes in clinical practice were introduced in either period. RESULTS: There were 30 neonates in the EPO Group and 20 in the No EPO Group. There were no significant differences in sex, race, mean birth weight (1,074 +/- 283 versus 965 +/- 330 g), mean gestational age (28.9 +/- 2.96 versus 27.8 +/- 2.86 wks), 5 minute Apgar score (7.8 +/- 1.2 versus 7.6 +/- 1.1), or mean hematocrit (48.2% +/- 6.05 versus 48.6% +/- 6.31) at admission. There were no significant differences in the total number of transfusions between the two periods. In the EPO Group, 8/30 patients received 27 transfusions. Six transfusions violated guidelines based on hematocrit level. EPO was discontinued in three infants secondary to treatment-related neutropenia. There were two deaths unassociated with EPO treatment. Excluding deaths, 6 patients received 16 transfusions. In the No EPO Group, 8/20 patients received 13 transfusions. Two transfusions violated guidelines based on hematocrit. There were three deaths and one patient transfer. Excluding these four patients, 6 infants received 11 transfusions (P < or = 1.) Among survivors, there were no significant differences in mean total length of stay (49.3 +/- 22.7 versus 53.2 +/- 26.4 d), mean discharge weight (2,144 +/- 405 versus 2,358 +/- 458 g), or average weight gain/d (20.7 +/- 5.44 versus 22.6 +/- 6.81 g), between the two groups respectively, nor were there significant differences when all babies were included in the analysis. There was a significant difference in mean hematocrit at discharge, respectively, (38.3% +/- 6.84</p>	<p>Submit Data</p> <p>1. Original research (no review articles, editorials, letters to the editor or commentaries)?</p> <p><input checked="" type="radio"/> Yes</p> <p><input type="radio"/> No</p> <p><input type="radio"/> Cannot determine</p> <p>Clear Selection</p> <p>2. Study published after January 1, 1990?</p> <p><input checked="" type="radio"/> Yes</p> <p><input type="radio"/> No</p> <p><input type="radio"/> Cannot determine</p> <p>Clear Selection</p> <p>3. Study published in English?</p> <p><input type="radio"/> Yes</p> <p><input type="radio"/> No</p> <p><input checked="" type="radio"/> Cannot determine</p> <p>Clear Selection</p> <p>4. Study conducted in a developed nation? (for example- US, Canada, western Europe, Japan, New Zealand, Australia)</p> <p><input type="radio"/> Yes</p> <p><input type="radio"/> No- if not then where? <input type="text"/> </p> <p><input checked="" type="radio"/> Cannot determine</p> <p>Clear Selection</p> <p>5. Study design is one of the following:</p> <p><input type="radio"/> RCT</p> <p><input checked="" type="radio"/> Cohort studies N => 40</p> <p><input type="radio"/> Case control with N => 40</p> <p><input type="radio"/> Case series N => 100</p> <p><input type="radio"/> Cross sectional N => 100</p> <p><input type="radio"/> None of the above- so exclude</p> <p><input type="radio"/> None of the above- but include (please provide explanation) <input type="text"/> </p> <p><input type="radio"/> Cannot determine</p> <p>Clear Selection</p> <p>6. Entirely or mostly singleton births?</p>
--	--

- Yes
- No (100% multi-fetal)
- Cannot determine

[Clear Selection](#)

7. Applies to research topic of maternal weight gain or the measurement body fat?

- Yes
- No- not maternal weight gain or the measurement of body fat
- No - "basic science"
- No - other (please elucidate)
- Cannot determine

[Clear Selection](#)

8. Article should be marked and saved for background but not abstracted (This question is optional).

- Yes
- No
- Cannot determine

[Clear Selection](#)

9. Population

- 100% healthy populations or mix of healthy populations and "nonhealthy" populations
- 100% populations with health conditions (ie. drug abuse or diabetes) Please define -

[Clear Selection](#)

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Form Creation Date: Not available
Form Last Modified: Not available

Reviewing

**Reviewing at Level 2**

Refid: 1611, Jain, N. J., C. E. Denk, L. K. Kruse and V. Dandolu, Maternal obesity: can pregnancy weight gain modify risk of selected adverse pregnancy outcomes?, *Am J Perinatol*, 24(5), 2007, p. 291-8

State: Ok, Level: 2

Full-Text Review

Save to finish later

Submit Data

1. Article is concerned with topics relevant to maternal weight gain or the measurement of body fat?

- Yes
- No- so exclude

[Clear Selection](#)

2. **Should the article be excluded for any of the following general reasons?**

Article should be excluded because (pick at least one of the following options)

n < 40 for comparisons including cohort studies

n < 100 for case-series

Not published in english

Wrong publication type (e.g. letter, commentary or editorial)

Wrong design - please explain

Includes only a population w/ a pre-existing condition - please list condition

100% multi-fetal

Published before 1990

Study not conducted in a developed nation? (Please provide country name)

Study reported as an abstract only

Not related to key questions

Other reason- please explain briefly

None of the above- should be included!

3. Regardless of inclusion/exclusion status, article should be retained for background.

- Yes
- No

[Clear Selection](#)

4. **Which of the following key questions are addressed by the article**

KQ1 What is the evidence that either total weight gain or rate of weight gain during pregnancy is associated with: (1) birth outcomes, (2) infant health outcomes, and (3) maternal health outcomes?

KQ2 What are the confounders and effect modifiers in examining the association between maternal weight gain (overall and patterns) and birth outcomes?

KQ3 What is the evidence that weight gain above or below thresholds defined in the 1990 Institute of Medicine BMI Guidelines or weight loss in pregnancy contribute to ante-partum or post-partum complications, or longer-term maternal and fetal complications?

KQ4 What are the harms or benefits of offering the same weight gain recommendations to all pregnant women, irrespective of age and body weight considerations (e.g., pregravid weight, actual body weight at a particular time point, or optimal body weight)?

KQ5 What are the anthropometric tools for determining adiposity and their appropriateness for the pregnancy state?

None of the above so exclude!

5. If study addresses KQ 1-4 it must include pre-pregnancy weight or BMI measures.

- Pre-pregnancy weight or BMI is not in article so exclude
- Include!

[Clear Selection](#)

6.
If article addresses KQ 3 it must include the IOM guidelines.

No IOM guidelines so exclude

Include!

[Clear Selection](#)

Save to finish later

Submit Data

Form took 0.2026367 seconds to render

Form Creation Date: Not available

Form Last Modified: Not available


Reviewing



Reviewing at Level 3

Reviewer Comments ([Add a Comment](#))

Refid: 127, Joseph, K. S., D. C. Young, L. Dodds, C. M. O'Connell, V. M. Allen, S. Chandra and A. C. Allen, Changes in maternal characteristics and obstetric practice and recent increases in primary cesarean delivery, *Obstet Gynecol*, 102(4), 2003, p. 791-800

State: Ok, Level: Abstraction form, KQ5 

Abstraction

1. First author et. al, year

[Enlarge](#) [Shrink](#)


2. Country and setting

If more than a couple of countries are included just call it multinational.

Settings include primary care, hospitals, university clinics, doctors offices, nursing home, multicenter etc.

[Enlarge](#) [Shrink](#)

3. Source of funding to conduct study:

 Pharmaceutical company or other commercial source- please list name. 
 Government or non-profit organization- please list name. 
 Not reported

4. Research objective (Please be brief and concise):

[Enlarge](#) [Shrink](#)

5. Which of the following key questions are addressed by the article

 KQ1 What is the evidence that either total weight gain or rate of weight gain during pregnancy is associated with: (1) birth outcomes, (2) infant health o

 KQ2 What are the confounders and effect modifiers in examining the association between maternal weight gain (overall and patterns) and birth outcom

 KQ3 What is the evidence that weight gain above or below thresholds defined in the 1990 Institute of Medicine BMI Guidelines or weight loss in pregnac

 KQ4 What are the harms or benefits of offering the same weight gain recommendations to all pregnant women, irrespective of age and body weight co

 KQ5 What are the anthropometric tools for determining adiposity and their appropriateness for the pregnancy state?


 None of the above so exclude!

6. Article reports on an observational study, check the applicable box -

 Case series



 Cohort

 Case-control

- Cross-sectional
- Other observational 
- No, not an observational study


[Clear Selection](#)

7. Observational study is-

- Prospective
- Retrospective
- Combination, please explain 
- Other, please explain! 

[Clear Selection](#)

8. Article reports on a RCT or meta-analysis, check appropriate box.

- RCT
- Meta-analysis
- Other controlled study design, please explain 
- No, it is not a controlled trial

[Clear Selection](#)


9. Overall study n =

[Enlarge](#) [Shrink](#)


10. Duration of study?

[Enlarge](#) [Shrink](#)

11. How was pregravid weight collected?

- Self-reported
- Measured by study investigators
- Routine pre-natal care
- Other- please explain! 
- Not reported

12. How was pregravid height collected?


- Self-reported
- Measured by study investigators
- Routine pre-natal care
- Other- please explain! 
- Not reported

13. Was BMI imputed?

- Yes
- No

[Clear Selection](#)

14. How was BMI categorized?


- Continuous
- IOM guidelines
- WHO International Taskforce
- Other- please define 
- Not reported

15. Are any other anthropometric measures collected?


- Yes
- No

[Clear Selection](#)



16. How were weight gain measurements categorized?

- Continuous
- Quartiles
- According to IOM
- Other - please define 

17. How were weight gain measurements collected?

- Self-reported
- Collected by study investigators
- Routine pre-natal care or maternity records
- Other - define or explain 

18. How was total weight gain ascertained?

- Self-reported
- Based on last clinically measured weight prior to delivery 
- Other- please explain! 
- Not reported
















19. Inclusion criteria

[Enlarge](#) [Shrink](#)

20. Exclusion criteria

[Enlarge](#) [Shrink](#)

Baseline Characteristics

	Group 1	Group 2	Group 3	G
21. Groups - if only one group please put in first column	<input type="text"/> 	<input type="text"/> 	<input type="text"/> 	<input type="text"/>
22. # in group (n):	<input type="text"/> 	<input type="text"/> 	<input type="text"/> 	<input type="text"/>
23. Mean age (years):	<input type="text"/> 	<input type="text"/> 	<input type="text"/> 	<input type="text"/>
24. Weight at baseline (lbs or kgs)	<input type="text"/> 	<input type="text"/> 	<input type="text"/> 	<input type="text"/>
25. BMI at baseline	<input type="text"/> 	<input type="text"/> 	<input type="text"/> 	<input type="text"/>

26. Parity (mean):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
27. Race (% white):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
28. Race (% black):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
29. Race (% hispanic):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
30. Race (% Asian and/or Pacific region origins):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
31. Race (% other):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
32. Smoking (%):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
33. Gestational diabetes mellitus (%):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
34. Hypertension (%):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
35. Additional characteristics:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
36. Additional characteristics:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
37. Additional characteristics:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Outcomes

38. How was post-partum weight collected?

Self-reported

Measured by study investigators

Routine care

Other- please explain!

Not reported

39. What type of statistical analysis was used? Check all that apply.

Bivariate

Multivariate

Risk ratios

Odds ratios

ANOVA







Other- please explain

40. If relevant, define comparison or reference group.

[Enlarge](#) [Shrink](#)

Outcomes- primarily bivariate

	Group 1	Group 2	Group 3	G
41. Groups - if only one group please put in first column. With intervention include p-values for example, (P < 0.05).	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
42. # in group (n):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
43. Birthweight (lbs or kgs):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
44. Maternal weight gain:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
45. Gestational diabetes (%):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

46. Caeserian delivery (%):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
47. Use of episiotomy:	<input type="text"/> 	<input type="text"/> 	<input type="text"/> 	<input type="text"/>
48. Instrumental delivery (%):	<input type="text"/> 	<input type="text"/> 	<input type="text"/> 	<input type="text"/>




49. Additional maternal outcomes of interest- please be brief!

[Enlarge](#) [Shrink](#)

50. Additional infant outcomes of interest- please be brief!


[Enlarge](#) [Shrink](#)

51. Maternal confounders accounted for in analysis:

- Age
- Race
- Parity
- Pre-gravid BMI
- GDM
- Pregnancy induced hypertension
- Pre-eclampsia
- Eclampsia
- C-section
- Post-partum weight retention
- Lactation/ Breast feeding (Which one?) 
- Obesity (How defined or categorized?) 
- Type 1 Diabetes or pre-existing Type 2 Diabetes
- CVD
- Cancer
- Others- please list 
- Smoking
- Pre-existing hypertension



















































52. Infant and child confounders accounted for in analysis:

- Pre-term birth
- Gestational age
- Birth weight
- SGA
- LGA
- Birth length
- Child weight/height
- Childhood obesity




- Childhood diabetes (Type 1)
- Child with CVD
- Child's blood pressure
- Others- please list 

53. More outcomes- mostly multivariate!




[Enlarge](#) [Shrink](#)





Category or confounder	Group 1	Group 2	Group 3	G	
54. Groups - if only one group please put in second column following confounder. If result is an odds ratio (95% CI) should be included.	<input type="checkbox"/>	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
55. # in group (n):	<input type="checkbox"/>	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
56. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
57. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
58. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
59. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
60. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
61. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
62. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
63. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
64. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
65. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>
66. Confounder:	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>





Additional outcomes





Characteristic	Group 1	Group 2	Group 3	G	
67. Outcomes - if only one outcome please put in second column following characteristic column. If result is an odds ratio (95% CI)	<input type="checkbox"/>	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/> 	<input style="width: 150px;" type="text"/>





should be included.





68. # in group (n):   





69. Characteristic:    





70. Characteristic:    





71. Characteristic:    





72. Characteristic:    





73. Characteristic:    





74. Characteristic:    

75. Characteristic:    


76. Characteristic:    


77. Characteristic:    


78. Characteristic:    

79. Characteristic:    

80. Is study generalizable?

Yes - why? 

No- why not? 

Can't tell... 

[Clear Selection](#)

Quality Review

81. Randomization adequate?

Yes

No

Not randomized

Method not reported

[Clear Selection](#)

82. Allocation concealment adequate?

Yes

No

Not randomized

Method not reported

[Clear Selection](#)

83. Groups similar at baseline?

Yes

No

[Clear Selection](#)84. **Outcome assessors masked?**

- Yes
- No
- Yes, but method not described
- Not reported

[Clear Selection](#)85. **Care provider masked?**

- Yes
- No
- Yes, but method not described
- Not reported


[Clear Selection](#)86. **Patient masked?**

- Yes
- No
- Yes, but method not described
- Not reported

[Clear Selection](#)87. **What was lost to follow-up (%)?**[Enlarge](#) [Shrink](#)88. **How many dropped out (%)?**[Enlarge](#) [Shrink](#)89. **Was the statistical analysis based on intention-to-treat (ITT)?**

- Yes
- No
- Cannot tell

[Clear Selection](#)90. **Were there any post-randomization exclusions?**

- Yes (how many?) 
- No
- Cannot tell

[Clear Selection](#)91. **Quality rating for efficacy/effectiveness**

- Good
- Fair
- Poor

Why?

92. Were both groups selected from the same source population?

- Yes
- No
- Yes, but method not described
- Not reported

[Clear Selection](#)

93. Did both groups have the same risk of having the outcome of interest at baseline?

- Yes
- No
- Not reported

[Clear Selection](#)

94. Were subjects in both groups recruited over the same time period?

- Yes
- No
- Yes, but method not described
- Not reported

[Clear Selection](#)

95. Was there any obvious selection bias?

- Yes
- No
- Not reported

[Clear Selection](#)

96. Were ascertainment methods adequate and equally applied to both groups?

- Yes
- No
- Not reported

[Clear Selection](#)

97. Was an attempt made to blind the outcome assessors?

- Yes
- No
- Yes, but method not described
- Not reported

[Clear Selection](#)

98. Was the time of follow-up equal in both groups?

- Yes
- No
- Not reported

[Clear Selection](#)

99. What was lost to follow-up (%)?

[Enlarge](#) [Shrink](#)

100. How many dropped out (%)?

[Enlarge](#) [Shrink](#)

101. Did the statistical analysis consider potential confounders or adjust for different lengths of follow-up?

- Yes
- No
- Yes, but method not described
- Not reported

[Clear Selection](#)

102. Was the length of follow-up adequate to assess the outcome of interest?

- Yes
- No
- Not reported

[Clear Selection](#)



103. Quality rating for observational studies

- Good
- Fair
- Poor

Why?

104. Is the principle focus of this article maternal weight gain and associated outcomes

- Yes 
- No then limit abstraction to MWG and associated outcomes and the confounders and effect modifiers 

105. Time frame?

[Enlarge](#) [Shrink](#)[Save to finish later](#)[Submit Data](#)

Form took 1.953125 seconds to render
Form Creation Date: Not available
Form Last Modified: Aug 20 2007 10:20AM

Evidence Table Template

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
Author, year:	Design:	Pregravid weight:	Race,%:
Country and setting:	Total Study N:	Pregravid BMI:	White
Enrollment period:	Group Description:	Age (mean, yrs):	Black
Funding:	Group N:	Parity:	Hispanic
Study Objective:	Inclusion criteria:		Asian/Pacific Islander
Time frame:	Exclusion criteria:		Other
Duration of the study:	<ul style="list-style-type: none">•		Smoking,%:
			Diabetes mellitus,%:
			Hypertension,%:
			Additional characteristics:

Evidence Table x

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): Total weight gain: Categorized: Collected from: Ascertained by: •	Birth weight: Gestational diabetes, %: Cesarean delivery, %: Instrumental delivery, %: Episiotomy, %: Other maternal outcomes: Other infant outcomes:	Outcomes Description: Groups: Results: Maternal confounders and effect modifiers accounted for in analysis: Infant and child confounders and effect modifiers accounted for in analysis:	Background: Sample selection: Definition of maternal weight gain: Definition of outcomes: Source of information on exposure, outcomes, and confounders: Followup: Analysis comparability: Analysis of outcomes: Interpretation: Sum of Good/Fair/Poor: Final Quality Score:

Quality Rating Form

(Items in yellow highlight not likely to be relevant for observational studies)

1. Background/Context

1.1. Provision of Background Information:

Is the study presented in the context of prior research and/or clinical practice?

Yes	
No	
Partially/Somewhat	
NA	

1.2. Problem/question clearly stated:

Is the hypothesis/aim/objective of the study clearly described?¹⁻³

Yes	
No	
Partially/Somewhat	
NA	

2. Sample Definition and Selection

2.1. Retrospective/prospective:

Is the study design prospective, retrospective, or mixed? *Higher score for prospective*

Retrospective	
Prospective	
Mixed	

2.2. Inclusion/exclusion criteria:

a. Are the inclusion/exclusion criteria explicitly stated? [May want to ask individually about unique criteria that are critically important.]

Yes	
No	
Partially/Somewhat	

b. Were inclusion/exclusion criteria applied uniformly to all groups?

Yes	
No	
Partially/Somewhat	
Cannot determine	
NA	

- c. If prospective or mixed, were the pathways by which participants entered the study (recruitment strategy) clearly described?

Yes	
No	
Partially/Somewhat	
Cannot determine	
NA	

- d. Are the characteristics of the participants included in the study clearly described? [In cohort studies and trials, inclusion and/or exclusion criteria should be given. In case-control studies, a case-definition and the source for controls should be given.]⁴

Yes	
No	
Partially/Somewhat	
Cannot determine	
NA	

- 2.3. c. Was there a power analysis or some other basis noted for determining the adequacy of study group sizes?⁵

Yes	
No	
NA (birth certificate or birth registry)	

- 2.4. Selected to be representative (External validity measure)

- a. Are the individuals selected to participate in the study likely to be representative of the target population? [selected from the relevant population, representative of whom results would be generalized]^{6,7}

Very likely	
Somewhat likely	
Not likely	
Cannot determine	
NA	

3. Interventions/exposure

- 3.1. Clear specification

- a. Is weight gain or rate of weight gain clearly defined?

Low (unclear, many details missing)	
Medium (pretty clear, most details provided)	
Very clear (all essential details provided)	

- b. Does the description of the intervention/exposure adequately describe (list separately): setting, duration, frequency, intensity.

Low (unclear, many details missing)	
Medium (pretty clear, most details provided)	
Very clear (all essential details provided)	

- c. Is the test reference standard (diagnostic test) clearly specified?

Low (unclear, many details missing)	
Medium (pretty clear, most details provided)	
Very clear (all essential details provided)	

- d. Is there a clearly specified intervention protocol?

Low (unclear, many details missing)	
Medium (pretty clear, most details provided)	
Very clear (all essential details provided)	

3.2. Concurrent/concomitant treatment

- a. Is usual clinical care clearly described?

Low (unclear, many details missing)	
Medium (pretty clear, most details provided)	
Very clear (all essential details provided)	

3.4 Was pregravid weight checked for biological plausibility?

Yes	
No	
Not applicable (from first prenatal visit, or measured)	

3.5 Details on data cleaning (on outliers)?

No information (unclear, many details missing)	
Medium (pretty clear, most details provided)	
Very clear (all essential details provided)	

4. Outcomes

4.1 Clear specification

- a. Are the primary outcomes clearly described?⁹ [this can be asked for all outcomes together or each primary outcome can be listed separately]

Low (unclear, many details missing)	
Medium (pretty clear, most details provided)	
Very clear (all essential details provided)	

- c. Are study questions relevant to the key questions of the SER? This should be part of an applicability rating, not study quality. Should it be deleted?

Yes	
Partially	
No	

5. Creation of treatment groups

5.3. How allocation occurred

- a. Is assignment made to study groups randomly?⁵ *Yes/No*

Yes	
No	

- b. Is an explicit case/comparison definition provided?

Yes	
No	
Partially/Somewhat	
Cannot determine	
NA	

- c. Are the criteria for assignment to study groups clearly described?

Yes	
No	
Partially/Somewhat	
Cannot determine	
NA	

- d. Is the selection of the non-exposed cohort appropriate?¹⁴ *Drawn from the same community as the exposed cohort/Drawn from a different source or no description of the derivation of the non- exposed cohort*

Yes	
No	
Partially/Somewhat	
Cannot determine	
NA	

5.4. Any attempt to balance

a. Any attempt to balance the allocation between the groups? /

Yes	
No	
Partially/Somewhat	
Cannot determine	
NA	

5.7. Contamination

a. Has the possibility of participants having received an unintended intervention that may influence results been reported and ruled out?¹⁴

Yes	
No	

d. Was there variation from the protocol in relation to: duration, intensity, frequency, and/or setting sufficiently large to compromise the findings?

Yes	
No	
Partially/Somewhat	
Cannot determine	
NA	

e. Is the level of adherence adequate?

Yes	
No	
Partially/Somewhat	
Cannot determine	
NA	

f. Is the evaluation of adherence adequate?

Yes	
No	
Partially/Somewhat	
Cannot determine	
NA	

6. Blinding

6.1. Blind or double blind administration

- a. Is there blinding of study subjects? (Blinding may not be possible with some interventions.)

Yes, all arms	
Yes, some arms	
No	
NA	

- b. Are those administering the intervention blinded to the study subject's exposure status? Blinding may not be possible with some interventions.

Yes	
No	
NA	

6.2. Blind outcomes assessment

- a. Are the outcome assessors blinded to the intervention or exposure status of participants?^{6,7}

Yes	
No	
NA	

7. Soundness of information

7.1. Source of information re interventions/exposure

- a. How was maternal weight gain or rate of weight gain obtained?

All self report (poor)	
Combination of self report and measured by observer (fair)	
All measured by observer, using pregravid weight or weight in first trimester and weight at last measurement before or at delivery (good)	

7.2. Source of information re outcomes

Are the sources establishing the validity and reliability of outcome measures described or referenced?^{15,16} [may want to list important measures separately]

Good	
------	--

Fair	
Poor	

8. Follow-up

8.1 Equality of length of follow-up for participants

In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls?⁴ [Where follow-up was the same for all study patients the answer is yes. If different lengths of follow-up were adjusted by, for example, survival analysis, the answer is yes. Studies where differences in follow-up are ignored should be answered no.]

Yes	
No	
Cannot determine	
NA (cross-sectional)	

8.2 Length of followup adequate

b. Is the length of followup sufficient to support the conclusions of the study?

Yes	
No	
NA (cross-sectional)	

8.3 Completeness of followup

Are the reasons why study subjects were lost to follow-up adequately reported?

Good	
Fair	
Poor	
NA (cross-sectional or retrospective)	

9. Analysis comparability

9.1 Assessment of baseline comparability by design

b. Are the cohorts comparable through the design of the study? If not, does the analysis control for differences?

Yes	
No	
Cannot determine	
NA	

- c. For categorical variables, is the choice of control/non-exposure groups reasonable? *Yes/No*

Yes	
No	
Partial/somewhat	
NA	

9.2. Identification of prognostic factors

- a. Does the study adequately identify confounding and modifying variables?

Gestational age at the time of weight measurement

Gestational age at delivery

Pregravid BMI

Smoking

Preexisting health condition (eating disorders, ??)

Pregnancy complications (PIH, GDM)

Parity

Age of mother

Race

SES or education (diet, physical, activity, access to medical care, proxy for other things)

Weight retention confounders (diet, energy expenditure/exercise/return to work, breastfeeding, maternal illness, pregnancy)

[list measures]

All	
Some	
None	

- b. Are the principal confounders in each group of subjects to be compared clearly described?⁴ [A list of principal confounders is provided.]

Yes	
No	
Somewhat	

7.4. Source of information re confounders

Are the sources establishing the validity and reliability of confounders described or referenced?^{15,16} [may want to list important measures separately]

Good (objective)	
Fair (self-report)	
Poor (not described)	

9.3. Adjustment for confounding

Is there adequate adjustment in the analysis for confounding variables? *Yes, No, Unable to determine*

Yes	
No	
Partially/somewhat	
Unable to determine	
NA	

10. Analysis outcome

10.1. Intention-to-treat analysis

a. **Is intention-to-treat (ITT) analysis reported?¹⁷**

Yes	
No	

b. Are all enrolled subjects (patients and comparison groups) accounted for in follow-up?¹⁸

Yes	
No	
Cannot determine	
NA	

c. Are all enrolled subjects accounted for in the follow-up through assessment of the impact of dropout rates, sensitivity analysis, or other intention-to-treat adjustment methods?

Yes	
No	
Cannot determine	
NA	

- d. Are subject withdrawals, lost to follow-up, and missing data adequately accounted for in the analysis? *Inadequate/Adequate/Excellent/Unable to determine*

Good	
Fair	
Poor/No	
NA	

Actual loss-to-followup or Missing data:

Missing data:

10.2. Appropriate statistical methods

- a. Is the statistical approach for analyzing the data reported in sufficient detail so that reported results may be replicated?¹⁹

Yes	
No	
Partially/somewhat	
Unable to determine	
NA	

- b. Are the statistical methods used to assess the main outcome appropriate to the data?^{20,21} *Yes/No/Unable to determine*

Yes	
No	
Partially/Somewhat	

i. Multivariate analysis

Yes	
No	

- ii. For cohort studies only, if the outcome has a greater than 10 percent prevalence, is the risk ratio and relative risk calculated directly (not using logistic regression)?

Yes	
No	
For some outcomes	
NA	

11. Interpretation

11.1. Appropriately based on results

- a. Are results interpreted appropriately based on study design and statistical analysis (trends noted, precision of confidence intervals noted, statistical results are clearly differentiated)?

Yes	
No	
Partially/somewhat	

- b. Are conclusions supported by results with possible bias and limitations taken into consideration?²²

					5 (excellent, clearly defined)
0 (poor, not defined)	1	2	3	4	

11.3. Application/implications

Are the results generally applicable or limited to one particular healthcare delivery setting?⁵

General	
Limited	

11.4. Clinical importance and statistical significance

- a. Are the statistical findings presented in a manner that is clinically useful?

Yes	
No	
Somewhat	

Are the statistical findings clinically useful?

Yes	
No	
Somewhat	

11.5. Interpretation in context

Are study conclusions presented in the context of prior research?

Yes	
No	
Somewhat	

References

1. McAlister F, Ezekowitz J, Wiebe N, Rowe B, Spooner C, Crumley E, et al. Cardiac Resynchronization Therapy for Congestive Heart Failure. Evidence Report/Technology Assessment No. 106 (Prepared by the University of Alberta Evidence-based Practice Center under Contract No. 290-02-0023). AHRQ Publication No. 05-E001-2. Rockville, MD: Agency for Healthcare Research and Quality 2004.
2. Buscemi N, Vandermeer B, Pandya R, Hooton N, Tjosvold L, Hartling L, et al. Melatonin for Treatment of Sleep Disorders. Evidence Report/Technology Assessment No. 108 (Prepared by the University of Alberta Evidence-based Practice Center under Contract No. 290-02-0023). AHRQ Publication No. 05-E001-2. Rockville, MD: Agency for Healthcare Research and Quality. 2004.
3. Schachter H, Reisman J, Tran K, Dales b, Kourad K, Barnes D, et al. Health Effects of Omega-3 Fatty Acids on Asthma. Evidence Report/Technology Assessment No. 91 (Prepared by the University of Ottawa Evidence-based Practice Center under Contract No. 290-02-0021). AHRQ Publication No. 04-E013-2. Rockville, MD: Agency for Healthcare Research and Quality 2004.
4. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Comm Health.* 1998;52:377-84.
5. Bonito AJ, Palton LL, Shugars DA, Lohr KN, Nelson MP, Bader JD, et al. Management of dental patients who are HIV-positive. Evidence Report/Technology Assessment No. 37. AHRQ Publication No. 01-E042. Rockville, MD: Agency for Healthcare Research and Quality 2002.
6. Ellis P, Robineson P, Ciliska D, al. e. Diffusion and Dissemination of Evidence-based Cancer Control Interventions. Evidence Report/Technology Assessment Number 79. (Prepared by McMaster University under Contract No. 290-97-0017.) AHRQ Publication No. 03-E033 Rockville, MD: Agency for Healthcare Research and Quality 2003.
7. Oremus M, Hanson M, Whitlock r, Young E, Gupta A, Dal Cin A, et al. Appendix E - Quality Assessment - Effective Public Health Practice Project Quality Assessment Tool 2003. *The Uses of Heparin to Treat Burn Injury*: Evidence Report/Technology Assessment No. 148. (Prepared by the McMaster University Evidence-based Practice Center, under Contract No. 290-02-0020). AHRQ Publication No. 07-E004. Rockville, MD: Agency for Healthcare Research and Quality 2006.
8. Berkman ND, Bulik CM, Brownley KA, Lohr KN, Sedway JA, Rooks A, et al. Management of eating disorders. Evidence Report/Technology Assessment Number 135. AHRQ Publication No. 06-E010. Rockville, Md: Agency for Healthcare Research and Quality 2006.
9. Viswanathan M, Ammerman A, Eng E, Gartlehner G, Lohr KN, Griffith D, et al. Community-based participatory research: assessing the evidence. Evidence Report/Technology Assessment No. 99. AHRQ Publication No. 04-E022-2. Rockville, MD: Agency for Healthcare Research and Quality 2004.
10. Chou R, Fu R, Carson S, Saha S, Helfand M. Chapter 2: Methods. *Empirical Evaluation of the Association Between Methodological Shortcomings and Estimates of Adverse Events*: Technical Review No. 13. (Prepared by the Oregon Evidence-based Practice Center under Contract No. 290-02-0024.) AHRQ Publication No. 07-0003. Rockville, MD: Agency for Healthcare Research and Quality 2006.

11. Hodge W, Barnes D, Schachter H, Pan Y, Lowcock E, Zhang L, et al. Effects of Omega-3 Fatty Acids on Eye Health. Evidence Report/Technology Assessment No. 117 (Prepared by University of Ottawa Evidence-based Practice Center under Contract No. 290-02-0021.) AHRQ Publication No. 05-E008-2. Rockville, MD: Agency for Healthcare Research and Quality 2005.
12. Viswanathan M, King VJ, Bordley C, Honeycutt AA, Wittenborn J, Jackman AM, et al. Management of bronchiolitis in infants and children. Evidence Report/Technology Assessment Number 69. AHRQ Publication No. 03-E014. Rockville, MD: Agency for Healthcare Research and Quality 2003.
13. Viswanathan M, Hartmann K, McKoy N, Stuart G, Rankins N, Thieda P, et al. Management of Uterine Fibroids: An Update of the Evidence. RTI International–University of North Carolina Evidence-based Practice Center, Contract No. 290-02-0016 2007.
14. Santaguida PL, Balion C, Hunt D, Morrison K, Gerstein H, Raina P, et al. Diagnosis, Prognosis, and Treatment of Impaired Glucose Tolerance and Impaired Fasting Glucose. Evidence Report/Technology Assessment No. 128. (Prepared by the McMaster University Evidence-based Practice Center under Contract No. 290-02-0020). AHRQ Pub No. 05-E026-2. Rockville, MD: Agency for Healthcare Research and Quality 2005.
15. Coulter ID, Hardy ML, Favreau JT, Elfenbaum PD, Morton SC, Roth EA, et al. Structured Abstract. *Mind-Body Interventions for Gastrointestinal Conditions*: Evidence Report/Technology Assessment No. 40. (Prepared by the Southern California Evidence-based Practice Center/RAND under Contract No. 290-97-0001). AHRQ Publication No. 01-E030. Rockville, MD: Agency for Healthcare Research and Quality 2001.
16. Hardy M, Coulter I, Venuturupalli S, al e. Ayurvedic Interventions for Diabetes Mellitus: A Systematic Review. Evidence Report/Technology Assessment No. 41 (Prepared by Southern California Evidence-based Practice Center/RAND under Contract No. 290-97-0001). AHRQ Publication No. 01-E040 2001.
17. Viswanathan M, Hartmann K, Palmieri R, Lux L, Swinson T, Lohr KN, et al. The use of episiotomy in obstetrical care: a systematic review. Evidence Report/Technology Assessment No. 112. AHRQ Publication No. 05-E009-1. Rockville, MD: Agency for Healthcare Research and Quality 2005.
18. Levine C, Ganz N, Estok R, Stone L, Ludensky V. Systematic Review of the Current Literature Related to Disability and Chronic Fatigue Syndrome. Evidence Report/Technology Assessment No. 66. (Prepared by MetaWorks Inc. Evidence-based Practice Center under Contract No 290-97-0016). AHRQ Publication No. 03-E007. Rockville, MD: Agency for Healthcare Research and Quality 2002.
19. Lau J, Ioannidis J, Balk E, Milch C, Chew P, Terrin N, et al. Evaluation of Technologies for Identifying Acute Cardiac Ischemia in Emergency Departments. Evidence Report/Technology Assessment Number 26. (Prepared by The New England Medical Center Evidence-based Practice Center under Contract No. 290-97-0019) AHRQ Publication No. 01-E006, Rockville, MD: Agency for Healthcare Research and Quality 2001.
20. Gaynes BN, Gavin N, Meltzer-Brody S, Lohr KN, Swinson T, Gartlehner G, et al. Perinatal depression: prevalence, screening accuracy, and screening outcomes. Evidence Report/Technology Assessment No. 119. AHRQ Publication No. 05-E006-2. Rockville, MD: Agency for Healthcare Research and Quality 2005.
21. Kiddoo D, Klassen TP, Lang ME, Friesen C, Russell K, Spooner C, et al. The Effectiveness of Different Methods of Toilet Training for Bowel and Bladder Control. Evidence Report/Technology Assessment No. 147. (Prepared by the University of Alberta Evidence-based Practice Center, under contract number 290-02-0023). AHRQ

- Publication No. 07-E003. Rockville, MD: Agency for Healthcare Research and Quality 2006.
22. Wilt TJ, Lederle FA, MacDonald R, Jonk YC, Rector TS, Kane RL. Appendix D. Abdominal Aortic Aneurysm (AAA): Surveillance Article Abstraction Form. *Comparison Endovascular and Open Surgical Repairs for Abdominal Aortic Aneurysm: Evidence Report/Technology Assessment No. 144.* (Prepared by the University of Minnesota Evidencebased Practice Center under Contract No. 290-02-0009.) AHRQ Publication No. Rockville, MD. Agency for Healthcare Research and Quality 2006:D2-D9.
 23. Beach J, Rowe BH, Blitz S, Crumley E, Hooton N, Russell K, et al. Diagnosis and Management of Work-Related Asthma. Evidence Report/Technology Assessment No. 129. (Prepared by the University of Alberta Evidence-based Practice Center, under Contract No. 290-02-0023.) AHRQ Publication No. 06-E003-2. Rockville, MD: Agency for Healthcare Research and Quality 2005.
 24. Shekelle P, Takata G, Chan L, Mangione-Smith R, Corley PM, Morpew T, et al. Diagnosis, Natural History, and Late Effects of Otitis Media with Effusion. Evidence Report/Technology Assessment No. 55 (Prepared by Southern California Evidence-based Practice Center under Contract No 290-97-0001, Task Order No. 4). AHRQ Publication No. 03-E023. Rockville, MD: Agency for Healthcare Research and Quality 2003.

Appendix C. Evidence Tables

Glossary

adj	adjusted	MWG	maternal weight gain
AGA	appropriate for gestational age	N	number
AOR	adjusted odds ratio?	NA	not applicable
bf	body fat	NICU	neonatal intensive care unit
BF	breast feeding	NIH	National Institutes of Health
bp	blood pressure	NIMU	neonatal intensive medical unit
BMI	body mass index	NR	not reported
CI	Confidence interval	NVSD	normal spontaneous vaginal delivery
CPD	cardiopulmonary disease	OGTT	oral glucose tolerance test
CPS	Collaborative Perinatal Study	p	P-value
ECW	extra cellular water	PE	pulmonary embolism
g	gram	pg	pregnancy?
ga	gestational age	PIH	pregnancy induced hypertension
GDM	gestational diabetes	PNC	prenatal care
gest	gestational	PPWR	postpartum weight reduction
GWG	gestational weigh gain	Prepg	prepregnancy
HDL	high density lipoprotein	PTB	preterm birth
HDP	hypertensive disorders of pregnancy	RR	relative risk
hg	hemoglobin	SD	standard deviation
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification	SE	standard error
IGT	impaired glucose tolerance	SGA	small for gestational age
IGUR	intrauterine growth retardation	TBW	total body water
IOM	Institute of Medicine	TSF	triceps skinfold
IUGR	intrauterine growth restriction	UCSF	University of California at San Francisco
IVF	in vitro fertilization	US	United States
kg	kilogram	VBAC	vaginal birth after cesarean
kg/wk	kilogram per week	VLBW	very low birth weight
lb	pound	WHO	World Health Organization
LBW	low birth weight	WHR	waist to hip ratio
LGA	large for gestational age	WIC	Women's, Infant, and Children program
MCH	maternal and child health		

Evidence Table 1. Gestational weight gain and discomforts of pregnancy

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Atwal et al., 2006</p> <p>Country and setting: United Kingdom, hospital</p> <p>Enrollment period: 4-month period (1 March 2000 to 30 June 2000 inclusive)</p> <p>Funding: NR</p> <p>Study Objective: To observe prevalence of striae gravidarum in primiparae and identify independent associated risk factors</p> <p>Time frame: 4-month period (1 March 2000 to 30 June 2000 inclusive)</p> <p>Duration of the study: Duration of pregnancy</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 309</p> <p>Group Description: NR</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Primiparae who delivered after 28 weeks of gestational age and had no previous pregnancies lasting more than 12 weeks <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple births • Non-white women 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Booking weight <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized: NR</p> <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 1. Gestational weight gain and discomforts of pregnancy (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: Odds ratio 1.08 (95% CI 1.02-1.14) <i>P</i> = 0.0121</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Not clear <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> • Women with largest weight gain had greatest incidence of striae <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Striae gravidum (%)</p> <p>Groups: G1: MWG < 15 kg G2: MWG > 15 kg</p> <p>Results: G1: 47 G2: 60</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 1. Gestational weight gain and discomforts of pregnancy (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Madlon-Kay DJ, 1993</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: NR</p> <p>Funding: Grant from American Academy of Family Physicians and Ramsey Foundation</p> <p>Study Objective: To study factors associated with formation of striae gravidarum and measures used by women to prevent them</p> <p>Time frame: NR</p> <p>Duration of the study: From gestational weeks 34 to 36 until birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 48</p> <p>Group Description:</p> <p>G1: All</p> <p>G2: Abdominal Striae Present</p> <p>G3: Abdominal Striae Absent</p> <p>Group N:</p> <p>G1: 48</p> <p>G2: 22</p> <p>G3: 26</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Nulliparous women at 34-36 weeks' gestational age who planned to give birth at either of 2 study hospitals <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • NR <p>G2: 61.7kg</p> <p>G3: 58.5kg</p> <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NR <p>Age (mean, yrs):</p> <p>G1: 26.7</p> <p>G2: 25 P < 0.05</p> <p>G3: 28 P < 0.05</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White</p> <p>G1: 98%</p> <p>G2: NR</p> <p>Black</p> <p>NR</p> <p>Hispanic</p> <p>NR</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 1. Gestational weight gain and discomforts of pregnancy (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): Total weight gain: G1: 17.6kg $P < 0.05$ G2: 14kg $P < 0.05$ Categorized: <ul style="list-style-type: none"> • Continuous Collected from: <ul style="list-style-type: none"> • Not stated Ascertained by: <ul style="list-style-type: none"> • Hospital charts 	Birth weight: G1: NR G2: NR Gestational diabetes, %: NR Cesarean delivery, %: NR Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: NR Other infant outcomes: NR	Outcomes Description: Abdominal striae (kg) Groups: G1: Abdominal Striae Present G2: Abdominal Striae Absent Results: Pregnancy weight gain in abdominal striae groups (kg) G1: 14.9 G2: 13.0 $P < 0.05$ Maternal confounders and effect modifiers accounted for in analysis: NA Infant and child confounders and effect modifiers accounted for in analysis: NA	Background: Good Sample selection: Poor Definition of maternal weight gain: Poor Definition of outcomes: Poor Source of information on exposure, outcomes, and confounders: Poor Followup: Fair Analysis comparability: Poor Analysis of outcomes: Fair Interpretation: Fair Sum of Good/Fair/Poor: 1 Good, 3 Fair, 5 Poor Final Quality Score: Poor

Evidence Table 1. Gestational weight gain and discomforts of pregnancy (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Marrero et al., 1992</p> <p>Country and setting: UK, teaching hospital</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: To study prevalence and severity of reflux symptoms in pregnancy</p> <p>Time frame: NR</p> <p>Duration of the study: 91 were in first trimester, 274 in second and 228 in third</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cross-sectional • Retrospective <p>Total Study N: 607</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 607 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Consecutive patients in antenatal clinic <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • incomplete survey responses 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 29.5 G2: NR</p> <p>Parity: % primigravid G1: 37.2 G2: NR</p>	<p>Race, %: White G1: 65% G2: NR</p> <p>Black G1: 14% G2: NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander G1: 16% G2: NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 1. Gestational weight gain and discomforts of pregnancy (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Says record but not clearly stated <p>Ascertained by:</p> <ul style="list-style-type: none"> Weight gain in this paper was up until time of questionnaire NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: BMI before pregnancy and weight gain in pregnancy were not found to be risk factors for pregnancy heartburn</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Heartburn</p> <p>Groups: NA, continuous weight gain measure</p> <p>Results: Weight gain in pregnancy not risk factor for heartburn in pregnancy</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 1. Gestational weight gain and discomforts of pregnancy (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Rodriguez et al., 2001</p> <p>Country and setting: Sweden, prenatal health care centers</p> <p>Enrollment Period: NR</p> <p>Funding: Swedish Council of Planning and Coordination of Research and Knut and Alice Wallenberg Foundation</p> <p>Study Objective: To document prevalence and frequency of 27 pregnancy symptoms and to systematically investigate, cross sectionally and prospectively, effect of psychosocial factors on prevalence and frequency of these symptoms, while controlling for biomedical</p> <p>Time frame: NR</p> <p>Duration of the study: initiation of prenatal care to delivery</p> <p>Quality: Fair</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 476 nulliparous Scandanavian women</p> <p>Group Description:</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Nulliparous • Scandinavian origin • Solicited by midwives from 5 prenatal health care centers (91% of women agreed to participate and provided information on at least one measure) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care recorded at first prenatal care visit <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Underweight BMI < 20; normal weight BMI 20-24.99; overweight BMI > 25 <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 1. Gestational weight gain and discomforts of pregnancy (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: weight at delivery minus prepreg weight 	<p>Birth weight: G1: 3.457 (0.633) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Pregnancy symptoms: urogenital, gastrointestinal, musculoskeletal, miscellaneous pregnancy symptoms <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Pearson correlation coefficient (r) for prevalence of 27 pregnancy symptoms for continuous weight gain measure Pearson correlation coefficient (r) for frequency of 27 pregnancy symptoms for continuous weight gain measure</p> <p>Groups: G1: Week 10 G2: Week 12 G3: Week 20 G4: Week 28 G5: Week 32 G6: Week 36</p> <p>Results Prevalence G1: 0.05 G2: 0.03 G3: 0.13 ($P < 0.05$) G4: 0.16 ($P < 0.01$) G5: 0.18 ($P < 0.01$) G6: 0.19 ($P < 0.001$)</p> <p>Frequency G1: 0.09 G2: 0.04 G3: 0.11 ($P < 0.05$) G4: 0.16 ($P < 0.01$) G5: 0.19 ($P < 0.01$) G6: 0.24 ($P < 0.001$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 7 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 1. Gestational weight gain and discomforts of pregnancy (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Tulman et al., 1998</p> <p>Country and setting: USA, obstetric and nurse-midwifery practices</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: To examine relationship of prepregnancy weight and pregnancy weight gain to functional status, physical symptoms, and physical energy</p> <p>Time frame: NR</p> <p>Duration of the study: Recruited from practices and had home visits during pregnancy-thus during pregnancy through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 222</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 222 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Englishspeaking, married, pregnant women at low risk who were 18 years of age and older. Participants could have no underlying medical problems (e.g., diabetes, chronic renal or cardiac disease) or preexisting factors in their obstetric histories that would classify them as high risk at time of recruitment during first trimester of pregnancy (e.g., previous premature birth, history of incompetent cervix) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Mmultiple gestations, if they delivered before 36 weeks, missing information on weight at first trimester interview or third trimester interview 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 22.82 (SD 3.49) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelinesno obese category - just > 26 <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 1. Gestational weight gain and discomforts of pregnancy (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 222 G2: NR</p> <p>Total weight gain: G1: 13.93 kg (SD 4.63) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Collected from:</p> <ul style="list-style-type: none"> • Collected by study investigators • Percentage weight gain during pregnancy <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery: difference in pounds between prepg weight and weight at time of data collection • Percentage weight gain during pregnancy was calculated as weight gain in pounds divided by prepregnancy weight 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> • There was a statistically significant difference in functional status between women whose total weight gain for pregnancy was more than recommended amount based on prepregnancy BMI (n = 62) and those who gained within recommended range (n = 160), t(220) = 2.47, P = .014. • Women who gained an excessive amount of weight had a lower third trimester level of functional status (M = 2.30) than those who did not (M = 2.43). • There were no differences in number of physical symptoms or level of physical energy for women who gained an excessive amount of weight and those who did not <p>Other infant outcomes:</p> <ul style="list-style-type: none"> • None 	<p>Outcomes Description: Inventory of Functional Status – Antepartum Period, 1-3 point scale (mean, SD)</p> <p>Groups: G1: Excess weight gain G2: Weight gain within recommended range</p> <p>Results: G1: 2.3 G2: 2.43 <i>P</i> < 0.014</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 2. Gestational weight gain and hyperemesis

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Dodds et al., 2006</p> <p>Country and setting: Canada, perinatal database</p> <p>Enrollment Period: 1988-2002</p> <p>Funding: NR</p> <p>Study Objective: To evaluate maternal and neonatal outcomes among women with hyperemesis during pregnancy</p> <p>Time frame: 1988-2002</p> <p>Duration of the study: Prenatal to neonatal</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 156,091</p> <p>Group Description: G1: Antepartum admission for hyperemesis G2: No antepartum admission for hyperemesis</p> <p>Group N: G1: 1,270 G2: 154,821</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton • 20 weeks or more gestation • $\geq 500g$ at birth • Hyperemetic pregnancies defined as those with 1 or more antepartum admissions for hyperemesis first of which occurred before 24 completed weeks gestation <p>Exclusion criteria: NA</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • From records in database not mentioned whether it was self reported or not <p>G1: < 60kg: 45.4% 60-69: 25.3% 70-79: 13.9% ≥ 80: 15.3%</p> <p>G2: < 60kg: 42.8% 60-69: 27.6% 70-79: 15.1% ≥ 80: 14.5%</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NR <p>Age (mean, yrs): G1: < 20 years: 12.1% 20-29: 64.8% 30-34: 17.8% 35-49: 5.4%</p> <p>G2: < 20 years: 8.0% 20-29: 56.7% 30-34: 25.5% 35-49: 9.8%</p> <p>Parity: G1: % nulliparous: 48.7 G2: 44.3</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 21.4 G2: 30.2</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 2. Gestational weight gain and hyperemesis (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> < 7kg and ≥ 7kf <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not specifically stated by authors 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Antepartum admission for hyperemesis (Kg)</p> <p>Groups: G1: No antepartum admission for hyperemesis G2: Antepartum admission for hyperemesis</p> <p>Results Adjusted RR for pregnancy weight gain < 7kg G1: 1.0 (ref) G2: 2.1 (1.8-2.5)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Maternal prepregnancy weight Time period Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 5 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 2. Gestational weight gain and hyperemesis (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Dodds et al., 2006
(continued)

Evidence Table 2. Gestational weight gain and hyperemesis (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
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Evidence Table 3. Maternal weight gain and abnormal glucose metabolism

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes: Incidence of gestational diabetes</p> <p>Groups Reported only for BMI > 35: G1: weight loss or no gain G2: 1-15 lb gain G3: 16-25 lb gain G4: 26-35 lb gain</p> <p>Results G1: 15.7% G2: 15.0% G3: 14.4% G4: 13.4% G5: 12.5% (<i>P</i> =NS)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Race Parity Clinic service Substance abuse And preexisting medical conditions <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Brennand et al., 2005</p> <p>Country and setting: Canada, medical records</p> <p>Enrollment Period: Prenatal to birth</p> <p>Funding: cree board of health and social services of James Bay (Quebec)</p> <p>Study Objective: To determine effect of pregravid weight and pregnancy weight gain on pregnancy outcomes in Cree women</p> <p>Time frame: Prenatal to birth</p> <p>Duration of the study: 7 year period: January 1994 to December 2000</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 603</p> <p>Group Description:</p> <p>G1: Normal: BMI 18.5 - 24.9</p> <p>G2: Overweight: BMI 25-29.9</p> <p>G3: Obese: BMI ≥ 30</p> <p>G4: Total</p> <p>Group N:</p> <p>G1: 139</p> <p>G2: 168</p> <p>G3: 296</p> <p>G4: 603</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Used only Cree women First birth observed per woman during study time period Must have first weight recorded within first 14 weeks gestation and final weight recorded within 4 weeks of birth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with secondary pregnancy in dataset (n = 792) Women with first weight record > 14 weeks gestation (n = 314) Women with final weight record > 4 weeks from birth (n = 202) Women with both first weight record > 14 weeks and final weight record > 4 weeks (n = 70) Women missing data on first or final weight (n = 3) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care Medical records Measured within 14 weeks of gestation <p>G1: 59.7 (5.0)</p> <p>G2: 73.0 (4.3)</p> <p>G3: 93.6 (12.3)</p> <p>G4: 80.0 (16.9)</p> <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> Yes <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce <p>Age (mean, yrs):</p> <p>G1: 20.8 (5.2)</p> <p>G2: 23.8 (5.4)</p> <p>G3: 25.5 (5.5)</p> <p>G4: 24.0 (5.7)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %:</p> <p>G1: 4.3</p> <p>G2: 14.9</p> <p>G3: 27.4</p> <p>G4: 18.6</p> <p>Hypertension, %:</p> <p>G1: 1.4</p> <p>G2: 1.8</p> <p>G3: 4.8</p> <p>G4: 3.2</p> <p>Additional characteristics:</p> <p>% low weight gain:</p> <p>G1: 20.1</p> <p>G2: 10.1</p> <p>G3: 28.0</p> <p>G4: 21.2</p> <p>% acceptable weight gain:</p> <p>G1: 28.8</p> <p>G2: 32.1</p> <p>G3: 33.4</p> <p>G4: 32.0</p> <p>% excessive weight gain:</p> <p>G1: 51.1</p> <p>G2: 57.7</p> <p>G3: 38.5</p> <p>G4: 46.6</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 139 G2: 168 G3: 296</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> 1999 Canadian guidelines <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: within 4 weeks of birth 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 4.3 G2: 14.9 G3: 27.4 G4: 18.6</p> <p>Cesarean delivery, %: G1: 10.8 G2: 11.3 G3: 24.1 (p < 0.001)</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Definition of low, adequate, and excessive weight gains: For normal weight women - adequate weight gain is 11.5 to 16 kg For overweight women, adequate weight gain is 7 to 11.5 kg For obese women, adequate weight gain is 7 to 11.5 kg Weight gain below specified range is "low" and weight gain above specified range is "excessive" <p>Other infant outcomes: > 4000g, > 4500g</p>	<p>Outcomes: Incidence of gestational diabetes and impaired glucose tolerance</p> <p>Groups: G1: "Low weight gain" G2: "Acceptable weight gain" G3: "Excessive weight gain" All categories per Canadian Guidelines</p> <p>Results: Incidence of GDM G1: 38.6% G2: 27.3% G3: 19.3% (P = 0.011)</p> <p>Incidence IGT: G1: 12.0% G2: 15.2% G3: 7.9% (P = 0.249)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 5 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Brennand et al., 2005 (continued)</p>	<ul style="list-style-type: none"> • Pregnancies with factors that may have influenced maternal weight gain such as 1 parent being non-Cree (n = 13), preterm deliveries (n = 91), twin pregnancies (n = 6), missing gestational age (n = 9) • Women with unknown glycemic status (n = 30), type 2 DM (n = 8), glycemic abnormalities before pregnancy not followed for diagnosis (n = 70) • Women classified as underweight (n = 5) 		

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
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Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Edwards et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1997-1993</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy course and outcomes in obese and normal weight women and their associations with gestational weight change</p> <p>Time frame: 1997-1993</p> <p>Duration of the study: 1997-1993</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 1,443</p> <p>Group Description: G1: Obese G2: Normal Weight G3: total sample</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Obese women and normal weight women identified from pregnancy and delivery summary records (normal weight matched to obese by race, age, parity) • Singleton deliveries • Live births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing data • Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 103.5 G2: 61</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelinesobese (> 29) and normal weight (BMI 19.8-26.0) <p>Age (mean, yrs): G1: 27.1 G2: 25.4</p> <p>Parity: NR</p>	<p>Race, %: White G1: NR G2: NR G3: 69.0 (Total sample)</p> <p>Black G1: NR G2: NR G3: 21.0 (Total sample)</p> <p>Hispanic G1: NR G2: NR G3: 7.0 (Total sample)</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: NR G2: NR G3: 4.0 (Total sample)</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 683 G2: 660</p> <p>Total weight gain: G1: 9.5 G2: 14.5 $P \leq 0.001$</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3420 G2: 3285 $P \leq 0.001$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 25.6 G2: 9.1 $P < 0.001$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes: Incidence of gestational diabetes</p> <p>Groups Pre gravid wt 19.8-26.0 BMI: G1: < 11.5 kg gain G2: 11.6-16 kg gain G3: > 16 kg gain</p> <p>Pre gravid wt > 29 kg G4: lost/gained nothing G5: 0.5-6.5 kg gain G6: 7-11.5 kg gain G7: 12-16 kg gain G8: >16 kg gain</p> <p>Results Incidence gestational diabetes: G1: 2.3% G2: 3.3% G3: 2.9% ($P = .759$)</p> <p>G4: 13.3% G5: 24.3% G6: 11.9% G7: 16.7% G8: 17.3% ($P = .554$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal age Parity Race Prenatal smoking Prenatal alcohol use Prenatal illicit drug use Pregravid health Weight and adequacy of prenatal care <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hackmon et al, 2007</p> <p>Country and setting: United States, Hospital</p> <p>Enrollment period: 2003</p> <p>Funding: NR</p> <p>Study Objective: Aim was to determine whether maternal age, prepregnancy and mid-trimester body mass index (BMI), or excessive mid-pregnancy weight gain predict abnormal glucose challenge test (GCT) results</p> <p>Time frame: 2003</p> <p>Duration of the study: Entry into prenatal care through 24 to 28 weeks of pregnancy</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 75</p> <p>Group Description: G1: Study population</p> <p>Group N: G1: 75</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Consecutive, inner city, singleton pregnancies <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Known gestational diabetes 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care • NR <p>Pregravid BMI: G1: 27.4</p> <ul style="list-style-type: none"> • <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 31 (range: 19-43)</p> <p>Parity: G1: 0.9</p>	<p>Race, %: White G1: 22 Black G1: 31 Hispanic G1: 39 Asian/Pacific Islander G1: 5 Other G1: 3</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: Abnl GCT: 29.3%</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): NR	Birth weight: NR	Outcomes : Gestational diabetes	Background: Good
Total weight gain: <ul style="list-style-type: none"> NR Categorized: <ul style="list-style-type: none"> Continuous Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> NR 	Gestational diabetes, %: G1: Abnl GCT: 29.3% Cesarean delivery, %: NR Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes <ul style="list-style-type: none"> No difference in maternal weight gain during early pregnancy between patients with abnormal versus normal GCT values (mean+SD of 4.13+/-3.2 and 4.16+/-1.67, respectively) Other infant outcomes NR	Groups NR Results There was no difference in maternal weight gain during early pregnancy between patients with abnormal versus normal GCT values (mean+/-SD of 4.13+/-3.2 and 4.16+/-1.67, respectively). Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> Gravidity Parity Ethnicity BMI Infant and child confounders and effect modifiers accounted for in analysis: NR	Sample selection: Poor Definition of maternal weight gain: Fair Definition of outcomes: Good Source of information on exposure, outcomes, and confounders: Fair Followup: Fair Analysis comparability: Poor Analysis of outcomes: Fair Interpretation: Fair Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor Final Quality Score: Fair

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kabiru and Raynor, 2004</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1999 to 2002</p> <p>Funding: NR</p> <p>Study Objective: To investigate effect of increase in body mass index category on obstetric outcomes</p> <p>Time frame: 1999 to 2002</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 5,131</p> <p>Group Description:</p> <p>G1: No change in BMI between first prenatal visit and delivery</p> <p>G2: 1 category increase in BMI between first prenatal visit and delivery</p> <p>G3: > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Group N:</p> <p>G1: 2,556</p> <p>G2: 2,252</p> <p>G3: 323</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancies <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple pregnancies • BMI < 20 • Missing BMI data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Measured at first prenatal visit <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • 20-24.9, 25-29.9, 30-34.9, 35-39.9, ≥ 40 <p>Age (mean, yrs):</p> <p>G1: 24.7 (6.1)</p> <p>G2: 24.4 (5.7)</p> <p>G3: 25.2 (5.9) <i>P</i> < 0.001</p> <p>Parity:</p> <p>G1: Gravidity (mean): 1.9 (1.9)</p> <p>G2: 1.5 (1.7)</p> <p>G3: 1.2 (1.7) <i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 1.9</p> <p>G2: 2.6</p> <p>G3: 2.8</p> <p>Black</p> <p>G1: 84.1</p> <p>G2: 82.8</p> <p>G3: 88.2</p> <p>Hispanic</p> <p>G1: 13.9</p> <p>G2: 14.6</p> <p>G3: 9.0</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>NR</p> <p>Smoking, %:</p> <p>NR</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>Mean weight gain:</p> <p>G1: 8.6 pounds (8.4)</p> <p>G2: 22.2 pounds (10.2)</p> <p>G3: 55.3 pounds (23.8)</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 579 G2: 942 G3: 189 G4: 819 G5: 790 G6: 104</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> > 35 pounds for normal BMI, > 25 pounds for overweight BMI, > 15 pounds for obese BMI <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not stated, most likely difference between weight at first prenatal visit and weight at delivery 	<p>Birth weight: G1: 2886.0 (756) G2: 3174.9 (600) G3: 3099.5 (673) <i>P</i> < 0.001 G4: 3116 (713) G5: 3269 (698) G6: 3371 (733) <i>P</i> = 0.015</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 8.2 G2: 12.6 G3: 21.0 <i>P</i> < 0.001 G4: 13.0 G5: 14.3 G6: 19.3 <i>P</i> = 0.256</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes description Incidence of gestational diabetes</p> <p>Groups: BMI < 25 first assessment: G1: no change BMI category G2: increase 1 category G3; increase > 1 category</p> <p>BMI≥25 first assessment G4: no change BMI category G5: increase 1 category G6: increase >1 category</p> <p>Results: G1: 0.5% G2: 1.5% G3: 3.7% (<i>P</i> = .005)</p> <p>G4: 1.0% G5: 3.3% G6: 1.9% (<i>P</i> = .005)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Pregravid BMI <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> NR 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kieffer et al., 2006</p> <p>Country and setting: United States, community health center</p> <p>Enrollment period: Jan 1999 to Feb 2001</p> <p>Funding: Study supported by National Institutes of Diabetes and Digestive and Kidney Diseases (grant R18DK 062344); Biostatistics and Measurement Cores of Michigan Diabetes Research and Training Center(grant NIH5P60 DK20572); General Clinic Center, National Institutes of Health (grant M01 RR00042); Maternal and Child Health Bureau (grant R40 MC00115-03); and Detroit Community Academic Urban Research Center</p> <p>Study Objective: Study assessed combined influence of maternal weight and other anthropometric and metabolic characteristics on birthweights of Latino infants</p> <p>Time frame: Jan 1999 to Feb 2001</p> <p>Duration of the study: From entry into prenatal care up til delivery. Ave ga at entry was 17 weeks.</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 1,041</p> <p>Group Description: G1: Total</p> <p>Group N: G1: 1,041</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Latino women entering prenatal care during study period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestation • Late entry into prenatal care • Previous participation in study • Miscarriage • Stillbirth • Missing records 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • When unknown or missing-used weight obtained within first 10 weeks of pregnancy <p>G1: 63.4 ±12.9</p> <p>Pregravid BMI: G1: 25.9 ±5.0</p> <p>Imputed:</p> <ul style="list-style-type: none"> • Yes <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 25.2 ±5.1</p> <p>Parity: Multiparous, no. (%)</p> <p>G1: 0 429 (41.2) 1- 574 (55.1) ≥4 38 (3.7)</p>	<p>Race,%: Hispanic G1: 100%</p> <p>Smoking,%: G1: 9% before 2% during</p> <p>Diabetes mellitus,%: G1: 6.8</p> <p>Hypertension,%: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: Total 933</p> <p>Total weight gain: G1: Adjusted R2: 0.30 kg [PE 8.2, SE 2.2, P < 0.01]</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous according to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 6.8</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Women with GDM had significantly lower average weight gain than those without GDM; weight gain not significantly related to glucose category Maternal waist, hip, and upper-arm circumference and upper-arm fat area associated with increasingly abnormal glucose categories among women with and without GDM Significant linear increase in birthweight with increasing glucose level maintained after further adjustment for maternal age, parity, BMI, weight gain, hypertensive disorders, and family history of diabetes <p>Other infant outcomes: NR</p>	<p>Outcomes Description: GDM</p> <p>Groups: NA, weight gain as continuous variable (study aim to determine relationship of anthropometric and metabolic variables on infant outcomes)</p> <p>Results Women with GDM had significantly lower average weight gain than those without GDM but weight gain was not significantly related to glucose category</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Parity Pregravid BMI Weight gain <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 7 Good, 2 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kieffer et al., 2001</p> <p>Country and setting: USA, city health system</p> <p>Enrollment Period: Latinas: August 1996 - December 1998 African Americans: January 1995 to February 1998</p> <p>Funding: Grants from Health Resources and Services Administration, Maternal and Child Health Bureau, and African American health Initiative of Blue Cross Blue Shield of Michigan Foundation</p> <p>Study Objective: To estimate prevalence of GDM, obesity, and excessive weight gain during pregnancy among Latinas and African American women and to explore risk factors associated with GDM and its implications</p> <p>Time frame: Latinas: August 1996 to December 1998 African Americans: January 1995 to February 1998</p> <p>Duration of the study: during prenatal care</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: Latinas:661 African American: 673</p> <p>Group Description: G1: Latina G2: African American</p> <p>Group N: G1: 661 G2: 673</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> African American and Latina women Received at least 4 prenatal care visits Delivery of single infant within large Detroit health system <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Documented diabetes prior to prenatal care Information on infants other than first pregnancy within study period 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported if not selfreported, used weight measured weight within 10 weeks of gestation <p>Pregravid BMI: Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines: < 19.8, 19.8-26.0, > 26.0-29.0, > 29.0-35.0, > 35.0 <p>Age (mean, yrs): G1: NR</p> <ul style="list-style-type: none"> < 20: 18.2% 20-29: 62.6% ≥ 30: 19.1% <p>G2: NR</p> <ul style="list-style-type: none"> < 20: 22.1% 20-29: 49.1% ≥ 30: 28.8% <p>Parity: % primiparous: G1: 39.7 G2: 43.6</p>	<p>Race, %: White NR Black G1: NR G2: 100 Hispanic G1: 100 G2: NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 3.8 G2: 10.7</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Married: G1: 60.3% G2: 31.5%</p> <p>Additional characteristics: NR</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): G1: 661 G2: 673 Total weight gain: G1: 29.1 (14.6) G2: 32.6 (12.1) P < 0.004 vs. Latinas Categorized: <ul style="list-style-type: none"> According to IOM Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	Birth weight: NR Gestational diabetes, %: NR Cesarean delivery, %: NR Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: NR Other infant outcomes: NR	Outcomes Description: GDM Groups: NR Results Multiple logistic regression analyses revealed statistically significant risk factors for GDM included weight gain during the first 28 wks gestation Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> Age Family history diabetes Parity BMI Weight gain first 28 weeks Ethnicity Infant and child confounders and effect modifiers accounted for in analysis: NR	Background: Good Sample selection: Fair Definition of maternal weight gain: Fair Definition of outcomes: Good Source of information on exposure, outcomes, and confounders: Fair Followup: Fair Analysis comparability: Good Analysis of outcomes: Fair Interpretation: Good Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor Final Quality Score: Fair

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Murakami et al., 2004</p> <p>Country and setting: Japan, hospital</p> <p>Enrollment Period: 2001</p> <p>Funding: NR</p> <p>Study Objective: To estimate risk of perinatal morbidity of mother and infant with respect to maternal prepregnancy BMI and weight gain in Japanese women</p> <p>Time frame: 2001</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 633</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 633 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Live, singletons delivered between 24 to 42 weeks gestation <p>Exclusion criteria:</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: 20.9 (2.8) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • WHO International Taskforce <p>Age (mean, yrs): G1: 29.1 (4.5) G2: NR</p> <p>Parity: G1: 0.6 (0.7) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 8.5 G2: NR</p> <p>Diabetes mellitus, %: G1: 2.1 G2: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: Preeclampsia - mild: 5.4%; severe: 4.1% G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 633 G2: NR</p> <p>Total weight gain: G1: 10.5 (3.4) G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> < 8.5kg, 8.5-12.5, > 12.5 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: last measurement was taken at hospitalization prior to delivery </p>	<p>Birth weight: G1: 3,052.6 (483.8) G2: NR</p> <p>Gestational diabetes, %: G1: 2.1 G2: NR</p> <p>Cesarean delivery, %: G1: 10.3 G2: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: AORs (95% CI) of gestational diabetes</p> <p>Groups G1: < 8.5 kg gain G2: 8.5-12.5 kg gain G3: >12.5 kg gain</p> <p>Results G1: 5.14 (0.97-27.20) G2: Reference G3: 3.91 (0.61-24.73)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal age Parity Smoking Weight gain Pregravid BMI <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 8 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Saldana et al., 2006</p> <p>Country and setting: United States, hospital</p> <p>Enrollment period: August 1, 1995 through May 31, 2000</p> <p>Funding: Supported in part by National Institute of General Medical Sciences (Grant R25GM55336), National Institute of Child Health and Development (Grant 28684), and North Carolina Clinical Nutrition Research (Grant DK56350)</p> <p>Study Objective: Objective of study to examine weight and its relationship to glucose intolerance during pregnancy</p> <p>Time frame: August 1, 1995 through May 31, 2000</p> <p>Duration of the study: Entry into prenatal care through end of second trimester</p> <p>Quality: Good</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 952</p> <p>Group Description: G1: Normal Glucose Tolerance G2: Impaired Glucose Tolerance G3: GDM</p> <p>Group N: G1: 809 G2: 48 G3: 95</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancy More than 16 years of age English speaking Access to phone Planned to continue care at 1 of study sites <p>Exclusion criteria:</p> <ul style="list-style-type: none"> From non-white or non-black racial group Having a second pregnancy in cohort Pre-existing diabetes No glucose screening data High screen without an oral glucose tolerance test 	<p>Pregavid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregavid BMI: G1: 25 (0.24) G2: 28 (1.1) G3: 30 (0.82)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 26 (0.22) G2: 29 (0.91) G3: 28 (0.59)</p> <p>Parity: G1: 0.9 (0.04) G2: 1.1 (0.16) G3: 0.9 (0.10)</p>	<p>Race, %: White G1: 58% G2: 73% G3: 69% Black G1: 42% G2: 27% G3: 31% Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 25% G2: 26% G3: 25%</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Weight gain ratio (observed/recommended[compared with IOM range]) G1: 1.43 (0.04) G2: 1.48 (0.21) G3: 1.88 (0.15)</p> <p>Additional characteristics: NR</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: 9.1 (0.19) G2: 8.1 (0.90) G3: 9.4 (0.62)</p> <p>Categorized:</p> <ul style="list-style-type: none"> 2 weight gain variables were created. Weight gain was calculated by subtracting prepregnancy weight from weight at end of second trimester (G2 weeks). Weight gain ratio calculated as ratio of observed weight gain to recommended <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes:</p>	<p>Outcomes Description: Impaired Glucose Tolerance GDM</p> <p>Groups: Weight gain ratio (observed/recommended)</p> <p>Results OR for weight gain ratio on Impaired Glucose Tolerance (95% CI) 0.9 (0.7, 1.1)</p> <p>OR for weight gain ratio on GDM (95% CI) 1.2 (0.9, 1.4)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Race Maternal age Gestational age of weight measurement</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Good</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 7 Good, 2 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Seghieri et al., 2005</p> <p>Country and setting: Italy, outpatient clinic</p> <p>Enrollment Period: January, 1997 to December 2003</p> <p>Funding: NR</p> <p>Study Objective: To study effect of parity on impairment of insulin sensitivity during pregnancy and on risk of GDM</p> <p>Time frame: January, 1997 to December 2003</p> <p>Duration of the study: Caucasian pregnant women who received a 3 hour OGTT at 24 to 28 weeks gestation; also 75 women whose glucose levels were tested in 2 consecutive pregnancies</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cross-sectional • Retrospective <p>Total Study N: 1880</p> <p>Group Description: G1: Parity = 0 G2: Parity = 1 G3: Parity = 2 G4: Parity = 3 G5: Parity > 3</p> <p>Group N: G1: 944 G2: 604 G3: 232 G4: 77 G5: 23</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women who tested glucose intolerant by glucose challenge or who had an elevated 1 hour glucose or had other risk factors for GDM (hx glucose intolerance, macrosomic infants, diabetes of first degree relative <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • No criteria are mentioned by authors 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Not explained in Methods section <p>Pregravid BMI: G1: 22.5 (3.4) G2: 23.4 (4.1) G3: 23.7 (4.1) G4: 24.1 (5.3) G5: 24.4 (6.1) (<i>P</i> Duncan's test after anova = 0.0001, 0 vs.3, > 3)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 29.2 (4.3) G2: 31.4 (4.5) G3: 31.9 (4.5) G4: 33.8 (4.3) G5: 35.2 (4.2) (<i>P</i> Duncan's test after anova = 0.0001, 0 vs. 1,2,3, > 3)</p> <p>Parity: NR</p>	<p>Race, %: White G1: 100 G2: 100 G3: 100 G4: 100 G5: 100 Group 6 Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Weight increase (kg) G1: 7.4 (3.6) G2: 7.2 (3.7) G3: 6.8 (4.0) G4: 6.9 (3.5) G5: 8.7 (8.6) (<i>P</i> Duncan's test after anova = 0.0119, 0, 1,2,3 vs. > 3)</p> <p>Additional characteristics: G1: 2-hr AUC glucose (area under the curve of glucose 0-120 min): 0.82 (0.17) G2: 0.85 (0.18) G3: 0.86 (0.18) G4: 0.86 (0.19) G5: 0.97 (0.17) (<i>P</i> Duncan's test after anova = 0.0001, 0, 1,2,3 vs. > 3)</p> <p>Additional characteristics: G1: ISI OGTT (mg/dl per min): 6 (3.3) G2: 5.8 (2.8) G3: 5.6 (2.2) G4: 5.6 (2.2) G5: 4 (2.5) (<i>P</i> Duncan's test after anova = 0.0002, 0, 1,2,3 vs. > 3)</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 1764 G2: 124</p> <p>Total weight gain: G1: 7.3 (3.9) G2: 7.2 (5.3)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated by researchers - appears that weight gain was computed at time of testing which was at 24-28 weeks rather than total weight gain 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Weight gain as predictor of GDM OR (95% CI)</p> <p>Groups NA, weight gain continuous variable</p> <p>Results 1.024 (0.974-1.077) (<i>P</i> = NS)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Parity Age Pregestational BMI Weight gain Family history diabetes <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 3 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Thorsdottir et al., 2002</p> <p>Country and setting: Maternity records, Department of Obstetrics and Gynecology at Landspítali University Hospital, Iceland</p> <p>Enrollment Period:</p> <p>Funding: NR</p> <p>Study Objective: To investigate relation between gestational weight gain in women of normal prepregnant weight and complications during pregnancy and delivery in a population with high gestational weight gain and birth weight</p> <p>Time frame: NR</p> <p>Duration of the study: 1998</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 614</p> <p>Group Description: G1: No complication G2: Complications in pregnancy or delivery G3: Complications in pregnancy G4: Complications in delivery</p> <p>Group N: G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women of normal prepregnancy weight randomly selected within 1 year (1998) • No history of diabetes, hypertension, CVD, or thyroid problems • Singleton births • 38 to 43 weeks gestation • 20 to 40 years of age • Routine fetal biometry at 18 to 20 week ultrasound • Received early and regular antenatal care <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 63.1 (6.2) G2: 62.0 (5.6) $P = 0.059$ G3: 61.7 (4.8) $P = 0.174$ G4: 62.2 (6.1) $P = 0.274$</p> <p>Pregravid BMI: G1: 22.2 G2: 22.4 (1.6) $P = 0.270$ G3: 22.4 (1.5) $P = 0.338$ G4: 22.3 $P = 0.584$</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 29 G2: 29 $P = 0.857$ G3: 29 $P = 0.404$ G4: 29 $P = 0.398$</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Proportional weight gain, %: G1: 26.0 G2: 28.0 $P = 0.018$ G3: 30.0 $P = 0.005$ G4: 27.0 $P = 0.546$</p> <p>Additional characteristics: NR</p>

Evidence Table 3. Maternal weight gain and abnormal glucose metabolism (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Total weight gain: G1: 16.6 (4.9) G2: 17.4 (5.1) <i>P</i> = 0.080 G3: 18.4 (5.1) <i>P</i> = 0.013 G4: 16.9 (5.1) <i>P</i> = 0.887</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM < 11.5, 11.-16.0, ≥ 16.1, also quintiles < 12.5, 12.5-15.5, 15.6-17.8, 17.9-20.8, > 20.8 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3789 (469) G2: 3749 (565) <i>P</i> = 0.389 G3: 3643 (526) <i>P</i> = 0.032 G4: 3806 (578) <i>P</i> = 0.529</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Incidence of gestational diabetes</p> <p>Groups: G1: <11.5 kg gain G2: 11.5-16.0 kg gain G3: 16.1-20.0 kg gain G4: >20 kg gain</p> <p>Results: G1: 2.9% G2: 0 G3: 0 G4: 0 (<i>P</i> = .015)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Height <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Birth weight 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) <i>(P < 0.05)</i></p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% <i>(P < 0.01)</i></p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: Incidence of pregnancy induced hypertension</p> <p>Groups Reported only for BMI > 35: G1: weight loss or no gain G2: 1-15 lb gain G3: 16-25 lb gain G4: 26-35 lb gain G5: > 35 lb gain <i>(P = NS)</i></p> <p>Results G1: 11.8% G2: 13.7% G3: 13.7% G4: 12.4% G5: 21.3%</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Race Parity Clinic service Substance abuse Preexisting medical conditions <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Brennand et al., 2005</p> <p>Country and setting: Canada, medical records</p> <p>Enrollment Period: Prenatal to birth</p> <p>Funding: cree board of health and social services of James Bay (Quebec)</p> <p>Study Objective: To determine effect of pregravid weight and pregnancy weight gain on pregnancy outcomes in Cree women</p> <p>Time frame: Prenatal to birth</p> <p>Duration of the study: 7 year period: January 1994 to December 2000</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 603</p> <p>Group Description:</p> <p>G1: Normal: BMI 18.5 - 24.9</p> <p>G2: Overweight: BMI 25-29.9</p> <p>G3: Obese: BMI ≥ 30</p> <p>G4: Total</p> <p>Group N:</p> <p>G1: 139 G2: 168 G3: 296 G4: 603</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Used only Cree women First birth observed per woman during study time period Must have first weight recorded within first 14 weeks gestation and final weight recorded within 4 weeks of birth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with secondary pregnancy in dataset (n = 792) Women with first weight record > 14 weeks gestation (n = 314) Women with final weight record > 4 weeks from birth (n = 202) Women with both first weight record > 14 weeks and final weight record > 4 weeks (n = 70) Women missing data on first or final weight (n = 3) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care Medical records Measured within 14 weeks of gestation <p>G1: 59.7 (5.0) G2: 73.0 (4.3) G3: 93.6 (12.3) G4: 80.0 (16.9)</p> <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> Yes <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce <p>Age (mean, yrs):</p> <p>G1: 20.8 (5.2) G2: 23.8 (5.4) G3: 25.5 (5.5) G4: 24.0 (5.7)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %:</p> <p>G1: 4.3 G2: 14.9 G3: 27.4 G4: 18.6</p> <p>Hypertension, %:</p> <p>G1: 1.4 G2: 1.8 G3: 4.8 G4: 3.2</p> <p>Additional characteristics:</p> <p>% low weight gain:</p> <p>G1: 20.1 G2: 10.1 G3: 28.0 G4: 21.2</p> <p>% acceptable weight gain:</p> <p>G1: 28.8 G2: 32.1 G3: 33.4 G4: 32.0</p> <p>% excessive weight gain:</p> <p>G1: 51.1 G2: 57.7 G3: 38.5 G4: 46.6</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 139 G2: 168 G3: 296</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> 1999 Canadian guidelines Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: within 4 weeks of birth </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 4.3 G2: 14.9 G3: 27.4 G4: 18.6</p> <p>Cesarean delivery, %: G1: 10.8 G2: 11.3 G3: 24.1 (p < 0.001)</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Definition of low, adequate, and excessive weight gains: For normal weight women - adequate weight gain is 11.5 to 16 kg For overweight women, adequate weight gain is 7 to 11.5 kg For obese women, adequate weight gain is 7 to 11.5 kg Weight gain below specified range is "low" and weight gain above specified range is "excessive" <p>Other infant outcomes: > 4000g, > 4500g</p>	<p>Outcomes Description: hypertensive disorders, PIH, preeclampsia</p> <p>Groups G1: "Low weight gain" G2: "Acceptable weight gain" G3: "Excessive weight gain" All categories per Canadian Guidelines</p> <p>Results HTN Disorders G1: 7.3% G2: 12.5% G3: 19.3% (P = 0.051)</p> <p>PIH: G1: 3.7% G2: 6.3% G3: 4.4% (P = 0.698)</p> <p>Preeclampsia G1: 3.7% G2: 6.3% G3: 14.9% (P = 0.013)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 5 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Brennand et al., 2005 (continued)</p>	<ul style="list-style-type: none"> • Pregnancies with factors that may have influenced maternal weight gain such as 1 parent being non-Cree (n = 13), preterm deliveries (n = 91), twin pregnancies (n = 6), missing gestational age (n = 9) • Women with unknown glycemic status (n = 30), type 2 DM (n = 8), glycemic abnormalities before pregnancy not followed for diagnosis (n = 70) • Women classified as underweight (n = 5) 		

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
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Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cedergren, 2006</p> <p>Country and setting: Sweden, Medical Birth Registry</p> <p>Enrollment Period: January 1, 1994 - December 31, 2002</p> <p>Funding: Ostergotland County Council</p> <p>Study Objective: To estimate effects of high and low gestational weight gain in different maternal BMI classes on obstetric and neonatal outcomes</p> <p>Time frame: January 1, 1994 to December 31, 2002</p> <p>Duration of the study: First visit to maternity health care center to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 245,526</p> <p>Group Description: BMI</p> <p>G1: < 20 G2: 20 to 24.9 G3: 25 to 29.9 G4: 30 to 34.9 G5: ≥ 35</p> <p>Group N: G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton, term pregnancies Information on maternal height, maternal weight in early pregnancy, and gestational weight gain <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported If unknown, standardized measurement is made during first visit to maternity health care center <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> < 20, 20.0-24.9, 25.0-29.9, 30-34.9, ≥ 35 <p>Age (mean, yrs):</p> <p>G1: 15 to 19 years: 3.8% 20 to 24: 23.0% 25 to 29: 38.7% 30 to 34: 25.7% 35 to 39: 7.7% ≥ 40: 1.1%</p> <p>G2: 15 to 19 years: 1.9% 20 to 24: 15.9% 25 to 29: 37.7% 30 to 34: 31.1% 35 to 39: 11.3% ≥ 40: 1.9%</p> <p>G3: 15 to 19 years: 1.5% 20 to 24: 15.7% 25 to 29: 36.1% 30 to 34: 31.2% 35 to 39: 12.9% ≥ 40: 2.5%</p> <p>G4: 15 to 19 years: 1.5% 20 to 24: 17.4% 25 to 29: 35.6% 30 to 34: 30.0% 35 to 39: 13.0% ≥ 40: 2.4%</p> <p>G5: 15 to 19 years: 1.1% 20 to 24: 17.3% 25 to 29: 38.0% 30 to 34: 29.6% 35 to 39: 11.7% ≥ 40: 2.3%</p>	<p>Race, %: White G1: 96.6 G2: NR Black NR Hispanic NR Asian/Pacific Islander G1: 1.4 G2: NR Other G1: 2.0 G2: NR</p> <p>Smoking, %: G1: % nonsmoking: 81.6 G2: 85.2 G3: 83.1 G4: 79.9 G5: 78.4 Group 6</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Total weight gain: G1: < 8kg: 6.9% 8-15.9kg: 65.2% ≥ 16kg: 28.0% G2: < 8kg: 8.4% 8-15.9kg: 67.1% ≥ 16kg: 30.4% G3: < 8kg: 15.7% 8-15.9kg: 54.4% ≥ 16kg: 29.9% G4: < 8kg: 30.2% 8-15.9kg: 48.7% ≥ 16kg: 21.1% G5: < 8kg: 44.6% 8-15.9kg: 40.9% ≥ 16kg</p> <p>Categorized: <ul style="list-style-type: none"> < 8kg, 8-16, > 16 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between maternal weights measured when woman attended delivery unit and maternal weight recorded at first visit to maternity health care center </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Preeclampsia</p> <p>Groups G1:BMI < 20 G2:BMI 20-24.9 G3:BMI 25-29.9 G4:BMI 30-34.9 G5:BMI>35</p> <p>Results Preeclampsia by BMI for weight gain < 8 kg (reference gain 8-16 kg) OR (95% CI): G1: 0.90 (0.55-1.48) G2: 0.73 (0.61-0.89) G3: 0.64 (0.54-0.76) G4: 0.52 (0.42-0.62) G5: 0.63 (0.51-0.79)</p> <p>Preeclampsia by BMI for weight gain >16 kg (reference weight gain 8-16kg) OR (95% CI): G1: 2.23 (1.83-2.71) G2: 2.31 (2.15-2.49) G3: 1.88 (1.72-2.06) G4: 1.65 (1.43-1.92) G5: 1.50 (1.17-1.92)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Smoking in early pregnancy <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Year of birth 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: DeVader et al., 2007</p> <p>Country and setting: United States, birth certificate data</p> <p>Enrollment period: 1999 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To investigate relationship between gestational weight gain and adverse pregnancy outcomes among women with normal prepregnancy BMI</p> <p>Time frame: 1999 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 94,696</p> <p>Group Description: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs</p> <p>Group N: G1: 16,852 G2: 37,292 G3: 40,552</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> All mothers with normal prepregnancy BMI (19.8 –26.0 kg/m²) who were 18 to 35 years of age at time of delivery and who delivered full-term (37 weeks or more) singleton infant during period January 1, 1999, to December 31, 2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women aged younger than 18 years and older than 35 years Non-Missouri residents Preterm deliveries Multiple gestations 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care If missing, obtained from mother during postpartum hospital stay <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized: NR</p> <p>Age (mean, yrs): G1: Maternal age (y) 18 to 24*: 42.3% 25 to 30: 36.2% 31 to 35: 21.5% G2: Maternal age (y) 18 to 24*: 36.7% 25 to 30: 39.5% 31 to 35: 23.8% G3: Maternal age (y) 18 to 24*: 44.7% 25 to 30: 35.9% 31 to 35: 19.4%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 79.7 G2: 85.6 G3: 85.2 Black G1: 15.7 G2: 10.8 G3: 12.1 Hispanic NR Asian/Pacific Islander NR Other G1: 4.6 G2: 3.5 G3: 2.7</p> <p>Smoking, %: G1: 20.5 G2: 14.9 G3: 17.4</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 plot risk for each adverse pregnancy outcome by 10-lb increments in gestational weight gain. Women who gained 25 to 34 lbs during their pregnancy had lower risks for most outcomes when balancing risk for SGA status and other adverse pregnancy outcomes Women who gained 15 to 24 lbs had lowest risks for most outcomes, but increased their risk of having an SGA infant from 9.6% to 14.3% Women who gained more than 34 lbs had higher risks for all outcomes, although their risk of having an SGA infant decreased from 9.6% to 6.6% <p>Other infant outcomes:</p> <ul style="list-style-type: none"> NR 	<p>Outcomes Description: Preeclampsia</p> <p>Groups G1: Weight gain < 25 lbs G2: Weight gain 25-35 lbs G3: Gained > 35 lbs</p> <p>Results AOR (95% CI) G1: 0.56 (0.49-0.64) G2: 1 G3: 1.88 (1.74-2.04)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal age Race/ethnicity Education Medicaid status Tobacco and alcohol use Maternal height Adequacy of prenatal care <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Child's sex Child's birth year 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Edwards et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1997-1993</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy course and outcomes in obese and normal weight women and their associations with gestational weight change</p> <p>Time frame: 1997-1993</p> <p>Duration of the study: 1997-1993</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 1,443</p> <p>Group Description: G1: Obese G2: Normal Weight G3: total sample</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Obese women and normal weight women identified from pregnancy and delivery summary records (normal weight matched to obese by race, age, parity) • Singleton deliveries • Live births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing data • Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 103.5 G2: 61</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelinesobese (> 29) and normal weight (BMI 19.8-26.0) <p>Age (mean, yrs): G1: 27.1 G2: 25.4</p> <p>Parity: NR</p>	<p>Race,%: White G1: NR G2: NR G3: 69.0 (Total sample)</p> <p>Black G1: NR G2: NR G3: 21.0 (Total sample)</p> <p>Hispanic G1: NR G2: NR G3: 7.0 (Total sample)</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: NR G2: NR G3: 4.0 (Total sample)</p> <p>Smoking,%: NR</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 683 G2: 660</p> <p>Total weight gain: G1: 9.5 G2: 14.5 $P \leq 0.001$</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3420 G2: 3285 $P \leq 0.001$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 25.6 G2: 9.1 $P < 0.001$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Preeclampsia, gestational hypertension</p> <p>Groups Pregravid wt 19.8-26.0 BMI: G1: < 11.5 kg gain G2: 11.6-16 kg gain G3: > 16 kg gain</p> <p>Pregravid wt > 29 kg G4: lost/gained nothing G5: 0.5-6.5 kg gain G6: 7-11.5 kg gain G7: 12-16 kg gain</p> <p>Results Preeclampsia: G1: 2.8% G2: 2.9% G3: 6.6% ($P = .048$)</p> <p>G4: 10.7% G5: 7.7% G6: 8.3% G7: 7.9% G8: 16.5% ($P = .076$)</p> <p>Gestational HTN: G1: 2.3% G2: 3.8% G3: 3.3% ($P = .607$)</p> <p>G4: 9.3% G5: 8.3% G6: 11.3% G7: 10.3% G8: 9.0% ($P = .832$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal age Parity Race Prenatal smoking Prenatal alcohol use Prenatal illicit drug use Pregravid health Weight and adequacy of prenatal care <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jensen et al., 2005</p> <p>Country and setting: Denmark, university hospitals</p> <p>Enrollment Period: Gestation through birth</p> <p>Funding: Many different funds</p> <p>Study Objective: To investigate effect of gestational weight gain in obese glucose tolerant women</p> <p>Time frame: Gestation through birth</p> <p>Duration of the study: NR</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 481</p> <p>Group Description:</p> <p>G1: GWG < 5.0 kg G2: GWG 5.0-9.9kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0kg</p> <p>Group N:</p> <p>G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Prepregnancy BMI ≥ 30 • Normal 2h 75g oral glucose tolerance test (OGTT) during third trimester (according to WHO criteria) • Only first pregnancy during study period included <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Well defined chronic disease • Twin pregnancies • Women with GDM (n = 323) • Known diet treatment (n = 10) • Incomplete data on weight gain during pregnancy (n-153) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Records • Patient report of pregravid BMI <p>Pregravid BMI:</p> <p>G1: 34.3 (32.2-39.9) G2: 33.9 (31.5-36.5) G3: 32.9 (31.2-35.6) G4: 32.7 (31.3-34.7)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs):</p> <p>G1: 29.8 (26.4-33.1) G2: 29.1 (26.3-33.1) G3: 30.0 (26.6-33.2) G4: 27.9 (24.8-31.8)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: 84.4 G2: 85.8 G3: 82.7 G4: 89.9</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 29.7 G2: 25.8 G3: 30.2 G4: 26.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> < 5.0. 5.0-9.9, 10.0-14.9, ≥ 15.0 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated by authors 	<p>Birth weight: G1: 3500 (3200-3840) G2: 3645 (3200-4000) G3: 3750 (3390-4125) G4: 3762 (3400-4120)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Gestational hypertension</p> <p>Groups G1: < 5kg gain G2: 5.0-9.9 kg gain G3: 10.0-14.9 kg gain G4: ≥ 15.0 kg gain</p> <p>Results OR (95% CI) G1: 1 G2: 2.1 (0.8-5.7) G3: 3.6 (1.3-9.8) G4: 4.8 (1.7-13.1) (P = 0.001)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Results of 2 hour OGTT Age Pregravid BMI Parity Smoking Ethnicity and site of prenatal care <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kabiru and Raynor, 2004</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1999 to 2002</p> <p>Funding: NR</p> <p>Study Objective: To investigate effect of increase in body mass index category on obstetric outcomes</p> <p>Time frame: 1999 to 2002</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 5,131</p> <p>Group Description:</p> <p>G1: No change in BMI between first prenatal visit and delivery</p> <p>G2: 1 category increase in BMI between first prenatal visit and delivery</p> <p>G3: > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Group N:</p> <p>G1: 2,556</p> <p>G2: 2,252</p> <p>G3: 323</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancies <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple pregnancies BMI < 20 Missing BMI data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured at first prenatal visit <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> 20-24.9, 25-29.9, 30-34.9, 35-39.9, ≥ 40 <p>Age (mean, yrs):</p> <p>G1: 24.7 (6.1)</p> <p>G2: 24.4 (5.7)</p> <p>G3: 25.2 (5.9) <i>P</i> < 0.001</p> <p>Parity:</p> <p>G1: Gravidity (mean): 1.9 (1.9)</p> <p>G2: 1.5 (1.7)</p> <p>G3: 1.2 (1.7) <i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 1.9</p> <p>G2: 2.6</p> <p>G3: 2.8</p> <p>Black</p> <p>G1: 84.1</p> <p>G2: 82.8</p> <p>G3: 88.2</p> <p>Hispanic</p> <p>G1: 13.9</p> <p>G2: 14.6</p> <p>G3: 9.0</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>NR</p> <p>Smoking, %:</p> <p>NR</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>Mean weight gain:</p> <p>G1: 8.6 pounds (8.4)</p> <p>G2: 22.2 pounds (10.2)</p> <p>G3: 55.3 pounds (23.8)</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 579 G2: 942 G3: 189 G4: 819 G5: 790 G6: 104</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> > 35 pounds for normal BMI, > 25 pounds for overweight BMI, > 15 pounds for obese BMI <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not stated, most likely difference between weight at first prenatal visit and weight at delivery 	<p>Birth weight: G1: 2886.0 (756) G2: 3174.9 (600) G3: 3099.5 (673) <i>P</i> < 0.001 G4: 3116 (713) G5: 3269 (698) G6: 3371 (733) <i>P</i> = 0.015</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 8.2 G2: 12.6 G3: 21.0 <i>P</i> < 0.001 G4: 13.0 G5: 14.3 G6: 19.3 <i>P</i> = 0.256</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Incidence preeclampsia</p> <p>Groups BMI < 25 first assessment: G1: no change BMI category G2: increase 1 category G3: increase > 1 category</p> <p>BMI ≥ 25 first assessment G4: no change BMI category G5: increase 1 category G6: increase > 1 category</p> <p>Results G1: 1.9% G2: 3.2% G3: 1.6% (<i>P</i> = .203)</p> <p>G4: 2.8% G5: 3.7% (<i>P</i> = .002)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Pre-gravid weight <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kiel et al., 2007</p> <p>Country and setting: United States, birth registry</p> <p>Enrollment period: 1990 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of gestational weight change on pregnancy outcomes in obese women</p> <p>Time frame: 1990 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 120,170</p> <p>Group Description:</p> <p>G1: Obese Class I (BMI 30–34.9) (n = 70,536)</p> <p>G2: Obese Class II (BMI 35–39.9) (n = 30,609)</p> <p>G3: Obese Class III (BMI 40 and More) (n = 19,025)</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Obese women residing in Missouri who delivered (at 37 or more weeks of gestation) liveborn, singleton infants during 1990–2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>G1: Total: Class I obese: 59% Class II obese: 25% Class III obese: 16%</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NIH guidelines <p>Age (mean, yrs):</p> <p>G1: <26: 46% 26-35: 47% Older than 35: 8%</p> <p>G2: <26: 44% 26-35: 48% Older than 35: 8%</p> <p>G3: <26: 40% 26-35: 52% Older than 35: 9%</p> <p>Parity: Nulliparous: G1: 34% G2: 33% G3: 32%</p>	<p>Race, %: White G1: 78 G2: 77 G3: 73</p> <p>Black G1: 22 G2: 23 G3: 27</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 22</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: GWG (lb) Less than 2: 3% 2 to 14: 15% 15 to 25: 26% More than 25: 56% G2: GWG (lb) Less than 2: 8% 2 to 14: 22% 15 to 25: 27% More than 25: 43% G3: GWG (lb) Less than 2: 15%</p> <p>Categorized:</p> <ul style="list-style-type: none"> 10-lb or less loss 2 to 9 lbs loss, no weight change, 2 to 9 lbs gain, 10 to 14 lbs gain, 15–25 lb gain, 26–35 lb gain, and greater than 35 lb gain <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: G1: SGA: 7% LGA: 13% (<i>P</i> < 0.05) G2: SGA: 7% LGA: 16% (<i>P</i> < 0.05) G3: SGA: 6% LGA: 18% (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 28 G2: 34 G3: 41</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Preeclampsia</p> <p>Groups Analysis done by each class of obesity and weight changes in gestation:</p> <ul style="list-style-type: none"> Weight loss ≥ 10 lbs Weight loss 2-9 lbs No weight change Gain 2-9 lbs Gain 10-14 lbs Gain 15-25 lbs Gain 26-35 lbs Gain > 35 lbs. <p>Results Data all presented in graph form: Using a gain of 15-25 pounds as reference for each obesity class, OR of preeclampsia lower with less weight gain and higher with more weight gain.</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Education Poverty (defined as participation in one or more subsidized programs) Tobacco use Parity Chronic hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Kiel et al., 2007
(continued)

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
	<p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 show absolute risk of preeclampsia, cesarean delivery, LGA, and SGA by GWG category for each obesity class. All 3 figures show similar patterns of increasing risk of preeclampsia, cesarean delivery, and LGA birth and decreasing risk of SGA birth with increasing GWG. Collectively, minimal risk for all 4 outcomes corresponds to GWG categories where risk of LGA and SGA births intersect. This equates to GWG of 10 of 25 lb for class I obese women, a gain of 0 to 9 lb for class II obese women, and weight loss of 0 to 9 lb for class III obese women. Adjusted odds ratios and 95% CIs for preeclampsia, cesarean delivery, SGA, and LGA by GWG category and obesity class. Compared with women who gained 15 to 25 lb during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births. Women who gained more than 25 lbs had higher odds for same 3 pregnancy outcomes and lower odds for SGA births. <p>Other infant outcomes: NR</p>	

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Murakami et al., 2004</p> <p>Country and setting: Japan, hospital</p> <p>Enrollment Period: 2001</p> <p>Funding: NR</p> <p>Study Objective: To estimate risk of perinatal morbidity of mother and infant with respect to maternal prepregnancy BMI and weight gain in Japanese women</p> <p>Time frame: 2001</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 633</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 633 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Live, singletons delivered between 24 to 42 weeks gestation <p>Exclusion criteria: NR</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 20.9 (2.8) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce <p>Age (mean, yrs): G1: 29.1 (4.5) G2: NR</p> <p>Parity: G1: 0.6 (0.7) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 8.5 G2: NR</p> <p>Diabetes mellitus, %: G1: 2.1 G2: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: Preeclampsia - mild: 5.4%; severe: 4.1% G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 633 G2: NR</p> <p>Total weight gain: G1: 10.5 (3.4) G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> < 8.5kg, 8.5-12.5, > 12.5 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: last measurement was taken at hospitalization prior to delivery </p>	<p>Birth weight: G1: 3,052.6 (483.8) G2: NR</p> <p>Gestational diabetes, %: G1: 2.1 G2: NR</p> <p>Cesarean delivery, %: G1: 10.3 G2: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Preeclampsia</p> <p>Groups G1: < 8.5 kg gain G2: 8.5-12.5 kg gain G3: >12.5 kg gain</p> <p>Results Estimated OR (95% CI) G1: 0.74 (0.37-1.48) G2: 1 G3: 0.57 (0.24-1.32)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal age Parity Smoking Weight gain Gestational weeks Pregravid BMI <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 8 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ogunyemi et al., 1999</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1990 to 1995</p> <p>Funding: NR</p> <p>Study Objective: To test IOM guidelines in a predominantly rural black population</p> <p>Time frame: 1990 to 1995</p> <p>Duration of the study: 582 women who delivered and then their medical record was abstracted</p>	<p>Design:</p> <ul style="list-style-type: none"> Other observational: 582 women consecutive women who delivered Retrospective <p>Total Study N: 582</p> <p>Group Description: G1: Underweight G2: Normal G3: Overweight G4: Obese</p> <p>Group N: G1: 78 G2: 223 G3: 78 G4: 203</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Single child > 37 weeks gestation Black Registration for prenatal care within first trimester of pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Difference between recalled pregravid weight and measured first trimester weight was $\geq 10\%$ 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 20.3 G2: 22.1 G3: 23.7 G4: 25.4 ($P < 0.01$)</p> <p>Parity: G1: # nulliparous: 53 G2: 54 G3: 42 G4: 26 ($P < 0.01$)</p>	<p>Race, %: White NR Black G1: 100 G2: 100 G3: 100 G4: 100 Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: n = 0 G2: n = 4 G3: n = 3 G4: n = 8 ($P = 0.02$)</p> <p>Hypertension, %: G1: n = 1 G2: n = 2 G3: n = 4 G4: n = 14 ($P < 0.01$)</p> <p>Additional characteristics: NR</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 196 G2: 181 G3: 205</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> According to IOM Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: weight at last prenatal visit </p>	<p>Birth weight: G1: 3,029 G2: 3,210 G3: 3,283 (<i>P</i> < 0.01)</p> <p>Gestational diabetes, %: G1: n = 0 G2: n = 4 G3: n = 3 G4: n = 8 (<i>P</i> = 0.02)</p> <p>Cesarean delivery, %: G1: n = 20 G2: n = 10 G3: n = 17 (<i>P</i> = 0.02)</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Asthma Preeclampsia Vomiting C-section <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Low birth weight Fetal distress NICU 	<p>Outcomes Description: Incidence preeclampsia</p> <p>Groups G1: “low weight gain” G2: “normal weight gain” G3: “high weight gain”</p> <p>Results G1: 10% G2: 7% G3: 19% (<i>P</i> = <.01)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pregravid BMI Tobacco use Hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Good</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Thorsdottir et al., 2002</p> <p>Country and setting: Maternity records, Department of Obstetrics and Gynecology at Landspítali University Hospital, Iceland</p> <p>Enrollment Period:</p> <p>Funding: NR</p> <p>Study Objective: To investigate relation between gestational weight gain in women of normal prepregnant weight and complications during pregnancy and delivery in a population with high gestational weight gain and birth weight</p> <p>Time frame: NR</p> <p>Duration of the study: 1998</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 614</p> <p>Group Description:</p> <p>G1: No complication</p> <p>G2: Complications in pregnancy or delivery</p> <p>G3: Complications in pregnancy</p> <p>G4: Complications in delivery</p> <p>Group N:</p> <p>G1: 452</p> <p>G2: 162</p> <p>G3: 56</p> <p>G4: 106</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women of normal prepregnancy weight randomly selected within 1 year (1998) • No history of diabetes, hypertension, CVD, or thyroid problems • Singleton births • 38 to 43 weeks gestation • 20 to 40 years of age • Routine fetal biometry at 18 to 20 week ultrasound • Received early and regular antenatal care <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 63.1 (6.2)</p> <p>G2: 62.0 (5.6) <i>P</i> = 0.059</p> <p>G3: 61.7 (4.8) <i>P</i> = 0.174</p> <p>G4: 62.2 (6.1) <i>P</i> = 0.274</p> <p>Pregravid BMI:</p> <p>G1: 22.2</p> <p>G2: 22.4 (1.6) <i>P</i> = 0.270</p> <p>G3: 22.4 (1.5) <i>P</i> = 0.338</p> <p>G4: 22.3 <i>P</i> = 0.584</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs):</p> <p>G1: 29</p> <p>G2: 29 <i>P</i> = 0.857</p> <p>G3: 29 <i>P</i> = 0.404</p> <p>G4: 29 <i>P</i> = 0.398</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Proportional weight gain, %:</p> <p>G1: 26.0</p> <p>G2: 28.0 <i>P</i> = 0.018</p> <p>G3: 30.0 <i>P</i> = 0.005</p> <p>G4: 27.0 <i>P</i> = 0.546</p> <p>Additional characteristics: NR</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Total weight gain: G1: 16.6 (4.9) G2: 17.4 (5.1) <i>P</i> = 0.080 G3: 18.4 (5.1) <i>P</i> = 0.013 G4: 16.9 (5.1) <i>P</i> = 0.887</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM < 11.5, 11.-16.0, ≥ 16.1, also quintiles < 12.5, 12.5-15.5, 15.6-17.8, 17.9-20.8, > 20.8 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3789 (469) G2: 3749 (565) <i>P</i> = 0.389 G3: 3643 (526) <i>P</i> = 0.032 G4: 3806 (578) <i>P</i> = 0.529</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Gestational hypertension, preeclampsia</p> <p>Groups G1: <11.5 kg gain G2: 11.5-16.0 kg gain G3: 16.1-20.0 kg gain G4: >20 kg gain</p> <p>Results % gestational htn G1: 1.5% G2: 4.6% G3: 5.1% G4: 9.2% (<i>P</i> = 0.026)</p> <p>% preeclampsia G1: 1.4% G2: 2.3% G3: 5.4% G4: 4.4% (<i>P</i> = 0.262)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Height <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Wataba et al., 2006</p> <p>Country and setting: Japan, academic medical center</p> <p>Enrollment Period: 1981 to 1999</p> <p>Funding: NR</p> <p>Study Objective: To analyze association of pregnancy complications with prepregnant body mass index and weight gain during pregnancy in Japanese women</p> <p>Time frame: 1981 to 1999</p> <p>Duration of the study: Entry into PNC up til delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Perinatal data base and look at medical records retrospectively • Retrospective <p>Total Study N: 21,718</p> <p>Group Description: G1: Nulliparous G2: Parous women</p> <p>Group N: G1: 10,413 G2: 11,305</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy delivering term baby at Osaka Med Center and Research Institute for Maternal and Child Health in 1981-1999 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • None reported 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • In data base don't know if self reported <p>Pregravid BMI: G1: 20.5 (2.6) G2: 21.1 (3.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Categorical in 2 kg/m² point intervals from prepregnancy weight; categorical into low, medium, high BMI groups (< 18, 18-23.9, > 24) <p>Age (mean, yrs): G1: 27.8 (4.1) G2: 30.45 (3.9)</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 4. Gestational weight gain and hypertensive disorders (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 10413 G2: 11305</p> <p>Total weight gain: G1: kg/wk: 0.25 (SD 0.09) G2: kg/wk: 0.24 (0.09) <i>P</i> < 0.01</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Categorical in kg/wk using prepregnancy weight and weight at delivery divided by gestational age of infant at birth <p>Collected from:</p> <ul style="list-style-type: none"> • Rate of weight gain determined by: total weight gain divided by weeks ga <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery: and subtracting prepregnancy weight 	<p>Birth weight: G1: SGA: 5.4% LGA 5.2% G2: SGA 6.5% LGA 5.2%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> • NR <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Preeclampsia</p> <p>Groups Separate analyses done for low, medium and high pregravid weight groups by following intervals of kg/week gain:</p> <ul style="list-style-type: none"> • <0.15 • 0.15-.20 • 0.20-.25 • 0.25-.30 • 0.30-.35 • 0.35-40 • >0.40 <p>Results No clear trends for preeclampsia or severe preeclampsia by pregravid weight status and kg/week weight gains. AOR generally crossed 1.0 or had wide confidence intervals</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Baseline BMI • Parity <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 5. Gestational weight gain and gallstones

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ko, 2006</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1987-2001</p> <p>Funding: NR</p> <p>Study Objective: Aim was to define incidence and risk factors for postpartum hospitalization as a result of gallstone-related disease</p> <p>Time frame: 1987 to 2001</p> <p>Duration of the study: Entry into prenatal care through the postpartum period</p>	<p>Design:</p> <ul style="list-style-type: none"> Case-control Retrospective <p>Total Study N: 26,680</p> <p>Group Description: G1: Cases G2: Controls</p> <p>Group N: G1: 6,670 G2: 20,010</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Diagnosis of biliary tract-related diseases either at delivery hospitalization or on hospitalizations within 1 year postpartum Women with acute pancreatitis with associated diagnosis of cholelithiasis, choledocholithiasis, or cholangitis. Cases were defined as any woman with a biliary tract diagnosis at delivery hospitalization, or with a primary discharge diagnosis related to the biliary tract for a postpartum hospitalization Four controls who were not hospitalized for biliary tract disease within 1 yr postpartum were randomly selected for each case and matched for year of delivery <p>Exclusion criteria:</p> <ul style="list-style-type: none"> See above 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: < 25 32.8%, 25-29.9 26.8%, > 30 40.4% G2: BMI < 25 62.8%, 25-29.9 22.1%, > 30 15.1%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce < 25, 25-29.9, > 30 <p>Age (mean, yrs): G1: 26.0 ± 5.9 G2: 27.2 ± 6.0 P < 0.001</p> <p>Parity: G1: Median 1 (0–13) G2: Median 1 (0–14)</p>	<p>Race, %: White G1: 71.3 G2: 83.5 Black G1: 3.6 G2: 3.9 Hispanic G1: 17.5 G2: 11.2 Asian/Pacific Islander G1: 2.6 G2: 6.4 Other G1: 17.8 G2: 12.8</p> <p>Smoking, %: G1: 17.4 G2: 15.0</p> <p>Diabetes mellitus, %: G1: 5.0 G2: 3.0</p> <p>Hypertension, %: Pregnancy: G1: 1.6% G2: 0.8%</p> <p>Additional characteristics: NR</p>

Evidence Table 5. Gestational weight gain and gallstones (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 6670 G2: 20010</p> <p>Total weight gain: G1: 12.6 ± 7.1 G2: 14.4 ± 6.0 <i>P</i> < 0.001</p> <p>Categorized: <ul style="list-style-type: none"> Continuous </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> birth certificate data </p>	<p>Birth weight: G1: 3,442 ± 767 G2: 3,443 ± 718</p> <p>Gestational diabetes, %: G1: 5.0 G2: 3.0</p> <p>Cesarean delivery, %: G1: 25.1 G2: 21.3</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> “Risk of hospitalization was inversely associated with weight gain during pregnancy, even after adjustment for prepregnancy body mass index.” <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Hospitalization for gallstones at delivery or within the first year postpartum <p>Groups: G1: Cases G2: Controls</p> <p>Results: OR for pregnancy weight gain, per kg G1: 0.98 (0.97- 0.99) <i>P</i> < 0.001 G2: NR</p> <p>Outcomes Set 2: NR</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Pre-gravid BMI GDM <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Poor</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 5. Gestational weight gain and gallstones (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Lindseth and Bird-Baker, 2004</p> <p>Country and setting: USA, hospitals and clinics</p> <p>Enrollment Period: NR</p> <p>Funding: NIH, NICHD</p> <p>Study Objective: To examine relationships of demographics, anthropometrics, prenatal physical activity, serum cholesterol, and nutrient intakes to symptomatic cholelithiasis occurrence</p> <p>Time frame: NR</p> <p>Duration of the study: 14 weeks gestation to 1 month post-partum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 128</p> <p>Group Description: G1: total cohort G2: NR</p> <p>Group N: G1: 128 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Within first 12 weeks of pregnancy • Consented to participation • 18 to 40 years of age • Could understand, read, and speak English <p>Exclusion criteria: NR</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Measured by study investigators • Routine pre-natal care <p>Pregravid BMI: G1: 26.5 (6.08) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • 1990 National Academy of Sciences Standards <p>Age (mean, yrs): G1: 26.0 (4.78) G2: NR</p> <p>Parity: Gravida: G1: 2.7 (1.65) G2: NR</p>	<p>Race, %: White G1: 76% G2: NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 24% (Native American) G2: NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 5. Gestational weight gain and gallstones (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not specifically stated 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: cholelithiasis in 16 women (12.5%)</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Cholelithiasis during pregnancy or upto 12 weeks postpartum <p>Groups: NA, weight gain continuous variable</p> <p>G1: 128 G2: NR</p> <p>Results: Prenatal weight gain Partial correlation = 0.33; B = 0.13; not statistically significant</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pre-gravid BMI Prenatal physical activity Dietary fat Dietary iron supplement History of gallbladder disease Serum cholesterol <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 6. Gestational weight gain and premature rupture of membranes

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Gosselink et al., 1992</p> <p>Country and setting: USA, university clinics</p> <p>Enrollment Period: September 1985-August 1987 (University of Iowa Hospitals) September 1987-April 1990 (University of Chicago)</p> <p>Funding: US Public Health Services, National Institute of Child Health and Human Development</p> <p>Study Objective: To test hypothesis that maternal prepregnancy body weight, weight gain during gestation, and prepregnancy and pregnancy diet and supplement status relate to PROM and preterm delivery</p> <p>Time frame: September 1985 to August 1987 (University of Iowa Hospitals) September 1987 to April 1990 (University of Chicago)</p> <p>Duration of the study: Interviewed within 72 hours of delivery to obtain retrospective data</p>	<p>Design:</p> <ul style="list-style-type: none"> • Case-control • Retrospective <p>Total Study N: Total n = 1,176</p> <ul style="list-style-type: none"> • n = 184, preterm delivery (≤ 36 weeks) and PROM • n = 220, preterm delivery without PROM • n = 184, fullterm delivery with PROM • n = 588, Controls <p>Group Description: G1: All cases G2: All controls</p> <p>Group N: G1: 588 G2: 588</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • 15-45 years • Singleton delivery • Consented to interview while still in hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Mothers with chronic conditions likely to adversely affect the course of pregnancy such as cystic fibrosis, emphysema, chronic heart failure, or poorly controlled diabetes mellitus • Women receiving chemotherapy or radiation treatments • Mothers with limited mental capacity 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: ≤ 20: 26.5% 20-29: 65.0% ≥ 30: 8.5% G2: ≤ 20: 19.4% 20-29: 68.6% ≥ 30: 12.0%</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Underweight: < 20 • Normal weight: 20-29 (referent) • Obese: > 30 <p>Age (mean, yrs): NR</p> <p>Parity: G1: % nulliparous: 44.4 G2: % nulliparous: 44.4</p>	<p>Race, %: White G1: 36.6 G2: 36.6 Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 6. Gestational weight gain and premature rupture of membranes (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 588 G2: 588</p> <p>Total weight gain: G1: < 21 lbs: 36.7% 21-30 lbs: 34.0% 31-40 lbs: 14.1% > 40 lbs: 15.1% G2: < 21 lbs: 19.6% 21-30 lbs: 28.9% 31-40 lbs: 24.1% > 40 lbs: 27.4%</p> <p>Categorized:</p> <ul style="list-style-type: none"> < 21lbs 21-30 31-40 > 40lbs <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records not stated <p>Ascertained by:</p> <ul style="list-style-type: none"> Not specifically stated 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes descriptions: AOR for premature rupture of membrane (95% CI)</p> <p>Groups: G1: GWG: 21-30 lbs G2: GWG: 31-40 lbs G3: GWG: > 40 lbs G4: GWG: < 21 lbs or lost weight</p> <p>Results: Preterm, PROM moms and matched controls G1: 1.00 G2: 0.24 (0.09-0.61) G3: 0.19 (0.07-0.57) G4: 2.70 (1.14-6.36)</p> <p>Full term, PROM moms and matched controls G1: 1.00 G2: 0.56 (0.33-0.94) G3: 0.83 (0.48-1.46) G4: 0.83 (0.44-1.57)</p> <p>Preterm without PROM moms and matched controls G1: 1.00 G2: 0.42 (0.21-0.84) G3: 0.37 (0.17-0.80) G4: 1.34 (0.78-2.32)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Fe supplementation Urinary tract infection Chorioamnionitis Chlamydia History of previous PROM Adequacy of pregnancy diet USDA suggested dairy intake Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 6. Gestational weight gain and premature rupture of membranes (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Nohr et al., 2007</p> <p>Country and setting: Denmark, primary care</p> <p>Enrollment period: 1996 to 2002</p> <p>Funding: Ellen Aagaard Nohr is supported by a grant (No.2002B020) from Health Insurance Foundation. Danish National Research Foundation established Danish Epidemiology Science Centre, which initiated and created Danish National Birth Cohort. Cohort is also result of major grant from this Foundation. Additional support for Danish National Birth Cohort obtained from Pharmacy Foundation, Egmont Foundation, March of Dimes Birth Defects Foundation and Augustinus Foundation</p> <p>Study Objective: Aim of present study to assess impact of obesity and gestational weight gain on risk of subtypes of preterm birth</p> <p>Time frame: 1996 to 2002</p> <p>Duration of the study: Entry into prenatal care - delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 0</p> <p>Group Description: G1: Total</p> <p>Group N: G1: 62,167</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women with singleton pregnancies who provided an interview at approximately 16 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing data on weight gain in pregnancy 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • WHO International Taskforce <p>Age (mean, yrs): G1: < 25: 7,757 (12.5%) 25 to 29: 26,152 (42.1%) 30 to 34: 21,181 (34.1%) 35+: 7,077 (11.4%)</p> <p>Parity: G1: 47% primiparous</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 84.1% nonsmoker</p> <p>Diabetes mellitus, %: G1: 1.2%</p> <p>Hypertension, %: G1: 1.6%</p> <p>Additional characteristics: NR</p>

Evidence Table 6. Gestational weight gain and premature rupture of membranes (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 62 167 G2: 2751 G3: 41 991 G4: 12 270 G5: 5155</p> <p>Total weight gain: G1: Weekly weight gain (g) 8722;275g: (15.3%) 276–675g: (68.3%) 676g+ (16.4%)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Weekly weight gain categorised into 3 groups (low, medium, high) using cutpoints at 275 and 675 g, which were similar to those used in other studies <p>Collected from:</p> <ul style="list-style-type: none"> Does not specify-women self-reported weight gain status <p>Ascertained by:</p> <ul style="list-style-type: none"> Self-reported 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 1.2%</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Before 34 weeks of gestation, risk of induced preterm delivery potentiated among obese women with high weight gain, and after 34 weeks, risk was potentiated at extremes, namely among underweight women with a low weight gain and obese women with a high weight gain <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Adjusted hazard of spontaneous preterm birth with preterm premature rupture of membrane (PPROM)</p> <p>Groups: weekly weight gain G1: <275 g G2: 276-675 g G2: >675 g</p> <p>Results: Spontaneous preterm birth with PPRM G4: 1.5 [1.2, 1.7] G4: 1.0 Reference G4: 1.2 [1.0, 1.5]</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Height Alcohol use Socio-occupational status Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 4 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 7. Gestational weight gain and preterm labor

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Lang et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment period: August 1977-March 1980</p> <p>Funding: NR</p> <p>Study Objective: To estimate effects of 23 factors on prevalence of premature labor and fetal growth retardation across birthweight spectrum</p> <p>Time frame: August 1977 to March 1980</p> <p>Duration of the study: Pregnancy through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 11,505</p> <p>Group Description: G1: Prevalence of preterm labor G2: Prevalence of SGA</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton • Livebirths • Had data on birthweight, gestational age, and sex • Infants with gestational age from 22 to 45 weeks • Birthweights no more than 50% higher than 90th percentile for sex and gestational age <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Women with menstrual abnormalities for whom gestational dating was problematic • Stillbirths • Incomplete data • Preterm delivery • Women with preexisting diabetes mellitus, hypertension, epilepsy, asthma 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Not stated by authors <p>G1: NR</p> <ul style="list-style-type: none"> • < 100 pounds: 11.2 • 100-125: 5.9 • 126-160: 5.1 • 161-180: 7.3 • > 180: 4.4 <p>G2: NR</p> <ul style="list-style-type: none"> • < 100 pounds: 24.9 • 100-125: 12.6 • 126-160: 7.7 • 161-180: 6.5 • > 180: 5.9 <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NR <p>Age (mean, yrs):</p> <p>G1:</p> <ul style="list-style-type: none"> • < 15: 14.8 • 16-19: 11.2 • 20-24: 8.2 • 25-34: 4.6 • ≥ 35: 5.5 <p>G2:</p> <ul style="list-style-type: none"> • < 15: 25.0 • 16-19: 17.6 • 20-24: 14.3 • 25-34: 9.4 • ≥ 35: 7.2 <p>Parity:</p> <p>G1: 6.4 G2: 12.3</p>	<p>Race, %:</p> <p>White G1: 5.3 G2: 9.1</p> <p>Black G1: 9.6 G2: 17.7</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 5.0 G2: 14.0</p> <p>Smoking, %: % smoked throughout pregnancy: G1: 8.3 G2: 17.9</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 7. Gestational weight gain and premature labor (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Weekly rate of weight gain <p>Collected from:</p> <ul style="list-style-type: none"> Not stated by authors <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> AOR for preterm labor (95% CI) <p>Groups</p> <p>G1: Weekly weight gain \leq 0.40</p> <p>G2: Weekly weight gain > 0.40-0.65</p> <p>G3: Weekly weight gain > 0.65-0.90</p> <p>G4: Weekly weight gain > 0.90</p> <p>G5: Weekly weight gain missing</p> <p>Results</p> <p>G1: 3.1 (2.3-4.2)</p> <p>G2: 1.6 (1.3-2.0)</p> <p>G3: 1.0 (ref)</p> <p>G4: 1.3 (1.0-1.6)</p> <p>G5: 2.4 (1.1-5.0)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Maternal height Prepregnancy weight Maternal education Health insurance Planned pregnancy Previous induced abortion Previous spontaneous abortion Previous still birth Maternal morbidity Caffeine intake Marijuana <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <p>Infant sex</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 3 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 8. Maternal weight gain and post-term pregnancy

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cedergren, 2006</p> <p>Country and setting: Sweden, Medical Birth Registry</p> <p>Enrollment Period: January 1, 1994 - December 31, 2002</p> <p>Funding: Ostergotland County Council</p> <p>Study Objective: To estimate effects of high and low gestational weight gain in different maternal BMI classes on obstetric and neonatal outcomes</p> <p>Time frame: January 1, 1994 to December 31, 2002</p> <p>Duration of the study: First visit to maternity health care center to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 245,526</p> <p>Group Description: BMI</p> <p>G1: < 20 G2: 20 to 24.9 G3: 25 to 29.9 G4: 30 to 34.9 G5: ≥ 35</p> <p>Group N: G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton, term pregnancies Information on maternal height, maternal weight in early pregnancy, and gestational weight gain <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported If unknown, standardized measurement is made during first visit to maternity health care center <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> < 20, 20.0-24.9, 25.0-29.9, 30-34.9, ≥ 35 <p>Age (mean, yrs):</p> <p>G1: 15 to 19 years: 3.8% 20 to 24: 23.0% 25 to 29: 38.7% 30 to 34: 25.7% 35 to 39: 7.7% ≥ 40: 1.1%</p> <p>G2: 15 to 19 years: 1.9% 20 to 24: 15.9% 25 to 29: 37.7% 30 to 34: 31.1% 35 to 39: 11.3% ≥ 40: 1.9%</p> <p>G3: 15 to 19 years: 1.5% 20 to 24: 15.7% 25 to 29: 36.1% 30 to 34: 31.2% 35 to 39: 12.9% ≥ 40: 2.5%</p> <p>G4: 15 to 19 years: 1.5% 20 to 24: 17.4% 25 to 29: 35.6% 30 to 34: 30.0% 35 to 39: 13.0% ≥ 40: 2.4%</p> <p>G5: 15 to 19 years: 1.1% 20 to 24: 17.3% 25 to 29: 38.0% 30 to 34: 29.6% 35 to 39: 11.7% ≥ 40: 2.3%</p>	<p>Race, %: White G1: 96.6 G2: NR Black NR Hispanic NR Asian/Pacific Islander G1: 1.4 G2: NR Other G1: 2.0 G2: NR</p> <p>Smoking, %: G1: % nonsmoking: 81.6 G2: 85.2 G3: 83.1 G4: 79.9 G5: 78.4 Group 6</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 8. Maternal weight gain and post-term pregnancy (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Total weight gain: G1: < 8kg: 6.9% 8-15.9kg: 65.2% ≥ 16kg: 28.0% G2: < 8kg: 8.4% 8-15.9kg: 67.1% ≥ 16kg: 30.4% G3: < 8kg: 15.7% 8-15.9kg: 54.4% ≥ 16kg: 29.9% G4: < 8kg: 30.2% 8-15.9kg: 48.7% ≥ 16kg: 21.1% G5: < 8kg: 44.6% 8-15.9kg: 40.9% ≥ 16kg</p> <p>Categorized: <ul style="list-style-type: none"> < 8kg, 8-16, > 16 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between maternal weights measured when woman attended delivery unit and maternal weight recorded at first visit to maternity health care center </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Post-term pregnancy (>41 weeks)</p> <p>Groups G1:BMI < 20 G2:BMI 20-24.9 G3:BMI 25-29.9 G4:BMI 30-34.9 G5:BMI>35</p> <p>Results Post-term pregnancy by BMI for weight gain < 8 kg (reference gain 8-16 kg) OR (95% CI): G1: 0.66 (0.27-1.63) G2: 0.86 (0.64-1.16) G3: 1.08 (0.87-1.42) G4: 1.23 (0.84-1.79) G5: 1.25 (0.66-2.37)</p> <p>Post-term pregnancy by BMI for weight gain >16 kg (reference weight gain 8-16kg) OR (95% CI): G1: 0.88 (0.56-1.39) G2: 0.87 (0.74-1.03) G3: 0.82 (0.66-1.03) G4: 0.78 (0.50-1.21) G5: 1.11 (0.51-2.41)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Smoking in early pregnancy <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Year of birth 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 9. Gestational weight gain and induction of labor

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: DeVader et al., 2007</p> <p>Country and setting: United States, birth certificate data</p> <p>Enrollment period: 1999 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To investigate relationship between gestational weight gain and adverse pregnancy outcomes among women with normal prepregnancy BMI</p> <p>Time frame: 1999 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 94,696</p> <p>Group Description: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs</p> <p>Group N: G1: 16,852 G2: 37,292 G3: 40,552</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> All mothers with normal prepregnancy BMI (19.8 –26.0 kg/m²) who were 18 to 35 years of age at time of delivery and who delivered full-term (37 weeks or more) singleton infant during period January 1, 1999, to December 31, 2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women aged younger than 18 years and older than 35 years Non-Missouri residents Preterm deliveries Multiple gestations 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care If missing, obtained from mother during postpartum hospital stay <p>Pregravid BMI: NR</p> <ul style="list-style-type: none"> Imputed: No Categorized: <p>NR</p> <p>Age (mean, yrs): G1: Maternal age (y) 18 to 24*: 42.3% 25 to 30: 36.2% 31 to 35: 21.5% G2: Maternal age (y) 18 to 24*: 36.7% 25 to 30: 39.5% 31 to 35: 23.8% G3: Maternal age (y) 18 to 24*: 44.7% 25 to 30: 35.9% 31 to 35: 19.4%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 79.7 G2: 85.6 G3: 85.2</p> <p>Black G1: 15.7 G2: 10.8 G3: 12.1</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 4.6 G2: 3.5 G3: 2.7</p> <p>Smoking, %: G1: 20.5 G2: 14.9 G3: 17.4</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 9. Gestational weight gain and induction of labor (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 plot risk for each adverse pregnancy outcome by 10-lb increments in gestational weight gain. Women who gained 25 to 34 lbs during their pregnancy had lower risks for most outcomes when balancing risk for SGA status and other adverse pregnancy outcomes Women who gained 15 to 24 lbs had lowest risks for most outcomes, but increased their risk of having an SGA infant from 9.6% to 14.3% Women who gained more than 34 lbs had higher risks for all outcomes, although their risk of having an SGA infant decreased from 9.6% to 6.6% <p>Other infant outcomes:</p> <ul style="list-style-type: none"> NR 	<p>Outcomes Description: AOR for failed induction of labor</p> <p>Groups G1: < 30 lbs G2: 30-35lbs G3: > 35 lbs</p> <p>Results G1: 0.68 (95% CI, 0.59–0.78) G2: 1.0 G3: 1.51 (95% CI, 1.39–1.64)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, maternal race or ethnicity, maternal education, Medicaid status, tobacco use, alcohol use, maternal height, prior pregnancy, adequacy of prenatal care</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Child's gender, birth year</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 9. Gestational weight gain and induction of labor (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ekblad and Grenman, 1992</p> <p>Country and setting: Finland, hospital</p> <p>Enrollment Period: July 1, 1985 - December 31, 1985 (6 months)</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of abnormal maternal weight or weight gain on pregnancy outcome</p> <p>Time frame: July 1, 1985 to December 31, 1985 (6 months)</p> <p>Duration of the study: Prepregnancy to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: retrospective data from records, prospective weight and height at delivery <p>Total Study N: Total n = 357</p> <ul style="list-style-type: none"> 191 women with abnormal prepregnant weight ($\geq 20\%$ under or over ideal weight for height) or abnormal pregnancy weight gain ($\geq 20\text{kg}$ or $\leq 5\text{kg}$) 166 controls <p>Group Description: G1: $\geq 20\%$ over normal weight for height G2: $\geq 20\%$ under normal weight for height G3: weight gain $\leq 5\text{kg}$ G4: weight gain $\geq 20\text{kg}$ G5: control Group 6</p> <p>Group N: G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Birth at hospital within study period selected those with abnormal maternal prepregnancy weight or abnormal weight gain during pregnancy, as well as next mother in sequential order with normal prepregnancy weight and weight gain during pregnancy to serve as a control <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Not stated 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records - not stated if self reported <p>G1: 83.9 (10.1) G2: 46.7 (3.4) G3: 73.1 (16.5) G4: 65.0 (12.2) G5: 58.3 (6.5)</p> <p>Pregravid BMI: G1: 39.5 (3.4) G2: 17.2 (0.9) G3: 26.1 (6.1) G4: 23.6 (4.1) G5: 21.6 (2.0)</p> <ul style="list-style-type: none"> Imputed: No Categorized: Continuous $\geq 20\%$ over or under normal weight for height <p>Age (mean, yrs): G1: 28 (5.1) G2: 25.5 (5.1) G3: 29.5 (5.1) G4: 28.7 (4.7) G5: 28.7 (4.4)</p> <p>Parity: G1: prior deliveries: 1.0 (1.0) G2: 0.8 (0.8) G3: 1.2 (1.1) G4: 0.8 (1.0) G5: 0.9 (1.0)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 9. Gestational weight gain and induction of labor (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Grading
<p>Groups (N): G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Total weight gain: G1: 11.8 (6.2) <i>P</i> < 0.05 compared to controls G2: 13.4 (4.5) G3: 3.0 (3.5) <i>P</i> < 0.0005 compared to controls G4: 23.2 (22.8) <i>P</i> < 0.0005 compared to controls G5: 13.2 (3.4)</p> <p>Categorized: <ul style="list-style-type: none"> ≤ 5kg or ≥ 20kg </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3712 g (614) <i>P</i> < 0.05 compared to controls G2: 3293 (362) <i>P</i> < 0.05 compared to controls G3: 3284 (880) G4: 3803 (538) <i>P</i> < 0.005 compared to controls G5: 3538 (535)</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: Elective 7% Emergency 14% Total 21% G2: Elective 4% Emergency 4% Total 8% G3: Elective 3% Emergency 3% Total 6% G4: Elective 5% Emergency 18% Total 23% G5: Elective 13% Emergency 9% Total 22%</p> <p>Instrumental delivery,%: NR</p> <p>Episiotomy,%: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Induction of labor (%)</p> <p>Groups G1: weight gain ≤ 5kg G2: weight gain ≥ 20kg G3: reference (normal prepregnancy weight and normal weight gain [undefined])</p> <p>Results G1: 23 % G2: 43 % G3: 24 % <i>P</i> < 0.05 for G2 vs. G3</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 4 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 9. Gestational weight gain and induction of labor (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Graves et al., 2006</p> <p>Country and setting: USA, midwifery practices</p> <p>Enrollment Period: January 1, 1998-December 31, 2000</p> <p>Funding: NR</p> <p>Study Objective: To identify association between prepregnancy BMI, weight gain in pregnancy, and newborn birth weight on route of delivery and induction of labor in patients receiving nurse-midwifery care</p> <p>Time frame: January 1, 1998-December 31, 2000</p> <p>Duration of the study: PRN care up til delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 1,500</p> <p>Group Description: G1: Total cohort</p> <p>Group N: G1: 1,500</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Non-diabetic • Entered labor after 34 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Planned cesarean delivery (n = 8) • Unknown parity (in analyses in which parity was an important consideration, n = 40) • Hypertension • Diabetes 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Actual prepregnant weight or early first trimester weight documented in medical records <p>Pregravid BMI: G1: < 19.8: 9.4% 19.8-26.0: 52.1% 26.1-29.0: 20.6% > 29: 17.4%</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: ≤ 19 years: 32.2% 20-34: 62.4% ≥ 35: 4.9%</p> <p>Parity: G1: % nulliparous: 42.3</p>	<p>Race, %: White G1: 26.9</p> <p>Black G1: 18.7</p> <p>Hispanic G1: 52.1</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 2.2</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 9. Gestational weight gain and induction of labor (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 1500 G2: NR</p> <p>Total weight gain: G1: < 15 pounds: 12.7% 15-25: 25.2% 26-35: 29.3% 36-45: 16.3% > 45: 10.1%</p> <p>Categorized: <ul style="list-style-type: none"> ≤ 15 pounds 16-24, 25-35, 36-45, > 45 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: < 2500g: 3.5% 2500-3999: 84.6% 4000-4449: 9.1% ≥ 4500: 1.4%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 8.8 G2: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: OR induction of labor</p> <p>Groups G1: ≤ 45 pounds G2: > 45 pounds</p> <p>Results G2: 1.5 (95% CI, 1.0-2.4)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal BMI <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Birth weight 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 9. Gestational weight gain and induction of labor (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jensen et al., 2005</p> <p>Country and setting: Denmark, university hospitals</p> <p>Enrollment Period: Gestation through birth</p> <p>Funding: Many different funds</p> <p>Study Objective: To investigate effect of gestational weight gain in obese glucose tolerant women</p> <p>Time frame: Gestation through birth</p> <p>Duration of the study: NR</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 481</p> <p>Group Description:</p> <p>G1: GWG < 5.0 kg G2: GWG 5.0-9.9kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0kg</p> <p>Group N:</p> <p>G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Prepregnancy BMI ≥ 30 • Normal 2h 75g oral glucose tolerance test (OGTT) during third trimester (according to WHO criteria) • Only first pregnancy during study period included <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Well defined chronic disease • Twin pregnancies • Women with GDM (n = 323) • Known diet treatment (n = 10) • Incomplete data on weight gain during pregnancy (n-153) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Records • Patient report of pregravid BMI <p>Pregravid BMI:</p> <p>G1: 34.3 (32.2-39.9) G2: 33.9 (31.5-36.5) G3: 32.9 (31.2-35.6) G4: 32.7 (31.3-34.7)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs):</p> <p>G1: 29.8 (26.4-33.1) G2: 29.1 (26.3-33.1) G3: 30.0 (26.6-33.2) G4: 27.9 (24.8-31.8)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: 84.4 G2: 85.8 G3: 82.7 G4: 89.9</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 29.7 G2: 25.8 G3: 30.2 G4: 26.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 9. Gestational weight gain and induction of labor (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> < 5.0, 5.0-9.9, 10.0-14.9, ≥ 15.0 Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records Ascertained by: <ul style="list-style-type: none"> Not stated by authors </p>	<p>Birth weight: G1: 3500 (3200-3840) G2: 3645 (3200-4000) G3: 3750 (3390-4125) G4: 3762 (3400-4120)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: OR for induction of labor</p> <p>Groups G1: GWG < 5.0 kg G2: GWG 5.0-9.9 kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0 kg</p> <p>Results G1: 1.0 G2: 2.7 (95% CI, 1.3-5.7) G3: 2.8 (95% CI, 1.3-5.9) G4: 3.7 (95% CI, 1.7-8.0) <i>P</i> for trend=0.002</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Pre-gravid BMI 2 hour OGTT result Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 9. Gestational weight gain and induction of labor (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kabiru and Raynor, 2004</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1999 to 2002</p> <p>Funding: NR</p> <p>Study Objective: To investigate effect of increase in body mass index category on obstetric outcomes</p> <p>Time frame: 1999 to 2002</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 5,131</p> <p>Group Description:</p> <p>G1: No change in BMI between first prenatal visit and delivery</p> <p>G2: 1 category increase in BMI between first prenatal visit and delivery</p> <p>G3: > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Group N:</p> <p>G1: 2,556</p> <p>G2: 2,252</p> <p>G3: 323</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancies <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple pregnancies BMI < 20 Missing BMI data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured at first prenatal visit <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> 20-24.9, 25-29.9, 30-34.9, 35-39.9, ≥ 40 <p>Age (mean, yrs):</p> <p>G1: 24.7 (6.1)</p> <p>G2: 24.4 (5.7)</p> <p>G3: 25.2 (5.9) <i>P</i> < 0.001</p> <p>Parity:</p> <p>G1: Gravidity (mean): 1.9 (1.9)</p> <p>G2: 1.5 (1.7)</p> <p>G3: 1.2 (1.7) <i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 1.9</p> <p>G2: 2.6</p> <p>G3: 2.8</p> <p>Black</p> <p>G1: 84.1</p> <p>G2: 82.8</p> <p>G3: 88.2</p> <p>Hispanic</p> <p>G1: 13.9</p> <p>G2: 14.6</p> <p>G3: 9.0</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>NR</p> <p>Smoking, %:</p> <p>NR</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>Mean weight gain:</p> <p>G1: 8.6 pounds (8.4)</p> <p>G2: 22.2 pounds (10.2)</p> <p>G3: 55.3 pounds (23.8)</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 9. Gestational weight gain and induction of labor (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 579 G2: 942 G3: 189 G4: 819 G5: 790 G6: 104</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> > 35 pounds for normal BMI, > 25 pounds for overweight BMI, > 15 pounds for obese BMI <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not stated, most likely difference between weight at first prenatal visit and weight at delivery 	<p>Birth weight: G1: 2886.0 (756) G2: 3174.9 (600) G3: 3099.5 (673) $P < 0.001$ G4: 3116 (713) G5: 3269 (698) G6: 3371 (733) $P = 0.015$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 8.2 G2: 12.6 G3: 21.0 $P < 0.001$ G4: 13.0 G5: 14.3 G6: 19.3 $P = 0.256$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Percent failed induction of labor</p> <p>Groups</p> <p>G1: normal BMI, no change in BMI between first prenatal visit and delivery</p> <p>G2: normal BMI, 1 category increase in BMI between first prenatal visit and delivery</p> <p>G3: normal BMI, > 1 category increase in BMI between first prenatal visit and</p> <p>G4: overweight BMI, no change in BMI between first prenatal visit and delivery</p> <p>G5: overweight BMI, 1 category increase in BMI between first prenatal visit and delivery</p> <p>G6: overweight BMI, > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Results G1: 4.7 G2: 9.2 G3: 15.9 $P < 0.001$ for difference in normal BMI groups</p> <p>G4: 7.9 G5: 10.3 G6: 14.6 $P < 0.001$ for difference in normal BMI groups</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 10. Maternal weight gain and length of labor

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ekblad and Grenman, 1992</p> <p>Country and setting: Finland, hospital</p> <p>Enrollment Period: July 1, 1985 - December 31, 1985 (6 months)</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of abnormal maternal weight or weight gain on pregnancy outcome</p> <p>Time frame: July 1, 1985 to December 31, 1985 (6 months)</p> <p>Duration of the study: Prepregnancy to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: retrospective data from records, prospective weight and height at delivery <p>Total Study N: Total n = 357</p> <ul style="list-style-type: none"> 191 women with abnormal prepregnant weight ($\geq 20\%$ under or over ideal weight for height) or abnormal pregnancy weight gain ($\geq 20\text{kg}$ or $\leq 5\text{kg}$) 166 controls <p>Group Description: G1: $\geq 20\%$ over normal weight for height G2: $\geq 20\%$ under normal weight for height G3: weight gain $\leq 5\text{kg}$ G4: weight gain $\geq 20\text{kg}$ G5: control Group 6</p> <p>Group N: G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Birth at hospital within study period selected those with abnormal maternal prepregnancy weight or abnormal weight gain during pregnancy, as well as next mother in sequential order with normal prepregnancy weight and weight gain during pregnancy to serve as a control <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Not stated 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records - not stated if self reported <p>G1: 83.9 (10.1) G2: 46.7 (3.4) G3: 73.1 (16.5) G4: 65.0 (12.2) G5: 58.3 (6.5)</p> <p>Pregravid BMI: G1: 39.5 (3.4) G2: 17.2 (0.9) G3: 26.1 (6.1) G4: 23.6 (4.1) G5: 21.6 (2.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous $\geq 20\%$ over or under normal weight for height <p>Age (mean, yrs): G1: 28 (5.1) G2: 25.5 (5.1) G3: 29.5 (5.1) G4: 28.7 (4.7) G5: 28.7 (4.4)</p> <p>Parity: G1: prior deliveries: 1.0 (1.0) G2: 0.8 (0.8) G3: 1.2 (1.1) G4: 0.8 (1.0) G5: 0.9 (1.0)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 10. Maternal weight gain and length of labor (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Total weight gain: G1: 11.8 (6.2) <i>P</i> < 0.05 compared to controls G2: 13.4 (4.5) G3: 3.0 (3.5) <i>P</i> < 0.0005 compared to controls G4: 23.2 (22.8) <i>P</i> < 0.0005 compared to controls G5: 13.2 (3.4)</p> <p>Categorized: <ul style="list-style-type: none"> ≤ 5kg or ≥ 20kg </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3712 g (614) <i>P</i> < 0.05 compared to controls G2: 3293 (362) <i>P</i> < 0.05 compared to controls G3: 3284 (880) G4: 3803 (538) <i>P</i> < 0.005 compared to controls G5: 3538 (535)</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: Elective 7% Emergency 14% Total 21% G2: Elective 4% Emergency 4% Total 8% G3: Elective 3% Emergency 3% Total 6% G4: Elective 5% Emergency 18% Total 23% G5: Elective 13% Emergency 9% Total 22%</p> <p>Instrumental delivery,%: NR</p> <p>Episiotomy,%: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Labor patterns by stage in minutes (SD)</p> <p>Groups G1: weight gain ≤ 5 kg G2: weight gain ≥ 20 kg G3: reference (normal prepregnancy weight and normal weight gain [undefined])</p> <p>Results I stage G1: 333 (208) G2: 374 (208) G3: 346 (188)</p> <p>II stage G1: 15 (18) <i>P</i> < 0.05 compared to reference category G2: 27 (25) G3: 21 (18)</p> <p>III stage G1: 13 (13) G2: 13 (11) G3: 12 (12)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 4 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 10. Maternal weight gain and length of labor (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Johnson et al., 1992</p> <p>Country and setting: USA, prenatal clinics</p> <p>Enrollment Period: January 1, 1987- December 31, 1989</p> <p>Funding: NR</p> <p>Study Objective: To determine influences of increased maternal prepregnancy weight and increased gestational weight gain on pregnancy outcome</p> <p>Time frame: January 1, 1987 to December 31, 1989</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,191</p> <p>Group Description: G1: BMI < 19.8 G2: 19.8-26.0 G3: 27-29 G4: > 29 G5: All</p> <p>Group N: G1: 755 G2: 1,621 G3: 329 G4: 486 G5: 3191</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Delivery at or beyond 38 weeks of gestation Singletons Received prenatal care and delivered in Shands Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Fetal abnormalities Oligohydramnios Polyhydramnios Medical or surgical complications (GI disorders, sickle cell hemoglobinopathy, hepatitis, hematologic disorders, malignant disease, renal disease, neurologic disease, pulmonary disease, psychiatric disorders, tuberculosis) Incomplete risk variable data or outcome variable information 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> National Academy of Sciences <p>Age (mean, yrs): G1: NR</p> <ul style="list-style-type: none"> < 20 years: 36.6% 20-26 years: 44.8% > 26 years: 18.7% <p>G2: NR</p> <ul style="list-style-type: none"> < 20 years: 30.8% 20-26 years: 46.5% > 26 years: 22.6% <p>G3:</p> <ul style="list-style-type: none"> < 20 years: 25.8% 20-26 years: 48.9% > 26 years: 25.2% <p>G4:</p> <ul style="list-style-type: none"> < 20 years: 16.5% 20-26 years: 53.9% > 26 years: 29.6% <p>G5:</p> <ul style="list-style-type: none"> < 20 years: 29.5% 20-26 years: 47.5 % > 26 years: 23.0% <p>Parity: G1: % first: 49.3 G2: 43.1 G3: 37.4 G4: 31.1 G5: 42.1</p>	<p>Race, %: White G1: 64.5 G2: 60.0 G3: 49.8 G4: 51.9 G5: 58.7</p> <p>Black G1: 33.6 G2: 37.9 G3: 48.9 G4: 47.5 G5: 39.5</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 1.9 G2: 2.1 G3: 1.2 G4: 0.6 G5: 1.7</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Hypertension, %: G1: 3.4 G2: 4.6 G3: 5.8 G4: 10.7 G5: 5.4</p> <p>Additional characteristics: G1: % married: 42.6 G2: 46.1 G3: 40.4 G4: 49.4 G5: 45.2</p> <p>Additional characteristics: NR</p>

Evidence Table 10. Maternal weight gain and length of labor (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 755 G2: 1621 G3: 329 G4: 486 G5: 3191</p> <p>Total weight gain: G1: <ul style="list-style-type: none"> < 16kg: 7.8% 16-25kg: 18.5% 26-35kg: 35.1% > 35kg: 38.5% G2: <ul style="list-style-type: none"> < 16kg: 11.7% 16-25kg: 18.0% 26-35kg: 28.8% > 35kg: 41.5% G3: <ul style="list-style-type: none"> < 16kg: 19.8% 16-25kg: 19.1% 26-35kg: 28.3% > 35kg: 32.8% G4: <ul style="list-style-type: none"> < 16kg: 32.3% 16-25kg: 22.0%; </p> <p>Categorized: <ul style="list-style-type: none"> Quartiles National Academy of Sciences (below, within, or above recommended range) </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self report and weight at last prenatal visit (mean 6.1 days prior to delivery) </p>	<p>Birth weight: G1: <ul style="list-style-type: none"> < 2500g: 4.8% 2500-4000g: 89.1% > 4000g: 6.1% G2: <ul style="list-style-type: none"> < 2500g: 2.0% 2500-4000g: 85.2% > 4000g: 12.8% G3: <ul style="list-style-type: none"> < 2500g: 1.5% 2500-4000g: 83.0% > 4000g: 15.5% G4: <ul style="list-style-type: none"> < 2500g: 0.2% 2500-4000g: 82.5% > 4000g: 17.3% </p> <p>Gestational diabetes, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Cesarean delivery, %: G1: NR G2: NR G3: NR G4: NR G5: 11.9</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: <ul style="list-style-type: none"> Frequency of macrosomia = 12.2% Frequency of cesarean = 11.9% Frequency of LBW = 2.9% </p>	<p>Outcomes Description: Odds of labor abnormalities</p> <p>Groups G1: total weight gain < 16 pounds G2: total weight gain 16-25 pounds G3: total weight gain 26-35 pounds G4: total weight gain > 35 pounds</p> <p>Results Elevated odds of labor abnormalities only in the group gaining > 35 pounds compared with women gaining < 16 pounds; not significant when adjusted for confounders</p> <p>Trend analysis showed risk of labor abnormalities with increased weight gain, a difference in 10 lb. corresponds to OR: 2 ($P < 0.0001$) after adjusting for BMI, patient care (private vs. nonprivate), parity, infant sex, hypertension, and macrosomia</p> <p>Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> Prepregnancy weight quartile Height (tertile) BMI category Race/ethnicity Marital status Private physician Parity Maternal age Hypertension </p> <p>Infant and child confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> Infant sex Birth weight </p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 9 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 10. Maternal weight gain and length of labor (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Johnson et al., 1992
(continued)

Evidence Table 10. Maternal weight gain and length of labor (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
	<ul style="list-style-type: none"> • Frequency of postdate pregnancy = 9.8% • Frequency of labor abnormalities (40% were unscheduled cesareans) = 7.8% • Frequency of oxytocin induction = 13.7% • Frequency of oxytocin augmentation = 16.1% • Frequency of meconium staining = 21.5% 	
	<p>Other infant outcomes: NA</p>	

Evidence Table 10. Maternal weight gain and length of labor (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Purfield and Morin, 1994</p> <p>Country and setting: Tertiary care medical center, Pennsylvania</p> <p>Enrollment Period:</p> <p>Funding: NR</p> <p>Study Objective: To determine whether a group of normal weight women with a low risk pregnancy who increased prepregnancy weight by more than 25% experienced a longer second stage of labor or higher proportion of operative deliveries than a group of normal weight women</p> <p>Time frame:</p> <p>Duration of the study: August 1991 to June 1992</p>	<p>Design:</p> <ul style="list-style-type: none"> Other observational : convenience sample Retrospective <p>Total Study N: 104</p> <p>Group Description: G1: prepregnant weight increased by 25% or less G2: prepregnant weight increased by more than 25%</p> <p>Group N: G1: 52 G2: 52</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Low risk primiparous pregnancy Normal prepregnant weight for height 18 to 40 years of age No medical or obstetric risk factors 37 to 42 weeks gestation Epidural anesthesia Delivery of singleton infant weighing between 5lb 8oz and 8lb 13oz <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Management of delivery influenced by any fetal or maternal risk factor such as fetal distress, malpresentation, cephalopelvic disproportion, or maternal infection 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 135.69 (15.43) G2: 129.81 (14.83)</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Normal weight was defined as a weight within 90-120% of standard weight for height based on Metropolitan Life Insurance Company Table of 1983 NR <p>Age (mean, yrs): G1: 25.75 (4.83) G2: 25.83 (4.81)</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 10. Maternal weight gain and length of labor (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 52 G2: 52</p> <p>Total weight gain: G1: % of weight gain (greater than prepregnant weight): 20.60 (3.52) G2: % of weight gain (greater than prepregnant weight): 33.21 (5.45) $t = -14.02$ $P = 0.001$</p> <p>Categorized:</p> <ul style="list-style-type: none"> > 25% of prepregnant weight and \leq 25% of prepregnant weight <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self report and weight at admission to hospital for birth 	<p>Birth weight: G1: 3266 (351.54) G2: 3384 (327.47) $t = -2.33$ $P = 0.02$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Length of second stage labor</p> <p>Groups G1: prepregnant weight increased by 25% or less G2: prepregnant weight increased by more than 25%</p> <p>Results Normal weight primigravidas with a low risk pregnancy who gained an excessive amount of weight had a longer mean length of second stage labor than women who gained less weight</p> <p>Length of second stage in minutes by weight groups (SD) G1: 72.42 (46.69) G2: 93.28 (52.87) $t = -2.05$ $P = 0.02$</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: Percentage of cesarean deliveries</p> <p>Groups G1: 0 or weight loss G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs</p> <p>Results G1: 25.8% G2: 26.8% G3: 28.8% G4: 35.0% G5: 33.8% <i>P</i> = NS</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Brennand et al., 2005</p> <p>Country and setting: Canada, medical records</p> <p>Enrollment Period: Prenatal to birth</p> <p>Funding: cree board of health and social services of James Bay (Quebec)</p> <p>Study Objective: To determine effect of pregravid weight and pregnancy weight gain on pregnancy outcomes in Cree women</p> <p>Time frame: Prenatal to birth</p> <p>Duration of the study: 7 year period: January 1994 to December 2000</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 603</p> <p>Group Description:</p> <p>G1: Normal: BMI 18.5 - 24.9</p> <p>G2: Overweight: BMI 25-29.9</p> <p>G3: Obese: BMI ≥ 30</p> <p>G4: Total</p> <p>Group N:</p> <p>G1: 139 G2: 168 G3: 296 G4: 603</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Used only Cree women First birth observed per woman during study time period Must have first weight recorded within first 14 weeks gestation and final weight recorded within 4 weeks of birth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with secondary pregnancy in dataset (n = 792) Women with first weight record > 14 weeks gestation (n = 314) Women with final weight record > 4 weeks from birth (n = 202) Women with both first weight record > 14 weeks and final weight record > 4 weeks (n = 70) Women missing data on first or final weight (n = 3) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care Medical records Measured within 14 weeks of gestation <p>G1: 59.7 (5.0) G2: 73.0 (4.3) G3: 93.6 (12.3) G4: 80.0 (16.9)</p> <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> Yes <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce <p>Age (mean, yrs):</p> <p>G1: 20.8 (5.2) G2: 23.8 (5.4) G3: 25.5 (5.5) G4: 24.0 (5.7)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %:</p> <p>G1: 4.3 G2: 14.9 G3: 27.4 G4: 18.6</p> <p>Hypertension, %:</p> <p>G1: 1.4 G2: 1.8 G3: 4.8 G4: 3.2</p> <p>Additional characteristics:</p> <p>% low weight gain:</p> <p>G1: 20.1 G2: 10.1 G3: 28.0 G4: 21.2</p> <p>% acceptable weight gain:</p> <p>G1: 28.8 G2: 32.1 G3: 33.4 G4: 32.0</p> <p>% excessive weight gain:</p> <p>G1: 51.1 G2: 57.7 G3: 38.5 G4: 46.6</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 139 G2: 168 G3: 296</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> 1999 Canadian guidelines Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: within 4 weeks of birth </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 4.3 G2: 14.9 G3: 27.4 G4: 18.6</p> <p>Cesarean delivery, %: G1: 10.8 G2: 11.3 G3: 24.1 (p < 0.001)</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Definition of low, adequate, and excessive weight gains: For normal weight women - adequate weight gain is 11.5 to 16 kg For overweight women, adequate weight gain is 7 to 11.5 kg For obese women, adequate weight gain is 7 to 11.5 kg Weight gain below specified range is "low" and weight gain above specified range is "excessive" <p>Other infant outcomes: > 4000g, > 4500g</p>	<p>Outcomes Description: Percentage of cesarean sections</p> <p>Groups Primigravid women (maternal weight gain outcomes by BMI presented only for obese women) G1: Obese - low weight gain (< 7 kg) G2: Obese - acceptable weight gain (7-11.5 kg) G3: Obese - excessive weight gain (> 11.5 kg) G4: Total</p> <p>Results G1: 25.3 G2: 23.5 G3: 23.7 $\chi^2 P=0.952$ G4: 24</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 5 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Brennand et al., 2005 (continued)</p>	<ul style="list-style-type: none"> • Pregnancies with factors that may have influenced maternal weight gain such as 1 parent being non-Cree (n = 13), preterm deliveries (n = 91), twin pregnancies (n = 6), missing gestational age (n = 9) • Women with unknown glycemic status (n = 30), type 2 DM (n = 8), glycemic abnormalities before pregnancy not followed for diagnosis (n = 70) • Women classified as underweight (n = 5) 		

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
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Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cedergren, 2006</p> <p>Country and setting: Sweden, Medical Birth Registry</p> <p>Enrollment Period: January 1, 1994 - December 31, 2002</p> <p>Funding: Ostergotland County Council</p> <p>Study Objective: To estimate effects of high and low gestational weight gain in different maternal BMI classes on obstetric and neonatal outcomes</p> <p>Time frame: January 1, 1994 to December 31, 2002</p> <p>Duration of the study: First visit to maternity health care center to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 245,526</p> <p>Group Description: BMI</p> <p>G1: < 20 G2: 20 to 24.9 G3: 25 to 29.9 G4: 30 to 34.9 G5: ≥ 35</p> <p>Group N: G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton, term pregnancies • Information on maternal height, maternal weight in early pregnancy, and gestational weight gain <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported • If unknown, standardized measurement is made during first visit to maternity health care center <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • < 20, 20.0-24.9, 25.0-29.9, 30-34.9, ≥ 35 <p>Age (mean, yrs):</p> <p>G1: 15 to 19 years: 3.8% 20 to 24: 23.0% 25 to 29: 38.7% 30 to 34: 25.7% 35 to 39: 7.7% ≥ 40: 1.1%</p> <p>G2: 15 to 19 years: 1.9% 20 to 24: 15.9% 25 to 29: 37.7% 30 to 34: 31.1% 35 to 39: 11.3% ≥ 40: 1.9%</p> <p>G3: 15 to 19 years: 1.5% 20 to 24: 15.7% 25 to 29: 36.1% 30 to 34: 31.2% 35 to 39: 12.9% ≥ 40: 2.5%</p> <p>G4: 15 to 19 years: 1.5% 20 to 24: 17.4% 25 to 29: 35.6% 30 to 34: 30.0% 35 to 39: 13.0% ≥ 40: 2.4%</p> <p>G5: 15 to 19 years: 1.1% 20 to 24: 17.3% 25 to 29: 38.0% 30 to 34: 29.6% 35 to 39: 11.7% ≥ 40: 2.3%</p>	<p>Race, %: White G1: 96.6 G2: NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander G1: 1.4 G2: NR</p> <p>Other G1: 2.0 G2: NR</p> <p>Smoking, %: G1: % nonsmoking: 81.6 G2: 85.2 G3: 83.1 G4: 79.9 G5: 78.4 Group 6</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Total weight gain: G1: < 8kg: 6.9% 8-15.9kg: 65.2% ≥ 16kg: 28.0% G2: < 8kg: 8.4% 8-15.9kg: 67.1% ≥ 16kg: 30.4% G3: < 8kg: 15.7% 8-15.9kg: 54.4% ≥ 16kg: 29.9% G4: < 8kg: 30.2% 8-15.9kg: 48.7% ≥ 16kg: 21.1% G5: < 8kg: 44.6% 8-15.9kg: 40.9% ≥ 16kg</p> <p>Categorized: <ul style="list-style-type: none"> < 8kg, 8-16, > 16 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between maternal weights measured when woman attended delivery unit and maternal weight recorded at first visit to maternity health care center </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: AOR for weight gain for weight gain groups by cesarean of instrumental deliveries (95% CI)</p> <p>Groups Weight gain < 8 kg, 8-16 kg, and > 16 kg for each BMI class below G1: BMI < 20 G2: BMI 20-24.9 G3: BMI 25-29.9 G4: BMI 30-34.9 G5: BMI ≥ 35</p> <p>AOR for weight gain < 8 kg for Cesarean section compared with weight gain 8-16 kg G1: 1.07 (0.89-1.29) G2: 0.98 (0.92-1.05) G3: 0.88 (0.82-0.95) G4: 0.81 (0.73-0.90) G5: 0.75 (0.66-0.87)</p> <p>AOR for weight gain < 8 kg for instrumental delivery compared with weight gain 8-16 kg G1: 0.89 (0.71-1.11) G2: 0.88 (0.80-0.96) G3: 0.85 (0.76-0.95) G4: 0.75 (0.63-0.88) G5: 0.83 (0.65-1.03)</p> <p>AOR for weight gain > 16 kg for instrumental delivery compared with weight gain 8-16 kg G1: 1.28 (1.15-1.43) G2: 1.19 (1.14-1.25) G3: 1.14 (1.06-1.23) G4: 1.09 (0.93-1.27) G5: 1.04 (0.77-1.40)</p> <p>AOR for weight gain > 16 kg for Cesarean section compared with weight gain 8-16 kg G1: 1.29 (1.17-1.43) G2: 1.24 (1.19-1.29) G3: 1.23 (1.17-1.30) G4: 1.22 (1.10-1.35) G5: 1.27 (1.05-1.52)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, parity, smoking in early pregnancy, and year of birth</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Year of birth</p>	<p>Background: Fair</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Chen et al., 2004</p> <p>Country and setting: USA, private practice</p> <p>Enrollment Period: Feb 1993-June 2001</p> <p>Funding: NR</p> <p>Study Objective: To develop an easily usable integrated formula for predicting probability of cephalopelvic disproportion/failure to progress (CPD) and cesarean delivery (CS) as function of demographic factors in middle-class private practice</p> <p>Time frame: Feb 1993-June 2001</p> <p>Duration of the study: Entry into prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 3,355</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 3,355 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • All primiparous, singleton births between February 1993 and June 13, 2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • insufficient data for analysis with respect to all 5 demographic factors 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported • Weight taken at first prenatal visit if presented before 20 weeks; if after 20 weeks, self-reported <p>Pregravid BMI: G1: BMI</p> <p>< 20 16.3% 20-25 48% 25-30 21% 30-40 12.8% > 40 2%</p> <p>G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous/categorical by 5 point increments (< 25, 20-25, etc.) <p>Age (mean, yrs): G1: < 20: 8.9 20-24: 25.8% 25-29: 36.7% 30-34: 20.2% > 35 8.4%</p> <p>G2: NR</p> <p>Parity:</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 852 G2: 1,383 G3: 1,120</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Categorical, < 25, 25-35, > 35 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: subtracted from weight at first prenatal visit 	<p>Birth weight: NR</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: 20.9 G2: 19.3 G3: 25.4</p> <p>Instrumental delivery,%:</p> <p>Episiotomy,%:</p> <p>Other maternal outcomes: Progression of adjusted OR of Cephalopelvic Disproportion (CPD): Every 5 lbs more weight gain during pregnancy = 1.057 (1.005-1.110) progression in OR. Progression of adjusted OR of Cesarean Delivery: Every 5 lb more weight gain during pregnancy = 1.094 (1.074 - 1.115) progression in OR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Progression of AOR of cesarean delivery weight gain (for every 5 lbs)</p> <p>Groups Gestational weight gain in lbs</p> <p>Results 1.094 (1.074 - 1.115)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal height Body mass index (BMI) Maternal height Maternal age Pregnancy weight gain <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age at delivery Fetal birth weight 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 8 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: DeVader et al., 2007</p> <p>Country and setting: United States, birth certificate data</p> <p>Enrollment period: 1999 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To investigate relationship between gestational weight gain and adverse pregnancy outcomes among women with normal prepregnancy BMI</p> <p>Time frame: 1999 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 94,696</p> <p>Group Description: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs</p> <p>Group N: G1: 16,852 G2: 37,292 G3: 40,552</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> All mothers with normal prepregnancy BMI (19.8 –26.0 kg/m²) who were 18 to 35 years of age at time of delivery and who delivered full-term (37 weeks or more) singleton infant during period January 1, 1999, to December 31, 2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women aged younger than 18 years and older than 35 years Non-Missouri residents Preterm deliveries Multiple gestations 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care If missing, obtained from mother during postpartum hospital stay <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized: NR</p> <p>Age (mean, yrs): G1: Maternal age (y) 18 to 24*: 42.3% 25 to 30: 36.2% 31 to 35: 21.5% G2: Maternal age (y) 18 to 24*: 36.7% 25 to 30: 39.5% 31 to 35: 23.8% G3: Maternal age (y) 18 to 24*: 44.7% 25 to 30: 35.9% 31 to 35: 19.4%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 79.7 G2: 85.6 G3: 85.2 Black G1: 15.7 G2: 10.8 G3: 12.1 Hispanic NR Asian/Pacific Islander NR Other G1: 4.6 G2: 3.5 G3: 2.7</p> <p>Smoking, %: G1: 20.5 G2: 14.9 G3: 17.4</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 plot risk for each adverse pregnancy outcome by 10-lb increments in gestational weight gain. Women who gained 25 to 34 lbs during their pregnancy had lower risks for most outcomes when balancing risk for SGA status and other adverse pregnancy outcomes Women who gained 15 to 24 lbs had lowest risks for most outcomes, but increased their risk of having an SGA infant from 9.6% to 14.3% Women who gained more than 34 lbs had higher risks for all outcomes, although their risk of having an SGA infant decreased from 9.6% to 6.6% 	<p>Outcomes Description: Adjusted odds ratio of mode of delivery by weight groups</p> <p>Groups G1: < 30 lbs G2: 30-35lbs G3: > 35 lbs</p> <p>Results AOR for cesarean (95% CI): G1: 0.82 (0.78–0.87) G2: 1.0 G3: 1.35 (1.29–1.40)</p> <p>AOR for instrumental (95% CI): G1: 0.97 (0.90–1.04) G2: 1.0 G3: 1.03 (0.97–1.08)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal age Maternal race or ethnicity Maternal education Medicaid status Tobacco use Alcohol use Maternal height, Prior pregnancy Adequacy of prenatal care <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Child's gender Birth year 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ekblad and Grenman, 1992</p> <p>Country and setting: Finland, hospital</p> <p>Enrollment Period: July 1, 1985 - December 31, 1985 (6 months)</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of abnormal maternal weight or weight gain on pregnancy outcome</p> <p>Time frame: July 1, 1985 to December 31, 1985 (6 months)</p> <p>Duration of the study: Prepregnancy to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: retrospective data from records, prospective weight and height at delivery <p>Total Study N: Total n = 357</p> <ul style="list-style-type: none"> 191 women with abnormal prepregnant weight ($\geq 20\%$ under or over ideal weight for height) or abnormal pregnancy weight gain ($\geq 20\text{kg}$ or $\leq 5\text{kg}$) 166 controls <p>Group Description: G1: $\geq 20\%$ over normal weight for height G2: $\geq 20\%$ under normal weight for height G3: weight gain $\leq 5\text{kg}$ G4: weight gain $\geq 20\text{kg}$ G5: control Group 6</p> <p>Group N: G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Birth at hospital within study period selected those with abnormal maternal prepregnancy weight or abnormal weight gain during pregnancy, as well as next mother in sequential order with normal prepregnancy weight and weight gain during pregnancy to serve as a control <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Not stated 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records - not stated if self reported <p>G1: 83.9 (10.1) G2: 46.7 (3.4) G3: 73.1 (16.5) G4: 65.0 (12.2) G5: 58.3 (6.5)</p> <p>Pregravid BMI: G1: 39.5 (3.4) G2: 17.2 (0.9) G3: 26.1 (6.1) G4: 23.6 (4.1) G5: 21.6 (2.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous $\geq 20\%$ over or under normal weight for height <p>Age (mean, yrs): G1: 28 (5.1) G2: 25.5 (5.1) G3: 29.5 (5.1) G4: 28.7 (4.7) G5: 28.7 (4.4)</p> <p>Parity: G1: prior deliveries: 1.0 (1.0) G2: 0.8 (0.8) G3: 1.2 (1.1) G4: 0.8 (1.0) G5: 0.9 (1.0)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Total weight gain: G1: 11.8 (6.2) <i>P</i> < 0.05 compared to controls G2: 13.4 (4.5) G3: 3.0 (3.5) <i>P</i> < 0.0005 compared to controls G4: 23.2 (22.8) <i>P</i> < 0.0005 compared to controls G5: 13.2 (3.4)</p> <p>Categorized:</p> <ul style="list-style-type: none"> ≤ 5kg or ≥ 20kg <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3712 g (614) <i>P</i> < 0.05 compared to controls G2: 3293 (362) <i>P</i> < 0.05 compared to controls G3: 3284 (880) G4: 3803 (538) <i>P</i> < 0.005 compared to controls G5: 3538 (535)</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: Elective 7% Emergency 14% Total 21% G2: Elective 4% Emergency 4% Total 8% G3: Elective 3% Emergency 3% Total 6% G4: Elective 5% Emergency 18% Total 23% G5: Elective 13% Emergency 9% Total 22%</p> <p>Instrumental delivery,%: NR</p> <p>Episiotomy,%: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Percentage of vaginal, forceps, vacuum, breech or cesarean deliveries by weight gain categories</p> <p>Groups G1: weight gain ≤ 5 kg G2: weight gain ≥ 20 kg G3: reference (normal prepregnancy weight and normal weight gain [undefined])</p> <p>Normal vaginal delivery (%) G1: 90 <i>P</i> < 0.05 compared to controls G2: 64 G3: 71</p> <p>Forceps or vacuum delivery (%) G1: 3 G2: 13 G3: 5</p> <p>Breech (%) G1: 1 G2: 0 G3: 2</p> <p>Cesarean section - elective % G1: 3 G2: 5 G3: 13</p> <p>Cesarean section - emergency % G1: 3 G2: 18 G3: 9</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 4 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Graves et al., 2006</p> <p>Country and setting: USA, midwifery practices</p> <p>Enrollment Period: January 1, 1998-December 31, 2000</p> <p>Funding: NR</p> <p>Study Objective: To identify association between prepregnancy BMI, weight gain in pregnancy, and newborn birth weight on route of delivery and induction of labor in patients receiving nurse-midwifery care</p> <p>Time frame: January 1, 1998-December 31, 2000</p> <p>Duration of the study: PRN care up til delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 1,500</p> <p>Group Description: G1: Total cohort</p> <p>Group N: G1: 1,500</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Non-diabetic • Entered labor after 34 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Planned cesarean delivery (n = 8) • Unknown parity (in analyses in which parity was an important consideration, n = 40) • Hypertension • Diabetes 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Actual prepregnant weight or early first trimester weight documented in medical records <p>Pregravid BMI: G1: < 19.8: 9.4% 19.8-26.0: 52.1% 26.1-29.0: 20.6% > 29: 17.4%</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: ≤ 19 years: 32.2% 20-34: 62.4% ≥ 35: 4.9%</p> <p>Parity: G1: % nulliparous: 42.3</p>	<p>Race, %: White G1: 26.9</p> <p>Black G1: 18.7</p> <p>Hispanic G1: 52.1</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 2.2</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 1500 G2: NR</p> <p>Total weight gain: G1: < 15 pounds: 12.7% 15-25: 25.2% 26-35: 29.3% 36-45: 16.3% > 45: 10.1%</p> <p>Categorized: <ul style="list-style-type: none"> ≤ 15 pounds 16-24, 25-35, 36-45, > 45 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: < 2500g: 3.5% 2500-3999: 84.6% 4000-4449: 9.1% ≥ 4500: 1.4%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 8.8 G2: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Association of weight gain on mode of delivery</p> <p>Groups G1: ≤ 45 pounds G2: > 45 pounds</p> <p>Results Greater weight gain in pregnancy was not associated significantly with route of delivery</p> <p>Confounders and effect modifiers NR</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Prepregnancy BMI category Total prenatal weight gain category Induction of labor Race/ethnicity <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age > 41 weeks Birth weight 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jain et al, 2007</p> <p>Country and setting: United States, hospitals</p> <p>Enrollment period: 2002-2005</p> <p>Funding: Not reported</p> <p>Study Objective: To analyze risks of cesarean section, macrosomia, and breastfeeding at 10 weeks postpartum using logistic regression to estimate independent effects of prepregnancy BMI and gestational weight gain</p> <p>Time frame: 2002-2005</p> <p>Duration of the study: Entry into prenatal care to 10 weeks postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 7661</p> <p>Group Description: NR</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Term (> 37 weeks) and singleton for macrosomia and breastfeeding <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Cesarean analysis limited to to women with cephalic presentation-records with missing data excluded 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <ul style="list-style-type: none"> NR <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race,%: NR</p> <p>Smoking,%: NR</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain:</p> <ul style="list-style-type: none"> NR <p>Categorized:</p> <ul style="list-style-type: none"> ≤ 15 lbs 15-25 lbs 25-35 lbs 35+ lbs <p>Collected from:</p> <ul style="list-style-type: none"> Not outlined <p>Ascertained by:</p> <ul style="list-style-type: none"> Birth certificate 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Cesarean delivery, primiparous and multiparous</p> <p>Groups: G1: WG ≤ 15 lbs G2: WG 15-24 lbs G3: WG 25-35 lbs G4: WG ≥ 35 lbs</p> <p>Results: AOR for primiparous cesarean delivery (from model including interaction term for overweight/obese + > 25 lbs weight gain) G1: 0.95 (0.59-1.52) G2: 1.0 (ref) G3: 1.10 (0.76-1.60) G4: 1.62 (1.10-2.39)</p> <p>AOR for multiparous cesarean delivery (from model including interaction term for overweight/obese + > 25 lbs weight gain) G1: 1.11 (0.60-2.04) G2: 1.0 (ref) G3: 1.08 (0.63-1.85) G4: 1.95 (1.02-3.72)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal age Pregravid BMI Parity Education Race/ethnicity US/foreign origin Interaction terms for pregravid BMI and weight gain <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> NA 	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 7 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jensen et al., 2005</p> <p>Country and setting: Denmark, university hospitals</p> <p>Enrollment Period: Gestation through birth</p> <p>Funding: Many different funds</p> <p>Study Objective: To investigate effect of gestational weight gain in obese glucose tolerant women</p> <p>Time frame: Gestation through birth</p> <p>Duration of the study: NR</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 481</p> <p>Group Description:</p> <p>G1: GWG < 5.0 kg G2: GWG 5.0-9.9kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0kg</p> <p>Group N:</p> <p>G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Prepregnancy BMI ≥ 30 Normal 2h 75g oral glucose tolerance test (OGTT) during third trimester (according to WHO criteria) Only first pregnancy during study period included <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Well defined chronic disease Twin pregnancies Women with GDM (n = 323) Known diet treatment (n = 10) Incomplete data on weight gain during pregnancy (n-153) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records Patient report of pregravid BMI <p>Pregravid BMI:</p> <p>G1: 34.3 (32.2-39.9) G2: 33.9 (31.5-36.5) G3: 32.9 (31.2-35.6) G4: 32.7 (31.3-34.7)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs):</p> <p>G1: 29.8 (26.4-33.1) G2: 29.1 (26.3-33.1) G3: 30.0 (26.6-33.2) G4: 27.9 (24.8-31.8)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: 84.4 G2: 85.8 G3: 82.7 G4: 89.9</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 29.7 G2: 25.8 G3: 30.2 G4: 26.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> < 5.0. 5.0-9.9, 10.0-14.9, ≥ 15.0 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated by authors 	<p>Birth weight: G1: 3500 (3200-3840) G2: 3645 (3200-4000) G3: 3750 (3390-4125) G4: 3762 (3400-4120)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: OR for cesarean delivery (95% CI)</p> <p>Groups G1: GWG 5.0-9.9 kg G2: GWG 10.0-14.9 kg G3: GWG ≥ 15 kg</p> <p>Results G1: 1.0 G2: 2.4 (1.1-5.3) G3: 3.0 (1.4-6.4) G4: 3.6 (1.6-7.8) <i>P</i> for trend = 0.002</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Pre-gravid BMI 2h OGTT result Parity Smoking Ethnic background Clinical center <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Johnson et al., 1992</p> <p>Country and setting: USA, prenatal clinics</p> <p>Enrollment Period: January 1, 1987- December 31, 1989</p> <p>Funding: NR</p> <p>Study Objective: To determine influences of increased maternal prepregnancy weight and increased gestational weight gain on pregnancy outcome</p> <p>Time frame: January 1, 1987 to December 31, 1989</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,191</p> <p>Group Description: G1: BMI < 19.8 G2: 19.8-26.0 G3: 27-29 G4: > 29 G5: All</p> <p>Group N: G1: 755 G2: 1,621 G3: 329 G4: 486 G5: 3191</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Delivery at or beyond 38 weeks of gestation Singletons Received prenatal care and delivered in Shands Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Fetal abnormalities Oligohydramnios Polyhydramnios Medical or surgical complications (GI disorders, sickle cell hemoglobinopathy, hepatitis, hematologic disorders, malignant disease, renal disease, neurologic disease, pulmonary disease, psychiatric disorders, tuberculosis) Incomplete risk variable data or outcome variable information 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> National Academy of Sciences <p>Age (mean, yrs): G1: NR</p> <ul style="list-style-type: none"> < 20 years: 36.6% 20-26 years: 44.8% > 26 years: 18.7% <p>G2: NR</p> <ul style="list-style-type: none"> < 20 years: 30.8% 20-26 years: 46.5% > 26 years: 22.6% <p>G3:</p> <ul style="list-style-type: none"> < 20 years: 25.8% 20-26 years: 48.9% > 26 years: 25.2% <p>G4:</p> <ul style="list-style-type: none"> < 20 years: 16.5% 20-26 years: 53.9% > 26 years: 29.6% <p>G5:</p> <ul style="list-style-type: none"> < 20 years: 29.5% 20-26 years: 47.5 % > 26 years: 23.0% <p>Parity: G1: % first: 49.3 G2: 43.1 G3: 37.4 G4: 31.1 G5: 42.1</p>	<p>Race, %: White G1: 64.5 G2: 60.0 G3: 49.8 G4: 51.9 G5: 58.7</p> <p>Black G1: 33.6 G2: 37.9 G3: 48.9 G4: 47.5 G5: 39.5</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 1.9 G2: 2.1 G3: 1.2 G4: 0.6 G5: 1.7</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Hypertension, %: G1: 3.4 G2: 4.6 G3: 5.8 G4: 10.7 G5: 5.4</p> <p>Additional characteristics: G1: % married: 42.6 G2: 46.1 G3: 40.4 G4: 49.4 G5: 45.2</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 755 G2: 1621 G3: 329 G4: 486 G5: 3191</p> <p>Total weight gain: G1: <ul style="list-style-type: none"> < 16kg: 7.8% 16-25kg: 18.5% 26-35kg: 35.1% > 35kg: 38.5% G2: <ul style="list-style-type: none"> < 16kg: 11.7% 16-25kg: 18.0% 26-35kg: 28.8% > 35kg: 41.5% G3: <ul style="list-style-type: none"> < 16kg: 19.8% 16-25kg: 19.1% 26-35kg: 28.3% > 35kg: 32.8% G4: <ul style="list-style-type: none"> < 16kg: 32.3% 16-25kg: 22.0%; Categorized: <ul style="list-style-type: none"> Quartiles National Academy of Sciences (below, within, or above recommended range) Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self report and weight at last prenatal visit (mean 6.1 days prior to delivery) </p>	<p>Birth weight: G1: <ul style="list-style-type: none"> < 2500g: 4.8% 2500-4000g: 89.1% > 4000g: 6.1% G2: <ul style="list-style-type: none"> < 2500g: 2.0% 2500-4000g: 85.2% > 4000g: 12.8% G3: <ul style="list-style-type: none"> < 2500g: 1.5% 2500-4000g: 83.0% > 4000g: 15.5% G4: <ul style="list-style-type: none"> < 2500g: 0.2% 2500-4000g: 82.5% > 4000g: 17.3% Gestational diabetes, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1 Cesarean delivery, %: G1: NR G2: NR G3: NR G4: NR G5: 11.9 Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: <ul style="list-style-type: none"> Frequency of macrosomia = 12.2% Frequency of cesarean = 11.9% Frequency of LBW = 2.9% </p>	<p>Outcomes Description: Adjusted odds ratio for unscheduled cesarean (95% CI)</p> <p>Groups G1: total weight gain < 16 pounds G2: total weight gain 16-25 pounds G3: total weight gain 26-35 pounds G4: total weight gain > 35 pounds</p> <p>Results G1: 1.0 G2: 0.95 (0.6-1.5) G3: 1.3 (0.86-1.95) G4: 1.95 (1.32 - 2.87)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> Prepregnancy weight quartile Height (tertile) BMI category Private physician (yes/no) Maternal age Parity Diabetes Hypertension Maternal education Infant and child confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> Birth weight Gestational age </p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 9 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Johnson et al., 1992
(continued)

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
	<ul style="list-style-type: none">• Frequency of postdate pregnancy = 9.8%• Frequency of labor abnormalities (40% were unscheduled cesareans) = 7.8%• Frequency of oxytocin induction = 13.7%• Frequency of oxytocin augmentation = 16.1%• Frequency of meconium staining = 21.5% <p>Other infant outcomes: NA</p>	

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Joseph et al., 2003</p> <p>Country and setting: All deliveries that occurred among residents of Nova Scotia, Canada - from Nova Scotia Atlee Perinatal Database</p> <p>Enrollment period: NR</p> <p>Funding: NR</p> <p>Study Objective: To estimate contribution of changes in maternal characteristics (namely, age, parity, prepregnancy weight, weight gain in pregnancy, smoking status) and obstetric practice (namely labor induction, epidural anesthesia, delivery by an obstetrician, midpelvic forceps delivery) to recent increases in primary cesarean delivery rates</p> <p>Time frame: NR</p> <p>Duration of the study: January 1, 1988 to December 31, 2000</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 100,259</p> <p>Group Description: G1: Births 1988-1991 G2: Births 1998-2000 G3: % Primary Cesarean Rate 1988-1991 G4: % Primary Cesarean Rate 1998-2000</p> <p>Group N: G1: 44,317 G2: 24,901 G3: 44,317 G4: 24,901</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> All deliveries that occurred to residents of Nova Scotia <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with previous cesarean delivery 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Data taken from standardized forms and hospital medical records - no mention of self-report <p>G1: < 55: 30.1% 55-59: 21.2% 60-69: 27.3% ≥ 70: 21.4%</p> <p>G2: < 55: 20.4% 55-59: 15.9% 60-69: 27.7% ≥ 70: 36.0%</p> <p>G3: < 55: 12.3% 55-59: 12.6% 60-69: 11.8% ≥ 70: 16.9%</p> <p>G4: < 55: 13.2% 55-59: 13.6% 60-69: 14.7% ≥ 70: 18.7%</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> NR <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NR <p>Age (mean, yrs): % Age: < 20yrs:</p> <p>G1: 9.4% 20-29 yrs: 62.6% 30-34yrs: 21.4% 35-39 yrs: 5.9% ≥ 40yrs: 0.7%</p> <p>G2: 8.0% 20-29 yrs: 54.6% 30-34yrs: 25.8% 35-39 yrs: 10.1% ≥ 40yrs: 1.5%</p> <p>G3: 12.5% 20-29 yrs: 13.2% 30-34yrs: 12.3% 35-39 yrs: 14.8% ≥ 40yrs: 17.6%</p> <p>G4: 11.4% 20-29 yrs: 15.1% 30-34yrs: 16.6% 35-39 yrs: 19.6% ≥ 40yrs: 22.7%</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 32.6 G2: 23.4 G3: 27.1 G4: 28.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 1.4 G2: 1.2 G3: 38.7 G4: 50.3</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain:</p> <ul style="list-style-type: none"> NR <p>Categorized:</p> <ul style="list-style-type: none"> < 5, 5-9, 10-14(ref), 15-19, ≥ 20 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not explained by authors - data taken from maternity records 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes NR</p> <p>Other infant outcomes NR</p>	<p>Outcomes Description: AOR for cesarean delivery (95% CI)</p> <p>Groups G1: < 5 kg G2: 5-9 kg G3: 10-14 kg G4: 15-19 kg G5: ≥ 20 kg</p> <p>Results G1: 1.10 (1.00, 1.20) G2: 1.04 (0.99, 1.10) G3: 1.00 G4: 1.09 (1.05, 1.14) G5: 1.41 (1.35, 1.47)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Prepregnancy weight Smoking Pregnancy (singleton or multiple) Hypertension Diabetes Previous fetal death Induction Epidural Physician type Time <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 3 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
Author, year: Joseph et al., 2003 (continued)		Parity: %Parity: Nulliparous: G1: 49.1% 1: 31.7% 2: 13.4% 3-4: 5.2% ≥ 5: 0.6% G2: 50.3% 1: 32.5% 2: 11.9% 3-4: 4.6% ≥ 5: 0.7% G3: 20.7% 1: 5.9% 2: 5.3% 3-4: 6.3% ≥ 5: 5.5% G4: 24.6% 1: 6.8% 2: 6.7% 3-4: 6.5% ≥ 5: 11.6%	

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
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Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kabiru and Raynor, 2004</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1999 to 2002</p> <p>Funding: NR</p> <p>Study Objective: To investigate effect of increase in body mass index category on obstetric outcomes</p> <p>Time frame: 1999 to 2002</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 5,131</p> <p>Group Description:</p> <p>G1: No change in BMI between first prenatal visit and delivery</p> <p>G2: 1 category increase in BMI between first prenatal visit and delivery</p> <p>G3: > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Group N:</p> <p>G1: 2,556</p> <p>G2: 2,252</p> <p>G3: 323</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancies <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple pregnancies • BMI < 20 • Missing BMI data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Measured at first prenatal visit <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • 20-24.9, 25-29.9, 30-34.9, 35-39.9, ≥ 40 <p>Age (mean, yrs):</p> <p>G1: 24.7 (6.1)</p> <p>G2: 24.4 (5.7)</p> <p>G3: 25.2 (5.9) <i>P</i> < 0.001</p> <p>Parity:</p> <p>G1: Gravidity (mean): 1.9 (1.9)</p> <p>G2: 1.5 (1.7)</p> <p>G3: 1.2 (1.7) <i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 1.9</p> <p>G2: 2.6</p> <p>G3: 2.8</p> <p>Black</p> <p>G1: 84.1</p> <p>G2: 82.8</p> <p>G3: 88.2</p> <p>Hispanic</p> <p>G1: 13.9</p> <p>G2: 14.6</p> <p>G3: 9.0</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>NR</p> <p>Smoking, %:</p> <p>NR</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>Mean weight gain:</p> <p>G1: 8.6 pounds (8.4)</p> <p>G2: 22.2 pounds (10.2)</p> <p>G3: 55.3 pounds (23.8)</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 579 G2: 942 G3: 189 G4: 819 G5: 790 G6: 104</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> > 35 pounds for normal BMI, > 25 pounds for overweight BMI, > 15 pounds for obese BMI <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not stated, most likely difference between weight at first prenatal visit and weight at delivery 	<p>Birth weight: G1: 2886.0 (756) G2: 3174.9 (600) G3: 3099.5 (673) $P < 0.001$ G4: 3116 (713) G5: 3269 (698) G6: 3371 (733) $P = 0.015$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 8.2 G2: 12.6 G3: 21.0 $P < 0.001$ G4: 13.0 G5: 14.3 G6: 19.3 $P = 0.256$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Primary cesarean</p> <p>Groups Primary cesarean</p> <p>G1: normal BMI, no change in BMI between first prenatal visit and delivery G2: normal BMI, 1 category increase in BMI between first prenatal visit and delivery G3: normal BMI, > 1 category increase in BMI between first prenatal visit and delivery G4: overweight BMI, no change in BMI between first prenatal visit and delivery G5: overweight BMI, 1 category increase in BMI between first prenatal visit and delivery G6: overweight BMI, > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Results Operative vaginal delivery G1: 11.4 G2: 12.4 G3: 12.2 $P = 0.837$ G4: 8.4 G5: 11.4 G6: 17.3 $P < 0.001$</p> <p>Cesarean delivery rate for failure to progress G1: 2.5 G2: 6.5 G3: 10.2 $P = 0.203$ G4: 3.5 G5: 6.9 G6: 10.2 $P = 0.002$</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Pre-gravid BMI <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kiel et al., 2007</p> <p>Country and setting: United States, birth registry</p> <p>Enrollment period: 1990 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of gestational weight change on pregnancy outcomes in obese women</p> <p>Time frame: 1990 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 120,170</p> <p>Group Description:</p> <p>G1: Obese Class I (BMI 30–34.9) (n = 70,536)</p> <p>G2: Obese Class II (BMI 35–39.9) (n = 30,609)</p> <p>G3: Obese Class III (BMI 40 and More) (n = 19,025)</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women residing in Missouri who delivered (at 37 or more weeks of gestation) liveborn, singleton infants during 1990–2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: Total: Class I obese: 59% Class II obese: 25% Class III obese: 16%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NIH guidelines <p>Age (mean, yrs):</p> <p>G1: <26: 46% 26-35: 47% Older than 35: 8%</p> <p>G2: <26: 44% 26-35: 48% Older than 35: 8%</p> <p>G3: <26: 40% 26-35: 52% Older than 35: 9%</p> <p>Parity: Nulliparous: G1: 34% G2: 33% G3: 32%</p>	<p>Race, %: White G1: 78 G2: 77 G3: 73</p> <p>Black G1: 22 G2: 23 G3: 27</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 22</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: GWG (lb) Less than 2: 3% 2 to 14: 15% 15 to 25: 26% More than 25: 56% G2: GWG (lb) Less than 2: 8% 2 to 14: 22% 15 to 25: 27% More than 25: 43% G3: GWG (lb) Less than 2: 15%</p> <p>Categorized:</p> <ul style="list-style-type: none"> 10-lb or less loss 2 to 9 lbs loss, no weight change, 2 to 9 lbs gain, 10 to 14 lbs gain, 15–25 lb gain, 26–35 lb gain, and greater than 35 lb gain <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: G1: SGA: 7% LGA: 13% (<i>P</i> < 0.05) G2: SGA: 7% LGA: 16% (<i>P</i> < 0.05) G3: SGA: 6% LGA: 18% (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 28 G2: 34 G3: 41</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Odds of preeclampsia, cesarean delivery, LGA births, SGA births</p> <p>Groups All obese women G1: Loss 10 lbs or more G2: Loss 2 to 9 lbs G3: No change G4: Gain 2-9 lbs G5: Gain 10-14 lbs G6: Gain 15-25 lbs G7: Gain 25-35 lbs</p> <p>Results Compared with women who gained 15–25 lb during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births.</p> <p>Magnitude differed by obesity classification, even after adjusting for known or suspected confounders</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Education Poverty (enrollment in Medicaid, WIC, food stamp programs) Tobacco use Chronic hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Kiel et al., 2007
(continued)

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
	<p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 show absolute risk of preeclampsia, cesarean delivery, LGA, and SGA by GWG category for each obesity class. All 3 figures show similar patterns of increasing risk of preeclampsia, cesarean delivery, and LGA birth and decreasing risk of SGA birth with increasing GWG. Collectively, minimal risk for all 4 outcomes corresponds to GWG categories where risk of LGA and SGA births intersect. This equates to GWG of 10 of 25 lb for class I obese women, a gain of 0 to 9 lb for class II obese women, and weight loss of 0 to 9 lb for class III obese women. Adjusted odds ratios and 95% CIs for preeclampsia, cesarean delivery, SGA, and LGA by GWG category and obesity class. Compared with women who gained 15 to 25 lb during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births. Women who gained more than 25 lbs had higher odds for same 3 pregnancy outcomes and lower odds for SGA births. <p>Other infant outcomes: NR</p>	

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Murakami et al., 2004</p> <p>Country and setting: Japan, hospital</p> <p>Enrollment Period: 2001</p> <p>Funding: NR</p> <p>Study Objective: To estimate risk of perinatal morbidity of mother and infant with respect to maternal prepregnancy BMI and weight gain in Japanese women</p> <p>Time frame: 2001</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 633</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 633 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Live, singletons delivered between 24 to 42 weeks gestation <p>Exclusion criteria:</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 20.9 (2.8) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce <p>Age (mean, yrs): G1: 29.1 (4.5) G2: NR</p> <p>Parity: G1: 0.6 (0.7) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 8.5 G2: NR</p> <p>Diabetes mellitus, %: G1: 2.1 G2: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: Preeclampsia - mild: 5.4%; severe: 4.1% G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 633 G2: NR</p> <p>Total weight gain: G1: 10.5 (3.4) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> < 8.5kg, 8.5-12.5, > 12.5 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: last measurement was taken at hospitalization prior to delivery 	<p>Birth weight: G1: 3,052.6 (483.8) G2: NR</p> <p>Gestational diabetes, %: G1: 2.1 G2: NR</p> <p>Cesarean delivery, %: G1: 10.3 G2: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: AOR for cesarean delivery (95% CI)</p> <p>Groups G1: < 8.5 kg G2: 8.5-12.5 kg G3: > 12.5 kg</p> <p>Results G1: 1.08 (0.56-2.07) G2: 1.00 G3: 1.23 (0.61-2.48)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pre-gravid BMI Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 8 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Purfield and Morin, 1994</p> <p>Country and setting: Tertiary care medical center, Pennsylvania</p> <p>Enrollment Period:</p> <p>Funding: NR</p> <p>Study Objective: To determine whether a group of normal weight women with a low risk pregnancy who increased prepregnancy weight by more than 25% experienced a longer second stage of labor or higher proportion of operative deliveries than a group of normal weight women</p> <p>Time frame:</p> <p>Duration of the study: August 1991 to June 1992</p>	<p>Design:</p> <ul style="list-style-type: none"> Other observational : convenience sample Retrospective <p>Total Study N: 104</p> <p>Group Description: G1: prepregnant weight increased by 25% or less G2: prepregnant weight increased by more than 25%</p> <p>Group N: G1: 52 G2: 52</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Low risk primiparous pregnancy Normal prepregnant weight for height 18 to 40 years of age No medical or obstetric risk factors 37 to 42 weeks gestation Epidural anesthesia Delivery of singleton infant weighing between 5lb 8oz and 8lb 13oz <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Management of delivery influenced by any fetal or maternal risk factor such as fetal distress, malpresentation, cephalopelvic disproportion, or maternal infection 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 135.69 (15.43) G2: 129.81 (14.83)</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Normal weight was defined as a weight within 90-120% of standard weight for height based on Metropolitan Life Insurance Company Table of 1983 NR <p>Age (mean, yrs): G1: 25.75 (4.83) G2: 25.83 (4.81)</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 52 G2: 52</p> <p>Total weight gain: G1: % of weight gain (greater than prepregnant weight): 20.60 (3.52) G2: % of weight gain (greater than prepregnant weight): 33.21 (5.45) $t = -14.02$ $P = 0.001$</p> <p>Categorized:</p> <ul style="list-style-type: none"> > 25% of prepregnant weight and \leq 25% of prepregnant weight <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self report and weight at admission to hospital for birth 	<p>Birth weight: G1: 3266 (351.54) G2: 3384 (327.47) $t = -2.33$ $P = 0.02$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Rates of different modes of delivery by weight gain</p> <p>Groups G1: prepregnant weight increased by 25% or less G2: prepregnant weight increased by more than 25%</p> <p>Results Higher rate of vacuum extraction and cesarean delivery and lower rate of spontaneous vaginal delivery. with excessive weight gain</p> <p>No difference in forceps delivery and vaginal delivery by weight gain status</p> <p>Vaginal delivery G1: n=27 G2: n=9</p> <p>Vacuum extraction G1: n=14 G2: n=25</p> <p>Low forceps G1: n=8 G2: n=8</p> <p>Cesarean section G1: n=3 G2: n=10</p> <p>$\chi^2=15.87$, $P=0.001$ for all 4 modes of delivery by weight groups</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Rosenberg et al., 2005</p> <p>Country and setting: USA, vital statistics data</p> <p>Enrollment Period: Bbirth certificates with self reported pregravid weight and weight gain</p> <p>Funding: NR</p> <p>Study Objective: To examine associations between obesity, diabetes, and 3 adverse pregnancy outcomes (primary cesarean section, preterm birth, and LBW) by race/ethnic groups</p> <p>Time frame: Birth certificates with self reported pregravid weight and weight gain</p> <p>Duration of the study: Birth certificates from 1999, 2000, and 2001</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 329988</p> <p>Group Description:</p> <p>G1: Non-hispanic blacks</p> <p>G2: Non-hispanic whites</p> <p>G3: Non-hispanic asians</p> <p>G4: Hispanics</p> <p>G5: Total</p> <p>Group N:</p> <p>G1: 86,908</p> <p>G2: 96,581</p> <p>G3: 38,570</p> <p>G4: 107,612</p> <p>G5: 329,988</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Live singleton births Information on maternal prepregnancy weight and maternal weight gain during pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: < 100 pounds: 1.7%</p> <p>100-149: 49.1%</p> <p>150-199: 37.5%</p> <p>200-299: 11.2%</p> <p>≥ 300: 0.5%</p> <p>G2: < 100 pounds: 1.8%</p> <p>100-149: 69.5%</p> <p>150-199: 24.0%</p> <p>200-299: 4.7%</p> <p>≥ 300: 0.1%</p> <p>G3: < 100 pounds: 8.1%</p> <p>100-149: 79.5%</p> <p>150-199: 11.6%</p> <p>200-299: 0.8%</p> <p>≥ 300</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NR <p>Age (mean, yrs):</p> <p>G1: 27.5</p> <p>G2: 30.6</p> <p>G3: 29.7</p> <p>G4: 26.4 <i>P</i> < 0.001</p> <p>G5: 28.3</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %:</p> <p>G1: 3.7</p> <p>G2: 2.6</p> <p>G3: 6.6</p> <p>G4: 3.5</p> <p>G5: 3.7 <i>P</i> < 0.001</p> <p>Hypertension, %:</p> <p>G1: 1.7</p> <p>G2: 0.6</p> <p>G3: 0.5</p> <p>G4: 0.7</p> <p>G5: 0.9 <i>P</i> < 0.001</p> <p>Additional characteristics:</p> <p>G1: PIH 1.9</p> <p>G2: 1.2</p> <p>G3: 0.7</p> <p>G4: 1.4</p> <p>G5: 1.4 <i>P</i> < 0.001</p> <p>Additional characteristics:</p> <p>G1: Preeclampsia 2.9</p> <p>G2: 1.3</p> <p>G3: 1.2</p> <p>G4: 2.6</p> <p>G5: 2.1 <i>P</i> < 0.001</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 86,908 G2: 96,581 G3: 38,570 G4: 107,612 G5: 329,988</p> <p>Total weight gain: G1: < 41pounds: 79.7% ≥ 41 pounds: 20.3% G2: < 41pounds: 83.2% ≥ 41 pounds: 16.8% <i>P</i> < 0.001 G3: < 41pounds: 89.2% ≥ 41 pounds: 10.8% G4: < 41pounds: 79.1% ≥ 41 pounds: 20.9% G5: < 41pounds: 81.6% ≥ 41 pounds: 18.4%</p> <p>Categorized: <ul style="list-style-type: none"> < 41, ≥ 41 pounds </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 3.7 G2: 2.6 G3: 6.6 G4: 3.5 G5: 3.7 <i>P</i> < 0.001</p> <p>Cesarean delivery, %: G1: 16.2 G2: 14.7 <i>P</i> < 0.001 G3: 14.4 G4: 13.8 G5: 14.7</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Preterm birth 10.5, 5.1, 5.9, 7.8, 7.5 <i>P</i> < 0.001 (groups defined above) LBW 9.7, 4.1, 5.7, 6.1, 6.4 <i>P</i> < 0.001 (groups defined above) 	<p>Outcomes Description: AOR for primary cesarean (95% CI)</p> <p>Groups G1: < 41 pounds G2: ≥ 41 pounds</p> <p>Results 1.38 (1.34-1.41)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity GDM Pregnancy induced hypertension Pre-eclampsia Prepregnancy weight Chronic diabetes Chronic hypertension Marital status Maternal education Mother's birthplace Prenatal care payer Social risk Trimester prenatal care began <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 7 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Sherrard, 2007</p> <p>Country and setting: Canada, hospital</p> <p>Enrollment Period: 1978 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To quantify the effects of pre-gravid BMI and gestational weight gain on caesarian delivery</p> <p>Time frame: 1978 to 2001</p> <p>Duration of the study: 22 years</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 63,930</p> <p>Group Description:</p> <p>G1: Primary caeserean w/o labor</p> <p>G2: Primary caeserean w/ labour</p> <p>G3: Repeat w/o labour</p> <p>G4: Repeat w/ labour</p> <p>Group N:</p> <p>G1: 58039</p> <p>G2: 57468</p> <p>G3: 5351</p> <p>G4: 2206</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton term births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> Yes <p>Categorized:</p> <ul style="list-style-type: none"> < 18.5, 18.5-24.9, 25-29.9, >30 <p>Age (mean, yrs):</p> <p>Categories by group</p> <p><20: 1.9%, 1.9%, 0.2%, 0.2%</p> <p>20 to 34: 82.2%, 82.4%, 70%, 72%</p> <p>35 or more: 15.9%, 15.7%, 29.8%, 27.8%</p> <p>Parity:</p> <p>Nulliparous- Yes</p> <p>G1: 51.5%</p> <p>G2: 51.3%</p> <p>G3: NA</p> <p>G4: NA</p>	<p>Race, %: NR</p> <p>Smoking, % (none):</p> <p>G1: 81%</p> <p>G2: 81%</p> <p>G3: 82.1%</p> <p>G4: 82.6%</p> <p>Diabetes mellitus, %: NA</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: Weight gain rate Low (<0.18) G1: 18.9% G2: 18.9% G3: 19.5% G4: 19.6%</p> <p>Normal (0.18-0.5) G1: 75.4% G2: 75.4% G3: 74.3% G4: 74.8%</p> <p>High (>0.5) G1: 5.7% G2: 5.7% G3: 6.2% G4: 5.6%</p>	<p>Birth weight:</p> <p>Gestational diabetes, %:</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Cesarean delivery, primary and repeat, labored and unlabored</p> <p>Groups: Rate of weight gain (kg/wk) G1: Low (≤ 0.17) G2: Normal (0.18-0.50) G3: High (> 0.50)</p> <p>Results: AOR for unlabored cesarean, primary G1: 0.79 (0.59-1.05) G2: 1.00 (ref) G3: 1.03 (0.64-1.64)</p> <p>AOR for labored cesarean, primary G1: 0.77 (0.68-0.86) G2: 1.00 (ref) G3: 1.40 (1.23-1.60)</p> <p>AOR for unlabored cesarean, repeat G1: 0.91 (0.76-1.09) G2: 1.00 (ref) G3: 1.38 (1.04-1.83)</p> <p>AOR for labored cesarean, repeat G1: 0.79 (0.54-1.15) G2: 1.00 (ref) G3: 1.22 (0.72-2.09)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • BMI • Gestational diabetes • Pregnancy-induced hypertension • Macrosomia • Socioeconomic factors • Parity • Maternal age <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • NA 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Shepard et al., 1998</p> <p>Country and setting: Obstetrical practices in New Haven, CT</p> <p>Enrollment Period: 1988 to 1992</p> <p>Funding: Grants NIH</p> <p>Study Objective: To examine absolute and proportional gestational weight gain and prepregnancy BMI as predictors of primary cesarean delivery</p> <p>Time frame: 1988 to 1992</p> <p>Duration of the study: First prenatal visit to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 2,301</p> <p>Group Description: G1: Cesarean delivery G2: Vaginal delivery</p> <p>Group N: G1: 312 G2: 1,989</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Privately insured women who received prenatal care from 13 largest obstetrical practices and health maintenance organizations in greater New Haven, CT region (part of a larger study of selected environmental risk factors on pregnancy) Singleton deliveries at Yale-New Haven Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Repeat cesareans births Missing information on key variables 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 140.9 (28.6) G2: 136.3 (25.2) $P = 0.007$</p> <p>Pregravid BMI:</p> <p>G1: 24.3 (4.6) G2: 22.9 (3.9) $P < 0.0001$</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NHANES II: ≤ 19.4; 19.5-22.4; 22.5-28.5; > 28.5 <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White G1: 88.4 G2: 91.2</p> <p>Black G1: 5.8 G2: 4.9</p> <p>Hispanic G1: 3.5 G2: 2.3</p> <p>Asian/Pacific Islander G1: 1.3 G2: 1.1</p> <p>Other G1: 1.0 G2: 0.4</p> <p>Smoking, %: % never smokers: G1: 82.3 G2: 85.9</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: %married: G1: 95.8 G2: 92.1</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 312 G2: 1989</p> <p>Total weight gain: G1: 35.4 (11.9) G2: 33.3 (11.9) <i>P</i> = 0.005</p> <p>Categorized:</p> <ul style="list-style-type: none"> Proportional weight gain based on prepregnancy weight and weight change during pregnancy <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Proportional weight gain, lb, mean: cesarean delivery - 26.5 (10.0); vaginal delivery - 25.2 (9.3) <i>P</i> = 0.048 <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Low birth weight rate = 3.3% for entire study population 	<p>Outcomes Description: Adjusted relative risk (95% CI) of cesarean delivery based on types of weight gain</p> <p>Groups G1: Proportional Weight Gain (total weight gain/ prepregnancy weight) G2: Absolute Weight Gain</p> <p>Results Underweight (< 19.4), ≤ median G1: 1.00 G2: 1.00</p> <p>Underweight (< 19.4), > median G1: 2.08 (0.86-5.04) G2: 1.20 (0.56-2.59)</p> <p>Low-Average (19.5-22.4), ≤ median G1: 1.62 (0.90-3.67) G2: 1.00 (0.54-1.84)</p> <p>Low-Average (19.5-22.4), > median G1: 2.35 (1.06-5.21) G2: 1.62 (0.94-3.02)</p> <p>High-Average(22.5-28.4), ≤ median G1: 2.78 (1.26-6.12) G2: 1.80 (1.01-3.21)</p> <p>High-Average (22.5-28.4), > median G1: 3.06 (1.40-6.73) G2: 2.02 (1.14-3.57)</p> <p>Obese (> 28.5), ≤ median G1: 3.25 (1.40-7.54) G2: 2.13 (1.12-4.08)</p> <p>Obese (> 28.5), > median G1: 2.69 (1.18-6.16) G2: 1.65 (0.90-3.03)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Ethnicity Parity GDM Pre-eclampsia Placental problems Fetal distress Macrosomia Induction Height Marital status <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Wataba et al., 2006</p> <p>Country and setting: Japan, academic medical center</p> <p>Enrollment Period: 1981 to 1999</p> <p>Funding: NR</p> <p>Study Objective: To analyze association of pregnancy complications with prepregnant body mass index and weight gain during pregnancy in Japanese women</p> <p>Time frame: 1981 to 1999</p> <p>Duration of the study: Entry into PNC up til delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Perinatal data base and look at medical records retrospectively Retrospective <p>Total Study N: 21,718</p> <p>Group Description: G1: Nulliparous G2: Parous women</p> <p>Group N: G1: 10413 G2: 11305</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancy delivering term baby at Osaka Med Center and Research Institute for Maternal and Child Health in 1981-1999 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> None reported 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Not stated <p>Pregravid BMI: G1: 20.5 (2.6) G2: 21.1 (3.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Categorical in 2 kg/m² point intervals from prepregnancy weight; categorical into low, medium, high BMI groups (< 18, 18-23.9, > 24) <p>Age (mean, yrs): G1: 27.8 (4.1) G2: 30.45 (3.9)</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 10413 G2: 11305</p> <p>Total weight gain: G1: kg/wk: 0.25 (SD 0.09) G2: kg/wk: 0.24 (0.09) <i>P</i> < 0.01</p> <p>Categorized:</p> <ul style="list-style-type: none"> Categorical in kg/wk using prepregnancy weight and weight at delivery divided by gestational age of infant at birth <p>Collected from:</p> <ul style="list-style-type: none"> Rate of weight gain determined by: total weight gain divided by weeks ga <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: and subtracting prepregnancy weight 	<p>Birth weight: G1: SGA: 5.4% LGA 5.2% G2: SGA 6.5% LGA 5.2%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> NR <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Adjusted odds ratio for cesarean deliveries by weight gain categories</p> <p>Groups Rate of weight gain, categorized differently across different BMI groups</p> <p>Results For nulliparous, low BMI women: Higher risk of cesarean delivery for women with weight gain \geq 0.4 kg/week (AOR: 2.30 [95% CI 1.06-4.98] compared with women gaining 0.25-0.3 kg/week)</p> <p>For nulliparous, medium BMI women: Higher risk of cesarean delivery for women with weight gain \geq 0.4 kg/week (AOR: 1.61 [95% CI 1.21-2.14] compared with women gaining 0.25-0.3 kg/week) and for women with weight gain 0.35-0.4 kg/week (AOR: 1.68 [95% CI 1.22-2.30] compared with women gaining 0.25-0.3 kg/week)</p> <p>For nulliparous, high BMI women: No increased risk</p> <p>For parous, medium BMI women: Higher risk of cesarean delivery for women with weight gain 0.25-0.3 kg/week (AOR: 1.49 [95% CI 1.09-2.04] compared with women gaining 0.20-0.25 kg/week)</p> <p>No data presented on cesarean delivery for other BMI groups for parous women</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
 Wataba et al., 2006
 (Continued)

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none">• Baseline BMI• Parity Infant and child confounders and effect modifiers accounted for in analysis: NR	

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Witter et al., 1995</p> <p>Country and setting: Obstetric database, Johns Hopkins Hospital, MD</p> <p>Enrollment period: NR</p> <p>Funding: NR</p> <p>Study Objective: To determine whether greater weight gain during pregnancy is associated with an increased risk of cesarean delivery and, if so, whether this effect is explained by positive influence of weight gain on birth weight and if there is a threshold of pregnancy weight gain above which risk of cesarean delivery is increased differentially</p> <p>Time frame: NR</p> <p>Duration of the study: 1987 to 1989</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 4,346</p> <p>Group Description: G1: Cesarean deliveries G2: Vaginal deliveries</p> <p>Group N: G1: 1,086 G2: 3,260</p> <p>Group 3Inclusion criteria:</p> <ul style="list-style-type: none"> Women who delivered infants \geq 28 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Incomplete data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported NR <p>Pregravid BMI: G1: 24.7 (5.9) G2: 23.1 (4.7)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 26.9 (6.7) G2: 24.3 (6.1)</p> <p>Parity: NR</p>	<p>Race, %: White G1: 40.3 G2: 29.0 Black G1: 59.7 G2: 71.0 Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 27.3 G2: 29.6</p> <p>Diabetes mellitus, %: G1: 6.1 G2: 2.6</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 1,086 G2: 3,260</p> <p>Total weight gain: G1: 14.56 (6.53) * <i>P</i> < 0.05 compared to vaginal deliveries G2: 13.49 (6.44)</p> <p>Categorized: <ul style="list-style-type: none"> • Continuous </p> <p>Collected from: <ul style="list-style-type: none"> • Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery: used weight recorded at last visit prior to delivery </p>	<p>Birth weight: G1: 3,128 (841) G2: 3,181 (618)</p> <p>Gestational diabetes, %: G1: 6.1 G2: 2.6</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> • Incidence of cesarean in study population was 25% <p>Other infant outcomes</p> <ul style="list-style-type: none"> • NA 	<p>Outcomes Description: AOR for cesarean (95% CI)</p> <p>Groups NA, continuous pregnancy weight gain (kg)</p> <p>Results 1.04 (1.02-1.05)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Pre-gravid BMI • Height • At least 1 previous viable pregnancy • Diagnosis of preeclampsia during the current pregnancy • Previous cesarean delivery <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age • Birth weight 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Young et al., 2002</p> <p>Country and setting: USA, private practice</p> <p>Enrollment Period: Feb 1993 to June 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine body mass index and pregnancy weight gain as risk factors for primary cesarean delivery in nulliparous women in middle-class private practice</p> <p>Time frame: Feb 1993 to June 2001</p> <p>Duration of the study: From entry into prenatal care up til delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,375 (hard to tell from tables however as #'s don't add up to this)</p> <p>Group Description: G1: BMI < 20 G2: BMI 20-25 G3: BMI 25-30 G4: BMI > 30 G5: All</p> <p>Group N: G1: 551 G2: 1616 G3: 709 G4: 500 G5: 3361</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Primiparous deliveries between Feb 1993 and June 13,2001 in large private practice obstetric clinic <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing BMI data on mother 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported Routine pre-natal care <p>Pregravid BMI: G1: 16.3% G2: 47.8% G3: 21% G4: 14.8%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Categorical based on American Bariatric Society definition of obesity and categories used by Cnattingius et al <p>Age (mean, yrs): G1: NR G2: NR G3: NR G4: NR G5: < 20: 8.91%, 20-29: 62.57%, 30-34: 20.1%, > 35: 8.43%</p> <p>Parity: NR</p>	<p>Race, %: White G1: NR G2: NR G3: NR G4: NR G5: 90.6%</p> <p>Black G1: NR G2: NR G3: NR G4: NR G5: 7.56%</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander G1: NR G2: NR G3: NR G4: NR G5: 1.88%</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 11. Gestational weight gain and mode of delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 551 G2: 1616 G3: 709 G4: 500</p> <p>Total weight gain: G1: * (computed these percentages from n values) < 30#: 40.7% 30-35#:27.2% > 35#: 32.1% G2: < 30#: 35.5% 30-35#:27.6% > 35#: 36.9% G3: < 30#: 44.6% 30-35#: 21.6% > 35#: 33.8% G4: < 30#: 63.6% 30-35#: 12.8% > 35#: 23.6%</p> <p>Categorized: <ul style="list-style-type: none"> Less than 30#, 30-35#, > 35# </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: last weight minus first wt </p>	<p>Birth weight: NR</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: 12.7 G2: 18.44 G3: 24.96 G4: 37.6</p> <p>Instrumental delivery,%:</p> <p>Episiotomy,%:</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> CPD rate doubles in women with BMI of < 25 kg/m2 with excessive weight gain <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Rate of cesarean deliveries by weight gain categories</p> <p>Groups G1: < 30 lbs G2: 30-35lbs G3: > 35 lbs</p> <p>Results Increase in overall cesarean delivery rate with increased weight gain was significant at all BMI levels</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> BMI <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Poor</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 3 Fair, 6 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 12. Gestational weight gain and vaginal birth after cesarean

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Juhasz et al., 2005</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: Prepregnancy weight as defined by patient and weight at last prenatal visit</p> <p>Funding: NR</p> <p>Study Objective: To estimate whether excessive weight gain or obesity are risk factors affecting success for vaginal birth after cesarean (VBAC)</p> <p>Time frame: Prepregnancy weight as defined by patient and weight at last prenatal visit</p> <p>Duration of the study: January 1, 1996 to December 31, 2000</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 1,213</p> <p>Group Description: G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI 26.1-29.0 G4: BMI > 29.0</p> <p>Group N: G1: 160 G2: 715 G3: 137 G4: 201</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women attempting VBAC per chart entry <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestation • More than one previous cesarean delivery • Previous uterine scar other than low transverse • Malpresentation in current pregnancy • Presence of an intrauterine fetal demise • Delivery at less than 36 weeks of gestation • Incomplete information for a patient 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 32.4 G2: 31.8 G3: 31.1 G4: 29.9 <i>P</i> < 0.001</p> <p>Parity: G1: gravidity (mean) 3.4 G2: 3.6 G3: 4.0 G4: 4.7</p>	<p>Race, %: White G1: 75.6 G2: 63.9 G3: 48.2 G4: 31.3</p> <p>Black G1: 6.9 G2: 9.1 G3: 22.6 G4: 32.8</p> <p>Hispanic G1: 10.0 G2: 20.6 G3: 24.8 G4: 34.8</p> <p>Asian/Pacific Islander G1: 7.5 G2: 5.2 G3: 2.9 G4: 1.0</p> <p>Other G1: 0 G2: 1.3 G3: 1.5 G4: 0 <i>P</i> for race < 0.001</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: diabetes: 4.0 G2: 6.0 G3: 16.0 G4: 20.0 <i>P</i> < 0.001</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 12. Gestational weight gain and vaginal birth after cesarean (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 160 G2: 715 G3: 137 G4: 201</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> ≤ 40 pounds, > 40 pounds Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self-reported prepregnancy weight and weight at last prenatal visit </p>	<p>Birth weight: G1: 3,345.0 G2: 3,367.8 G3: 3,486.6 G4: 3,448.9 <i>P</i> = 0.004</p> <p>Gestational diabetes, %: G1: Diabetes: 4.0 G2: 6.0 G3: 16.0 G4: 20.0 <i>P</i> < 0.001</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Vaginal birth after cesarean</p> <p>Groups: G1: ≤ 40 pounds G2: > 40 pounds</p> <p>Results:</p> <ul style="list-style-type: none"> Adjusted odds of VBAC success with respect to excessive weight gain, adjusted for previous NSVD, previous VBAC, diabetes, induction, birth weight > 4000g, recurrent indication, one-layer closure, and complications with respect to pregnancy weight gain, VBAC success rate was 79.1% in those who gained < 40 pounds and 66.8% for those who gained more than 40 pounds during the pregnancy, <i>P</i> < 0.001 A higher VBAC success rate was still noted in group gaining less than 40 pounds when controlling for previous normal spontaneous vaginal delivery (NSVD), previous VBAC, indication for previous cesarean, birth weight, and diabetes, OR 1.58 (1.04-2.40) Those who were successful at VBAC gained significantly less weight than those who failed VBAC (29 +/-10.1 pounds and 31.4 +/-12.7 pounds, respectively, <i>P</i> = 0.005) There were fewer patients who gained more than 40 pounds in successful VBAC group (13.6%) than in failed VBAC group (22.7%, <i>P</i> < 0.001). Although there were more uterine ruptures in group that gained more than 40 pounds (2.1% vs. 1.5%), this difference was not statistically significant, <i>P</i> = 0.515- weight gain specifically was found to decrease VBAC success, OR 0.65 (0.42-0.98) 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 5 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 12. Gestational weight gain and vaginal birth after cesarean (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Juhasz et al., 2005
(continued)

Evidence Table 12. Gestational weight gain and vaginal birth after cesarean (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		<p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none">• Previous NVSD• Previous VBAC• Diabetes• Induction• Birth weight > 4000g• Recurrent indication• One layer closure• Complications <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <p>NR</p>	

Evidence Table 13. Gestational weight gain and vaginal lacerations

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kabiru and Raynor, 2004</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1999 to 2002</p> <p>Funding: NR</p> <p>Study Objective: To investigate effect of increase in body mass index category on obstetric outcomes</p> <p>Time frame: 1999 to 2002</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 5,131</p> <p>Group Description:</p> <p>G1: No change in BMI between first prenatal visit and delivery</p> <p>G2: 1 category increase in BMI between first prenatal visit and delivery</p> <p>G3: > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Group N:</p> <p>G1: 2,556</p> <p>G2: 2,252</p> <p>G3: 323</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancies <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple pregnancies BMI < 20 Missing BMI data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured at first prenatal visit <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> 20-24.9, 25-29.9, 30-34.9, 35-39.9, ≥ 40 <p>Age (mean, yrs):</p> <p>G1: 24.7 (6.1)</p> <p>G2: 24.4 (5.7)</p> <p>G3: 25.2 (5.9) <i>P</i> < 0.001</p> <p>Parity:</p> <p>G1: Gravidity (mean): 1.9 (1.9)</p> <p>G2: 1.5 (1.7)</p> <p>G3: 1.2 (1.7) <i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 1.9</p> <p>G2: 2.6</p> <p>G3: 2.8</p> <p>Black</p> <p>G1: 84.1</p> <p>G2: 82.8</p> <p>G3: 88.2</p> <p>Hispanic</p> <p>G1: 13.9</p> <p>G2: 14.6</p> <p>G3: 9.0</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>NR</p> <p>Smoking, %:</p> <p>NR</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>Mean weight gain:</p> <p>G1: 8.6 pounds (8.4)</p> <p>G2: 22.2 pounds (10.2)</p> <p>G3: 55.3 pounds (23.8)</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 13. Gestational weight gain and vaginal lacerations (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 579 G2: 942 G3: 189 G4: 819 G5: 790 G6: 104</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> > 35 pounds for normal BMI, > 25 pounds for overweight BMI, > 15 pounds for obese BMI <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not stated, most likely difference between weight at first prenatal visit and weight at delivery 	<p>Birth weight: G1: 2886.0 (756) G2: 3174.9 (600) G3: 3099.5 (673) <i>P</i> < 0.001 G4: 3116 (713) G5: 3269 (698) G6: 3371 (733) <i>P</i> = 0.015</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 8.2 G2: 12.6 G3: 21.0 <i>P</i> < 0.001 G4: 13.0 G5: 14.3 G6: 19.3 <i>P</i> = 0.256</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Third/fourth degree lacerations</p> <p>Groups Primary cesarean</p> <p>G1: normal BMI, no change in BMI between first prenatal visit and delivery G2: normal BMI, 1 category increase in BMI between first prenatal visit and delivery G3: normal BMI, > 1 category increase in BMI between first prenatal visit and G4: overweight BMI, no change in BMI between first prenatal visit and delivery G5: overweight BMI, 1 category increase in BMI between first prenatal visit and delivery G6: overweight BMI, > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Results Third/fourth degree lacerations (%) G1: 24.0 G2: 29.3 G3: 31.7 <i>P</i> < 0.001 G4: 26.3 G5: 27.5 G6: 30.8 <i>P</i> = 0.780</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Pre-gravid BMI <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 13. Gestational weight gain and vaginal lacerations (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ekblad and Grenman, 1992</p> <p>Country and setting: Finland, hospital</p> <p>Enrollment Period: July 1, 1985 - December 31, 1985 (6 months)</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of abnormal maternal weight or weight gain on pregnancy outcome</p> <p>Time frame: July 1, 1985 to December 31, 1985 (6 months)</p> <p>Duration of the study: Prepregnancy to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: retrospective data from records, prospective weight and height at delivery <p>Total Study N: Total n = 357</p> <ul style="list-style-type: none"> 191 women with abnormal prepregnant weight ($\geq 20\%$ under or over ideal weight for height) or abnormal pregnancy weight gain ($\geq 20\text{kg}$ or $\leq 5\text{kg}$) 166 controls <p>Group Description: G1: $\geq 20\%$ over normal weight for height G2: $\geq 20\%$ under normal weight for height G3: weight gain $\leq 5\text{kg}$ G4: weight gain $\geq 20\text{kg}$ G5: control Group 6</p> <p>Group N: G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Birth at hospital within study period selected those with abnormal maternal prepregnancy weight or abnormal weight gain during pregnancy, as well as next mother in sequential order with normal prepregnancy weight and weight gain during pregnancy to serve as a control <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Not stated 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records - not stated if self reported <p>G1: 83.9 (10.1) G2: 46.7 (3.4) G3: 73.1 (16.5) G4: 65.0 (12.2) G5: 58.3 (6.5)</p> <p>Pregravid BMI:</p> <p>G1: 39.5 (3.4) G2: 17.2 (0.9) G3: 26.1 (6.1) G4: 23.6 (4.1) G5: 21.6 (2.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous $\geq 20\%$ over or under normal weight for height <p>Age (mean, yrs): G1: 28 (5.1) G2: 25.5 (5.1) G3: 29.5 (5.1) G4: 28.7 (4.7) G5: 28.7 (4.4)</p> <p>Parity: G1: prior deliveries: 1.0 (1.0) G2: 0.8 (0.8) G3: 1.2 (1.1) G4: 0.8 (1.0) G5: 0.9 (1.0)</p>	<p>Race,%: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking,%: NR</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 13. Gestational weight gain and vaginal lacerations (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Total weight gain: G1: 11.8 (6.2) <i>P</i> < 0.05 compared to controls G2: 13.4 (4.5) G3: 3.0 (3.5) <i>P</i> < 0.0005 compared to controls G4: 23.2 (22.8) <i>P</i> < 0.0005 compared to controls G5: 13.2 (3.4)</p> <p>Categorized: <ul style="list-style-type: none"> ≤ 5kg or ≥ 20kg </p> <p>Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3712 g (614) <i>P</i> < 0.05 compared to controls G2: 3293 (362) <i>P</i> < 0.05 compared to controls G3: 3284 (880) G4: 3803 (538) <i>P</i> < 0.005 compared to controls G5: 3538 (535)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: Elective 7% Emergency 14% Total 21% G2: Elective 4% Emergency 4% Total 8% G3: Elective 3% Emergency 3% Total 6% G4: Elective 5% Emergency 18% Total 23% G5: Elective 13% Emergency 9% Total 22%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Vaginal repair II/ III %</p> <p>Groups G1: weight gain ≤ 5 kg G2: weight gain ≥ 20 kg G3: reference (normal prepregnancy weight and normal weight gain [undefined])</p> <p>Results G1: 4/0 G2: 5/0 G3: 2/0</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 4 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 14. Maternal weight gain and shoulder dystocia

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ekblad and Grenman, 1992</p> <p>Country and setting: Finland, hospital</p> <p>Enrollment Period: July 1, 1985 - December 31, 1985 (6 months)</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of abnormal maternal weight or weight gain on pregnancy outcome</p> <p>Time frame: July 1, 1985 to December 31, 1985 (6 months)</p> <p>Duration of the study: Prepregnancy to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: retrospective data from records, prospective weight and height at delivery <p>Total Study N: Total n = 357</p> <ul style="list-style-type: none"> 191 women with abnormal prepregnant weight ($\geq 20\%$ under or over ideal weight for height) or abnormal pregnancy weight gain ($\geq 20\text{kg}$ or $\leq 5\text{kg}$) 166 controls <p>Group Description: G1: $\geq 20\%$ over normal weight for height G2: $\geq 20\%$ under normal weight for height G3: weight gain $\leq 5\text{kg}$ G4: weight gain $\geq 20\text{kg}$ G5: control Group 6</p> <p>Group N: G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Birth at hospital within study period selected those with abnormal maternal prepregnancy weight or abnormal weight gain during pregnancy, as well as next mother in sequential order with normal prepregnancy weight and weight gain during pregnancy to serve as a control <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Not stated 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records - not stated if self reported <p>G1: 83.9 (10.1) G2: 46.7 (3.4) G3: 73.1 (16.5) G4: 65.0 (12.2) G5: 58.3 (6.5)</p> <p>Pregravid BMI: G1: 39.5 (3.4) G2: 17.2 (0.9) G3: 26.1 (6.1) G4: 23.6 (4.1) G5: 21.6 (2.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous $\geq 20\%$ over or under normal weight for height <p>Age (mean, yrs): G1: 28 (5.1) G2: 25.5 (5.1) G3: 29.5 (5.1) G4: 28.7 (4.7) G5: 28.7 (4.4)</p> <p>Parity: G1: prior deliveries: 1.0 (1.0) G2: 0.8 (0.8) G3: 1.2 (1.1) G4: 0.8 (1.0) G5: 0.9 (1.0)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 14. Maternal weight gain and shoulder dystocia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Total weight gain: G1: 11.8 (6.2) P < 0.05 compared to controls G2: 13.4 (4.5) G3: 3.0 (3.5) P < 0.0005 compared to controls G4: 23.2 (22.8) P < 0.0005 compared to controls G5: 13.2 (3.4)</p> <p>Categorized: <ul style="list-style-type: none"> ≤ 5kg or ≥ 20kg </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3712 g (614) P < 0.05 compared to controls G2: 3293 (362) P < 0.05 compared to controls G3: 3284 (880) G4: 3803 (538) P < 0.005 compared to controls G5: 3538 (535)</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: Elective 7% Emergency 14% Total 21% G2: Elective 4% Emergency 4% Total 8% G3: Elective 3% Emergency 3% Total 6% G4: Elective 5% Emergency 18% Total 23% G5: Elective 13% Emergency 9% Total 22%</p> <p>Instrumental delivery,%: NR</p> <p>Episiotomy,%: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Percentage of shoulder dystocia cases by weight gain categories</p> <p>Groups G1: weight gain ≤ 5 kg G2: weight gain ≥ 20 kg G3: reference (normal prepregnancy weight and normal weight gain [undefined])</p> <p>Results G1: 3 G2: 2 G3: 0.6</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 4 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 14. Maternal weight gain and shoulder dystocia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Geary et al., 1995</p> <p>Country and setting: Ireland, hospital</p> <p>Enrollment Period: March 1991 - December 1992</p> <p>Funding: NR</p> <p>Study Objective: To determine if routine clinical indicators are useful predictors for shoulder dystocia</p> <p>Time frame: March 1991 - December 1992</p> <p>Duration of the study: Pregnancy through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Case-control • Prospective <p>Total Study N: 363</p> <p>Group Description: G1: Cases G2: Controls</p> <p>Group N: G1: 66 G2: 297</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • All cases of shoulder dystocia during study period • Controllofs consisted consecutive women recruited mid-way through study period: must have had delivery in same hospital, singleton births and cephalic, vaginal delivery at term <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • not stated <p>G1: < 90 kg: 98.5% G2: 98.0</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NR <p>Age (mean, yrs): G1: ≥ 30: 48.5% G2: 42.1</p> <p>Parity: G1: %Multiparous: 89.4 G2: 56.6</p>	<p>Race,%: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking,%: NR</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 14. Maternal weight gain and shoulder dystocia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 66 G2: 297</p> <p>Total weight gain: G1: < 12kg: 59.1% G2: 74.1</p> <p>Categorized:</p> <ul style="list-style-type: none"> < 12kg and ≥ 12kg <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated 	<p>Birth weight: G1: ≥ 4000g: 87.9% G2: 16.8</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Shoulder dystocia by weight gain categories</p> <p>Groups Weight gain < 12 kg and ≥ 12 kg for cases with shoulder dystocia and controls G1: Cases with shoulder dystocia G2: Controls</p> <p>Results maternal weight gain < 12 kg G1: 59.1% G2: 74.1% OR 2.0 (1.6-2.2)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Parity Previous birth ≥ 4000g <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 14. Maternal weight gain and shoulder dystocia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kabiru and Raynor, 2004</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1999 to 2002</p> <p>Funding: NR</p> <p>Study Objective: To investigate effect of increase in body mass index category on obstetric outcomes</p> <p>Time frame: 1999 to 2002</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 5,131</p> <p>Group Description:</p> <p>G1: No change in BMI between first prenatal visit and delivery</p> <p>G2: 1 category increase in BMI between first prenatal visit and delivery</p> <p>G3: > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Group N:</p> <p>G1: 2,556</p> <p>G2: 2,252</p> <p>G3: 323</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancies <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple pregnancies BMI < 20 Missing BMI data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured at first prenatal visit <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> 20-24.9, 25-29.9, 30-34.9, 35-39.9, ≥ 40 <p>Age (mean, yrs):</p> <p>G1: 24.7 (6.1)</p> <p>G2: 24.4 (5.7)</p> <p>G3: 25.2 (5.9) <i>P</i> < 0.001</p> <p>Parity:</p> <p>G1: Gravidity (mean): 1.9 (1.9)</p> <p>G2: 1.5 (1.7)</p> <p>G3: 1.2 (1.7) <i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 1.9</p> <p>G2: 2.6</p> <p>G3: 2.8</p> <p>Black</p> <p>G1: 84.1</p> <p>G2: 82.8</p> <p>G3: 88.2</p> <p>Hispanic</p> <p>G1: 13.9</p> <p>G2: 14.6</p> <p>G3: 9.0</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>NR</p> <p>Smoking, %:</p> <p>NR</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>Mean weight gain:</p> <p>G1: 8.6 pounds (8.4)</p> <p>G2: 22.2 pounds (10.2)</p> <p>G3: 55.3 pounds (23.8)</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 14. Maternal weight gain and shoulder dystocia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 579 G2: 942 G3: 189 G4: 819 G5: 790 G6: 104</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> > 35 pounds for normal BMI, > 25 pounds for overweight BMI, > 15 pounds for obese BMI <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not stated, most likely difference between weight at first prenatal visit and weight at delivery 	<p>Birth weight: G1: 2886.0 (756) G2: 3174.9 (600) G3: 3099.5 (673) $P < 0.001$ G4: 3116 (713) G5: 3269 (698) G6: 3371 (733) $P = 0.015$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 8.2 G2: 12.6 G3: 21.0 $P < 0.001$ G4: 13.0 G5: 14.3 G6: 19.3 $P = 0.256$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Rates of shoulder dystocia by weight gain categories (%)</p> <p>Groups</p> <p>G1: normal BMI, no change in BMI between first prenatal visit and delivery</p> <p>G2: normal BMI, 1 category increase in BMI between first prenatal visit and delivery</p> <p>G3: normal BMI, > 1 category increase in BMI between first prenatal visit and delivery</p> <p>G4: overweight BMI, no change in BMI between first prenatal visit and delivery</p> <p>G5: overweight BMI, 1 category increase in BMI between first prenatal visit and delivery</p> <p>G6: overweight BMI, > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Preeclampsia</p> <p>Results G1: 0.5 G2: 1.4 G3: 1.1 $P = 0.278$ for associations within normal BMI categories</p> <p>G4: 1.0 G5: 1.8 G6: 1.9 $P = 0.357$ for associations within overweight BMI categories</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 15. Gestational weight gain and cephalopelvic disproportion

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Devader et al., 2007</p> <p>Country and setting: United States, birth certificate data</p> <p>Enrollment period: 1999 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To investigate relationship between gestational weight gain and adverse pregnancy outcomes among women with normal prepregnancy BMI</p> <p>Time frame: 1999 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 94,696</p> <p>Group Description: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs</p> <p>Group N: G1: 16,852 G2: 37,292 G3: 40,552</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> All mothers with normal prepregnancy BMI (19.8 –26.0 kg/m²) who were 18 to 35 years of age at time of delivery and who delivered full-term (37 weeks or more) singleton infant during period January 1, 1999, to December 31, 2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women aged younger than 18 years and older than 35 years Non-Missouri residents Preterm deliveries Multiple gestations 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care If missing, obtained from mother during postpartum hospital stay <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized: NR</p> <p>Age (mean, yrs): G1: Maternal age (y) 18 to 24*: 42.3% 25 to 30: 36.2% 31 to 35: 21.5% G2: Maternal age (y) 18 to 24*: 36.7% 25 to 30: 39.5% 31 to 35: 23.8% G3: Maternal age (y) 18 to 24*: 44.7% 25 to 30: 35.9% 31 to 35: 19.4%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 79.7 G2: 85.6 G3: 85.2 Black G1: 15.7 G2: 10.8 G3: 12.1 Hispanic NR Asian/Pacific Islander NR Other G1: 4.6 G2: 3.5 G3: 2.7</p> <p>Smoking, %: G1: 20.5 G2: 14.9 G3: 17.4</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 15. Gestational weight gain and cephalopelvic disproportion (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 plot risk for each adverse pregnancy outcome by 10-lb increments in gestational weight gain. Women who gained 25 to 34 lbs during their pregnancy had lower risks for most outcomes when balancing risk for SGA status and other adverse pregnancy outcomes Women who gained 15 to 24 lbs had lowest risks for most outcomes, but increased their risk of having an SGA infant from 9.6% to 14.3% Women who gained more than 34 lbs had higher risks for all outcomes, although their risk of having an SGA infant decreased from 9.6% to 6.6% 	<p>Outcomes Description: Adjusted Odds Ratios for Women With Normal Prepregnancy BMI (19.8 –26.0 kg/m²) by GWG Category for cephalopelvic disproportion (95% CI)</p> <p>Groups: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs</p> <p>Results: CPD G1: 0.64 (0.55–0.75) G2: 1.0 G3: 1.58 (1.44–1.75)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Education Income Alcohol use Height Prior pregnancy Inadequate prenatal care use Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Child's gender Birth year 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 15. Gestational weight gain and cephalopelvic disproportion (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Devader et al., 2007
(combined)

Evidence Table 15. Gestational weight gain and cephalopelvic disproportion (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	Other infant outcomes: NR	•	

Evidence Table 15. Gestational weight gain and cephalopelvic disproportion (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Young et al., 2002</p> <p>Country and setting: USA, private practice</p> <p>Enrollment Period: Feb 1993 to June 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine body mass index and pregnancy weight gain as risk factors for primary cesarean delivery in nulliparous women in middle-class private practice</p> <p>Time frame: Feb 1993 to June 2001</p> <p>Duration of the study: From entry into prenatal care up til delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,375 (computed)</p> <p>Group Description:</p> <p>G1: BMI < 20 G2: BMI 20-25 G3: BMI 25-30 G4: BMI > 30 G5: All</p> <p>Group N:</p> <p>G1: 551 G2: 1616 G3: 709 G4: 500 G5: 3361</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Primiparous deliveries between Feb 1993 and June 13,2001 in large private practice obstetric clinic <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing BMI data on mother 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported Routine pre-natal care <p>Pregravid BMI:</p> <p>G1: 16.3% G2: 47.8% G3: 21% G4: 14.8%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Categorical based on American Bariatric Society definition of obesity and categories used by Cnattingius et al <p>Age (mean, yrs):</p> <p>G1: NR G2: NR G3: NR G4: NR G5: < 20: 8.91%, 20-29: 62.57%, 30-34: 20.1%, > 35: 8.43%</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: NR G2: NR G3: NR G4: NR G5: 90.6%</p> <p>Black G1: NR G2: NR G3: NR G4: NR G5: 7.56%</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander G1: NR G2: NR G3: NR G4: NR G5: 1.88%</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 15. Gestational weight gain and cephalopelvic disproportion (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 551 G2: 1616 G3: 709 G4: 500</p> <p>Total weight gain: G1: (computed these percentages from n values) < 30 lbs: 40.7% 30-35 lbs:27.2% > 35lbs: 32.1% G2: < 30 lbs: 35.5% 30-35 lbs:27.6% > 35 lbs: 36.9% G3: < 30 lbs: 44.6% 30-35 lbs: 21.6% > 35 lbs: 33.8% G4: < 30 lbs: 63.6% 30-35 lbs: 12.8% > 35 lbs: 23.6%</p> <p>Categorized: <ul style="list-style-type: none"> Less than 30 lbs, 30-35 lbs, > 35 lbs </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: last weight minus first wt </p>	<p>Birth weight: NR</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: 12.7 G2: 18.44 G3: 24.96 G4: 37.6</p> <p>Instrumental delivery,%:</p> <p>Episiotomy,%:</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> CPD rate doubles in women with BMI of < 25 kg/m² with excessive weight gain <p>Other infant outcomes: NR</p>	<p>Outcomes Description: OR for cephalopelvic disproportion (95% CI)</p> <p>Groups: G1: < 30 pounds G2: 30-35 pounds G3: > 35 pounds</p> <p>BMI < 20: G1: 1.0 G2: - G3: 3.8 (3-4.6) <i>P</i> < 0.01</p> <p>BMI 20-25: G1: 1.0 G2: - G3: 1.85 (1.63-2.06) <i>P</i> < 0.0001</p> <p>BMI 25-30: G1: 1.0 G2: - G3: NS</p> <p>BMI > 30: G1: 1.0 G2: - G3: NS</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Obesity: BMI at first prenatal visit <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Poor</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 3 Fair, 6 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 16. Gestational weight gain and complications of labor and delivery

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Marshall, 1991</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: not stated</p> <p>Funding: NR</p> <p>Study Objective: To examine relationships between a healthful lifestyle, demonstrated by selected health practices, and complications in term labor</p> <p>Time frame: Not stated</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 493</p> <p>Group Description: G1: total cohort G2: NR</p> <p>Group N: G1: 493 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women who had reached but not exceeded term (37-41 weeks) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women who delivered at an outside hospital 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Medical records <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Weight for height < 110% of ideal and > 111% of ideal <p>Age (mean, yrs): G1: < 18 years: 4% 18-25: 68% 26-34: 25% > 34: 3%</p> <p>G2: NR</p> <p>Parity:</p>	<p>Race, %: White G1: 77 G2: NR</p> <p>Black G1: 18 G2: NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 5 G2: NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % married: G1: 44 G2: NR</p>

Evidence Table 16. Gestational weight gain and complications of labor and delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> 20-40 lbs and < 20/ > 40 lbs <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: from medical records 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Specific complications that were examined: dystocia, retained placenta, postpartum hemorrhage, PIH</p> <p>Other infant outcomes: Specific complications that were examined: fetal distress and neonatal distress</p>	<p>Outcomes Description: Risk of complications (dystocia, retained placenta, pp hemorrhage PIH, fetal distress and neonatal distress</p> <p>Groups: G1: <20 lbs G2: 20-40 lbs G3: > 40 lbs</p> <p>Results: In multivariate analysis a gestational weight gain of > 40 pounds increased the risk of complications (dystocia, retained placenta, pp hemorrhage PIH, fetal distress and neonatal distress) by 40%;</p> <p>Three variables, smoking, weight for height, and gestational weight gain explain 15% of the outcome; of note: smoking was associated with a protective effect (with a beta coefficient of .593 (p=.021)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Pre-gravid BMI Exercise Alcohol Drugs Sleep Breakfast Snacks Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 16. Gestational weight gain and complications of labor and delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Thorsdottir et al., 2002</p> <p>Country and setting: Maternity records, Department of Obstetrics and Gynecology at Landspítali University Hospital, Iceland</p> <p>Enrollment Period:</p> <p>Funding: NR</p> <p>Study Objective: To investigate relation between gestational weight gain in women of normal prepregnant weight and complications during pregnancy and delivery in a population with high gestational weight gain and birth weight</p> <p>Time frame: NR</p> <p>Duration of the study: 1998</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 614</p> <p>Group Description: G1: No complication G2: Complications in pregnancy or delivery G3: Complications in pregnancy G4: Complications in delivery</p> <p>Group N: G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women of normal prepregnancy weight randomly selected within 1 year (1998) No history of diabetes, hypertension, CVD, or thyroid problems Singleton births 38 to 43 weeks gestation 20 to 40 years of age Routine fetal biometry at 18 to 20 week ultrasound Received early and regular antenatal care <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 63.1 (6.2) G2: 62.0 (5.6) $P = 0.059$ G3: 61.7 (4.8) $P = 0.174$ G4: 62.2 (6.1) $P = 0.274$</p> <p>Pregravid BMI: G1: 22.2 G2: 22.4 (1.6) $P = 0.270$ G3: 22.4 (1.5) $P = 0.338$ G4: 22.3 $P = 0.584$</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 29 G2: 29 $P = 0.857$ G3: 29 $P = 0.404$ G4: 29 $P = 0.398$</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Proportional weight gain, %: G1: 26.0 G2: 28.0 $P = 0.018$ G3: 30.0 $P = 0.005$ G4: 27.0 $P = 0.546$</p> <p>Additional characteristics: NR</p>

Evidence Table 16. Gestational weight gain and complications of labor and delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Total weight gain: G1: 16.6 (4.9) G2: 17.4 (5.1) <i>P</i> = 0.080 G3: 18.4 (5.1) <i>P</i> = 0.013 G4: 16.9 (5.1) <i>P</i> = 0.887</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM < 11.5, 11.-16.0, 16.1-20, ≥20, also quintiles < 12.5, 12.5-15.5, 15.6-17.8, 17.9-20.8, > 20.8 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3789 (469) G2: 3749 (565) <i>P</i> = 0.389 G3: 3643 (526) <i>P</i> = 0.032 G4: 3806 (578) <i>P</i> = 0.529</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Rates of complications in pregnancy and delivery and neonatal outcome by maternal weight gain categories based on IOM recommendations for women of normal weight before pregnancy and additionally at 20.0kg (G1 to G4) Relative risk for complications in pregnancy and delivery by quartiles of weight gain in pregnancy adjusted for age, height, parity, gestational length, and birth weight (G5-G9) <p>Groups: G1: < 11.5 G2: 11.-16.0 G3: 16.1-20 G4: ≥ 20 kg</p> <p>G5: < 12.5 kg G6: 12.5-15.5kg G7: > 15.5-17.8 G8: > 17.8-20.8 G9: > 20.8</p> <p>Results for quartiles:</p> <p>Complications in pregnancy or delivery G1: 29 G2: 20.7 (<i>P</i> < 0.05 compared to > 20kg) G3: 28 G4: 32.1 <i>P</i> = 0.105</p> <p>Complications in pregnancy G1: 5.8 G2: 6.8 (<i>P</i> < 0.05 compared to > 20kg) G3: 10.2 G4: 13.1 <i>P</i> = 0.24</p> <p>Complications in delivery G1: 23.2 G2: 14 G3: 17.7 G4: 19 <i>P</i> = 0.866</p> <p>Results for quintiles:</p> <p>Complications in pregnancy or delivery n = 162 G5: 1.16 (0.63-2.13) G6: 1.00 G7: 1.02 (0.54-1.90) G8: 1.61 (0.88-2.93) G9: 1.88 (1.04-3.4)</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 16. Gestational weight gain and complications of labor and delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Thorsdottir et al., 2002
(continued)

Evidence Table 16. Gestational weight gain and complications of labor and delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		Complications in pregnancy n = 56 G5: 1.17 (0.40-3.41) G6: 1.00 G7: 2.0 (0.73-5.42) G8: 2.69 (1.01-7.18) G9: 3.58 (1.36-9.4)	
		Complications in delivery n = 106 G5: 1.13 (0.58-2.21) G6: 1.00 G7: 0.71 (0.34-1.47) G8: 1.10 (0.55-2.10) G9: 1.14 (0.57-2.2)	
		Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> • Age • Parity • Height 	
		Infant and child confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> • Gestational age • Birth weight 	

Evidence Table 17. Gestational weight gain and preterm birth

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Carmichael et al., 1997</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1980 to 1990</p> <p>Funding: Grant HD27347-05 from National Institute of Child Health and Human Development</p> <p>Study Objective: To investigate usefulness of monitoring weight gain during pregnancy and mechanisms by which weight gain pattern relate to preterm delivery</p> <p>Time frame: 1980 to 1990</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 7,259</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 7,259 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> All deliveries during time study period at study hospital Spontaneous preterm deliveries <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple births (n = 642) Randomly selected 1 delivery for those women who experienced more than 1 pregnancy during study period (n = 2412) Obese women (BMI > 29) Women with diabetes or hypertension during pregnancy Deliveries with congenital malformations Women who reported "other" race/ethnicity Non-spontaneous or medically indicated preterm deliveries Women lacking data on pattern of weight gain Women with missing data on at least 1 covariate 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 28.0 G2: NR</p> <p>Parity: G1: Nulliparous: 55% G2: NR</p>	<p>Race, %: White G1: 52 G2: NR</p> <p>Black G1: 10 G2: NR</p> <p>Hispanic G1: 12 G2: NR</p> <p>Asian/Pacific Islander G1: 26 G2: NR</p> <p>Other NR</p> <p>Smoking, %: G1: 16 G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 7,259 G2: NR</p> <p>Total weight gain: G1: Mean estimated total weight gain 16.8 kg G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> • Continuous </p> <p>Collected from: <ul style="list-style-type: none"> • Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery: difference between self reported prepregnancy weight and last measured weight </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> • Spontaneous preterm birth • Gestational age 	<p>Outcomes Description: AOR (95% CI) of spontaneous preterm birth/ kg increase in total weight gain</p> <p>Groups Total gestational weight gain (continuous)</p> <p>Results Linear regression analysis of gestational age (days) as dependent variable and gestational weight gain (kg) as independent variable: Regression coefficient= 0.51; t-statistic=13.1; $P < 0.001$</p> <p>AOR (95% CI) of spontaneous preterm birth/ kg increase in total weight gain: 0.84 (0.82-0.87)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: BMI, maternal age, infant sex cigarettes per day maternal height, parity, race, pattern of gain derived from quadratic curves</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Infant sex</p>	<p>Background: Poor</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Dietz et al., 2006</p> <p>Country and setting: USA, PRAMS data</p> <p>Enrollment Period: 1996-2001</p> <p>Funding: NR</p> <p>Study Objective: Objective of study to estimate combined effects of prepregnancy BMI and pregnancy weight gain on preterm delivery of singleton births</p> <p>Time frame: 1996-2001</p> <p>Duration of the study: Cross-sectional</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cross-sectional • Retrospective <p>Total Study N: 113,019</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 113,019 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • New mothers delivering live birth in states participating in PRAMS with annual response rate of 70% or higher during 1996-2001 • Stratified, systematic sample <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing or implausible estimates of birth weight, pre-pregnancy BMI, weight gain during pg, gestational age; multiple births 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: Underweight < 19.8 16% (20,352) Normal 19.8–26.5 44% (59,088) Overweight 26.1–28.9 12% (12,928) Obese 29–34.9 12% (13,910) Very obese > 35 6% (6744)</p> <p>G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines redefined obese as 29.0-34.9 and added additional category for very obese: BMI > 35 <p>Age (mean, yrs): G1: < 20: 13% (13,258) 20–34: 75% (81,157) 35+: 12% (18,586)</p> <p>G2: NR</p> <p>Parity: G1: 0: 43% (51,918) 1–2: 49% (50,648) > 3: 8% (10,050)</p> <p>G2: NR</p>	<p>Race, %: White G1: 67 G2: NR</p> <p>Black G1: 18 G2: NR</p> <p>Hispanic G1: 11 G2: NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 4 G2: NR</p> <p>Smoking, %: G1: 17 G2: NR</p> <p>Diabetes mellitus, %: G1: 5 (pre-existing or gestational) G2: NR</p> <p>Hypertension, %: G1: 11 (pre-existing or during pg) G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 20,352 G2: 59,088 G3: 12,928 G4: 13,910 G5: 6,744</p> <p>Total weight gain: G1: Weight gain during second and third trimesters of pregnancy: < 0.12 21% (763) 0.12–0.22 4.4% (1299) 0.23–0.68 75.6% (14,905) 0.69–0.79 9.1% (1632) > 0.79 8.8% (1753)</p> <p>G2: Weight gain during second and third trimesters of pregnancy: < 0</p> <p>Categorized:</p> <ul style="list-style-type: none"> Based on weight gain second and third trimesters of pregnancy (kg/wk) <p>Collected from:</p> <ul style="list-style-type: none"> Weight gain data from birth certificate - presumably measured at prenatal visits, self report- however rates were determined by formula <p>Ascertained by:</p> <ul style="list-style-type: none"> Birth certificate data and PRAMS survey 	<p>Birth weight: G1: Moderately Preterm (32-36 weeks) 4188 Very Preterm (20-31 weeks) 1,753 G2: Moderately Preterm (32-36 weeks): 9,495 Very Preterm (20-31 weeks): 4291 G3: Moderately Preterm (32-36 weeks): 2047 Very Preterm (20-31 weeks): 1,143 G4: Moderately</p> <p>Gestational diabetes, %: G1: 5 (pre-existing or gestational) G2: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Risk of preterm birth</p> <p>Groups Categories of mean rate of gestational weight gain (kg/wk) during second and third trimesters stratified by pregravid BMI and type of preterm birth (very preterm, 20-31 weeks; moderate preterm, 32-36 weeks): G1: < 0.12 G2: 0.12-0.22 G3: 0.23-0.68 G4: 0.69-0.79 G5: > 0.79</p> <p>Results In general, in comparison to women with normal BMI in G3: underweight women in G1- G5 and normal weight women in G1, G2, and G5 were at increased risk of very preterm births (AOR: 1.5-9.8). Underweight women in G1-G3 and G5 and normal women in G1, G2, and G5 were at increased risk moderate preterm births (AOR: 1.4-3.1). Overweight and obese women in G1 and G5 were at increased risk of very preterm birth (AOR: 2.3-2.5) but had no elevated risk of moderate preterm birth. Very obese women with G1, G4, G5 had increased risks of very preterm births (AOR: 2.1-2.8) and with G4 had increased risks of moderate preterm birth (AOR: 1.3)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Race, Medicaid recipient, parity, marital status</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jensen et al., 2005</p> <p>Country and setting: Denmark, university hospitals</p> <p>Enrollment Period: Gestation through birth</p> <p>Funding: Many different funds</p> <p>Study Objective: To investigate effect of gestational weight gain in obese glucose tolerant women</p> <p>Time frame: Gestation through birth</p> <p>Duration of the study: NR</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 481</p> <p>Group Description:</p> <p>G1: GWG < 5.0 kg G2: GWG 5.0-9.9kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0kg</p> <p>Group N:</p> <p>G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Prepregnancy BMI ≥ 30 • Normal 2h 75g oral glucose tolerance test (OGTT) during third trimester (according to WHO criteria) • Only first pregnancy during study period included <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Well defined chronic disease • Twin pregnancies • Women with GDM (n = 323) • Known diet treatment (n = 10) • Incomplete data on weight gain during pregnancy (n-153) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Records • Patient report of pregravid BMI <p>Pregravid BMI:</p> <p>G1: 34.3 (32.2-39.9) G2: 33.9 (31.5-36.5) G3: 32.9 (31.2-35.6) G4: 32.7 (31.3-34.7)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs):</p> <p>G1: 29.8 (26.4-33.1) G2: 29.1 (26.3-33.1) G3: 30.0 (26.6-33.2) G4: 27.9 (24.8-31.8)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: 84.4 G2: 85.8 G3: 82.7 G4: 89.9</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 29.7 G2: 25.8 G3: 30.2 G4: 26.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): G1: 93 G2: 134 G3: 132 G4: 122 Total weight gain: Categorized: <ul style="list-style-type: none"> < 5.0, 5.0-9.9, 10.0-14.9, ≥ 15.0 Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Not stated by authors 	Birth weight: G1: 3500 (3200-3840) G2: 3645 (3200-4000) G3: 3750 (3390-4125) G4: 3762 (3400-4120) Gestational diabetes, %: NR Cesarean delivery, %: NR Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: NA Other infant outcomes: NA	Outcomes Description: Percentage of preterm delivery Groups: Total gestational weight gain categories (kg): G1: < 5.0 G2: 5.0-9.9 G3: 10.0-14.9 G4: > 15.0 Results Percent (%) preterm delivery by weight gain categories: G1: 6.5 G2: 6.0 G3: 4.6 G4: 2.5 <i>P</i> for trend = 0.11 Maternal confounders and effect modifiers accounted for in analysis: NA Infant and child confounders and effect modifiers accounted for in analysis: NA	Background: Good Sample selection: Poor Definition of maternal weight gain: Poor Definition of outcomes: Fair Source of information on exposure, outcomes, and confounders: Poor Followup: Fair Analysis comparability: Fair Analysis of outcomes: Good Interpretation: Fair Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor Final Quality Score: Poor

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kramer et al., 1995</p> <p>Country and setting: Canada, university hospitals</p> <p>Enrollment Period: July 1990- July 1992</p> <p>Funding: National Health Research and Development Program, Health Canada</p> <p>Study Objective: To assess etiologic role of maternal short stature, low prepregnancy BMI, and low rate of gestational weight gain in idiopathic preterm labor</p> <p>Time frame: July 1990 to July 1992</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Case-control • Retrospective <p>Total Study N: 555</p> <p>Group Description: G1: Cases G2: Controls</p> <p>Group N: G1: 244 G2: 311</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women with spontaneous onset of labor before 37 weeks - 1 subsample composed of women with spontaneous onset of labor before 34 weeks and another subsample with spontaneous onset of labor before 37 weeks in index pregnancy plus a history of prior preterm delivery or second trimester miscarriage • Cases were matched with 1 control by history of smoking (and race in early preterm labor subsample) • To qualify as a case, 1 of following a priori criteria had to be met: (1) cervical dilation at least 2cm and effacement at least 75% on admission, (2) documented increase in cervical dilation or effacement during observation in hospital, or (3) at least 6 uterine contractions per hour for at least 2 hours documented during observation in hospital 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: 21.8 (4.2) G2: 22.7 (4.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines < 19.8 vs. ≥ 19.8 <p>Age (mean, yrs): G1: < 20: 7.8%; 20-34: 79.1%; ≥ 35: 13.1% G2: < 20: 2.6%; 20-34: 75.8%; ≥ 35: 21.6%</p> <p>Parity: %primiparous: G1: 44.3% G2: 41.2%</p>	<p>Race, %: White G1: 72.5 G2: 79.7</p> <p>Black G1: 13.9 G2: 10.9</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 13.5 G2: 9.3</p> <p>Smoking, %: G1: 24.6 during pregnancy G2: 25.7</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: % married: 73.4 G2: 80.7</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 244 G2: 311</p> <p>Total weight gain: G1: 0.35 (0.15) kg/wk G2: 0.37 (0.13) kg/wk</p> <p>Categorized:</p> <ul style="list-style-type: none"> Rate of weight gain < 0.27kg/wk <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: used rate of weight gain since cases had preterm labor 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: AOR (95% CI) for cases with preterm delivery versus controls</p> <p>Groups Gestational weight gain categories (kg/wk): G1: < 0.27 G2: ≥ 0.27</p> <p>Results G1: 1.56 (0.94-2.58) G2: 1.00 (reference) labor subsample</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Marital status English-speaking Education Matched on smoking history <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kramer et al., 1995 (continued)</p>	<p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multifetal gestation • Known uterine malformation • History of exposure to diethylstilbestrol in utero • Cervical incompetence documented before pregnancy • Rupture of membranes on admission • Placenta previa • Abruptio placentae • Chronic illnesses known to predispose to preterm labor • Severely growth retarded fetuses 		

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
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Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Nohr et al., 2007</p> <p>Country and setting: Denmark, primary care</p> <p>Enrollment period: 1996 to 2002</p> <p>Funding: Ellen Aagaard Nohr is supported by a grant (No.2002B020) from Health Insurance Foundation. Danish National Research Foundation established Danish Epidemiology Science Centre, which initiated and created Danish National Birth Cohort. Cohort is also result of major grant from this Foundation. Additional support for Danish National Birth Cohort obtained from Pharmacy Foundation, Egmont Foundation, March of Dimes Birth Defects Foundation and Augustinus Foundation</p> <p>Study Objective: Aim of present study to assess impact of obesity and gestational weight gain on risk of subtypes of preterm birth</p> <p>Time frame: 1996 to 2002</p> <p>Duration of the study: Entry into prenatal care - delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 0</p> <p>Group Description: G1: Total</p> <p>Group N: G1: 62,167</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women with singleton pregnancies who provided an interview at approximately 16 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing data on weight gain in pregnancy 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • WHO International Taskforce <p>Age (mean, yrs): G1: < 25: 7,757 (12.5%) 25 to 29: 26,152 (42.1%) 30 to 34: 21,181 (34.1%) 35+: 7,077 (11.4%)</p> <p>Parity: G1: 47% primiparous</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 84.1% nonsmoker</p> <p>Diabetes mellitus, %: G1: 1.2%</p> <p>Hypertension, %: G1: 1.6%</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 62 167 G2: 2751 G3: 41 991 G4: 12 270 G5: 5155</p> <p>Total weight gain: G1: Weekly weight gain (g) >275g: (15.3%) 276–675g: (68.3%) 676g+ (16.4%)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Weekly weight gain categorised into 3 groups (low, medium, high) using cutpoints at 275 and 675 g, which were similar to those used in other studies <p>Collected from:</p> <ul style="list-style-type: none"> Does not specify-women self-reported weight gain status <p>Ascertained by:</p> <ul style="list-style-type: none"> Self-reported 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 1.2%</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Before 34 weeks of gestation, risk of induced preterm delivery potentiated among obese women with high weight gain, and after 34 weeks, risk was potentiated at extremes, namely among underweight women with a low weight gain and obese women with a high weight gain <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Rate of gestational weight gain for women with early or late preterm birth by PPROM</p> <p>Groups Rate of gestational weight gain (g/wk) for women with early preterm birth (22-33 weeks) with PPROM :</p> <p>G1: < 275 G2: 276-675 G3: ≥ 676</p> <p>Rate of gestational weight gain (g/wk) for women with early preterm birth (22-33 weeks) without PPROM :</p> <p>G4: < 275 G5: 276-675 G6: ≥ 676</p> <p>Rate of gestational weight gain (g/wk) for women with late preterm birth (34-36 weeks) with PPROM:</p> <p>G7: < 275 G8: 276-675 G9: ≥ 676</p> <p>Rate of gestational weight gain (g/wk) for women with late preterm birth (34-36 weeks) without PPROM:</p> <p>G10: < 275 G11: 276-675 G12: ≥ 676</p> <p>Results HR (95% CI): G1: 2.1 (1.5-3.0) G2: 1.0 (ref) G3: 1.2 (0.8-1.8)</p> <p>HR (95% CI): G4: 1.9 (1.3-2.6) G5: 1.0 (ref) G6: 1.9 (1.3-2.6)</p> <p>HR (95% CI): G7: 1.3 (1.0-1.6) G8: 1.0 (ref) G9: 1.2 (1.0-1.5)</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 4 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Nohr et al., 2007
(continued)

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		HR (95% CI): G10: 1.0(0.9-1.2) G11: 1.0(ref) G12: 1.0 (0.9-1.2)	
		Maternal confounders and effect modifiers accounted for in analysis: Pregravid BMI, age, height, parity, socio-occupational status, smoking alcohol consumption	
		Infant and child confounders and effect modifiers accounted for in analysis: NR	

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Rosenberg et al., 2005</p> <p>Country and setting: USA, vital statistics data</p> <p>Enrollment Period: Birth certificates with self reported pregravid weight and weight gain</p> <p>Funding: NR</p> <p>Study Objective: To examine associations between obesity, diabetes, and 3 adverse pregnancy outcomes (primary cesarean section, preterm birth, and LBW) by race/ethnic groups</p> <p>Time frame: Birth certificates with self reported pregravid weight and weight gain</p> <p>Duration of the study: Birth certificates from 1999, 2000, and 2001</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 329988</p> <p>Group Description:</p> <p>G1: Non-hispanic blacks</p> <p>G2: Non-hispanic whites</p> <p>G3: Non-hispanic asians</p> <p>G4: Hispanics</p> <p>G5: Total</p> <p>Group N:</p> <p>G1: 86,908</p> <p>G2: 96,581</p> <p>G3: 38,570</p> <p>G4: 107,612</p> <p>G5: 329,988</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Live singleton births Information on maternal prepregnancy weight and maternal weight gain during pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: < 100 pounds: 1.7%</p> <p>100-149: 49.1%</p> <p>150-199: 37.5%</p> <p>200-299: 11.2%</p> <p>≥ 300: 0.5%</p> <p>G2: < 100 pounds: 1.8%</p> <p>100-149: 69.5%</p> <p>150-199: 24.0%</p> <p>200-299: 4.7%</p> <p>≥ 300: 0.1%</p> <p>G3: < 100 pounds: 8.1%</p> <p>100-149: 79.5%</p> <p>150-199: 11.6%</p> <p>200-299: 0.8%</p> <p>≥ 300</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NR <p>Age (mean, yrs):</p> <p>G1: 27.5</p> <p>G2: 30.6</p> <p>G3: 29.7</p> <p>G4: 26.4 P < 0.001</p> <p>G5: 28.3</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %:</p> <p>G1: 3.7</p> <p>G2: 2.6</p> <p>G3: 6.6</p> <p>G4: 3.5</p> <p>G5: 3.7 P < 0.001</p> <p>Hypertension, %:</p> <p>G1: 1.7</p> <p>G2: 0.6</p> <p>G3: 0.5</p> <p>G4: 0.7</p> <p>G5: 0.9 P < 0.001</p> <p>Additional characteristics:</p> <p>G1: PIH 1.9</p> <p>G2: 1.2</p> <p>G3: 0.7</p> <p>G4: 1.4</p> <p>G5: 1.4 P < 0.001</p> <p>Additional characteristics:</p> <p>G1: Preeclampsia 2.9</p> <p>G2: 1.3</p> <p>G3: 1.2</p> <p>G4: 2.6</p> <p>G5: 2.1 P < 0.001</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 86,908 G2: 96,581 G3: 38,570 G4: 107,612 G5: 329,988</p> <p>Total weight gain: G1: < 41pounds: 79.7% ≥ 41 pounds: 20.3% G2: < 41pounds: 83.2% ≥ 41 pounds: 16.8% <i>P</i> < 0.001 G3: < 41pounds: 89.2% ≥ 41 pounds: 10.8% G4: < 41pounds: 79.1% ≥ 41 pounds: 20.9% G5: < 41pounds: 81.6% ≥ 41 pounds: 18.4%</p> <p>Categorized: <ul style="list-style-type: none"> < 41, ≥ 41 pounds </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 3.7 G2: 2.6 G3: 6.6 G4: 3.5 G5: 3.7 <i>P</i> < 0.001</p> <p>Cesarean delivery, %: G1: 16.2 G2: 14.7 <i>P</i> < 0.001 G3: 14.4 G4: 13.8 G5: 14.7</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Preterm birth 10.5, 5.1, 5.9, 7.8, 7.5 <i>P</i> < 0.001 (groups defined above) LBW 9.7, 4.1, 5.7, 6.1, 6.4 <i>P</i> < 0.001 (groups defined above) 	<p>Outcomes Description: AOR (95% CI) for Preterm Birth</p> <p>Groups Categories of total gestational weight gain (lbs): G1: <41 G2: ≥ 41</p> <p>Results AOR (95% CI) for Preterm Birth: G1: 1.00 (reference) G2: 0.54 (0.52-0.57)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Pregavid weight, chronic diabetes, GDM, chronic hypertension, PIH preeclampsia, maternal age marital status maternal education maternal birthplace, prenatal care payer, social risk, parity, trimester that prenatal care began</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 7 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Schieve et al., 1999</p> <p>Country and setting: USA, Pregnancy Nutrition Surveillance System of women participating in federally funded prenatal public health programs</p> <p>Enrollment Period: 1990 to 1993</p> <p>Funding: NR</p> <p>Study Objective: To examine associations between weight gain per week of pregnancy and net weight gain per week of pregnancy and preterm delivery</p> <p>Time frame: 1990 to 1993</p> <p>Duration of the study: First prenatal visit to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 266,172</p> <p>Group Description: G1: Total sample G2: NR</p> <p>Group N: G1: 266,172 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> White, black, or hispanic women Women attending WIC clinics both prenatally and postnatally Liveborn, singletons delivered between 26 to 42 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data for prepregnancy BMI, pregnancy weight gain, or infant birth weight Incompatible birth weight for gestational age 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 12.0-19.7: 17.0% 19.8-26.0: 50.9% 26.1-29.0: 12.7% 29.1-61.0 : 19.5% G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 10-14y: 0.7% 15-19y: 24.8% 20-29y: 58.3% 30-34y: 11.5% 35-39y: 3.9% 40-55y: 0.7% G2: NR</p> <p>Parity: Primiparous: G1: 40.9% G2: NR</p>	<p>Race, %: White G1: 63.4 G2: NR</p> <p>Black G1: 20.5 G2: NR</p> <p>Hispanic G1: 16.1 G2: NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 266,172 G2: 45,142 G3: 135,390 G4: 33,697 G5: 51943</p> <p>Total weight gain: G1: 14.19 (6.70) kg G2: 15.15 (5.75) G3: 14.97 (6.27) G4: 13.78 (6.94) G5: 11.56 (7.62)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Weight gain/week was calculated as weight gain (kg) divided by completed weeks gestation Weight gain/week and net weight gain/week were categorized on basis of percentile distributions in total sample <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> Self-reported 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Mean weight gain rate (kg/wk) for total sample: 0.36 (0.17) Mean net weight gain (= weight gain-birth weight) (kg) for total sample: 10.86 (6.60) Mean net weight gain rate (kg/wk) for total sample: 0.28 (0.17) <p>Other infant outcomes:</p> <ul style="list-style-type: none"> 6.8% delivered at 32-36 weeks gestation 0.7% delivered at 20-31 weeks gestation 	<p>Outcomes Description: RD of preterm birth</p> <p>Groups Rate of weight gain (kg/week) in percentiles stratified by Low, Average, High, and Obese pregravid BMI: G1: 5th,0.10 G2: 10th, 0.16 G3: 25th,0.26 G4: 50th,0.35 G5: 75th, 0.46 G6: 90th, 0.57 G7: 95th, 0.65</p> <p>Results Reference category of rate of weight gain: 0.35-<0.46 kg/wk</p> <p>RD of preterm birth varied by prepregnant BMI and gestational weight gain. Overall, women gaining 0.26-0.46 kg/wk had the lowest RD of preterm birth. The highest RD occurred for women gaining the least and most amount of weight, irrespective of prepregnant BMI; however, the highest RD of preterm births were among women of low BMI</p> <p>Maternal confounders and effect modifiers accounted for in analysis: None</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Siega-Riz et al., 1996</p> <p>Country and setting: USA, public health clinics</p> <p>Enrollment Period: 1983 to 1987</p> <p>Funding: State of California Maternal and Child Health Branch, March of Dimes, and University of North Carolina Department of Nutrition</p> <p>Study Objective: To examine differences in pattern of weight gain according to trimesters of pregnancy and analyze effects on preterm delivery</p> <p>Time frame: 1983 to 1987</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 7589</p> <p>Group Description: G1: Preterm G2: Term</p> <p>Group N: G1: 517 G2: 7072</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Pregnant women attending public health clinics who were eligible to participate in Prematurity Prevention Project <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Mismatched prenatal and birth outcome files • Unreasonable gestational age • Stillbirths • Missing data • Multiple gestations • Medical inductions • Inability to determine timing of PPROM or PTL 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 57.6 (0.53) G2: 59.0 (0.15)</p> <p>Pregravid BMI:</p> <p>G1: 23.7 (0.22) G2: 24.5 (0.06)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 24.9 (0.25) G2: 24.9 (0.06)</p> <p>Parity: %primiparous: G1: 36.9 G2: 34.4</p>	<p>Race, %: White G1: 8.7 G2: 8.9</p> <p>Black G1: 10.3 G2: 4.9</p> <p>Hispanic G1: 76.1 G2: 82.8</p> <p>Asian/Pacific Islander G1: 4.0 G2: 3.3</p> <p>Other NR</p> <p>Smoking, %: G1: 5.4 G2: 3.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 4.8 G2: 2.5</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: AOR (95% CI) for rate of preterm birth, preterm labor, PPROM</p> <p>Groups Categories of 3rd trimester weekly weight gain rates (kg/week): G1: Inadequate (Underweight, < 0.34; Normal weight, < 0.35; Overweight/ Obese, < 0.30) G2: Adequate (Underweight, > 0.34; Normal, > 0.35; Overweight/Obese, > 0.30)</p> <p>Results Preterm birth: G1: 1.91 (1.40-2.61) G2: 1.00 (reference)</p> <p>Preterm labor: G1:1.75 (1.15-2.64) G2: 1.00 (reference)</p> <p>PPROM: G1: 2.70 (1.35-5.42) G2: 1.00 (reference)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Iron status, parity combined with maternal age, ethnicity, hypertension (chronic or pregnancy induced), smoking status, week prenatal care began</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Good</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 8 Good, 1 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Spinillo et al., 1998</p> <p>Country and setting: Italy, University Hospital</p> <p>Enrollment Period: 1988 to 1995</p> <p>Funding: NR</p> <p>Study Objective: To investigate whether maternal anthropometric factors interact with 1 another or with other risk factors, thus modifying risk of spontaneous preterm delivery</p> <p>Time frame: 1988 to 1995</p> <p>Duration of the study: NR</p>	<p>Design:</p> <ul style="list-style-type: none"> • Case-control • Prospective <p>Total Study N: 690</p> <p>Group Description: G1: Cases G2: Controls</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Cases were patients with spontaneous preterm delivery between 24 and 35 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • PROM indicated premature delivery associated with abruptio placentae, placenta previa, preeclampsia, impaired fetal growth, diabetes, or other severe maternal diseases prior to pregnancy • Severe fetal malformations • Missing data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 55.7 (10.3) G2: 57.7 (9.7)</p> <p>Pregravid BMI:</p> <p>G1: 21.3 (3.7) G2: 21.8 (3.4)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • ≤ 19.5 or > 19.5 <p>Age (mean, yrs): G1: 28.7+/- 5.2 G2: 29.6+/-4.6</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: Categorized:</p> <ul style="list-style-type: none"> Dichotomized into second/third trimester weight gain ≤ 0.37 kg/wk and > 0.37 kg/wk. Also, net weight gain ≤ 0.135 kg/wk or > 0.135 kg/wk <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Crude ORs for spontaneous preterm delivery: BMI $< 19.5 = 1.68(1.20-2.38)$ Second/third trimester weight gain ≤ 0.37 kg/wk: $2.40 (1.69 - 3.42)$; Net weight gain ≤ 0.135 kg/wk $2.31 (1.45-3/68)$ <p>Other infant outcomes: NR</p>	<p>Outcomes Description: AOR for spontaneous preterm delivery</p> <p>Groups G1: Prepregnancy BMI ≤ 19.5 and 2nd/3rd trimester weight gain ≤ 0.37 kg/wk G2: Prepregnancy BMI > 19.5 and 2nd/3rd trimester weight gain ≤ 0.37 kg/wk G3: Prepregnancy BMI ≤ 48 kg and 2nd/3rd trimester weight gain ≤ 0.37 kg/wk G4: Prepregnancy BMI > 48 kg and 2nd/3rd trimester weight gain ≤ 0.37 kg/wk</p> <p>Results AOR (95% CI) for cases with spontaneous preterm delivery versus controls: G1: 5.63 (2.35-13.8) G2: 2.45 (1.60-3.75) $P = 0.06$ for interaction between G1 and G2 G3: 5.29 (1.45-20.90) G4: 2.42 (1.65-3.55) $P = 0.21$ for interaction between G3 and G4</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Pregravid BMI, pregravid weight, height, age, parity, smoking, social class education</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gender</p>	<p>Background: Poor</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 2 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stotland et al., 2006</p> <p>Country and setting: USA, academic medical center</p> <p>Enrollment Period: 1976 to 2001</p> <p>Funding: NIH</p> <p>Study Objective: To study how relationship between gestational weight gain and spontaneous preterm birth interacts with maternal race or ethnicity and previous preterm birth status</p> <p>Time frame: 1976 to 2001</p> <p>Duration of the study: From entry into prenatal care until delivery (actually used a perinatal data base and looked at info)</p>	<p>Design:</p> <ul style="list-style-type: none"> Perinatal data base review Retrospective <p>Total Study N: 15,101</p> <p>Group Description:</p> <p>G1: Total G2: White G3: African American G4: Latina G5: Asian</p> <p>Group N:</p> <p>G1: 15,101 G2: 6,513 G3: 1,533 G4: 1,614 G5: 3,440</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women of low or normal prepregnancy BMI delivering singleton during study period with complete data on all variables considered <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple gestations Hypertension Diabetes Delivery before 24 weeks of gestation Congenital anomalies Missing data on any key variables Prepregnancy BMI of 26 or greater Transport from another hospital 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported data base <p>Pregravid BMI:</p> <p>G1: Low 29.6%; Normal 70.4% G2: Low 25.9%; Normal 74.1% G3: Low 23.0%; Normal 77% G4: Low 19%; Normal 81% G5: Low 42.2%; 57.9%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines Low (< 19.8) Normal (19.8-25.9) but this is not explicitly stated <p>Age (mean, yrs):</p> <p>G1: 28.19 G2: 29.43 G3: 24.25 G4: 26.17 G5: 29.10</p> <p>Parity: Nulliparous</p> <p>G1: 53.8% G2: 57.5 G3: 48.0 G4: 49.0 G5: 52.9</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 10.9% G2: 14.5% G3: 21.4% G4: 6.7% G5: 4.5%</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Previous preterm birth (%)</p> <p>G1: NR G2: 4.4 G3: 4.1 G4: 8.3 G5: 5.58 G6: 2.91</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 15,101 G2: 6513 G3: 1533 G4: 1614 G5: 3440 Group 6</p> <p>Total weight gain: G1: Below IOM: 20.5%; % Within IOM 39.1%; Above 40.4% P < .001</p> <p>G2: Below 15.5%; Within 38.5%; above 46.1% P < .001</p> <p>G3: Below 16.9%; Within 30.9%; Above 41.2% P < .001</p> <p>G4: Below 21.1%; Within 37.4%; Above 41.5% P < .001</p> <p>G5: Below 25.4%; Within</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous • According to IOM3-way categorical variable, low (less than 0.27 kg/wk), normal (between 0.27 and 0.52 kg/wk), and high (greater than 0.52kg/wk) <p>Collected from:</p> <ul style="list-style-type: none"> • Rate of weight gain was determined by: total weight gain divided by GA minus 2 weeks <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> • Spontaneous PTB for all women 4.0% white 3.6%, blacks 6.8%, latinias 4.4% asians 3.6% <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Rates of preterm delivery at 34 and 37 weeks</p> <p>Groups Categories of rate of gestational weight gain (kg/wk): G1: < 0.27 G2: 0.27 to 0.52 G3: > 0.52</p> <p>Results AOR (95% CI) for preterm delivery < 37 weeks: G1: 2.6 (2.1-3.2) G2: 1.0 (reference) G3: 1.0 (0.8-1.2)</p> <p>AOR (95% CI) for preterm delivery < 34 weeks: G1: 3.0 (2.0-4.8) G2: 1.0 (ref)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Race, age pregravid BMI, year of delivery, parity, previous preterm birth, number of days between last weighing and delivery, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Velonakis et al., 1997</p> <p>Country and setting: France, hospital</p> <p>Enrollment Period: 1988</p> <p>Funding: NR</p> <p>Study Objective: To identify impact of various biological, occupational, and socioeconomic factors on gestational age and birth weight</p> <p>Time frame: 1988</p> <p>Duration of the study: First prenatal visit through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort <p>Total Study N: 2,040</p> <p>Group Description:</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women with regular cycle not exceeding 32 days Last menstrual period was not withdrawal bleed from pill <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NR <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery: calculated by subtracting prepregnancy weight, fetal and placental weight from final weight 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Risk for preterm birth</p> <p>Groups NA, total gestational weight gain (continuous)</p> <p>Results Regression analysis with gestational age (weeks) as the dependent variable and net gestational weight gain as the independent variable: B = 0.191 (SE, 0.06) P = 0.001</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Age, race, gravidity, previous diseases, parity, abortions, marital status, pathology of index pregnancy, , height, pregravid weight, job classification, alcohol, smoking, duration of pregnancy</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Infant sex, APGAR score</p>	<p>Background: Poor</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 6 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Wen et al., 1990</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: January 1983 to December 1987</p> <p>Funding: NIH contract N01-HD-4-2811</p> <p>Study Objective: To determine effect of factors related to LBW on IUGR and preterm delivery</p> <p>Time frame: January 1983 to December 1987</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 17,149</p> <p>Group Description: G1: Total G2: IUGR G3: Preterm delivery</p> <p>Group N: G1: 100% G2: 7.4% G3: 12.6%</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women seen for prenatal care and delivered of infants at study location <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Diabetes Pregnancies involving multiple births Fetal death Congenital malformation 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal careweight at first prenatal visit was used <p>G1: (Prepregnancy?) Maternal weight (kg) < 50: 10.6%, 50-60: 32.6%, 61-72: 28.7%, 73-84: 14.5%, > 85: 13.6%</p> <p>G2: (Prepregnancy?) Maternal weight (kg) < 50: 12.9%, 50-60: 8.5%, 61-72: 6.4%, 73-84: 5.5%, > 85: 4.8%</p> <p>G3: (Prepregnancy?) Maternal wei</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NR <p>Age (mean, yrs):</p> <p>G1: < 17: 7.5%, 17-19: 22.7%, 20-25: 43.1%, 26-30: 17.5%, 31-35: 7.0%, > 36: 2.3%</p> <p>G2: < 17: 8.0%, 17-19: 6.6%, 20-25: 7.4%, 26-30: 7.6%, 31-35: 8.2%, > 36: 8.6%</p> <p>G3: < 17: 15.4%, 17-19: 13.0%, 20-25: 11.6%, 26-30: 12.9%, 31-35: 14.3%, > 36: 13.4%</p> <p>Parity:</p> <p>G1: Parity 0: 44.1, 1: 29.9, > 1: 26.0</p> <p>G2: Parity 0: 8.4, 1: 6.3, > 1: 6.6</p> <p>G3: Parity 0: 12.5, 1: 12.3, > 1: 12.8</p>	<p>Race, %: White G1: 29.7 G2: NR Black G1: 70.3 G2: NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 29.4 G2: 10.3 G3: 13.3</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: Married: 38.0% G2: Married: 6.6% G3: Married: 10.6%</p> <p>Additional characteristics: Education: G1: < 12: 41.1%, 12: 41.6%, > 12: 15.8% G2: < 12: 7.7%, 12: 7.3%, > 12: 7.6% G3: < 12: 12.8%, 12: 12.1%, > 12: 12.2%</p> <p>Additional characteristics: NR</p>

Evidence Table 17. Gestational weight gain and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>G1: Weight gain/week (after the 20th week) in kg: < 0.24: 12.2%, 0.24-0.57: 54.4%, 0.58-0.74: 19.2%, ≥ 0.75: 14.3%</p> <p>G2: Weight gain/week (after the 20th week) in kg: < 0.24: 9.9%, 0.24-0.57: 7.9%, 0.58-0.74: 5.2%, ≥ 0.75: 5.7%</p> <p>G3: Weight gain/</p> <p>Categorized:</p> <ul style="list-style-type: none"> Ave weight gain per week after 20th week <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Maternal weight at delivery not available, so total weight gain not calculated 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Risk for preterm birth</p> <p>Groups Rate of weight gain (kg/wk) after 20 weeks gestation G1: < 0.24 G2: 0.24-0.57 G3: 0.58-0.74 G4: ≥0.75</p> <p>Results AOR for preterm birth: G1: 1.52 (<i>P</i> < 0.05) G2: 1.11 (NS) G3: 1.00 (ref) G4: 1.71 (<i>P</i> < 0.05)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Race, parity, infant sex, marital status, education, age, previous preterm delivery, smoking, alcohol consumption, drug use, height, pregravid weight</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gender</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Abrams et al., 1995</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: 1980-1990</p> <p>Funding: NICHD grant</p> <p>Study Objective: To determine relationship between maternal weight gain pattern and birth weight</p> <p>Time frame: 1980-1990</p> <p>Duration of the study: initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 4,420</p> <p>Group Description: G1: total sample G2: NR</p> <p>Group N: G1: 2994 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> White women delivering at hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple gestation Fetal congenital abnormalities Maternal diabetes Hypertensive disorders Maternal obesity (BMI > 29.0) Missing data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 58.5 (7.8) kg G2: NR</p> <p>Pregravid BMI: G1: 21.5 (2.5) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 28.8 (5.4) G2: NR</p> <p>Parity: G1: 0.6 (0.9) G2: NR</p>	<p>Race, %: White G1: 100 G2: NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: G1: cigarettes per day: 2.0 (5.6) G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 2994 G2: NR</p> <p>Total weight gain: G1: 16.7 (0.5) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> Weight gain by trimester - 25th percentile was used to define low (L) vs. not low (N) maternal gain in each trimester (i.e. below 25th percentile and above 25th percentile) <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: using weight at last prenatal visit prior to delivery 	<p>Birth weight: G1: 3485.8 (523.1) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> First trimester, 25th percentile value (kg) = -0.05 Second trimester, 25th percentile value (kg) = 5.7 Third trimester, 25th percentile value (kg) = 4.8 First-trimester gain (kg): 2.1 (3.3) Second-trimester gain (kg): 7.7 (2.9) Third-trimester gain (kg): 6.6 (2.7) <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant weight gain</p> <p>Groups NA, weight gain as continuous variable</p> <p>Results Infant BW among nonobese women 3,485.8g ± 523.1</p> <p>Increase in birth weight per 1 kg increase in total pregnancy weight gain $\beta = 22.6g$ ($P < 0.001$)</p> <p>Increase in birth weight per 1 kg increase in first trimester weight gain $\beta = 18.0g \pm 2.4$ ($P < 0.001$)</p> <p>Increase in birth weight per 1 kg increase in second trimester weight gain $\beta = 32.8g \pm 2.8$ ($P < 0.001$)</p> <p>Increase in birth weight per 1 kg increase in third trimester weight gain $\beta = 17.0g \pm 2.9$ ($P < 0.001$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, parity, pregravid BMI, height, smoking, difference in weeks between the last measured weight and delivery</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Infant sex, gestational age</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancy Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple gestations Extremes of age BMI between 27 and 34 Missing height Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) ($P < 0.05$)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> NR <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 ($P = NS$)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% ($P < 0.01$)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% ($P < 0.01$)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% ($P < 0.01$)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% ($P < 0.01$)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% ($P < 0.01$)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% ($P < 0.01$)</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) <i>(P < 0.05)</i></p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% (<i>P < 0.01</i>)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: Increase in birthweight</p> <p>Groups G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: >35 lbs</p> <p>Results G1: 3,302 G2: 3,192 G3: 3,337 G4: 3,506 G5: 3,453 <i>(P < 0.05)</i></p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Brown et al., 2002</p> <p>Country and setting: USA, primary care clinics</p> <p>Enrollment Period: 1989 to 1993</p> <p>Funding: NIH</p> <p>Study Objective: To identify effects of maternal weight change by trimester of pregnancy on weight, length, head circumference, and ponderal index (PI; in kg/m³) of newborns</p> <p>Time frame: 1989 - 1993</p> <p>Duration of the study: From preconception or entry into prenatal care through 6 to 8 weeks postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 389</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 389 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women aged 22-35 years enrolled in Group Health managed care organization Intended to become pg within enrollment period Had not been attempting pg for > 3 mo Had delivered last infant > 12 mo before enrollment Did not intend to use contraceptives during study Delivery of live, singleton infants Pg lasting > 241 days from conception <p>Exclusion criteria:</p> <ul style="list-style-type: none"> History of hypertension, renal disease, DM, heart disease, infertility No data on preconceptional weight and height within 6 months of conception or 2 weeks after conception Missing data on weight with 25 days of end of each trimester 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured by study investigators Weight was measured < 6 months before conception for 364 women by study investigators <p>G1: 61.2 ± 9.4 (50.7, 73.2) G2: NR</p> <p>Pregravid BMI: G1: 22.5 ± 3.2 (19.2, 26.9) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 29.4 ± 3.1 (25.3, 33.7) G2: NR</p> <p>Parity: G1: 0.5 ± 0.7 (0, 1) G2: NR</p>	<p>Race, %: White G1: 97 G2: NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 389 G2: NR</p> <p>Total weight gain: G1: 15.6 ± 4.1 (10.5–21.4)² G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> Continuous </p> <p>Collected from: <ul style="list-style-type: none"> Collected by investigatorsRoutine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3575g ± 448 (3033–4167) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: Although nonsignificant, a trend was noted that suggested, among women with lower preconception weight, an increased effect of first-trimester weight gain on weight of their newborns (51 kg preconception weight, 51 g/kg weight gain; 62 kg preconceptional</p>	<p>Outcomes Description: Increase in birthweight</p> <p>Groups NA, weight gain as continuous variable</p> <p>Results Increase in birth weight per 1 kg increase in total pregnancy weight gain $\beta = 20g$ ($P < 0.0001$)</p> <p>Increase in birth weight per 1 kg increase in first trimester weight gain $\beta = 31g$ ($P < 0.0007$)</p> <p>Increase in birth weight per 1 kg increase in second trimester weight gain $\beta = 26g$ ($P < 0.007$)</p> <p>Increase in birth weight per 1 kg increase in third trimester weight gain $\beta = 7g$ ($P < 0.40$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, parity, pregravid BMI, height</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age, sex (female)</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 8 Good, 1 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Butte et al., 2003</p> <p>Country and setting: USA, children’s nutrition center</p> <p>Enrollment Period: NR</p> <p>Funding: US Department of Army and US Department of Agriculture/Agriculture Research Service</p> <p>Study Objective: To evaluate how changes in gestational weight and body composition affect infant birth weight and maternal fat retention after delivery in underweight, normal weight and overweight women</p> <p>Time frame: NR</p> <p>Duration of the study: Prior to preg through pp</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 63</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 63 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Nonsmokers • 18-40 years • parity ≤ 4 • Physically active (20 to 30 minutes of moderate exercise at least 3 times/week) • No long term medicine use • No alcohol/drug abuse <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiparous • Preterm deliveries • Miscarriage • Preeclampsia 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Measured by study investigators <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 31 (4) G2: NR</p> <p>Parity: NR</p>	<p>Race,%: White G1: 77 G2: NR</p> <p>Black G1: 10 G2: NR</p> <p>Hispanic G1: 10 G2: NR</p> <p>Asian/Pacific Islander G1: 3 G2: NR</p> <p>Other NR</p> <p>Smoking,%: NR</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: 15.0 (3.8) kg G2: 14.5 (4.5) kg G3: 17.9 (5.4) kg</p> <p>Categorized: <ul style="list-style-type: none"> • Continuous </p> <p>Collected from: <ul style="list-style-type: none"> • Collected by study investigators </p> <p>Ascertained by: <ul style="list-style-type: none"> • NR </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> • Birth weight 	<p>Outcomes Description: Infant birthweight</p> <p>Groups G1: Correlation coefficient G2: Variability in BW accounted for by gestational age, pregravid weight, and total pregnancy weight gain</p> <p>Results G1: 0.28 G2: 37.9%</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Race, pre-gravid BMI</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cherry et al., 1993</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: NR-to examine effect of zinc on birth outcomes</p> <p>Time frame: NR</p> <p>Duration of the study: 9 months-from time of enrollment in to prenatal care up to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> RCT <p>Total Study N: 599</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 599 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Adolescents in prenatal clinic at Charity Hospital of New Orleans <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured by study investigators <p>G1: 53% were 90-110% Expected Weight (EW); 26% < 90% EW; 21% were > 110% EW</p> <p>G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Calculated weight for age and height <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race,%: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking,%: NR</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Grams gained per week per cm height <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Table 1 provided data above-LBW, wt for length of infant, % of infants in high risk nursery</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant BW by Quartiles of weight gain</p> <p>Groups Quartiles defined as weekly weight gain in g per cm height G1: Quartile 1 (≤ 1.87g) G2: Quartile 2 (1.88-2.68g) G3: Quartile 3 (2.69-3.58g) G4: Quartile 4 (≥ 3.59g)</p> <p>Results G1: 2,829g G2: 2,990g G3: 3,112g G4: 3,189g</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Poor</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 3 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cianni et al., 2003</p> <p>Country and setting: Italy, clinic</p> <p>Enrollment Period: not stated</p> <p>Funding: NR</p> <p>Study Objective: To determine predictive value of serum triglyceride levels for neonatal weight in pregnant women with positive diabetic screening but normal glucose tolerance</p> <p>Time frame: Not stated</p> <p>Duration of the study: 24 to 30 weeks GA to birth</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 180</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 180 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Positive diabetic screening performed at 24-30th week of gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Hypertensive disorders Thyroid disorder Lupus Antiphospholipid syndrome 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Not stated <p>G1: 64 (11) G2: NR</p> <p>Pregravid BMI: G1: 23.6 (4) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 33 (4) G2: NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): G1: 180 G2: NR Total weight gain: G1: 8 (3) G2: NR Categorized: <ul style="list-style-type: none"> • Continuous Collected from: <ul style="list-style-type: none"> • Not stated Ascertained by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery: not stated 	Birth weight: G1: 3,442 (440) G2: NR Gestational diabetes, %: NR Cesarean delivery, %: NR Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: NA Other infant outcomes: NA	Outcomes Description: Infant birthweight Groups NA continuous measure Results F statistic = 3.16, <i>P</i> = 0.08 Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> • Pre-gravid BMI • Maternal triglycerides • Plasma glucose Infant and child confounders and effect modifiers accounted for in analysis: NR	Background: Good Sample selection: Poor Definition of maternal weight gain: Poor Definition of outcomes: Fair Source of information on exposure, outcomes, and confounders: Poor Followup: Fair Analysis comparability: Fair Analysis of outcomes: Fair Interpretation: Poor Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor Final Quality Score: Poor

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Edwards et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1997-1993</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy course and outcomes in obese and normal weight women and their associations with gestational weight change</p> <p>Time frame: 1997-1993</p> <p>Duration of the study: 1997-1993</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 1,443</p> <p>Group Description: G1: Obese G2: Normal Weight G3: total sample</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women and normal weight women identified from pregnancy and delivery summary records (normal weight matched to obese by race, age, parity) Singleton deliveries Live births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 103.5 G2: 61</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelinesobese (> 29) and normal weight (BMI 19.8-26.0) <p>Age (mean, yrs): G1: 27.1 G2: 25.4</p> <p>Parity: NR</p>	<p>Race, %: White G1: NR G2: NR G3: 69.0 (Total sample)</p> <p>Black G1: NR G2: NR G3: 21.0 (Total sample)</p> <p>Hispanic G1: NR G2: NR G3: 7.0 (Total sample)</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: NR G2: NR G3: 4.0 (Total sample)</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 683 G2: 660</p> <p>Total weight gain: G1: 9.5 G2: 14.5 $P \leq 0.001$</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3420 G2: 3285 $P \leq 0.001$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 25.6 G2: 9.1 $P < 0.001$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant birthweight</p> <p>Groups G1: Increase in birth weight per 1 kg increase in total pregnancy weight gain for obese women G2: Increase in birth weight per 1 kg increase in total pregnancy weight gain for normal weight women</p> <p>Results G1: $\beta = 11\text{g} \pm 2$ ($P \leq 0.001$) G2: $\beta = 15\text{g} \pm 2$ ($P \leq 0.001$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Age, parity, pregravid BMI, pregnancy-induced hypertension, adequacy of prenatal care, alcohol use, drug use, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ekblad and Grenman, 1992</p> <p>Country and setting: Finland, hospital</p> <p>Enrollment Period: July 1, 1985 - December 31, 1985 (6 months)</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of abnormal maternal weight or weight gain on pregnancy outcome</p> <p>Time frame: July 1, 1985 to December 31, 1985 (6 months)</p> <p>Duration of the study: Prepregnancy to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: retrospective data from records, prospective weight and height at delivery <p>Total Study N: Total n = 357</p> <ul style="list-style-type: none"> 191 women with abnormal prepregnant weight ($\geq 20\%$ under or over ideal weight for height) or abnormal pregnancy weight gain ($\geq 20\text{kg}$ or $\leq 5\text{kg}$) 166 controls <p>Group Description:</p> <p>G1: $\geq 20\%$ over normal weight for height G2: $\geq 20\%$ under normal weight for height G3: weight gain $\leq 5\text{kg}$ G4: weight gain $\geq 20\text{kg}$ G5: control Group 6</p> <p>Group N:</p> <p>G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Birth at hospital within study period selected those with abnormal maternal prepregnancy weight or abnormal weight gain during pregnancy, as well as next mother in sequential order with normal prepregnancy weight and weight gain during pregnancy to serve as a control <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Not stated 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records - not stated if self reported <p>G1: 83.9 (10.1) G2: 46.7 (3.4) G3: 73.1 (16.5) G4: 65.0 (12.2) G5: 58.3 (6.5)</p> <p>Pregravid BMI:</p> <p>G1: 39.5 (3.4) G2: 17.2 (0.9) G3: 26.1 (6.1) G4: 23.6 (4.1) G5: 21.6 (2.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous $\geq 20\%$ over or under normal weight for height <p>Age (mean, yrs):</p> <p>G1: 28 (5.1) G2: 25.5 (5.1) G3: 29.5 (5.1) G4: 28.7 (4.7) G5: 28.7 (4.4)</p> <p>Parity:</p> <p>G1: prior deliveries: 1.0 (1.0) G2: 0.8 (0.8) G3: 1.2 (1.1) G4: 0.8 (1.0) G5: 0.9 (1.0)</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Total weight gain: G1: 11.8 (6.2) <i>P</i> < 0.05 compared to controls G2: 13.4 (4.5) G3: 3.0 (3.5) <i>P</i> < 0.0005 compared to controls G4: 23.2 (22.8) <i>P</i> < 0.0005 compared to controls G5: 13.2 (3.4)</p> <p>Categorized: <ul style="list-style-type: none"> ≤ 5kg or ≥ 20kg </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3712 g (614) <i>P</i> < 0.05 compared to controls G2: 3293 (362) <i>P</i> < 0.05 compared to controls G3: 3284 (880) G4: 3803 (538) <i>P</i> < 0.005 compared to controls G5: 3538 (535)</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: Elective 7% Emergency 14% Total 21% G2: Elective 4% Emergency 4% Total 8% G3: Elective 3% Emergency 3% Total 6% G4: Elective 5% Emergency 18% Total 23% G5: Elective 13% Emergency 9% Total 22%</p> <p>Instrumental delivery,%: NR</p> <p>Episiotomy,%: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant birthweight</p> <p>Groups G1: Normal prepregnancy weight and normal weight gain G2: Weight gain ≤5 kg G3: Weight gain ≥20 kg</p> <p>Results G1: 3,538g ± 535 G2: 3,284g ± 880 G3: 3,803g ± 538 (<i>P</i> < 0.005 compared to G1)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 4 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Groff et al., 1997</p> <p>Country and setting: USA, multispecialty clinics</p> <p>Enrollment Period: 1991-1993</p> <p>Funding: National Cancer Institute grant</p> <p>Study Objective: To determine effects of smoking status and maternal weight gain on infant birthweight</p> <p>Time frame: 1991-1993</p> <p>Duration of the study: Entry into prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 341</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 341 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Adult, white, non-Hispanic pregnant women beginning prenatal care before 14 weeks gestation who self-identified as never smokers, continuing smokers, and women who stopped smoking during pregnancy First or second pregnancies, singletons with recorded weights at 12, 26, and 39 weeks (+/- 2 weeks) Documented infant birth weight <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Gestation > 42 weeks Black women Diabetics Hispanics 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported Routine pre-natal care first prenatal visit for 18%, self-report for 82% <p>Pregravid BMI: G1: 23.9 G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 26.4 G2: NR</p> <p>Parity: G1: Nulliparous: 52.8% G2: NR</p>	<p>Race, %: White G1: 100% G2: NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: G1: 32% Never smoked G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Married/living with partner: G1: 73.9% G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>G1: 39.68 lb (15.42)</p> <p>G2: 32.75 lb (13.23)</p> <p>G3: 34.16 lb (11.77)</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • NR 	<p>Birth weight:</p> <p>G1: 3732 g (501)</p> <p>G2: 3440 g (465)</p> <p>G3: 3693 g (443)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> • Significant effects were found for weight gain by smoking status @ < 0.001) and weight gain over time (<i>P</i> < 0.001) • First trimester slopes differed slightly, but not significantly, among 3 groups (<i>P</i> = 0.075) • Second trimester slopes differed significantly (<i>P</i> = 0.013), with women who reported stopping smoking gaining more weight than never smokers during this period (difference of 2.57 lb, 99% CI = 0.46, 8.07) • Third trimester slopes also differed significantly (<i>P</i> = 0.003). Pairwise contrasts revealed significant differences in weight gain during third trimester between women who stopped smoking and continuing smokers (difference of 4.31 lb, 99% CI = 1.88, 12.00) and between women who stopped and never smokers (difference of 1.25 lb, 99% CI = 0.56, 10.49) <p>Other infant outcomes:</p> <ul style="list-style-type: none"> • Statistically significant proportion of variance in infant birthweight was accounted for by both maternal weight gain and maternal smoking status. However, interaction of maternal weight gain with smoking status did not contribute significantly 	<p>Outcomes Description: Increase in birthweight</p> <p>Groups</p> <p>G1: Increase in birth weight per 1 lb increase in total pregnancy weight gain</p> <p>Results</p> <p>G1: $\beta = 10.1g \pm 1.76$ (<i>P</i> ≤ 0.001)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Pre-gravid BMI • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gender 	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Guihard-Costa et al., 2004</p> <p>Country and setting: France, hospital database</p> <p>Enrollment Period: 1980-1990</p> <p>Funding: NR</p> <p>Study Objective: To determine relative influences of maternal factors on infant skinfold thickness and other outcomes</p> <p>Time frame: 1980-1990</p> <p>Duration of the study: Pregnancy to birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 13,972</p> <p>Group Description:</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Liveborn singletons • Term infants (37 to 41 weeks) • Both parents born in France • No maternal smoking during gestation • All data available, specifically subscapular skinfold thickness • French metropolitan mothers <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • French mothers born in French Caribbean Islands or outside of France 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Not stated - from database 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Effect of pregnancy weight gain on infant birth weight</p> <p>Groups G1: Standardized coefficient for effect of pregnancy weight gain on infant birth weight.</p> <p>Standardized coefficients are regression coefficients calculated as if all of the independent variables had a variance of 1</p> <p>Results G1: SC = 0.199</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Parity • Pre-gravid BMI • Height <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hediger et al., 1994</p> <p>Country and setting: USA, setting NR</p> <p>Enrollment Period: 1985</p> <p>Funding: NICHD grant</p> <p>Study Objective: To study relationship between changes in maternal subcutaneous fat and infant birth weight</p> <p>Time frame: 1985</p> <p>Duration of the study: Initiation of prenatal care to 4 to 6 weeks postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 608</p> <p>Group Description: G1: Teenagers 13-15 years G2: Teenagers 16-18 years G3: Adults 19-29 years</p> <p>Group N: G1: 197 G2: 207 G3: 204</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Primigravid and multigravid teenagers (< 19 years) with first pregnancy at < 16 y Older women ages 18 to 29 years at first pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> History of serious nonobstetric problems (seizure disorders, leukemia or drug or alcohol abuse) Fetal demise Multiple pregnancy Missing data on study variables Women who breast fed after delivery or who were still breastfeeding at 4 to 6 weeks postpartum 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 56.00 (0.84) kg G2: 59.95 (0.82) G3: 60.91 (0.82)</p> <p>Pregravid BMI:</p> <p>G1: 21.81 (0.30) G2: 23.02 (0.29) G3: 23.18 (0.29)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs):</p> <p>G1: 14.49 (0.14) G2: 17.41 (0.13) G3: 22.63 (0.14)</p> <p>Parity: % primiparous:</p> <p>G1: 93.9 G2: 37.2 G3: 36.3</p>	<p>Race, %:</p> <p>White G1: 7.6 G2: 9.2 G3: 8.8</p> <p>Black G1: 69.5 G2: 57.5 G3: 61.8</p> <p>Hispanic G1: 22.8 G2: 33.3 G3: 29.4</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 20.8 G2: 34.8 G3: 40.2</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Mean change in arm muscle area, cm²:</p> <p>G1: 2.19 (0.44) G2: 1.78 (0.38) G3: 2.00 (0.39)</p> <p>Change in arm fat area, cm²:</p> <p>G1: -0.46 (0.48) G2: -1.18 (0.43) G3: -1.26 (0.44)</p> <p>Change in triceps skinfold, mm</p> <p>Change in subscapular skinfold, mm:</p> <p>G1: -0.85 (0.38) -1.13 (0.38) G2: 1.22 (0.33) -0.87 (0.33) G3: -1.25 (0.34) -1.53 (0.34)</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 197 G2: 207 G3: 204</p> <p>Total weight gain: G1: 14.85 (0.54) kg G2: 13.82 (0.47) G3: 14.12 (0.48)</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery, infant sex 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> • Anthropometric measurements taken were: mid-upper arm circumference, triceps, and subscapular skinfold thickness from left side of body - upper arm muscle and fat area <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant birthweight by maternal weight gain</p> <p>Groups G1: Increase in birth weight per 1 kg increase in total pregnancy weight gain</p> <p>Results G1: $\beta = 16.7g \pm 2.5$ ($P = 0.001$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Age, race/ethnicity, parity, pregravid weight, height, prior poor outcome, fat loss, pregravid weight: low weight, fat accretion, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hickey et al., 1990</p> <p>Country and setting: United States, prenatal clinics</p> <p>Enrollment Period: Does not state</p> <p>Funding: Supported by Garry A Weber Graduate Fellowship in Anthropology, Southern Methodist University, and through University Affiliated Center, Department of Pediatrics, University of Texas Southwestern Medical Center at Dallas, Maternal and Child Health Training Grant MCJ-2000, Department of Health and Human Services</p> <p>Study Objective: Present study was designed to (1) determine prevalence of low maternal weight-for-height near term among low income black and Hispanic women attending public prenatal clinics, and (2) compare maternal weight-for-height near term with current guidelines</p> <p>Time frame: Does not state</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 325</p> <p>Group Description: G1: Black G2: Hispanic</p> <p>Group N: G1: 172 G2: 153</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Black and Hispanic pregnant women aged ≥ 17 who subsequently delivered singleton infants free from congenital malformations <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women whose last prenatal weight was recorded > 14 days before delivery, gestational diabetes, other medical or obstetrical conditions, missing records, moved to another city before delivery 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: NR</p> <ul style="list-style-type: none"> $< 90\%$ standard: 27.3% 90-119%: 44.2% $\geq 120\%$ standard: 21.5% <p>G2: NR</p> <ul style="list-style-type: none"> $< 90\%$ standard: 15.7% 90-119%: 38.6% $\geq 120\%$ standard: 9.8% <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NR <p>Age (mean, yrs): G1: 22.65 ± 4.48 G2: 23.18 ± 4.78</p> <p>Parity: G1: 0.98 ± 1.23 G2: 1.10 ± 1.50</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> • % of standard weight for height by use of nomogram and chart developed by Rosso <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Weight gain</p> <p>Groups Infant BW for groups defined by maternal weight near term (% of standard weight-for-height) G1: > 135%, Black G2: > 135%, Hispanic G3: 120-135%, Black G4: 120-135%, Hispanic G5: 110-119%, Black G6: 110-119%, Hispanic G7: 100-109%, Black G8: 100-109%, Hispanic G9: < 100%, Black G10: < 100%, Hispanic</p> <p>Results G1: 3,325g ± 460 G2: 3,543g ± 410 G3: 3,200g ± 389 G4: 3,381g ± 385 G5: 3,157g ± 373 G6: 3,282g ± 400 G7: 3,025g ± 494 G8: 3,154g ± 375 G9: 2,813g ± 289 G10: 3,205g ± 472</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 7 Good, 2 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jensen et al., 2005</p> <p>Country and setting: Denmark, university hospitals</p> <p>Enrollment Period: Gestation through birth</p> <p>Funding: Many different funds</p> <p>Study Objective: To investigate effect of gestational weight gain in obese glucose tolerant women</p> <p>Time frame: Gestation through birth</p> <p>Duration of the study: NR</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 481</p> <p>Group Description:</p> <p>G1: GWG < 5.0 kg G2: GWG 5.0-9.9kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0kg</p> <p>Group N:</p> <p>G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Prepregnancy BMI ≥ 30 • Normal 2h 75g oral glucose tolerance test (OGTT) during third trimester (according to WHO criteria) • Only first pregnancy during study period included <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Well defined chronic disease • Twin pregnancies • Women with GDM (n = 323) • Known diet treatment (n = 10) • Incomplete data on weight gain during pregnancy (n-153) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Records • Patient report of pregravid BMI <p>Pregravid BMI:</p> <p>G1: 34.3 (32.2-39.9) G2: 33.9 (31.5-36.5) G3: 32.9 (31.2-35.6) G4: 32.7 (31.3-34.7)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs):</p> <p>G1: 29.8 (26.4-33.1) G2: 29.1 (26.3-33.1) G3: 30.0 (26.6-33.2) G4: 27.9 (24.8-31.8)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: 84.4 G2: 85.8 G3: 82.7 G4: 89.9</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 29.7 G2: 25.8 G3: 30.2 G4: 26.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> < 5.0. 5.0-9.9, 10.0-14.9, ≥ 15.0 Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records Ascertained by: <ul style="list-style-type: none"> Not stated by authors </p>	<p>Birth weight: G1: 3500 (3200-3840) G2: 3645 (3200-4000) G3: 3750 (3390-4125) G4: 3762 (3400-4120)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant birthweight</p> <p>Groups G1: MWG < 5.0 kg G2: MWG 5.0-9.9 kg G3: MWG 10-14.9 kg G4: MWG ≥ 15.0 kg</p> <p>Results G1: 3,456g ± 620 G2: 3,624g ± 675 G3: 3,757g ± 582 G4: 3,784g ± 597 <i>P</i> < 0.0001</p> <p>Increase in birth weight per 1 kg increase in total pregnancy weight gain</p> <p>G1: $\beta = 18.4g$ <i>(P</i> < 0.001)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, pregravid BMI, smoking, gestational age, result of 2-hour oral glucose tolerance test</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Johnson et al., 1992</p> <p>Country and setting: USA, prenatal clinics</p> <p>Enrollment Period: January 1, 1987- December 31, 1989</p> <p>Funding: NR</p> <p>Study Objective: To determine influences of increased maternal prepregnancy weight and increased gestational weight gain on pregnancy outcome</p> <p>Time frame: January 1, 1987 to December 31, 1989</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 3,191</p> <p>Group Description: G1: BMI < 19.8 G2: 19.8-26.0 G3: 27-29 G4: > 29 G5: All</p> <p>Group N: G1: 755 G2: 1,621 G3: 329 G4: 486 G5: 3191</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Delivery at or beyond 38 weeks of gestation • Singletons • Received prenatal care and delivered in Shands Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Fetal abnormalities • Oligohydramnios • Polyhydramnios • Medical or surgical complications (GI disorders, sickle cell hemoglobinopathy, hepatitis, hematologic disorders, malignant disease, renal disease, neurologic disease, pulmonary disease, psychiatric disorders, tuberculosis) • Incomplete risk variable data or outcome variable information 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • National Academy of Sciences <p>Age (mean, yrs): G1: NR</p> <ul style="list-style-type: none"> • < 20 years: 36.6% • 20-26 years: 44.8% • > 26 years: 18.7% <p>G2: NR</p> <ul style="list-style-type: none"> • < 20 years: 30.8% • 20-26 years: 46.5% • > 26 years: 22.6% <p>G3:</p> <ul style="list-style-type: none"> • < 20 years: 25.8% • 20-26 years: 48.9% • > 26 years: 25.2% <p>G4:</p> <ul style="list-style-type: none"> • < 20 years: 16.5% • 20-26 years: 53.9% • > 26 years: 29.6% <p>G5:</p> <ul style="list-style-type: none"> • < 20 years: 29.5% • 20-26 years: 47.5 % • > 26 years: 23.0% <p>Parity: G1: % first: 49.3 G2: 43.1 G3: 37.4 G4: 31.1 G5: 42.1</p>	<p>Race, %: White G1: 64.5 G2: 60.0 G3: 49.8 G4: 51.9 G5: 58.7</p> <p>Black G1: 33.6 G2: 37.9 G3: 48.9 G4: 47.5 G5: 39.5</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 1.9 G2: 2.1 G3: 1.2 G4: 0.6 G5: 1.7</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Hypertension, %: G1: 3.4 G2: 4.6 G3: 5.8 G4: 10.7 G5: 5.4</p> <p>Additional characteristics: G1: % married: 42.6 G2: 46.1 G3: 40.4 G4: 49.4 G5: 45.2</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 755 G2: 1621 G3: 329 G4: 486 G5: 3191</p> <p>Total weight gain: G1:</p> <ul style="list-style-type: none"> < 16kg: 7.8% 16-25kg: 18.5% 26-35kg: 35.1% > 35kg: 38.5% <p>G2:</p> <ul style="list-style-type: none"> < 16kg: 11.7% 16-25kg: 18.0% 26-35kg: 28.8% > 35kg: 41.5% <p>G3:</p> <ul style="list-style-type: none"> < 16kg: 19.8% 16-25kg: 19.1% 26-35kg: 28.3% > 35kg: 32.8% <p>G4:</p> <ul style="list-style-type: none"> < 16kg: 32.3% 16-25kg: 22.0%; <p>Categorized:</p> <ul style="list-style-type: none"> Quartiles National Academy of Sciences (below, within, or above recommended range) <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records 	<p>Birth weight: G1:</p> <ul style="list-style-type: none"> < 2500g: 4.8% 2500-4000g: 89.1% > 4000g: 6.1% <p>G2:</p> <ul style="list-style-type: none"> < 2500g: 2.0% 2500-4000g: 85.2% > 4000g: 12.8% <p>G3:</p> <ul style="list-style-type: none"> < 2500g: 1.5% 2500-4000g: 83.0% > 4000g: 15.5% <p>G4:</p> <ul style="list-style-type: none"> < 2500g: 0.2% 2500-4000g: 82.5% > 4000g: 17.3% <p>Gestational diabetes, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Cesarean delivery, %: G1: NR G2: NR G3: NR G4: NR G5: 11.9</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Infant birthweight by maternallweight gain</p> <p>Groups G1: Increase in birth weight per 1 lb increase in net pregnancy weight gain</p> <p>Results G1: $\beta = 15.4g \pm 2.2$ ($P < 0.0001$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Race, parity, pregravid BMI, height, pregravid weight, marital status, education, tobacco/alcohol/drug use, pregnancy-induced hypertension, macrosomia</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age, infant sex, macrosomia</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 9 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Johnson et al., 1992
(continued)

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self report and weight at last prenatal visit (mean 6.1 days prior to delivery) 	<p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Frequency of macrosomia = 12.2% Frequency of cesarean = 11.9% Frequency of LBW = 2.9% Frequency of postdate pregnancy = 9.8% Frequency of labor abnormalities (40% were unscheduled cesareans) = 7.8% Frequency of oxytocin induction = 13.7% Frequency of oxytocin augmentation = 16.1% Frequency of meconium staining = 21.5% <p>Other infant outcomes: NA</p>		

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kieffer et al., 2006</p> <p>Country and setting: United States, community health center</p> <p>Enrollment Period: Jan 1999 to Feb 2001</p> <p>Funding: This study was supported by National Institutes of Diabetes and Digestive and Kidney Diseases (grant R18DK 062344); Biostatistics and Measurement Cores of Michigan Diabetes Research and Training Center (grant NIH5P60 DK20572); General Clinic Center, National Institutes of Health (grant M01 RR00042); the Maternal and Child Health Bureau (grant R40 MC00115-03); and Detroit Community Academic Urban Research Center</p> <p>Study Objective: Our study assessed combined influence of maternal weight and other anthropometric and metabolic characteristics on birthweights of Latino infants</p> <p>Time frame: Jan 1999 to Feb 2001</p> <p>Duration of the study: From entry into prenatal care up til delivery. Ave ga at entry was 17 weeks</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 1,041</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 1041 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Latino women entering prenatal care during study period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestation • Late entry into prenatal care • Previous participation in study • Miscarriage • Stillbirth • Missing records 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported when unknown or missing - used weight obtained within first 10 weeks of pregnancy <p>G1: 63.4 \pm12.9 G2: NR</p> <p>Pregravid BMI: G1: 25.9 \pm5.0 G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • Yes <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 25.2 \pm5.1 G2: NR</p> <p>Parity: G1: Multiparous, no. (%)0 429 (41.2) 1st 3 574 (55.1) \bar{y} 4 38 (3.7) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic G1: 100% G2: NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 9%before; 2% during G2: NR</p> <p>Diabetes mellitus, %: G1: 6.8 G2: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: total n = 933 G2: NR</p> <p>Total weight gain: G1: Adjusted R2: 0.30 kg [PE 8.2, SE 2.2, <i>P</i> < 0.01] G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> Continuous According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 6.8 G2: NR</p> <p>Cesarean delivery, %:</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Women with GDM had significantly lower average weight gain than those without GDM, but weight gain was not significantly related to glucose category Maternal waist, hip, and upper-arm circumference and upper-arm fat area were associated with increasingly abnormal glucose categories among women with and without GDM Significant linear increase in birthweight with increasing glucose level was maintained after further adjustment for maternal age, parity, BMI, weight gain, hypertensive disorders, and family history of diabetes <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Infant birth weight</p> <p>Groups G1: Increase in birth weight per 1 kg increase in total pregnancy weight gain</p> <p>Results G1: $\beta = 19.7g \pm 2.8$ (<i>P</i> < 0.01)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Parity, pregravid BMI, height, 1-hour glucose value</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 7 Good, 2 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kirchengast and Hartmann, 2003</p> <p>Country and setting: Singleton births that took place at University Clinic for Gynecology and Obstetrics in Vienna, Austria</p> <p>Enrollment period: NR</p> <p>Funding: NR</p> <p>Study Objective: Examine impact of biological factors such as young maternal age and maternal somatic characteristics on pregnancy outcome among group of adolescent mothers who gave birth between 39th and 41st week of gestation after period of intensive psychological support</p> <p>Time frame: NR</p> <p>Duration of the study: 1985 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 8,011</p> <p>Group Description: G1: 12 to 16 years G2: 17 to 19 years G3: 20 to 29 years</p> <p>Group N: G1: 215 G2: 1,336 G3: 6,460</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women ages 12 to 29 • All prenatal check-ups of mother-child passport were performed • Delivery of single infant without congenital malformations • Receiving psychosocial support by family and/or specially trained social worker within young adolescent group (12 to 16 years) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Coincident medical diseases such as diabetes mellitus or nephropathy • Drug or alcohol abuse • Twin birth • IVF • Registered maternal diseases before and during pregnancy • Hypertension (BP < 150/90 mmHG) • Protein or glucose in urine • Pregnancy related immunization 	<p>Pregravid weight: Estimated by means of retrospective method and first weight determination, which was carried out at first prenatal visit (8th week of gestation)</p> <p>G1: 56.0 G2: 57.2 G3: 59.2</p> <p>Pregravid BMI: G1: 21.45 G2: 21.59 G3: 22.10</p> <p>Imputed:</p> <ul style="list-style-type: none"> • Yes <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 14.5 G2: 17.8 G3: 24.1</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Age at menarche: G1: 12.2 G2: 12.9 G3: 13.3</p> <p>Gynecological age: G1: 3.4 G2: 5.3 G3: 10.8</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 215 G2: 1,336 G3: 6,460</p> <p>Total weight gain: G1: 13.1 G2: 13.1 G3: 13.1 (<i>P</i> = .10)</p> <p>Categorized: <ul style="list-style-type: none"> • Continuous </p> <p>Collected from: <ul style="list-style-type: none"> • Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3237.6 (significantly different from 17-19 and 20-29) G2: 3298.3 (significantly different from < 17 and 20-29) G3: 3368.9 (significantly different from < 17 and 17-19) (<i>F</i> = 24.1, <i>P</i> < .0001)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> • Chronological age • Age at menarche • Gynecological age • Height • Distancia spinarum • Distancia christarum • Prepregnancy weight • Weight at end of pregnancy <p>Other infant outcomes</p> <ul style="list-style-type: none"> • Birth length • Head circumference • Acromial circumference • Diameter frontooccipitale 	<p>Outcomes Description: Increase in birth weight per 1 kg increase in total pregnancy weight gain</p> <p>Groups NA, weight gain as continuous variable</p> <p>Results Increase in birth weight per 1 kg increase in total pregnancy weight gain (95% CI) G1: β = 17.32 (14.62, 20.03)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, age at menarche, pregravid weight, height, distantia cristarum</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Luke et al., 1996</p> <p>Country and setting: USA, clinic</p> <p>Enrollment Period: March 1, 1974 to June 15, 1979</p> <p>Funding: NR</p> <p>Study Objective: Reanalysis of original data to examine contribution of maternal weight gain to infant birth weight and retained maternal weight in immediate postpartum period, and effect of weight gains below, at, and above IOM guidelines on both infant birt</p> <p>Time frame: March 1, 1974 to June 15, 1979</p> <p>Duration of the study: Prenatal visit through 2 days postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 487</p> <p>Group Description: G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI > 26.0</p> <p>Group N: G1: 104 G2: 268 G3: 115</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Referred for nutrition counseling > 37- < 43 weeks gestation Singleton pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with history of or concurrent metabolic disease, such as diabetes, seizure disorder, hypertension, cardiac disease, asthma, or drug dependence Women developing antepartum complications such as preeclampsia, GDM, or multiple gestation 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 47.9 (5.1) G2: 58.7 (6.3) G3: 83.9 (16.9)</p> <p>Pregravid BMI: G1: 18.3 (1.0) G2: 22.6 (1.7) G3: 31.7 (5.3)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 23.1 (5.5) G2: 23.8 (5.5) G3: 27.4 (6.2)</p> <p>Parity: % primipara: G1: 60.6 G2: 48.1 G3: 27.0</p>	<p>Race, %: White NR Black G1: 48.1 G2: 48.8 G3: 63.5 Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 17.3 G2: 15.3 G3: 13.0</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 104 G2: 268 G3: 115</p> <p>Total weight gain: G1: 12.6 (0.7) G2: 13.2 (0.4) G3: 11.7 (0.7) <i>Significantly different from mean for normal BMI group at $P < 0.05$</i></p> <p><i>Categorized:</i></p> <ul style="list-style-type: none"> According to IOM <p><i>Collected from:</i></p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: total weight gain: difference between last measurement and pregravid weight; net weight gain: difference between pregravid weight and last measured weight minus infant birth weight 	<p>Birth weight: G1: 3,067 (44) $P < 0.05$ significantly different from mean for normal BMI</p> <p>G2: 3308 (27) G3: 3300 (43)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Net gain (kg): 9.5 (0.6), 9.9 (0.4), 7.8 (0.6) significantly different from mean for normal BMI group at $P < 0.05$ Retained weight (kg): 6.6 (0.6), 6.6 (0.4), 4.2 (0.6) significantly different from mean for normal BMI group at $P < 0.05$ Percent retained weight (%): 11.4 (0.9), 9.4 (0.5), 4.4 (0.8) significantly different from mean for normal BMI group at $P < 0.05$ <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant birthweight for total weight gain and net weight gain</p> <p>Groups G1: Underweight G2: Normal weight G3: Overweight</p> <p>Results Increase in birth weight per 1 kg increase in total pregnancy weight gain for BMI categories G1: $\beta = 44.9\text{g} \pm 6.8$ ($P < 0.01$) G2: $\beta = 22.9\text{g} \pm 3.9$ ($P < 0.01$) G3: $\beta = 11.9\text{g} \pm 5.2$ ($P < 0.05$)</p> <p>Increase in birth weight per 1 kg increase in net pregnancy weight gain for BMI categories: G1: $\beta = 41.9\text{g} \pm 7.5$ ($P < 0.01$) G2: $\beta = 19.2\text{g} \pm 3.9$ ($P < 0.01$) G3: $\beta = 9.1\text{g} \pm 5.3$</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Age, parity, black ethnicity, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age, infant sex</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Muscatti et al., 1996</i></p> <p>Country and setting: <i>Canada, public health department</i></p> <p>Enrollment Period: <i>1979 to 1989</i></p> <p>Funding: <i>NR</i></p> <p>Study Objective: <i>To examine association of extent and timing of pregnancy weight gain with infant birth weight and postpartum weight retention</i></p> <p>Time frame: <i>1979 to 1989</i></p> <p>Duration of the study: <i>Pregnancy through 6 weeks postpartum</i></p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 371</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 371 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • White, low income, non-smoking women • Pregnant women <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Prematurity < 37 weeks • Adolescents < 16 years • Women > 40 years • Maternal health problems • Women who consume alcohol or drugs • Pregnancy complications such as proteinuria, hypertension, diabetes, negative weight gain, missing values 	<p>Pregravid weight: Family physicians' records G1: 62.8 +/- 16.0 kg G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Pregravid weight status categorized into 3 groups as a percentage of standard weight: underweight < 90%, normal 90-120%, and overweight > 120% <p>Age (mean, yrs): G1: 24.5 +/- 5.6 G2: NR</p> <p>Parity: G1: Primiparous 52% G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: PPWR: 5.3 +/- 5.7 kg G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): Total weight gain: G1: 16.1 +/- 6.4 kg G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: From Table 1: Pearson's Correlation Coefficient and determination coefficient of maternal weight gain with PP weight retention and Infant BW. Maternal PP weight retention and Preg weight gain: [Total amount $r = 0.808$, R square 65.3%, $P < 0.001$], [Up to week 20 $r = 0.682$, R square 46.5%, $P < 0.001$], [Weeks 21-30 $r = 0.411$, R square 16.9%, $P < 0.001$], [Week 31 - term $r = 0.414$, R square 17.1%, $P < 0.001$]</p> <p>Other infant outcomes: Pregnancy Weight Gain and Infant Birth Weight (from Table 1): [Total amount $r = 0.216$, R square 4.7%, $P < 0.001$], [Up to week 20 $r = 0.114$, R-square 1.3%, $P < 0.05$], [Weeks 21-30 $r = 0.157$, R square 2.5%, $P < 0.01$], [Week 31 - term $r = 0.160$, R square 2.6%, $P < 0.01$]</p>	<p>Outcomes Description: Infant birthweight</p> <p>Groups</p> <p>G1: Increase in birth weight per 1 kg increase in total weight gain up to week 20</p> <p>G2: Increase in birth weight per 1 kg increase in total weight gain from weeks 21 to 30</p> <p>G3: Increase in birth weight per 1 kg increase in total weight gain from weeks 31 to term</p> <p>Results</p> <p>G1: $\beta = 22g \pm 6$ ($P < 0.01$)</p> <p>G2: $\beta = 31g \pm 7$ ($P < 0.001$)</p> <p>G3: $\beta = 12g \pm 6$ ($P < 0.05$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Parity Pregravid standard weight Pregravid excess weight, <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Birth length Infant gender 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Paauw et al., 2005</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1995 to 1998</p> <p>Funding: NR</p> <p>Study Objective: To evaluate relationship of maternal hyperemesis gravidarum to neonatal birth weight, infant hospital length of stay, and other birth outcomes</p> <p>Time frame: 1995 to 1998</p> <p>Duration of the study: Initiation of prenatal care to delivery (+any time in NICU or NIMU)</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 351</p> <p>Group Description: G1: Controls G2: HG patients</p> <p>Group N: G1: 306 G2: 45</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple or molar gestation • Diabetes or GDM • Causes of nausea such as appendicitis or pyleonephritis 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 65.2 (1.2) kg G2: 66.7 (3.3)</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NR <p>Age (mean, yrs): G1: 25.9 (0.3) G2: 25.5 (0.7)</p> <p>Parity: NR</p>	<p>Race, %: White G1: 83.7 G2: 67.4 (<i>P</i> < .05 vs controls)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: G1: 21.9 G2: 11.1</p> <p>Diabetes mellitus, %: G1: 0.7 G2: 2.2</p> <p>Hypertension, %: G1: 3.6 G2: 4.4</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 306 G2: 45</p> <p>Total weight gain: G1: 14.9 (0.3) G2: 10.6 (1.3)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not explained by authors 	<p>Birth weight: G1: 3523 (29) G2: 3232 (88) ($P < 0.05$)</p> <p>Gestational diabetes, %: G1: 0.7 G2: 2.2</p> <p>Cesarean delivery, %:</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant birthweight by maternal weight gain</p> <p>Groups G1: Increase in birth weight per 1 kg increase in total pregnancy weight gain</p> <p>Results G1: $\beta = 21.0g$</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Race Prepravid weight Marital status Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Pezzarossa et al., 1996</p> <p>Country and setting: Italy, not stated</p> <p>Enrollment Period: Not stated</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of gestational weight gain on neonatal birthweight in women who were diagnosed with gestational diabetes after 3second week gestation</p> <p>Time frame: Not stated</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 192</p> <p>Group Description: G1: Normal G2: GDM</p> <p>Group N: G1: 132 G2: 60</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Caucasian women who had 1 or more risk factors for GDM: BMI > 28.6, gestational weight gain > 12kg, previous GDM, or previous neonatal macrosomia and underwent a diagnostic oral glucose tolerance test for GDM after 3second week of gestation - women with positive tests formed GDM group while women with negative test results formed normal singleton <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Smoking • Hypertension • Underweight (BMI < 19.6) • Previous metabolic treatment • Diabetic counseling 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: 25.7 (0.5) G2: 25.4 (0.8)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 29.1 (0.4) G2: 28.07 (0.6)</p> <p>Parity: NR</p>	<p>Race, %: White G1: 100 G2: 100 Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 132 G2: 60</p> <p>Total weight gain: G1: 13.4 (0.5) G2: 12.2 (0.6)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: used weight at last prenatal visit 	<p>Birth weight: G1: 3576.8 (41.3) G2: 3678.7 (69.3)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: macrosomia</p>	<p>Outcomes Description: Infant birthweight by maternal weight gain</p> <p>Groups Increase in birth weight per 1 kg increase in total pregnancy weight gain for: G1: Controls (normal glucose tolerance) G2: GDM</p> <p>Results G1: $\beta = 27.8\text{g}$ ($P = 0.0001$) G2: $\beta = 39.5$ ($P = 0.0001$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Pre-gravid BMI Fasting plasma glucose <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Shapiro et al., 2000</i></p> <p>Country and setting: <i>USA, community hospital</i></p> <p>Enrollment Period: <i>NR</i></p> <p>Funding: <i>NR</i></p> <p>Study Objective: <i>To ascertain whether increased weight gain during pregnancy resulted in higher birth weight infants in women delivering at a community hospital</i></p> <p>Time frame: <i>NR</i></p> <p>Duration of the study: <i>First prenatal visit (0-15 wks of gestation) to 2 weeks after birth</i></p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 159</p> <p>Group Description: G1: total cohort G2: NR</p> <p>Group N: G1: 159 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Randomly selected from hospital database • Ages 19 to 37 • Term delivery <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Smokers • Drug abusers • Chronic hypertensives • Preeclampsia requiring magnesium sulfate • Underlying systemic disease such as lupus or diabetes • Patients not screened for GDM 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 144.4 (36.0) G2: NR</p> <p>Pregravid BMI: G1: 24.5 (5.7) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • < 25 > 25 <p>Age (mean, yrs): G1: 27.8 (4.6) G2: NR</p> <p>Parity: G1: 1.3 G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 159 G2: NR</p> <p>Total weight gain: G1: 30.3 lbs (11.4) G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> < 35, > 35 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between weight measured at first visit (0-15 weeks gestation) and weight at last visit (35-41 weeks) </p>	<p>Birth weight: G1: 3513.4 gms (468.8) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant birthweight</p> <p>Groups G1: Low BMI (< 25), Low gain (< 35lbs) G2: Low BMI (< 25), High gain (> 35lbs) G3: High BMI (> 25), Low gain (< 35lbs) G4: High BMI (> 25), High gain (> 35lbs)</p> <p>Results G1: 3,363g G2: 3,636g G3: 3,565g G4: 3,774g</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Poor</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Shepard et al., 1998</p> <p>Country and setting: Obstetrical practices in New Haven, CT</p> <p>Enrollment Period: 1988 to 1992</p> <p>Funding: Grants NIH</p> <p>Study Objective: To examine absolute and proportional gestational weight gain and prepregnancy BMI as predictors of primary cesarean delivery</p> <p>Time frame: 1988 to 1992</p> <p>Duration of the study: First prenatal visit to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 2,301</p> <p>Group Description: G1: Cesarean delivery G2: Vaginal delivery</p> <p>Group N: G1: 312 G2: 1,989</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Privately insured women who received prenatal care from 13 largest obstetrical practices and health maintenance organizations in greater New Haven, CT region (part of a larger study of selected environmental risk factors on pregnancy) Singleton deliveries at Yale-New Haven Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Repeat cesareans births Missing information on key variables 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 140.9 (28.6) G2: 136.3 (25.2) $P = 0.007$</p> <p>Pregravid BMI:</p> <p>G1: 24.3 (4.6) G2: 22.9 (3.9) $P < 0.0001$</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NHANES II: ≤ 19.4; 19.5-22.4; 22.5-28.5; > 28.5 <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: 88.4 G2: 91.2</p> <p>Black G1: 5.8 G2: 4.9</p> <p>Hispanic G1: 3.5 G2: 2.3</p> <p>Asian/Pacific Islander G1: 1.3 G2: 1.1</p> <p>Other G1: 1.0 G2: 0.4</p> <p>Smoking, %: % never smokers: G1: 82.3 G2: 85.9</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: %married: G1: 95.8 G2: 92.1</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 312 G2: 1989</p> <p>Total weight gain: G1: 35.4 (11.9) G2: 33.3 (11.9) $P = 0.005$</p> <p>Categorized:</p> <ul style="list-style-type: none"> Proportional weight gain based on prepregnancy weight and weight change during pregnancy <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Proportional weight gain, lb, mean: cesarean delivery - 26.5 (10.0); vaginal delivery - 25.2 (9.3) $P = 0.048$ <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Low birth weight rate = 3.3% for entire study population 	<p>Outcomes Description: Infant birthweight</p> <p>Groups Infant BW for mothers with:</p> <p>G1: Low average BMI (19.5 to 22.4), proportional weight gained > median G2: Low average BMI (19.5 to 22.4), gained < median G3: High average BMI (22.5 to 28.5), gained > median G4: High average BMI (22.5 to 28.5), gained < median G5: Obese (> 28.5 BMI), gained > median G6: Obese (> 28.5 BMI), gained < median</p> <p>Results G1: 3,231g G2: 3,553g G3: 3,395g G4: 3,620g G5: 3,685g G6: 3,453g</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Springer et al., 1992</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: Sept 1988</p> <p>Funding: NIH-nursing</p> <p>Study Objective: Purpose of study to examine relationship between early weight gain and other nutrition-related risk factors and 2 pregnancy outcomes: length of gestation and birth weight</p> <p>Time frame: Sept 1988</p> <p>Duration of the study: Entry into prenatal care up to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Other observational Retrospective <p>Total Study N: 107</p> <p>Group Description:</p> <p>Group N: G1: 107 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women giving birth during September 1988 at University of Michigan Women's Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported Listed on medical record <p>G1: Underweight 96.1 lbs Normal weight 128.4 lbs Overwt 188.5 lbs</p> <p>G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Weight standards published by Metropolitan Life Insurance Company <p>Age (mean, yrs): G1: 28 G2: NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 32% G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): Total weight gain: Categorized: <ul style="list-style-type: none"> Continuous Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Weight gain at 10 and 20 weeks ascertained to within 5 weeks NR </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: Estimated weight gain at 20 weeks' gestation was positively related to both length of gestation and birth weight; this association was statistically significant ($P = .02$) for birth weight, as shown by a simple regression.</p>	<p>Outcomes Description: Infant birthweight by maternal weight gain</p> <p>Groups G1: Increase in birth weight per 1 lb increase in total pregnancy weight gain</p> <p>Results G1: $\beta = 20.1g$</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, pregravid weight, length of gestation, smoking, weight gain at 20 weeks</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Velonakis et al., 1997</p> <p>Country and setting: France, hospital</p> <p>Enrollment Period: 1988</p> <p>Funding: NR</p> <p>Study Objective: To identify impact of various biological, occupational, and socioeconomic factors on gestational age and birth weight</p> <p>Time frame: 1988</p> <p>Duration of the study: First prenatal visit through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort <p>Total Study N: 2,040</p> <p>Group Description:</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women with regular cycle not exceeding 32 days • Last menstrual period was not withdrawal bleed from pill <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NR <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery: calculated by subtracting prepregnancy weight, fetal and placental weight from final weight 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant birthweight</p> <p>Groups G1: Increase in birth weight for net pregnancy weight gain</p> <p>Results G1: $\beta = 111.17g \pm 12.94$ ($P = 0.000$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, parity, pathology of previous/current pregnancy, previous diseases, reproductive history, marital status, employment, height weight, smoking, alcohol use, nationality</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Infant sex, APGAR score, gestational age</p>	<p>Background: Poor</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 6 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Zaren et al., 1997</p> <p>Country and setting: Norway and Sweden, university hospitals</p> <p>Enrollment Period: January 1986 to March 1988</p> <p>Funding: NR</p> <p>Study Objective: To assess effects of maternal smoking on birthweight in term pregnancies among mothers with different anthropometric stature</p> <p>Time frame: January 1986 to March 1988</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 1,099</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 1,099 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • 10% random sample of nonsmoking mothers • 50% random sample of smokers from Successive Small for Gestational Age Births • Women speaking Swedish or Norwegian • Para 1 and 2 • First prenatal visit before 17 weeks <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Preterm delivery • Incomplete information 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: ≤ 55: 30.9%; 56-66: 45.8%; ≥ 67: 23.3%</p> <p>G2: NR</p> <p>Pregravid BMI:</p> <p>G1: ≤ 19.8: 26.6%; 19.9-23.4: 48.5%; ≥ 23.5: 24.9%</p> <p>G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • ≤ 19.8, 19.9-23.4, ≥ 23.5 <p>Age (mean, yrs):</p> <p>G1: 15-19 years: 0.5%; 20-24: 13.7%; 25-29: 42.4%; 30-34: 32.2%; ≥ 35: 11.2%</p> <p>G2: NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 70.4% G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 18. Gestational weight gain and birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 1099 G2: NR</p> <p>Total weight gain: G1: ≤ 11kg: 30.8%; 12-16kg: 45.6%; ≥ 17: 23.6% G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> • ≤ 11, 12-16, ≥ 17 kg </p> <p>Collected from: <ul style="list-style-type: none"> • Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: β is estimated change in infant BW (g)</p> <p>Groups G1: MWG ≤ 11 kg; G2: MWG ≥ 17 kg</p> <p>Results G1: β = -131 (<i>P</i> = 0.0001) G2: β = 164 (<i>P</i> = 0.0001)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, height, pregravid weight, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 19. Gestational weight gain and low birth weight

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) ($P < 0.05$)</p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% ($P < 0.01$)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: LBW (%)</p> <p>Groups G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: >35 lbs</p> <p>Results G1: 2.0 G2: 11.1 G3: 8.3 G4: 5.2 G5: 3.8</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cherry et al., 1993</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: NR-to examine effect of zinc on birth outcomes</p> <p>Time frame: NR</p> <p>Duration of the study: 9 months-from time of enrollment in to prenatal care up to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • RCT <p>Total Study N: 599</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 599 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Adolescents in prenatal clinic at Charity Hospital of New Orleans <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Measured by study investigators <p>G1: 53% were 90-110% Expected Weight (EW); 26% < 90% EW; 21% were > 110% EW G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Calculated weight for age and height <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Grams gained per week per cm height <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Table 1 provided data above-LBW, wt for length of infant, % of infants in high risk nursery</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Percentage of low birth weight for each shifting of EW category.</p> <p>Groups Light: < 90% EW Normal: 90 to 110% of EW Heavy: > 110% EW G1: Heavy to normal G2: Normal to light G3: Normal to heavy G4: Light to normal</p> <p>Results G1: 5% G2: 32% G3: 3.1% G4: 2.7%</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Poor</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 3 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cogswell et al., 1994</p> <p>Country and setting: USA, Pregnancy Nutrition Surveillance System</p> <p>Enrollment Period: 1990-1991</p> <p>Funding: NR</p> <p>Study Objective: To determine association between increased gestational weight gain and birth weight outcomes for low income women</p> <p>Time frame: 1990-1991</p> <p>Duration of the study: Women in WIC but everything is self reported so it is when they were first enrolled in WIC until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 53,541</p> <p>Group Description: G1: Average weight G2: Overweight G3: Very overweight</p> <p>Group N: G1: 33,809 G2: 7,661 G3: 12,071</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • White, black and hispanic women who delivered single, liveborn, term infants <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Low or high values for; birth weight, prepregnancy BMI, or weight gain during pregnancy • Missing data on one or more study variables • Underweight women • Only 1 infant was used in analysis for women who delivered more than once during study period 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 11-17 yr: 11.9% 18-34yr: 85.0% 35-54 yr: 3.1% G2: 11-17 yr: 6.9% 18-34yr: 88.7% 35-54 yr: 4.4% G3: 11-17 yr: 4.0% 18-34yr: 90.1% 35-54 yr: 6.0%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 75.1 G2: 72.4 G3: 74.5 Black G1: 13.8 G2: 14.1 G3: 16.1 Hispanic G1: 11.1 G2: 13.5 G3: 9.4 Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 29.9 G2: 28.3 G3: 25.7</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 33,809 G2: 7,661 G3: 12,071</p> <p>Total weight gain: G1: < 15 lb: 6.2% 15-19: 5.8% 20-24: 11.2% 25-29: 14.4% 30-34: 17.1% 35-39: 13.9% ≥ 40: 31.4% G2: < 15 lb: 11.4% 15-19: 7.8% 20-24: 13.0% 25-29: 12.7% 30-34: 15.9% 35-39: 11.2% ≥ 40: 28.1% G3: < 15 lb: 25.1% 15-19: 10.1% 20-24: 1</p> <p>Categorized:</p> <ul style="list-style-type: none"> 4 lbs increments starting at 15 lbs <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> Self-reported 	<p>Birth weight: G1: < 2500g: 2.7% 2500-4000g: 87.5% > 4000-4500: 8.5% > 4500g: 1.4% G2: < 2500g: 2.5% 2500-4000g: 83.9% > 4000-4500: 11.7% > 4500g: 2.0% G3: < 2500g: 2.1% 2500-4000g: 81.1% > 4000-4500: 13.2% > 4500g: 3.6%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Odds ratio (95% CI) for LBW by MWG and prepregnancy BMI</p> <p>Groups G1: Normal BMI, MWG < 15lbs G2: Normal BMI, MWG ≥40lbs G3: Normal BMI, MWG 25-29lbs (Reference for Normal BMI) G4: Overweight BMI, MWG 30-34lbs G5: Overweight BMI, MWG 35-39 G6: Overweight BMI, MWG ≥40lbs G7: Overweight BMI, MWG 15-19lbs (Reference for Overweight BMI)</p> <p>Results G1: 2.1 (1.6-2.6) G2: 0.5 (0.4-0.6) G3: 1.0 G4: 0.5 (0.3-0.8) G5: 0.6 (0.3-1.1) G6: 0.4 (0.3-0.7) G7: 1.0</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race height Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Sex of infant 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 4 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Desjardins and Hardwick, 1999</p> <p>Country and setting: Canada, Healthiest Babies Possible Program</p> <p>Enrollment Period: January 1, 1987 - December 31, 1996</p> <p>Funding: Health Information and Research Services, Toronto Public Health</p> <p>Study Objective: To evaluate HBP program as mediator of impact of smoking, adolescence, prepregnancy underweight, and erratic weight gain/initial weight loss on LBW</p> <p>Time frame: January 1, 1987 - December 31, 1996</p> <p>Duration of the study:</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 1,892 (1883 completed program to delivery - used in regression analyses)</p> <p>Group Description: G1: N - total sample G2: LBW - 6.8% of total sample</p> <p>Group N: G1: 1892 G2: 128</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton births Women who remained in HBP program until delivery (31% did not complete program - mainly because they moved out of area) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women for whom number of visits for HBP program was missing 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: % underweight: 20.5 G2: % underweight: 8.8</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Dichotomized as prepregnancy BMI < 20 (underweight) and ≥ 20, done for women older than 19 years women younger than 19 years were determined to be underweight or not by program nurse/dietitian <p>Age (mean, yrs): G1: % less than 19 years: 19.1 G2: % less than 19 years: 8.3</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 29.0 G2: 9.1</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % Inadequate weight gain G1: 39.9 G2: 7.3</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 793 G2: 528 G3: 562</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> NR <p>Collected from:</p> <ul style="list-style-type: none"> Home visitor's scale <p>Ascertained by:</p> <ul style="list-style-type: none"> Dichotomized as inadequate (determined by nurse/dietitian as weight loss, lack of weight gain, or very inadequate weight gain since conception) or not 	<p>Birth weight: % < 2500g: G1: 8.8 G2: 5.1 G3: 5.5</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Odds ratio (95% CI) for LBW and inadequate weight gain</p> <p>Groups G1: LBW and inadequate weight gain (defined by dietician)</p> <p>Results G1: 1.15 (0.78-1.67)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Gestational age, adolescence, pregravid underweight, number of Healthiest Baby Possible visits</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hickey et al., 1990</p> <p>Country and setting: United States, prenatal clinics</p> <p>Enrollment Period: Does not state</p> <p>Funding: Supported by Garry A Weber Graduate Fellowship in Anthropology, Southern Methodist University, and through University Affiliated Center, Department of Pediatrics, University of Texas Southwestern Medical Center at Dallas, Maternal and Child Health Training Grant MCJ-2000, Department of Health and Human Services</p> <p>Study Objective: Present study was designed to (1) determine prevalence of low maternal weight-for-height near term among low income black and Hispanic women attending public prenatal clinics, and (2) compare maternal weight-for-height near term with current guidelines</p> <p>Time frame: Does not state</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 325</p> <p>Group Description: G1: Black G2: Hispanic</p> <p>Group N: G1: 172 G2: 153</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Black and Hispanic pregnant women aged ≥ 17 who subsequently delivered singleton infants free from congenital malformations <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women whose last prenatal weight was recorded > 14 days before delivery, gestational diabetes, other medical or obstetrical conditions, missing records, moved to another city before delivery 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: NR</p> <ul style="list-style-type: none"> < 90% standard: 27.3% 90-119%: 44.2% $\geq 120\%$standard: 21.5% <p>G2: NR</p> <ul style="list-style-type: none"> < 90% standard: 15.7% 90-119%: 38.6% $\geq 120\%$standard: 9.8% <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NR <p>Age (mean, yrs): G1: 22.65 ± 4.48 G2: 23.18 ± 4.78</p> <p>Parity: G1: 0.98 ± 1.23 G2: 1.10 ± 1.50</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> • % of standard weight for height by use of nomogram and chart developed by Rosso <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Infant birthweight</p> <p>Groups G1: Percent BW < 3,000, Low weight gain < 120% of standard G2: Percent BW ≥ 3,000, Low weight gain < 120% of standard G3: Percent BW < 3,000, Acceptable weight gain ≥120% of standard G4: Percent BW ≥ 3,000, Acceptable weight gain ≥120% of standard</p> <p>Results G1: 38.2 G2: 61.8 G3: 22.1 G4: 77.9</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 7 Good, 2 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Johnson et al., 1992</p> <p>Country and setting: USA, prenatal clinics</p> <p>Enrollment Period: January 1, 1987- December 31, 1989</p> <p>Funding: NR</p> <p>Study Objective: To determine influences of increased maternal prepregnancy weight and increased gestational weight gain on pregnancy outcome</p> <p>Time frame: January 1, 1987 to December 31, 1989</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,191</p> <p>Group Description: G1: BMI < 19.8 G2: 19.8-26.0 G3: 27-29 G4: > 29 G5: All</p> <p>Group N: G1: 755 G2: 1,621 G3: 329 G4: 486 G5: 3191</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Delivery at or beyond 38 weeks of gestation Singletons Received prenatal care and delivered in Shands Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Fetal abnormalities Oligohydramnios Polyhydramnios Medical or surgical complications (GI disorders, sickle cell hemoglobinopathy, hepatitis, hematologic disorders, malignant disease, renal disease, neurologic disease, pulmonary disease, psychiatric disorders, tuberculosis) Incomplete risk variable data or outcome variable information 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> National Academy of Sciences <p>Age (mean, yrs): G1: NR</p> <ul style="list-style-type: none"> < 20 years: 36.6% 20-26 years: 44.8% > 26 years: 18.7% <p>G2: NR</p> <ul style="list-style-type: none"> < 20 years: 30.8% 20-26 years: 46.5% > 26 years: 22.6% <p>G3:</p> <ul style="list-style-type: none"> < 20 years: 25.8% 20-26 years: 48.9% > 26 years: 25.2% <p>G4:</p> <ul style="list-style-type: none"> < 20 years: 16.5% 20-26 years: 53.9% > 26 years: 29.6% <p>G5:</p> <ul style="list-style-type: none"> < 20 years: 29.5% 20-26 years: 47.5 % > 26 years: 23.0% <p>Parity: G1: % first: 49.3 G2: 43.1 G3: 37.4 G4: 31.1 G5: 42.1</p>	<p>Race, %:</p> <p>White</p> <p>G1: 64.5 G2: 60.0 G3: 49.8 G4: 51.9 G5: 58.7</p> <p>Black</p> <p>G1: 33.6 G2: 37.9 G3: 48.9 G4: 47.5 G5: 39.5</p> <p>Hispanic</p> <p>NR</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>G1: 1.9 G2: 2.1 G3: 1.2 G4: 0.6 G5: 1.7</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Hypertension, %: G1: 3.4 G2: 4.6 G3: 5.8 G4: 10.7 G5: 5.4</p> <p>Additional characteristics: G1: % married: 42.6 G2: 46.1 G3: 40.4 G4: 49.4 G5: 45.2</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 755 G2: 1621 G3: 329 G4: 486 G5: 3191</p> <p>Total weight gain: G1:</p> <ul style="list-style-type: none"> < 16kg: 7.8% 16-25kg: 18.5% 26-35kg: 35.1% > 35kg: 38.5% <p>G2:</p> <ul style="list-style-type: none"> < 16kg: 11.7% 16-25kg: 18.0% 26-35kg: 28.8% > 35kg: 41.5% <p>G3:</p> <ul style="list-style-type: none"> < 16kg: 19.8% 16-25kg: 19.1% 26-35kg: 28.3% > 35kg: 32.8% <p>G4:</p> <ul style="list-style-type: none"> < 16kg: 32.3% 16-25kg: 22.0%; <p>Categorized:</p> <ul style="list-style-type: none"> Quartiles National Academy of Sciences (below, within, or above recommended range) <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self report and weight at last prenatal visit (mean 6.1 days prior to delivery) 	<p>Birth weight: G1:</p> <ul style="list-style-type: none"> < 2500g: 4.8% 2500-4000g: 89.1% > 4000g: 6.1% <p>G2:</p> <ul style="list-style-type: none"> < 2500g: 2.0% 2500-4000g: 85.2% > 4000g: 12.8% <p>G3:</p> <ul style="list-style-type: none"> < 2500g: 1.5% 2500-4000g: 83.0% > 4000g: 15.5% <p>G4:</p> <ul style="list-style-type: none"> < 2500g: 0.2% 2500-4000g: 82.5% > 4000g: 17.3% <p>Gestational diabetes, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Cesarean delivery, %: G1: NR G2: NR G3: NR G4: NR G5: 11.9</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Frequency of macrosomia = 12.2% Frequency of cesarean = 11.9% Frequency of LBW = 2.9% 	<p>Outcomes Description: Odds ratio (95% CI) for LBW</p> <p>Groups G1: Net WG < 14.9 lbs (Reference) G2: Net WG 14.9-23.5 lbs G3: Net WG 24-33 lbs G4: Net WG > 33 lbs</p> <p>Results G1: 1.0 (Reference) G2: 0.51 (0.27-0.98) G3: 0.54 (0.28-1.04) G4: 0.38 (0.2-0.8)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal race, parity, pregravid BMI, height, pregravid weight, marital status, education, tobacco/alcohol/drug use, pregnancy-induced hypertension</p> <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Infant sex Macrosomia 	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 9 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Johnson et al., 1992
(continued)

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<ul style="list-style-type: none"> • Frequency of postdate pregnancy = 9.8% • Frequency of labor abnormalities (40% were unscheduled cesareans) = 7.8% • Frequency of oxytocin induction = 13.7% • Frequency of oxytocin augmentation = 16.1% • Frequency of meconium staining = 21.5% 		
	<p>Other infant outcomes: NA</p>		

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kiel et al., 2007</p> <p>Country and setting: United States, birth registry</p> <p>Enrollment period: 1990 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of gestational weight change on pregnancy outcomes in obese women</p> <p>Time frame: 1990 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 120,170</p> <p>Group Description:</p> <p>G1: Obese Class I (BMI 30–34.9) (n = 70,536)</p> <p>G2: Obese Class II (BMI 35–39.9) (n = 30,609)</p> <p>G3: Obese Class III (BMI 40 and More) (n = 19,025)</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Obese women residing in Missouri who delivered (at 37 or more weeks of gestation) liveborn, singleton infants during 1990–2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>G1: Total: Class I obese: 59% Class II obese: 25% Class III obese: 16%</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NIH guidelines <p>Age (mean, yrs):</p> <p>G1: <26: 46% 26-35: 47% Older than 35: 8%</p> <p>G2: <26: 44% 26-35: 48% Older than 35: 8%</p> <p>G3: <26: 40% 26-35: 52% Older than 35: 9%</p> <p>Parity: Nulliparous: G1: 34% G2: 33% G3: 32%</p>	<p>Race, %: White G1: 78 G2: 77 G3: 73</p> <p>Black G1: 22 G2: 23 G3: 27</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 22</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: GWG (lb) Less than 2: 3% 2 to 14: 15% 15 to 25: 26% More than 25: 56% G2: GWG (lb) Less than 2: 8% 2 to 14: 22% 15 to 25: 27% More than 25: 43% G3: GWG (lb) Less than 2: 15%</p> <p>Categorized:</p> <ul style="list-style-type: none"> 10-lb or less loss 2 to 9 lbs loss, no weight change, 2 to 9 lbs gain, 10 to 14 lbs gain, 15–25 lb gain, 26–35 lb gain, and greater than 35 lb gain <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: G1: SGA: 7% LGA: 13% ($P < 0.05$) G2: SGA: 7% LGA: 16% ($P < 0.05$) G3: SGA: 6% LGA: 18% ($P < 0.05$)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 28 G2: 34 G3: 41</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Odds of low birth weight</p> <p>Groups G1: Odds of LBW for weight gain > 25 lbs G2: OR of LBW for weight gain < 15 lbs G3: Reference Weight gain 15-25 lbs</p> <p>Results G1: Lower for women in this group G2: Higher for women in this group Numerical value for ORs not reported in study</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Education Poverty (enrollment in Medicaid, WIC, food stamp programs) Smoking Chronic hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Kiel et al., 2007
(continued)

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 show absolute risk of preeclampsia, cesarean delivery, LGA, and SGA by GWG category for each obesity class. All 3 figures show similar patterns of increasing risk of preeclampsia, cesarean delivery, and LGA birth and decreasing risk of SGA birth with increasing GWG. Collectively, minimal risk for all 4 outcomes corresponds to GWG categories where risk of LGA and SGA births intersect. This equates to GWG of 10 to 25 lb for class I obese women, a gain of 0 to 9 lb for class II obese women, and weight loss of 0 to 9 lb for class III obese women. Adjusted odds ratios and 95% CIs for preeclampsia, cesarean delivery, SGA, and LGA by GWG category and obesity class. Compared with women who gained 15 to 25 lb during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births. Women who gained more than 25 lbs had higher odds for same 3 pregnancy outcomes and lower odds for SGA births. <p>Other infant outcomes: NR</p>		

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kirchengast and Hartmann, 2003</p> <p>Country and setting: Singleton births that took place at University Clinic for Gynecology and Obstetrics in Vienna, Austria</p> <p>Enrollment period: NR</p> <p>Funding: NR</p> <p>Study Objective: Examine impact of biological factors such as young maternal age and maternal somatic characteristics on pregnancy outcome among group of adolescent mothers who gave birth between 39th and 41st week of gestation after period of intensive psychological support</p> <p>Time frame: NR</p> <p>Duration of the study: 1985 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 8,011</p> <p>Group Description: G1: 12 to 16 years G2: 17 to 19 years G3: 20 to 29 years</p> <p>Group N: G1: 215 G2: 1,336 G3: 6,460</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women ages 12 to 29 • All prenatal check-ups of mother-child passport were performed • Delivery of single infant without congenital malformations • Receiving psychosocial support by family and/or specially trained social worker within young adolescent group (12 to 16 years) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Coincident medical diseases such as diabetes mellitus or nephropathy • Drug or alcohol abuse • Twin birth • IVF • Registered maternal diseases before and during pregnancy • Hypertension (BP < 150/90 mmHG) • Protein or glucose in urine • Pregnancy related immunization 	<p>Pregravid weight: Estimated by means of retrospective method and first weight determination, which was carried out at first prenatal visit (8th week of gestation)</p> <p>G1: 56.0 G2: 57.2 G3: 59.2</p> <p>Pregravid BMI: G1: 21.45 G2: 21.59 G3: 22.10</p> <p>Imputed:</p> <ul style="list-style-type: none"> • Yes <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 14.5 G2: 17.8 G3: 24.1</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Age at menarche: G1: 12.2 G2: 12.9 G3: 13.3</p> <p>Gynecological age: G1: 3.4 G2: 5.3 G3: 10.8</p>

Evidence Table 18. Gestational weight gain and low birthweight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 215 G2: 1,336 G3: 6,460</p> <p>Total weight gain: G1: 13.1 G2: 13.1 G3: 13.1 (<i>P</i> = .10)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3237.6 (significantly different from 17-19 and 20-29) G2: 3298.3 (significantly different from < 17 and 20-29) G3: 3368.9 (significantly different from < 17 and 17-19) (F = 24.1, <i>P</i> < .0001)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Chronological age Age at menarche Gynecological age Height Distancia spinarum Distancia christarum Prepregnancy weight Weight at end of pregnancy <p>Other infant outcomes</p> <ul style="list-style-type: none"> Birth length Head circumference Acromial circumference Diameter frontooccipitale 	<p>Outcomes Description: OR and 95% CI, for LBW</p> <p>Groups NA, weight gain as continuous variable</p> <p>Results 0.90 (0.85-0.95)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, age at menarche, pregravid weight, height, distantia cristarum</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Lasker et al., 2005</p> <p>Country and setting: USA, hospital</p> <p>Enrollment period: November 1997 to October 1999</p> <p>Funding: NR</p> <p>Study Objective: To investigate predictors of LBW in population of Eastern Pennsylvania</p> <p>Time frame: November 1997 to October 1999</p> <p>Duration of the study: NA, retrospective</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 5,528</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 5,528 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women delivering in 1 of 2 hospitals in a single hospital network <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • NR <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • WHO International Taskforce • BMI at delivery <p>Age (mean, yrs): G1:</p> <ul style="list-style-type: none"> • < 15: 0.5% • 15-19.9: 8.2% • 20-24.9: 17.2% • 25-29.9: 34.7% • 30-34.9: 23.6% • 35-39.9: 13.5% • 40-50: 2.3% <p>G2: NR</p> <p>Parity: NR</p>	<p>Race, %: White G1: 74.1 G2: NR</p> <p>Black G1: 3.3 G2: NR</p> <p>Hispanic G1: 11.0 G2: NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 11.5 G2: NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): <i>Total weight gain:</i></p> <p><i>Categorized:</i></p> <ul style="list-style-type: none"> < 10, 11-20, 21-30, > 30 <p><i>Collected from:</i></p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> 490 (8.9%) delivered LBW babies (< 2500g) 103 (1.9%) delivered VLBW babies (< 1500g) 	<p>Outcomes Description: Odds ratio (95% CI) for LBW</p> <p>Groups G1: MWG < 10 lbs G2: MWG > 30 lbs G3: MWG 21-30 lbs (Reference)</p> <p>Results G1: 2.43 (1.45-4.05) G2: 0.63 (0.47-0.85) G3: 1.00</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, maternal race, marital status, prenatal care, prior term births, prior abortions, prior preterm births, BMI at delivery, preeclampsia, bleeding, smoking, multiple births, premature birth, congenital anomaly, incompetent cervix, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Murakami et al., 2004</p> <p>Country and setting: Japan, hospital</p> <p>Enrollment Period: 2001</p> <p>Funding: NR</p> <p>Study Objective: To estimate risk of perinatal morbidity of mother and infant with respect to maternal prepregnancy BMI and weight gain in Japanese women</p> <p>Time frame: 2001</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 633</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 633 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Live, singletons delivered between 24 to 42 weeks gestation <p>Exclusion criteria:</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: 20.9 (2.8) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • WHO International Taskforce <p>Age (mean, yrs): G1: 29.1 (4.5) G2: NR</p> <p>Parity: G1: 0.6 (0.7) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 8.5 G2: NR</p> <p>Diabetes mellitus, %: G1: 2.1 G2: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: Preeclampsia - mild: 5.4%; severe: 4.1% G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 633 G2: NR</p> <p>Total weight gain: G1: 10.5 (3.4) G2: NR</p> <p><i>Categorized:</i></p> <ul style="list-style-type: none"> < 8.5kg, 8.5-12.5, > 12.5 <p><i>Collected from:</i></p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: last measurement was taken at hospitalization prior to delivery 	<p>Birth weight: G1: 3,052.6 (483.8) G2: NR</p> <p>Gestational diabetes, %: G1: 2.1 G2: NR</p> <p>Cesarean delivery, %: G1: 10.3 G2: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Odds ratio (95% CI) for LBW</p> <p>Groups G1: MWG < 8.5 kg G2: MWG 8.5-12.5 kg G3: MWG > 12.5 kg</p> <p>Results G1: 1.26 (0.57-2.75) G2: Reference G3: 0.62 (0.24-1.62)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pre-gravid BMI Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 8 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Rosenberg et al., 2005</p> <p>Country and setting: USA, vital statistics data</p> <p>Enrollment Period: Bbirth certificates with self reported pregravid weight and weight gain</p> <p>Funding: NR</p> <p>Study Objective: To examine associations between obesity, diabetes, and 3 adverse pregnancy outcomes (primary cesarean section, preterm birth, and LBW) by race/ethnic groups</p> <p>Time frame: Birth certificates with self reported pregravid weight and weight gain</p> <p>Duration of the study: Birth certificates from 1999, 2000, and 2001</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 329988</p> <p>Group Description:</p> <p>G1: Non-hispanic blacks G2: Non-hispanic whites G3: Non-hispanic asians G4: Hispanics G5: Total</p> <p>Group N:</p> <p>G1: 86,908 G2: 96,581 G3: 38,570 G4: 107,612 G5: 329,988</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Live singleton births • Information on maternal prepregnancy weight and maternal weight gain during pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: < 100 pounds: 1.7% 100-149: 49.1% 150-199: 37.5% 200-299: 11.2% ≥ 300: 0.5%</p> <p>G2: < 100 pounds: 1.8% 100-149: 69.5% 150-199: 24.0% 200-299: 4.7% ≥ 300: 0.1%</p> <p>G3: < 100 pounds: 8.1% 100-149: 79.5% 150-199: 11.6% 200-299: 0.8% ≥ 300</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NR <p>Age (mean, yrs):</p> <p>G1: 27.5 G2: 30.6 G3: 29.7 G4: 26.4 $P < 0.001$ G5: 28.3</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %:</p> <p>G1: 3.7 G2: 2.6 G3: 6.6 G4: 3.5 G5: 3.7 $P < 0.001$</p> <p>Hypertension, %:</p> <p>G1: 1.7 G2: 0.6 G3: 0.5 G4: 0.7 G5: 0.9 $P < 0.001$</p> <p>Additional characteristics:</p> <p>G1: PIH 1.9 G2: 1.2 G3: 0.7 G4: 1.4 G5: 1.4 $P < 0.001$</p> <p>Additional characteristics:</p> <p>G1: Preeclampsia 2.9 G2: 1.3 G3: 1.2 G4: 2.6 G5: 2.1 $P < 0.001$</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 86,908 G2: 96,581 G3: 38,570 G4: 107,612 G5: 329,988</p> <p>Total weight gain: G1: < 41pounds: 79.7% ≥ 41 pounds: 20.3% G2: < 41pounds: 83.2% ≥ 41 pounds: 16.8% <i>P</i> < 0.001 G3: < 41pounds: 89.2% ≥ 41 pounds: 10.8% G4: < 41pounds: 79.1% ≥ 41 pounds: 20.9% G5: < 41pounds: 81.6% ≥ 41 pounds: 18.4%</p> <p>Categorized: <ul style="list-style-type: none"> < 41, ≥ 41 pounds </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 3.7 G2: 2.6 G3: 6.6 G4: 3.5 G5: 3.7 <i>P</i> < 0.001</p> <p>Cesarean delivery, %: G1: 16.2 G2: 14.7 <i>P</i> < 0.001 G3: 14.4 G4: 13.8 G5: 14.7</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Preterm birth 10.5, 5.1, 5.9, 7.8, 7.5 <i>P</i> < 0.001 (groups defined above) LBW 9.7, 4.1, 5.7, 6.1, 6.4 <i>P</i> < 0.001 (groups defined above) 	<p>Outcomes Description: Odds ration (95% CI) for LBW</p> <p>Groups G1: MWG ≥ 41 lbs G2: MGW < 41 lbs</p> <p>Results G1: 0.41 (0.39-0.43) G2: Reference</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, parity, GDM, pregnancy-induced hypertension, preeclampsia, pregravid weight, chronic diabetes, chronic hypertension, marital status, maternal education, mother's birthplace, prenatal care payer, social risk, trimester prenatal care began</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 7 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Shepard et al., 1998</i></p> <p>Country and setting: <i>Obstetrical practices in New Haven, CT</i></p> <p>Enrollment Period: <i>1988 to 1992</i></p> <p>Funding: <i>Grants NIH</i></p> <p>Study Objective: <i>To examine absolute and proportional gestational weight gain and prepregnancy BMI as predictors of primary cesarean delivery</i></p> <p>Time frame: <i>1988 to 1992</i></p> <p>Duration of the study: <i>First prenatal visit to delivery</i></p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 2,301</p> <p>Group Description: G1: Cesarean delivery G2: Vaginal delivery</p> <p>Group N: G1: 312 G2: 1,989</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Privately insured women who received prenatal care from 13 largest obstetrical practices and health maintenance organizations in greater New Haven, CT region (part of a larger study of selected environmental risk factors on pregnancy) Singleton deliveries at Yale-New Haven Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Repeat cesareans births Missing information on key variables 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 140.9 (28.6) G2: 136.3 (25.2) $P = 0.007$</p> <p>Pregravid BMI:</p> <p>G1: 24.3 (4.6) G2: 22.9 (3.9) $P < 0.0001$</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NHANES II: ≤ 19.4; 19.5-22.4; 22.5-28.5; > 28.5 <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: 88.4 G2: 91.2</p> <p>Black G1: 5.8 G2: 4.9</p> <p>Hispanic G1: 3.5 G2: 2.3</p> <p>Asian/Pacific Islander G1: 1.3 G2: 1.1</p> <p>Other G1: 1.0 G2: 0.4</p> <p>Smoking, %: % never smokers: G1: 82.3 G2: 85.9</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: %married: G1: 95.8 G2: 92.1</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 312 G2: 1989</p> <p>Total weight gain: G1: 35.4 (11.9) G2: 33.3 (11.9) <i>P</i> = 0.005</p> <p>Categorized:</p> <ul style="list-style-type: none"> Proportional weight gain based on prepregnancy weight and weight change during pregnancy <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Proportional weight gain, lb, mean: cesarean delivery - 26.5 (10.0); vaginal delivery - 25.2 (9.3) <i>P</i> = 0.048 <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Low birth weight rate = 3.3% for entire study population 	<p>Outcomes Description: Percent low birth weight</p> <p>Groups G1: Proportional WG < median, underweight (BMI < 19.4) G2: Proportional WG < median, obese (BMI > 28.5) G3: Proportional WG > median, underweight (BMI < 19.4) G4: Proportional WG > median, Low-average BMI (19.5-22.4) G5: Proportional WG > median, High-average BMI (22.5-28.5) G6: Proportional WG > median, obese (BMI > 28.5)</p> <p>Results G1: 3.5% G2: 7.4% G3: 2.1% G4: 2.8% G5: 2.1% G6: 4.6%</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Zhou and Olsen, 1997</p> <p>Country and setting: Denmark, two communities</p> <p>Enrollment Period: April 1984 to April 1987</p> <p>Funding: Danish National Research Foundation and Sygekassernes Helsefond</p> <p>Study Objective: To study association between gestational weight gain and different birth weight indicators considering prepregnancy BMI</p> <p>Time frame: April 1984 to April 1987</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 7122</p> <p>Group Description: G1: Entire study G2: NR</p> <p>Group N: G1: 7122 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women who provided detailed information on lifestyle during pregnancy • Singletons • Non-diabetic women who gave birth between weeks 37 and 42 for whom weight gain was reported <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: % < 19.8: 27.2; %19.8-26: 63.7; %26+: 9.1 G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): % < 25: G1: 30.3 G2: NR</p> <p>Parity: %nulliparous: G1: 48.9 G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: %non-smoking: G1: 60.0 G2: NR</p> <p>Diabetes mellitus, %: G1: 0 G2: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 19. Gestational weight gain and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 7122 G2: NR</p> <p>Total weight gain: G1: % < 11kg: 35.2; %12-15: 35.5; %16+: 29.3 G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> ≤ 11, 12-15, ≥ 16 kg <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between last measured weight prior to delivery and prepregnancy weight 	<p>Birth weight: G1: %LBW: 1.7; %normal: 96.8; %HBW: 1.5 G2: NR</p> <p>Gestational diabetes, %: G1: 0 G2: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Low birth weight (< 2500g) High birth weight (> 4500g) Growth retarded were newborns with a birth weight below 3000g in spite of a placenta weight higher than 66 percentile (491g) 	<p>Outcomes Description: Odds ratio (95% CI) for LBW for MWG categories by BMI</p> <p>Groups G1: MWG < 11 kg, Underweight (Reference) G2: MWG < 11 kg, Normal weight G3: MWG < 11 kg, Overweight G4: MWG 12-15 kg, Underweight, G5: MWG 12-15 kg, Normal weight G6: MWG 12-15 kg, Overweight G7: MWG ≥16 kg, Underweight G8: MWG ≥16 kg, Normal weight G9: MWG ≥16 kg, Overweight</p> <p>Results G1: 1.0 G2: 0.9 (0.5-1.5) G3: 0.8 (0.3-2.0) G4: 0.5 (0.2-1.0) G5: 0.8 (0.4-1.5) G6: 0.9 (0.2-3.8) G7: 0.3 (0.1-1.0) G8: 0.4 (0.2-0.8) G9: 0.0 (0.0-2500)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Alcohol No diabetes Term delivery Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Infant sex 	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 20. Gestational weight gain and macrosomia

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bergmann, 2003</p> <p>Country and setting: Hospital deliveries in Berlin collected by Berlin Medical Board</p> <p>Enrollment period: NR</p> <p>Funding: NR</p> <p>Study Objective: To investigate trend in prevalence of neonatal macrosomia and to evaluate influences of potential determinants, key features of 206,308 hospital deliveries (97% of all) in Berlin in years 1993 to 1999, collected by Berlin Medical Board</p> <p>Time frame: NR</p> <p>Duration of the study: 1993 to 1999</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 206,308</p> <p>Group Description:</p> <p>G1: 1993 G2: 1994 G3: 1995 G4: 1996 G5: 1997 G6: 1998 (1999)</p> <p>Group N:</p> <p>G1: 25,449 G2: 25,070 G3: 24,784 G4: 27,100 G5: 27,753 G6: 27,653 (27,513)</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Recorded hospital birth by Berlin Perinatal ReGistry <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple births Preterm infants 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Hospital records <p>Pregravid BMI:</p> <p>G1: % \geq 20-26 \geq 26: 62.3, 17.8 G2: 62.1, 19.0 G3: 62.4, 19.7 G4: 62.2, 20.6 G5: 63.1, 20.6 G6: 61.4, 21.5 (61.2,21.1)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> \geq 20-26, \geq 26 <p>Age (mean, yrs): % \geq 30: G1: 34.9 G2: 37.5 G3: 40.6 G4: 43.4 G5: 45.7 G6: 47.7 (48.5)</p> <p>Parity: Multiparity: G1: % 49.2 G2: 51.1 G3: 50.4 G4: 49.9 G5: 49.1 G6: 50.3 (49.2)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 18.9 G2: 18.8 G3: 19.2 G4: 17.2 G5: 17.9 G6: 18.0 (18.3)</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 25,449 G2: 25,070 G3: 24,784 G4: 27,100 G5: 27,753 G6: 27,653</p> <p>Total weight gain: %10-16kg: G1: 62.3 G2: 62.1 G3: 62.4 G4: 62.2 G5: 63.1 G6: 61.4</p> <p>Categorized: 10-16kg and ≥ 16kg</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Method not mentioned by authors 	<p>Birth weight: % ≥ 4000g: G1: 10.0 G2: 10.2 G3: 10.6 G4: 10.9 G5: 11.0 G6: 11.3</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> % weight gain: <ul style="list-style-type: none"> ≥ 26: 21.0, 21.0, 21.4, 22.3, 22.2, 24.2 <p>1999: n = 27513 % birthweight ≥ 4000g, 11.3% % weight gain ≥ 10-16kg, 45.3 % weight gain ≥ 16kg, 25.0%</p> <p>Other infant outcomes NR</p>	<p>Outcomes Description: Odds ratio (95% CI) of macrosomia</p> <p>Groups G1: WG < 10 kg (Reference) G2: WG 10-16 kg G3: WG ≥ 16 kg</p> <p>Results G1: 1.0 G2: 1.85 (1.77-1.93) G3: 3.37 (3.22-3.53)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Pregravid BMI, height, parity, smoking, diabetes, postterm delivery</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: : 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Brennand et al., 2005</p> <p>Country and setting: Canada, medical records</p> <p>Enrollment Period: Prenatal to birth</p> <p>Funding: cree board of health and social services of James Bay (Quebec)</p> <p>Study Objective: To determine effect of pregravid weight and pregnancy weight gain on pregnancy outcomes in Cree women</p> <p>Time frame: Prenatal to birth</p> <p>Duration of the study: 7 year period: January 1994 to December 2000</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 603</p> <p>Group Description:</p> <p>G1: Normal: BMI 18.5 - 24.9</p> <p>G2: Overweight: BMI 25-29.9</p> <p>G3: Obese: BMI ≥ 30</p> <p>G4: Total</p> <p>Group N:</p> <p>G1: 139 G2: 168 G3: 296 G4: 603</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Used only Cree women First birth observed per woman during study time period Must have first weight recorded within first 14 weeks gestation and final weight recorded within 4 weeks of birth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with secondary pregnancy in dataset (n = 792) Women with first weight record > 14 weeks gestation (n = 314) Women with final weight record > 4 weeks from birth (n = 202) Women with both first weight record > 14 weeks and final weight record > 4 weeks (n = 70) Women missing data on first or final weight (n = 3) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care Medical records Measured within 14 weeks of gestation <p>G1: 59.7 (5.0) G2: 73.0 (4.3) G3: 93.6 (12.3) G4: 80.0 (16.9)</p> <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> Yes <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce <p>Age (mean, yrs):</p> <p>G1: 20.8 (5.2) G2: 23.8 (5.4) G3: 25.5 (5.5) G4: 24.0 (5.7)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %:</p> <p>G1: 4.3 G2: 14.9 G3: 27.4 G4: 18.6</p> <p>Hypertension, %:</p> <p>G1: 1.4 G2: 1.8 G3: 4.8 G4: 3.2</p> <p>Additional characteristics:</p> <p>% low weight gain:</p> <p>G1: 20.1 G2: 10.1 G3: 28.0 G4: 21.2</p> <p>% acceptable weight gain:</p> <p>G1: 28.8 G2: 32.1 G3: 33.4 G4: 32.0</p> <p>% excessive weight gain:</p> <p>G1: 51.1 G2: 57.7 G3: 38.5 G4: 46.6</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 139 G2: 168 G3: 296</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> 1999 Canadian guidelines <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: within 4 weeks of birth 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 4.3 G2: 14.9 G3: 27.4 G4: 18.6</p> <p>Cesarean delivery, %: G1: 10.8 G2: 11.3 G3: 24.1 (p < 0.001)</p> <p>Instrumental delivery, %: >4000g</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Definition of low, adequate, and excessive weight gains: For normal weight women - adequate weight gain is 11.5 to 16 kg For overweight women, adequate weight gain is 7 to 11.5 kg For obese women, adequate weight gain is 7 to 11.5 kg Weight gain below specified range is "low" and weight gain above specified range is "excessive" <p>Other infant outcomes: > 4000g, > 4500g</p>	<p>Outcomes Description: Percentage of macrosomia among obese women only</p> <p>Groups G1: Low WG, < 7 kg G2: Acceptable WG, 7-11.5 kg G3: Excessive WG, > 11.5 kg</p> <p>Results >4500g G1: 16.9% G2: 15.3% G3: 18.4% (P = 0.834)</p> <p>>4000g G1: 47.0% G2: 42.9% G3: 54.4% (P = 0.234)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: : 1 Good, 5 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Brennand et al., 2005 (continued)</p>	<ul style="list-style-type: none"> • Pregnancies with factors that may have influenced maternal weight gain such as 1 parent being non-Cree (n = 13), preterm deliveries (n = 91), twin pregnancies (n = 6), missing gestational age (n = 9) • Women with unknown glycemic status (n = 30), type 2 DM (n = 8), glycemic abnormalities before pregnancy not followed for diagnosis (n = 70) • Women classified as underweight (n = 5) 		

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
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Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Clausen et al., 2005</i></p> <p>Country and setting: <i>Norway, university hospital</i></p> <p>Enrollment Period: <i>1995-1996 (21 months)</i></p> <p>Funding: <i>NR</i></p> <p>Study Objective: <i>To investigate prospectively if maternal metabolic parameters associated with maternal weight were independent determinants of large baby size at term</i></p> <p>Time frame: <i>1995-1996 (21 months)</i></p> <p>Duration of the study: <i>Dring pregnancy until delivery</i></p>	<p>Design:</p> <ul style="list-style-type: none"> • Case-control • Combination: prospective cohort and retrospective nested case control <p>Total Study N: 2,50 and 219</p> <p>Group Description: G1: Cohort study G2: Birth weight < 4500 g G3: Birth weight > 4500 g</p> <p>Group N: G1: 2050 G2: 1962 G3: 88</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • All pregnant women of norwegian decent receiving care at Aker Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Pre-gestational diabetes • Mltiple pregnancy • Peterm births • Mssing medical records • Mssing information on birth weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal careNR <p>G1: 65.0 (11.2) G2: 64.7 (11.0) G3: 72.2 (13.9)***<i>P</i>, 0.001</p> <p>Pregravid BMI: G1: 23.0 (3.7) G2: 22.9 (3.7) G3: 24.8 (4.3) *** <i>P</i>, 0.001</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • WHO International Taskforce Lan < 20 Nrmal weight 20-25 Ovrweight 25-30 Obse > 30 <p>Age (mean, yrs): G1: 29.9 (4.4) G2: 29.9 (4.5) G3: 30.6 (4.2)</p> <p>Parity: G1: 50.3% nullipara G2: 51% nullipara G3: 34.1% nullipara **<i>P</i>, 0.001</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 22.2% G2: 22.5% G3: 17.0%</p> <p>Diabetes mellitus, %: G1: 2.1% G2: 1.9 G3: 5.7 *<i>P</i>, 0.05,</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 2050 G2: 1962 G3: 88</p> <p>Total weight gain: G1: 15.4 (9.7) G2: 15.3 (9.8) G3: 18.2 (5.7)**P, 0.001,</p> <p><i>Categorized:</i></p> <ul style="list-style-type: none"> Continuous Quartiles <p><i>Collected from:</i></p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 2.1% G2: 1.9 G3: 5.7 *P, 0.05</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Odds ratios (95% CIs) for macrosomia</p> <p>Groups G1: WG, Quartile 1 (Reference) G2: WG, Quartile 2 G3: WG, Quartile 3 G4: WG, Quartile 4</p> <p>Results G1: 1.0 G2: 2.1 (0.8-5.1) G3: 3.5 (1.5-8.0) G4: 4.3 (1.9-9.8)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, parity, smoking, placental weight, gestational diabetes, first trimester BMI</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 6 Good, 1 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cogswell et al., 1994</p> <p>Country and setting: USA, Pregnancy Nutrition Surveillance System</p> <p>Enrollment Period: 1990-1991</p> <p>Funding: NR</p> <p>Study Objective: To determine association between increased gestational weight gain and birth weight outcomes for low income women</p> <p>Time frame: 1990-1991</p> <p>Duration of the study: Women in WIC but everything is self reported so it is when they were first enrolled in WIC until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 53,541</p> <p>Group Description: G1: Average weight G2: Overweight G3: Very overweight</p> <p>Group N: G1: 33,809 G2: 7,661 G3: 12,071</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • White, black and hispanic women who delivered single, liveborn, term infants <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Low or high values for; birth weight, prepregnancy BMI, or weight gain during pregnancy • Missing data on one or more study variables • Underweight women • Only 1 infant was used in analysis for women who delivered more than once during study period 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 11-17 yr: 11.9% 18-34yr: 85.0% 35-54 yr: 3.1% G2: 11-17 yr: 6.9% 18-34yr: 88.7% 35-54 yr: 4.4% G3: 11-17 yr: 4.0% 18-34yr: 90.1% 35-54 yr: 6.0%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 75.1 G2: 72.4 G3: 74.5 Black G1: 13.8 G2: 14.1 G3: 16.1 Hispanic G1: 11.1 G2: 13.5 G3: 9.4 Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 29.9 G2: 28.3 G3: 25.7</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 33,809 G2: 7,661 G3: 12,071</p> <p>Total weight gain: G1: < 15 lb: 6.2% 15-19: 5.8% 20-24: 11.2% 25-29: 14.4% 30-34: 17.1% 35-39: 13.9% ≥ 40: 31.4% G2: < 15 lb: 11.4% 15-19: 7.8% 20-24: 13.0% 25-29: 12.7% 30-34: 15.9% 35-39: 11.2% ≥ 40: 28.1% G3: < 15 lb: 25.1% 15-19: 10.1% 20-24: 1</p> <p>Categorized:</p> <ul style="list-style-type: none"> 4 lbs increments starting at 15 lbs <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> Self-reported 	<p>Birth weight: G1: < 2500g: 2.7% 2500-4000g: 87.5% > 4000-4500: 8.5% > 4500g: 1.4% G2: < 2500g: 2.5% 2500-4000g: 83.9% > 4000-4500: 11.7% > 4500g: 2.0% G3: < 2500g: 2.1% 2500-4000g: 81.1% > 4000-4500: 13.2% > 4500g: 3.6%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Odds ratios (95% CIs) for macrosomia by MWG and prepregnancy BMI</p> <p>Groups G1: Normal BMI, MWG 25-29 lbs (Reference for normal BMI) G2: Normal BMI, MWG 35-39 lbs G3: Normal BMI, MWG ≥ 40 lbs G4: Overweight BMI, MWG 15-19 lbs (Reference for overweight BMI) G5: Overweight BMI, MWG ≥ 40 lbs G6: Obese, MWG 15-19 lbs (Reference for obese GMI) G7: Obese BMI, MWG 30-34 lbs G8: Obese BMI, MWG 35-39 lbs G9: Obese BMI, MWG ≥ 40 lbs</p> <p>Results G1: 1.0 G2: 1.5 (1.0-2.3) G3: 3.3 (2.3-4.7) G4: 1.0 G5: 4.0 (1.6-10.1) G6: 1.0 G7: 1.9 (1.3-2.9) G8: 2.1 (1.3-3.2) G9: 2.3 (1.6-3.3)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Height Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Sex of infant 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 4 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hedderson et al., 2006</p> <p>Country and setting: USA, Kaiser Permanente Medical Care Program</p> <p>Enrollment Period: January 1, 1996 - June 31, 1998</p> <p>Funding: R01 DK 54834 from National Institute of Diabetes and Digestive and Kidney Diseases, grant from American Diabetes Association and Kaiser Community Benefit research support</p> <p>Study Objective: To examine whether pregnancy weight gains outside IOM recommendations and rates of maternal weight gain are associated with neonatal complications</p> <p>Time frame: January 1, 1996 to June 31, 1998</p> <p>Duration of the study: First prenatal care visit to 30 days post delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Case-control Retrospective <p>Total Study N: 45,245</p> <p>Group Description: G1: Controls G2: Macrosomia G3: Hypoglycemia G4: Hyperbilirubinemia</p> <p>Group N: G1: 652 G2: 391 G3: 328 G4: 432</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton livebirth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> No pregestational diabetes or history of gestational diabetes (screened at 24-28 weeks gestation - meeting National Diabetes Data Group criteria for GDM) 	<p>Pregavid weight:</p> <ul style="list-style-type: none"> Self-reported in some cases used measured weight recorded in chart closes to woman's last menstrual period but no more than 12 months before her last menstrual period <p>Pregavid BMI: G1: < 19.8: 13.5% 19.8-24.9: 56.4% 25.0-29.0: 12.4% > 29.0: 17.6% G2: < 19.8: 5.1% 19.8-24.9: 51.2% 25.0-29.0: 16.6% > 29.0: 27.1% G3: < 19.8: 10.1% 19.8-24.9: 50.0% 25.0-29.0: 17.1% > 29.0: 22.9% G4: < 19.8: 13.9% 19.8-24.9: 57.9% 25.0-29.0: 13.2% > 29.0: 57.1%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: < 25 years: 22.1% 25-29: 24.2% 30-34: 33.6% ≥ 35: 20.1% G2: < 25 years: 15.9% 25-29: 28.0% 30-34: 31.7% ≥ 35: 24.3% G3: < 25 years: 24.1% 25-29: 25.3% 30-34: 26.8% ≥ 35: 23.8% G4: < 25 years: 17.1% 25-29: 29.4% 30-34: 32.6% ≥ 35: 20.8%</p> <p>Parity: % primiparous: G1: 56.9 G2: 31.2 G3: 50.0 G4: 59.3</p>	<p>Race, %: White G1: 54.0 G2: 67.8 G3: 47.6 G4: 42.6 Black G1: 10.0 G2: 5.1 G3: 11.3 G4: 4.4 Hispanic G1: 17.2 G2: 15.1 G3: 20.4 G4: 15.5 Asian/Pacific Islander G1: 8.1 G2: 3.6 G3: 6.7 G4: 20.1 Other G1: 10.7 G2: 8.4 G3: 14.0 G4: 17.4</p> <p>Smoking, %: G1: %nonsmoking during pregnancy: 92.0; %smoked but quit: 4.2; %smoked 3.9 G2: %nonsmoking during pregnancy: 90.8; %smoked but quit: 5.3; %smoked 4.0 G3: %nonsmoking during pregnancy: 92.6; %smoked but quit: 1.5; %smoked 5.8 G4: %nonsmoking during pregnancy: 94.2; %smoked but quit: 4.9; %smoked 1.0</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Screening glucose value less than 140: G1: 85.0%: > 140: 15.0% G2: 81.6%: > 140: 18.4% G3: 81.4%: > 140: 18.6% G4: 83.3%: > 140: 16.7%</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records rate of maternal weight gain was calculated as total pregnancy weight gain minus infant birth weight divided by weeks of gestation when last weight was measured; rate of maternal weight gain before the third trimester was calculated using the weight measured at or before the screening test for GDM (24-28 wks of gestation) minus prepregnancy weight divided by weeks of gestation <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between final recorded weight at last prenatal visit (within 2 weeks of delivery date) and prepregnancy weight 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Odds ratio (95% CI) for macrosomia based on rate of weight gain</p> <p>Groups Rate of gain kg/wk: G1: -0.26 to 0.21 G2: 0.22 to 0.31 (Reference) G3: 0.32 to 0.39 G4: 0.40 to 1.03</p> <p>Results G1: 0.52 (0.34-0.79) G2: 1.00 G3: 0.99 (0.67-1.47) G4: 2.23 (1.54-3.22)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Age, race/ethnicity, parity, pregravid BMI, screening glucose value</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jain et al, 2007</p> <p>Country and setting: United States, hospitals</p> <p>Enrollment period: 2002-2005</p> <p>Funding: Not reported</p> <p>Study Objective: To analyze risks of cesarean section, macrosomia, and breastfeeding at 10 weeks postpartum using logistic regression to estimate independent effects of prepregnancy BMI and gestational weight gain</p> <p>Time frame: 2002-2005</p> <p>Duration of the study: Entry into prenatal care to 10 weeks postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 7661</p> <p>Group Description: NR</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Term (> 37 weeks) and singleton for macrosomia and breastfeeding <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Cesarean analysis limited to women with cephalic presentation-records with missing data excluded 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: • NR</p> <p>Categorized: • ≤ 15 lbs • 15-25 lbs • 25-35 lbs • 35+ lbs</p> <p>Collected from: • Not outlined</p> <p>Ascertained by: • Birth certificate</p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Odds ratios (95% CIs) for macrosomia</p> <p>Groups G1: WG ≤ 15 lbs G2: WG 15-24 lbs G3: WG 25-35 lbs G4: WG ≥ 35 lbs</p> <p>Results G1: 0.49 (0.30-0.82) G2: 1.0 G3: 1.17 (0.82-1.65) G4: 2.83 (2.04-3.92)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, pregravid BMI, parity, education, race/ethnicity, US/foreign origin</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 7 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jensen et al., 2005</p> <p>Country and setting: Denmark, university hospitals</p> <p>Enrollment Period: Gestation through birth</p> <p>Funding: Many different funds</p> <p>Study Objective: To investigate effect of gestational weight gain in obese glucose tolerant women</p> <p>Time frame: Gestation through birth</p> <p>Duration of the study: NR</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 481</p> <p>Group Description:</p> <p>G1: GWG < 5.0 kg G2: GWG 5.0-9.9kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0kg</p> <p>Group N:</p> <p>G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Prepregnancy BMI ≥ 30 Normal 2h 75g oral glucose tolerance test (OGTT) during third trimester (according to WHO criteria) Only first pregnancy during study period included <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Well defined chronic disease Twin pregnancies Women with GDM (n = 323) Known diet treatment (n = 10) Incomplete data on weight gain during pregnancy (n-153) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records Patient report of pregravid BMI <p>Pregravid BMI:</p> <p>G1: 34.3 (32.2-39.9) G2: 33.9 (31.5-36.5) G3: 32.9 (31.2-35.6) G4: 32.7 (31.3-34.7)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs):</p> <p>G1: 29.8 (26.4-33.1) G2: 29.1 (26.3-33.1) G3: 30.0 (26.6-33.2) G4: 27.9 (24.8-31.8)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: 84.4 G2: 85.8 G3: 82.7 G4: 89.9</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 29.7 G2: 25.8 G3: 30.2 G4: 26.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> < 5.0, 5.0-9.9, 10.0-14.9, ≥ 15.0 Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Not stated by authors </p>	<p>Birth weight: G1: 3500 (3200-3840) G2: 3645 (3200-4000) G3: 3750 (3390-4125) G4: 3762 (3400-4120)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Odds ratios (95% CIs) for macrosomia</p> <p>Groups G1: MWG < 5.0 kg (Reference) G2: MWG 5.0-9.9 kg G3: MWG 10.0-14.9 kg G4: MWG ≥ 15.0 kg</p> <p>Results G1: 1.0 G2: 1.8 (0.8-3.8) G3: 2.2 (1.0-4.7) G4: 4.0 (1.8-9.0)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Pregravid BMI 2h OGTT result Parity Smoking Ethnicity Clinical Center <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Johnson et al., 1992</p> <p>Country and setting: USA, prenatal clinics</p> <p>Enrollment Period: January 1, 1987- December 31, 1989</p> <p>Funding: NR</p> <p>Study Objective: To determine influences of increased maternal prepregnancy weight and increased gestational weight gain on pregnancy outcome</p> <p>Time frame: January 1, 1987 to December 31, 1989</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,191</p> <p>Group Description: G1: BMI < 19.8 G2: 19.8-26.0 G3: 27-29 G4: > 29 G5: All</p> <p>Group N: G1: 755 G2: 1,621 G3: 329 G4: 486 G5: 3191</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Delivery at or beyond 38 weeks of gestation Singletons Received prenatal care and delivered in Shands Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Fetal abnormalities Oligohydramnios Polyhydramnios Medical or surgical complications (GI disorders, sickle cell hemoglobinopathy, hepatitis, hematologic disorders, malignant disease, renal disease, neurologic disease, pulmonary disease, psychiatric disorders, tuberculosis) Incomplete risk variable data or outcome variable information 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> National Academy of Sciences <p>Age (mean, yrs): G1: NR</p> <ul style="list-style-type: none"> < 20 years: 36.6% 20-26 years: 44.8% > 26 years: 18.7% <p>G2: NR</p> <ul style="list-style-type: none"> < 20 years: 30.8% 20-26 years: 46.5% > 26 years: 22.6% <p>G3:</p> <ul style="list-style-type: none"> < 20 years: 25.8% 20-26 years: 48.9% > 26 years: 25.2% <p>G4:</p> <ul style="list-style-type: none"> < 20 years: 16.5% 20-26 years: 53.9% > 26 years: 29.6% <p>G5:</p> <ul style="list-style-type: none"> < 20 years: 29.5% 20-26 years: 47.5 % > 26 years: 23.0% <p>Parity: G1: % first: 49.3 G2: 43.1 G3: 37.4 G4: 31.1 G5: 42.1</p>	<p>Race, %:</p> <p>White</p> <p>G1: 64.5 G2: 60.0 G3: 49.8 G4: 51.9 G5: 58.7</p> <p>Black</p> <p>G1: 33.6 G2: 37.9 G3: 48.9 G4: 47.5 G5: 39.5</p> <p>Hispanic</p> <p>NR</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>G1: 1.9 G2: 2.1 G3: 1.2 G4: 0.6 G5: 1.7</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Hypertension, %: G1: 3.4 G2: 4.6 G3: 5.8 G4: 10.7 G5: 5.4</p> <p>Additional characteristics: G1: % married: 42.6 G2: 46.1 G3: 40.4 G4: 49.4 G5: 45.2</p> <p>Additional characteristics: NR</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 755 G2: 1621 G3: 329 G4: 486 G5: 3191</p> <p>Total weight gain: G1:</p> <ul style="list-style-type: none"> < 16kg: 7.8% 16-25kg: 18.5% 26-35kg: 35.1% > 35kg: 38.5% <p>G2:</p> <ul style="list-style-type: none"> < 16kg: 11.7% 16-25kg: 18.0% 26-35kg: 28.8% > 35kg: 41.5% <p>G3:</p> <ul style="list-style-type: none"> < 16kg: 19.8% 16-25kg: 19.1% 26-35kg: 28.3% > 35kg: 32.8% <p>G4:</p> <ul style="list-style-type: none"> < 16kg: 32.3% 16-25kg: 22.0%; <p><i>Categorized:</i></p> <ul style="list-style-type: none"> Quartiles National Academy of Sciences (below, within, or above recommended range) <p><i>Collected from:</i></p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self report and weight at last prenatal visit (mean 6.1 days prior to delivery) 	<p>Birth weight: G1:</p> <ul style="list-style-type: none"> < 2500g: 4.8% 2500-4000g: 89.1% > 4000g: 6.1% <p>G2:</p> <ul style="list-style-type: none"> < 2500g: 2.0% 2500-4000g: 85.2% > 4000g: 12.8% <p>G3:</p> <ul style="list-style-type: none"> < 2500g: 1.5% 2500-4000g: 83.0% > 4000g: 15.5% <p>G4:</p> <ul style="list-style-type: none"> < 2500g: 0.2% 2500-4000g: 82.5% > 4000g: 17.3% <p>Gestational diabetes, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Cesarean delivery, %: G1: NR G2: NR G3: NR G4: NR G5: 11.9</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Frequency of macrosomia = 12.2% Frequency of cesarean = 11.9% Frequency of LBW = 2.9% 	<p>Outcomes Description: Odds ratio (95% CI) for macrosomia</p> <p>Groups G1: Net WG < 14.9 lbs (Reference) G2: Net WG 14.9-23.5 lbs G3: Net WG 24-33 lbs G4: Net WG > 33 lbs</p> <p>Results G1: 1.0 G2: 1.20 (0.83-1.75) G3: 1.77 (1.24-2.52) G5: 2.86 (2.02-4.02)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Race Parity Pre-gravid BMI Pregnancy induced hypertension Height Prepregnancy weight Marital status Education Tobacco/alcohol/drug use <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Infant sex Macrosomia 	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 9 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Johnson et al., 1992
(continued)

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<ul style="list-style-type: none"> • Frequency of postdate pregnancy = 9.8% • Frequency of labor abnormalities (40% were unscheduled cesareans) = 7.8% • Frequency of oxytocin induction = 13.7% • Frequency of oxytocin augmentation = 16.1% • Frequency of meconium staining = 21.5% 		
	<p>Other infant outcomes: NA</p>		

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kiel et al., 2007</p> <p>Country and setting: United States, birth registry</p> <p>Enrollment period: 1990 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of gestational weight change on pregnancy outcomes in obese women</p> <p>Time frame: 1990 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 120,170</p> <p>Group Description:</p> <p>G1: Obese Class I (BMI 30–34.9) (n = 70,536)</p> <p>G2: Obese Class II (BMI 35–39.9) (n = 30,609)</p> <p>G3: Obese Class III (BMI 40 and More) (n = 19,025)</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Obese women residing in Missouri who delivered (at 37 or more weeks of gestation) liveborn, singleton infants during 1990–2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>G1: Total: Class I obese: 59% Class II obese: 25% Class III obese: 16%</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NIH guidelines <p>Age (mean, yrs):</p> <p>G1: <26: 46% 26-35: 47% Older than 35: 8%</p> <p>G2: <26: 44% 26-35: 48% Older than 35: 8%</p> <p>G3: <26: 40% 26-35: 52% Older than 35: 9%</p> <p>Parity: Nulliparous: G1: 34% G2: 33% G3: 32%</p>	<p>Race, %: White G1: 78 G2: 77 G3: 73</p> <p>Black G1: 22 G2: 23 G3: 27</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 22</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: GWG (lb) Less than 2: 3% 2 to 14: 15% 15 to 25: 26% More than 25: 56% G2: GWG (lb) Less than 2: 8% 2 to 14: 22% 15 to 25: 27% More than 25: 43% G3: GWG (lb) Less than 2: 15%</p> <p>Categorized:</p> <ul style="list-style-type: none"> 10-lb or less loss 2 to 9 lbs loss, no weight change, 2 to 9 lbs gain, 10 to 14 lbs gain, 15–25 lb gain, 26–35 lb gain, and greater than 35 lb gain <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: G1: SGA: 7% LGA:13% (<i>P</i> < 0.05) G2: SGA: 7% LGA:16% (<i>P</i> < 0.05) G3: SGA: 6% LGA:18% (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 28 G2: 34 G3: 41</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Odds of macrosomia</p> <p>Groups G1: Odds of macrosomia for WG > 2 5lbs G2: OR of macrosomia for WG < 15 lbs G3: Reference WG 15-25 lbs</p> <p>Results G1: higher for women in this group G2: lower for women in this group</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Education Poverty (enrollment in Medicaid, WIC, food stamp programs) Smoking Chronic hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Kiel et al., 2007
(continued)

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 show absolute risk of preeclampsia, cesarean delivery, LGA, and SGA by GWG category for each obesity class. All 3 figures show similar patterns of increasing risk of preeclampsia, cesarean delivery, and LGA birth and decreasing risk of SGA birth with increasing GWG. Collectively, minimal risk for all 4 outcomes corresponds to GWG categories where risk of LGA and SGA births intersect. This equates to GWG of 10 to 25 lb for class I obese women, a gain of 0 to 9 lb for class II obese women, and weight loss of 0 to 9 lb for class III obese women. Adjusted odds ratios and 95% CIs for preeclampsia, cesarean delivery, SGA, and LGA by GWG category and obesity class. Compared with women who gained 15 to 25 lb during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births. Women who gained more than 25 lbs had higher odds for same 3 pregnancy outcomes and lower odds for SGA births. <p>Other infant outcomes: NR</p>		

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kirchengast and Hartmann, 2003</p> <p>Country and setting: Singleton births that took place at University Clinic for Gynecology and Obstetrics in Vienna, Austria</p> <p>Enrollment period: NR</p> <p>Funding: NR</p> <p>Study Objective: Examine impact of biological factors such as young maternal age and maternal somatic characteristics on pregnancy outcome among group of adolescent mothers who gave birth between 39th and 41st week of gestation after period of intensive psychological support</p> <p>Time frame: NR</p> <p>Duration of the study: 1985 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 8,011</p> <p>Group Description: G1: 12 to 16 years G2: 17 to 19 years G3: 20 to 29 years</p> <p>Group N: G1: 215 G2: 1,336 G3: 6,460</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women ages 12 to 29 • All prenatal check-ups of mother-child passport were performed • Delivery of single infant without congenital malformations • Receiving psychosocial support by family and/or specially trained social worker within young adolescent group (12 to 16 years) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Coincident medical diseases such as diabetes mellitus or nephropathy • Drug or alcohol abuse • Twin birth • IVF • Registered maternal diseases before and during pregnancy • Hypertension (BP < 150/90 mmHG) • Protein or glucose in urine • Pregnancy related immunization 	<p>Pregravid weight: Estimated by means of retrospective method and first weight determination, which was carried out at first prenatal visit (8th week of gestation)</p> <p>G1: 56.0 G2: 57.2 G3: 59.2</p> <p>Pregravid BMI: G1: 21.45 G2: 21.59 G3: 22.10</p> <p>Imputed: <ul style="list-style-type: none"> • Yes </p> <p>Categorized: <ul style="list-style-type: none"> • Continuous </p> <p>Age (mean, yrs): G1: 14.5 G2: 17.8 G3: 24.1</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Age at menarche: G1: 12.2 G2: 12.9 G3: 13.3</p> <p>Gynecological age: G1: 3.4 G2: 5.3 G3: 10.8</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 215 G2: 1,336 G3: 6,460</p> <p>Total weight gain: G1: 13.1 G2: 13.1 G3: 13.1 (P = .10)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3237.6 (significantly different from 17-19 and 20-29) G2: 3298.3 (significantly different from < 17 and 20-29) G3: 3368.9 (significantly different from < 17 and 17-19) (F = 24.1, P < .0001)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Chronological age Age at menarche Gynecological age Height Distancia spinarum Distancia christarum Prepregnancy weight Weight at end of pregnancy <p>Other infant outcomes</p> <ul style="list-style-type: none"> Birth length Head circumference Acromial circumference Diameter frontooccipitale 	<p>Outcomes Description: OR and 95% CI, for Macrosomia</p> <p>Groups NA, weight gain as continuous variable</p> <p>Results G1: 1.07 (1.05-1.10)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, age at menarche, pregravid weight, height, distantia cristarum</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Takimoto et al., 2006</p> <p>Country and setting: Japan, obstetric units</p> <p>Enrollment Period: 2001 to 2002</p> <p>Funding: Ministry of Health, Labour, and Welfare, Health, and Labour Research Grant, Research on Children and Families</p> <p>Study Objective: To identify adequate weight gain ranges during pregnancy in Japanese women</p> <p>Time frame: 2001 to 2002</p> <p>Duration of the study: Pregnancy through delivery (all info derived from delivery records)</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cross-sectional <p>Total Study N: 112,257</p> <p>Group Description: G1: Study cohort G2: NR</p> <p>Group N: G1: 46,659 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Vaginal birth • Singleton pregnancy • Low risk • Term <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Cesarean deliveries (n = 30,559) • Delivery method unknown (n = 2258) • Multiple gestations (n = 8387) • Preterm deliveries < 37 weeks (n = 19623) • Post-term deliveries > 41 weeks (n = 623) • Stillbirths and neonatal deaths (n = 2558) • Maternal deaths (n = 11) • Congenital anomalies of the infant (n = 2449) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Taken from records not stated whether it was self-reported or measured <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NR <p>Age (mean, yrs): G1: 29.9 (4.8) G2: NR</p> <p>Parity: % primiparous: G1: 53.5 G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 6.3 G2: NR</p> <p>Diabetes mellitus, %: G1: 1.2 G2: NR</p> <p>Hypertension, %: G1: 2.0 G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 46,659 G2: NR</p> <p>Total weight gain: G1: 9.9 (4.3) G2: NR</p> <p><i>Categorized:</i></p> <ul style="list-style-type: none"> <i>Gestational age specific percentile values of weight gain: under the 25th, 25th-49th, 50th-74th, 75th-89th, ≥ 90th</i> <p><i>Collected from:</i></p> <ul style="list-style-type: none"> <i>Routine pre-natal care or maternity records</i> <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> <i>Based on last clinically measured weight prior to delivery: not stated</i> 	<p>Birth weight: G1: 2982 (472) G2: NR</p> <p>Gestational diabetes, %: G1: 1.2 G2: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> • Macrosomia • IUGR 	<p>Outcomes Description: Odds ratio (95% CI) for macrosomia</p> <p>Groups G1: Total MWG < 25th percentile for GA G2: Total MWG 25-49th percentile for GA G3: Total MWG 50-74th percentile for GA (Reference) G4: Total MWG 75-89th percentile for GA G5: Total MWG ≥90th percentile for GA</p> <p>Results G1: 0.31 (0.20,-0.47) G2: 0.49 (0.34-0.70) G3: 1.0 G4: 1.62 (1.24-2.12) G5: 2.41 (1.83-3.17)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Parity • Pre-pregnancy weight <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age • Infant sex 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 6 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Zhou and Olsen, 1997</p> <p>Country and setting: Denmark, two communities</p> <p>Enrollment Period: April 1984 to April 1987</p> <p>Funding: Danish National Research Foundation and Sygekassernes Helsefond</p> <p>Study Objective: To study association between gestational weight gain and different birth weight indicators considering prepregnancy BMI</p> <p>Time frame: April 1984 to April 1987</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 7122</p> <p>Group Description: G1: Entire study G2: NR</p> <p>Group N: G1: 7122 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women who provided detailed information on lifestyle during pregnancy • Singletons • Non-diabetic women who gave birth between weeks 37 and 42 for whom weight gain was reported <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: % < 19.8: 27.2; %19.8-26: 63.7; %26+: 9.1 G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): % < 25: G1: 30.3 G2: NR</p> <p>Parity: %nulliparous: G1: 48.9 G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: %non-smoking: G1: 60.0 G2: NR</p> <p>Diabetes mellitus, %: G1: 0 G2: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 20. Gestational weight gain and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 7122 G2: NR</p> <p>Total weight gain: G1: % < 11kg: 35.2; %12-15: 35.5; %16+: 29.3 G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> ≤ 11, 12-15, ≥ 16 kg <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between last measured weight prior to delivery and prepregnancy weight 	<p>Birth weight: G1: %LBW: 1.7; %normal: 96.8; %HBW: 1.5 G2: NR</p> <p>Gestational diabetes, %: G1: 0 G2: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Low birth weight (< 2500g) High birth weight (> 4500g) Growth retarded were newborns with a birth weight below 3000g in spite of a placenta weight higher than 66 percentile (491g) 	<p>Outcomes Description: Odds ratios (95% CI) for macrosomia by MWG categories and BMI</p> <p>Groups G1: MWG < 11 kg, underweight (Reference) G2: MWG < 11 kg, normal weight G3: MWG < 11 kg, overweight G4: MWG 12-15 kg, underweight, G5: MWG 12-15 kg, normal weight G6: MWG 12-15 kg, overweight G7: MWG ≥ 16 kg, underweight G8: MWG ≥ 16 kg, normal weight G9: MWG ≥ 16 kg, overweight</p> <p>Results G1: 1.0 G2: 52.8 (0.3-22.9) G3: 9.7 (1.2-81.8) G4: 0.0 (0.0-7x10⁵) G5: 6.8 (0.9-51) G6: 27.1 (3.3-220) G7: 6.1 (0.7-52.5) G8: 15.7 (2.2-114) G9: 45.6 (6.0-349)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Alcohol No diabetes Term delivery Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Infant sex 	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 21. Gestational weight gain and large-for-gestational age

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) ($P < 0.05$)</p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% ($P < 0.01$)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: Percentage of LGA for MWG</p> <p>Groups G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs</p> <p>Results G1: 12.0 G2: 11.8 G3: 18.8 G4: 25.8 G5: 23.8 ($P < 0.01$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bo et al., 2003</p> <p>Country and setting: Italy, university clinic</p> <p>Enrollment Period: April 1999 to February 2001</p> <p>Funding: NR</p> <p>Study Objective: To evaluate pregnancy outcomes in cohort of caucasian pregnant women in relation to BMI and glucose toleranc status; role of central fat distribution, as indicated by waist to hip circumference ratio also considered</p> <p>Time frame: April 1999 to February 2001</p> <p>Duration of the study: Screened during pregnancy at 24 to 28 weeks, recall data on pregravid weight</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 700</p> <p>Group Description: G1: Normal wieight, normal OGTT G2: Overweight/Obese, normal OGTT G3: Normal Weight, IGT/GDM G4: Overweight/Obese, IGT/GDM</p> <p>Group N: G1: 333 G2: 117 G3: 133 G4: 117</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Caucasian pregnant women attending Gynecological and Obstetrical Department of University of Torino screened with 50g oral glucose test at 24 to 28 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women known to have preexistent diabetes mellitus, a disease affecting glucose metabolism, or hypertension 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 21.2 G2: 29.9 G3: 21.5 G4: 29.9</p> <p>Imputed: <ul style="list-style-type: none"> No </p> <p>Categorized: NR</p> <p>Age (mean, yrs): G1: 31.7 G2: 31.1 G3: 32.9 G4: 32.6</p> <p>Parity: G1: Nulliparous (%): 63.7 G2: 53.0 G3: 62.4 G4: 51.3</p>	<p>Race, %: White G1: 100 G2: 100 G3: 100 G4: 100</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: G1: 11.4 G2: 15.4 G3: 15.0 G4: 18.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 1.2 G2: 10.3 G3: 4.5 G4: 11.1</p> <p>Additional characteristics: Waist-to-hip ratio: G1: 0.86 G2: 0.87 G3: 0.89 G4: 0.90</p> <p>Additional characteristics: Preterm delivery (%): G1: 6.9 G2: 6.7 G3: 9.2 G4: 8.5</p> <p>Additional characteristics: LGA (%): G1: 13.1 G2: 27.6 G3: 13.3 G4: 27.4</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 333 G2: 117 G3: 133 G4: 117</p> <p>Total weight gain: G1: 13.2+/-4.1 (<i>P</i> < 0.01 vs. G2) G2: 10.5+/-6.1 G3: 11.8+/-5.7 (<i>P</i> < 0.05 vs. G2, <i>P</i> < 0.05 vs. G4) G4: 9.5+/-6.8 (<i>P</i> < 0.01 vs. G1) (overall <i>P</i> < 0.0001)</p> <p>Categorized: <ul style="list-style-type: none"> Continuous </p> <p>Collected from: <ul style="list-style-type: none"> Gains during pregnancy not collected </p> <p>Ascertained by: <ul style="list-style-type: none"> Not explained by researchers, may be difference between prepregnancy weight and weight measured at 24 to 28 weeks gestation </p>	<p>Birth weight: G1: 3271+/-446 (<i>P</i> < 0.05 vs. G2) G2: 3413+/-589 (<i>P</i> < 0.01 vs. G3) G3: 3186+/-578 (<i>P</i> < 0.01 vs. G4) G4: 3389+/-447 (<i>P</i> < 0.05 vs. G1) (overall <i>P</i> = 0.001)</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: 30.5 G2: 38.1 G3: 39.2 G4: 44.3 (<i>P</i> < 0.01 vs. G1) (overall <i>P</i> = 0.044)</p> <p>Instrumental delivery,%: NR</p> <p>Episiotomy,%: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Height Parental diabetes Waist Systolic bp Diastolic bp Hypertension Triglycerides HDL <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Weeks of delivery SGA Neonatal pathologies 	<p>Outcomes Description: Odds ratio (95% CI) for LGA</p> <p>Groups G1: for each 1 kg increase in MWG</p> <p>Results G1: 1.08 (1.03-1.12)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Age, pregravid BMI, smoking, gestational hyperglycaemia</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 7 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Caulfield et al., 1998</p> <p>Country and setting: USA, hospital obstetric database</p> <p>Enrollment Period: 1987 to 1989</p> <p>Funding: NR</p> <p>Study Objective: To examine relation between gestational weight gain and risk of delivering a small for gestational age infant by race</p> <p>Time frame: 1987-1989</p> <p>Duration of the study: Entry into pn care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,870</p> <p>Group Description: G1: BMI < 19.8 Black G2: BMI < 19.8 White G3: BMI 19.8 to 26.0 Black G4: BMI 19.8 to 26.0 White G5: BMI > 26.0 Black G6: BMI > 26.0 White</p> <p>Group N: G1: 523 G2: 267 G3: 1,479 G4: 796 G5: 615 G6: 190</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancies White or black ethnicity At least 28 weeks' gestation One delivery per woman (randomly chosen) Information on anthropometric data <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Improbable data Non-black or non-white ethnicity 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 13.3 (5.7) G2: 14.6 (5.1) G3: 13.6 (6.7) G4: 15.3 (5.4) G5: 12.4 (7.7) G6: 14.5 (7.3)</p> <p>Pregravid BMI:</p> <p>G1: 18.4 (1.0) G2: 18.5 (1.0) G3: 22.7 (1.8) G4: 22.1 (1.8)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 21.7 (4.8) G2: 27.1 (6.6) G3: 22.7 (5.3) G4: 29.8 (5.8) G5: 24.9 (6.0) G6: 28.2 (5.5)</p> <p>Parity: G1: % primiparous: 52.4 G2: 55.4 G3: 50.1 G4: 48.0 G5: 36.9 G6: 46.9</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 32.8 G2: 20.6 G3: 35.4 G4: 20.0 G5: 28.8 G6: 25.4</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 4.3 G2: 3.0 G3: 6.0 G4: 5.7 G5: 11.9 G6: 17.0</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: 13.3 (5.7) G2: 14.6 (5.1) G3: 13.6 (6.7) G4: 15.3 (5.4) G5: 12.4 (7.7) G6: 14.5 (7.3)</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between selfreport pre-pregnancy weight and last recorded weight </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: ORs and 95% CIs for LGA per 50g/wk increase in rate of weight gain by BMI</p> <p>G1: Underweight G2: Normal weight G3: Overweight</p> <p>G1: 1.25 (1.11-1.41) G2: 1.14 (1.08,-1.20) G3: 1.13 (1.07-1.20)</p> <p>Maternal age, race, parity, pre- gravid BMI, height, hypertension, provider type, smoking, infant sex</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Height Hypertension Provider type Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Female infant</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 6 Good, 3 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cedergren, 2006</p> <p>Country and setting: Sweden, Medical Birth Registry</p> <p>Enrollment Period: January 1, 1994 - December 31, 2002</p> <p>Funding: Ostergotland County Council</p> <p>Study Objective: To estimate effects of high and low gestational weight gain in different maternal BMI classes on obstetric and neonatal outcomes</p> <p>Time frame: January 1, 1994 to December 31, 2002</p> <p>Duration of the study: First visit to maternity health care center to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 245,526</p> <p>Group Description: BMI</p> <p>G1: < 20 G2: 20 to 24.9 G3: 25 to 29.9 G4: 30 to 34.9 G5: ≥ 35</p> <p>Group N: G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton, term pregnancies Information on maternal height, maternal weight in early pregnancy, and gestational weight gain <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported If unknown, standardized measurement is made during first visit to maternity health care center <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> < 20, 20.0-24.9, 25.0-29.9, 30-34.9, ≥ 35 <p>Age (mean, yrs):</p> <p>G1: 15 to 19 years: 3.8% 20 to 24: 23.0% 25 to 29: 38.7% 30 to 34: 25.7% 35 to 39: 7.7% ≥ 40: 1.1%</p> <p>G2: 15 to 19 years: 1.9% 20 to 24: 15.9% 25 to 29: 37.7% 30 to 34: 31.1% 35 to 39: 11.3% ≥ 40: 1.9%</p> <p>G3: 15 to 19 years: 1.5% 20 to 24: 15.7% 25 to 29: 36.1% 30 to 34: 31.2% 35 to 39: 12.9% ≥ 40: 2.5%</p> <p>G4: 15 to 19 years: 1.5% 20 to 24: 17.4% 25 to 29: 35.6% 30 to 34: 30.0% 35 to 39: 13.0% ≥ 40: 2.4%</p> <p>G5: 15 to 19 years: 1.1% 20 to 24: 17.3% 25 to 29: 38.0% 30 to 34: 29.6% 35 to 39: 11.7% ≥ 40: 2.3%</p>	<p>Race, %: White G1: 96.6 G2: NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander G1: 1.4 G2: NR</p> <p>Other G1: 2.0 G2: NR</p> <p>Smoking, %: G1: % nonsmoking: 81.6 G2: 85.2 G3: 83.1 G4: 79.9 G5: 78.4 Group 6</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Total weight gain: G1: < 8kg: 6.9% 8-15.9kg: 65.2% ≥ 16kg: 28.0% G2: < 8kg: 8.4% 8-15.9kg: 67.1% ≥ 16kg: 30.4% G3: < 8kg: 15.7% 8-15.9kg: 54.4% ≥ 16kg: 29.9% G4: < 8kg: 30.2% 8-15.9kg: 48.7% ≥ 16kg: 21.1% G5: < 8kg: 44.6% 8-15.9kg: 40.9% ≥ 16kg</p> <p>Categorized: <ul style="list-style-type: none"> < 8kg, 8-16, > 16 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between maternal weights measured when woman attended delivery unit and maternal weight recorded at first visit to maternity health care center </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Odds ratio (95% CIs) for LGA (> 2 SD above the mean)</p> <p>Groups Weight gain < 8 kg G1: BMI < 20 G2: BMI 20-24.9 G3: BMI 25-29.9 G4: BMI 30-34.9 G5: BMI ≥ 35</p> <p>Weight gain > 16 kg G6: BMI < 20 G7: BMI 20-24.9 G8: BMI 25-29.9 G9: BMI 30-34.9 G10: BMI ≥ 35</p> <p>Weight gain 8-16 kg (Reference)</p> <p>Results G1: 0.43 (0.24-0.75) G2: 0.53 (0.47-0.61) G3: 0.48 (0.43-0.53) G4: 0.66 (0.59-0.75) G5: 0.54 (0.46-0.63)</p> <p>G6: 3.26 (2.76-3.86) G7: 2.73 (2.60-2.88) G8: 2.14 (2.01-2.28) G9: 2.24 (2.00-2.51) G10: 1.54 (1.24-1.90)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Year of birth</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ekblad and Grenman, 1992</p> <p>Country and setting: Finland, hospital</p> <p>Enrollment Period: July 1, 1985 - December 31, 1985 (6 months)</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of abnormal maternal weight or weight gain on pregnancy outcome</p> <p>Time frame: July 1, 1985 to December 31, 1985 (6 months)</p> <p>Duration of the study: Prepregnancy to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: retrospective data from records, prospective weight and height at delivery <p>Total Study N: Total n = 357</p> <ul style="list-style-type: none"> 191 women with abnormal prepregnant weight ($\geq 20\%$ under or over ideal weight for height) or abnormal pregnancy weight gain ($\geq 20\text{kg}$ or $\leq 5\text{kg}$) 166 controls <p>Group Description: G1: $\geq 20\%$ over normal weight for height G2: $\geq 20\%$ under normal weight for height G3: weight gain $\leq 5\text{kg}$ G4: weight gain $\geq 20\text{kg}$ G5: control Group 6</p> <p>Group N: G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Birth at hospital within study period selected those with abnormal maternal prepregnancy weight or abnormal weight gain during pregnancy, as well as next mother in sequential order with normal prepregnancy weight and weight gain during pregnancy to serve as a control <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Not stated 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records - not stated if self reported <p>G1: 83.9 (10.1) G2: 46.7 (3.4) G3: 73.1 (16.5) G4: 65.0 (12.2) G5: 58.3 (6.5)</p> <p>Pregravid BMI: G1: 39.5 (3.4) G2: 17.2 (0.9) G3: 26.1 (6.1) G4: 23.6 (4.1) G5: 21.6 (2.0)</p> <p>Imputed: <ul style="list-style-type: none"> No </p> <p>Categorized: <ul style="list-style-type: none"> Continuous $\geq 20\%$ over or under normal weight for height </p> <p>Age (mean, yrs): G1: 28 (5.1) G2: 25.5 (5.1) G3: 29.5 (5.1) G4: 28.7 (4.7) G5: 28.7 (4.4)</p> <p>Parity: G1: prior deliveries: 1.0 (1.0) G2: 0.8 (0.8) G3: 1.2 (1.1) G4: 0.8 (1.0) G5: 0.9 (1.0)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): G1: 77 G2: 28 G3: 30 G4: 56 G5: 166 Total weight gain: G1: 11.8 (6.2) <i>P</i> < 0.05 compared to controls G2: 13.4 (4.5) G3: 3.0 (3.5) <i>P</i> < 0.0005 compared to controls G4: 23.2 (22.8) <i>P</i> < 0.0005 compared to controls G5: 13.2 (3.4) Categorized: <ul style="list-style-type: none"> ≤ 5kg or ≥ 20kg Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	Birth weight: G1: 3712 g (614) <i>P</i> < 0.05 compared to controls G2: 3293 (362) <i>P</i> < 0.05 compared to controls G3: 3284 (880) G4: 3803 (538) <i>P</i> < 0.005 compared to controls G5: 3538 (535) Gestational diabetes, %: NR Cesarean delivery, %: G1: Elective 7% Emergency 14% Total 21% G2: Elective 4% Emergency 4% Total 8% G3: Elective 3% Emergency 3% Total 6% G4: Elective 5% Emergency 18% Total 23% G5: Elective 13% Emergency 9% Total 22% Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: NA Other infant outcomes: NA	Outcomes Description: Percentage of Infant BW by maternal weight gain groups Groups Infant weight percentile for mothers with normal pregravid weight and normal weight gain G1: < 2.5% G2: 2.5-10% G3: 10-50% G4: 50-90% G5: 90-97.5% G6: > 97.5% Infant weight percentile for mothers with weight gain ≤5 kg G7: < 2.5% G8: 2.5-10% G9: 10-50% G10: 50-90% G11: 90-97.5% G12: > 97.5% Infant weight percentile for mothers with weight gain ≥20 kg G13: < 2.5% G14: 2.5-10% G15: 10-50% G16: 50-90% G17: 90-97.5% G18: > 97.5% Results G1: 1% G2: 6% G3: 35% G4: 43% G5: 13% G6: 2% G7: 3% G8: 14% G9: 32% G10: 34% G11: 14% G12: 3% G13: 0% G14: 2% G15: 42% G16: 29% G17: 20% G18: 7%	Background: Fair Sample selection: Poor Definition of maternal weight gain: Poor Definition of outcomes: Poor Source of information on exposure, outcomes, and confounders: Fair Followup: Fair Analysis comparability: Poor Analysis of outcomes: Fair Interpretation: Poor Sum of Good/Fair/Poor: 0 Good, 4 Fair, 5 Poor Final Quality Score: Poor

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Ekblad and Grenman,
1992 (continued)

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		Maternal confounders and effect modifiers accounted for in analysis: NA	
		Infant and child confounders and effect modifiers accounted for in analysis: NAR	

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jensen et al., 2005</p> <p>Country and setting: Denmark, university hospitals</p> <p>Enrollment Period: Gestation through birth</p> <p>Funding: Many different funds</p> <p>Study Objective: To investigate effect of gestational weight gain in obese glucose tolerant women</p> <p>Time frame: Gestation through birth</p> <p>Duration of the study: NR</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 481</p> <p>Group Description:</p> <p>G1: GWG < 5.0 kg G2: GWG 5.0-9.9kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0kg</p> <p>Group N:</p> <p>G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Prepregnancy BMI ≥ 30 Normal 2h 75g oral glucose tolerance test (OGTT) during third trimester (according to WHO criteria) Only first pregnancy during study period included <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Well defined chronic disease Twin pregnancies Women with GDM (n = 323) Known diet treatment (n = 10) Incomplete data on weight gain during pregnancy (n-153) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records Patient report of pregravid BMI <p>Pregravid BMI:</p> <p>G1: 34.3 (32.2-39.9) G2: 33.9 (31.5-36.5) G3: 32.9 (31.2-35.6) G4: 32.7 (31.3-34.7)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs):</p> <p>G1: 29.8 (26.4-33.1) G2: 29.1 (26.3-33.1) G3: 30.0 (26.6-33.2) G4: 27.9 (24.8-31.8)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: 84.4 G2: 85.8 G3: 82.7 G4: 89.9</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 29.7 G2: 25.8 G3: 30.2 G4: 26.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> < 5.0, 5.0-9.9, 10.0-14.9, ≥ 15.0 Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Not stated by authors </p>	<p>Birth weight: G1: 3500 (3200-3840) G2: 3645 (3200-4000) G3: 3750 (3390-4125) G4: 3762 (3400-4120)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Odds ratios (95% CIs) for LGA</p> <p>Groups G1: MWG < 5.0 kg (Reference) G2: MWG 5.0-9.9 kg G3: MWG 10.0-14.9 kg G4: MWG ≥ 15.0 kg</p> <p>Results G1: 1.0 G2: 2.4 (1.1-5.3) G3: 2.1 (1.1-4.8) G4: 4.7 (2-11)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Pregravid BMI 2h OGTT result Parity Smoking Ethnicity Clinical Center <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kiel et al., 2007</p> <p>Country and setting: United States, birth registry</p> <p>Enrollment period: 1990 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of gestational weight change on pregnancy outcomes in obese women</p> <p>Time frame: 1990 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 120,170</p> <p>Group Description:</p> <p>G1: Obese Class I (BMI 30–34.9) (n = 70,536)</p> <p>G2: Obese Class II (BMI 35–39.9) (n = 30,609)</p> <p>G3: Obese Class III (BMI 40 and More) (n = 19,025)</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women residing in Missouri who delivered (at 37 or more weeks of gestation) liveborn, singleton infants during 1990–2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: Total: Class I obese: 59% Class II obese: 25% Class III obese: 16%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NIH guidelines <p>Age (mean, yrs):</p> <p>G1: < 26: 46% 26-35: 47% Older than 35: 8%</p> <p>G2: < 26: 44% 26-35: 48% Older than 35: 8%</p> <p>G3: < 26: 40% 26-35: 52% Older than 35: 9%</p> <p>Parity: Nulliparous:</p> <p>G1: 34% G2: 33% G3: 32%</p>	<p>Race, %: White G1: 78 G2: 77 G3: 73</p> <p>Black G1: 22 G2: 23 G3: 27</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 22</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: GWG (lb) Less than 2: 3% 2 to 14: 15% 15 to 25: 26% More than 25: 56% G2: GWG (lb) Less than 2: 8% 2 to 14: 22% 15 to 25: 27% More than 25: 43% G3: GWG (lb) Less than 2: 15%</p> <p>Categorized:</p> <ul style="list-style-type: none"> 10-lb or less loss 2 to 9 lbs loss, no weight change, 2 to 9 lbs gain, 10 to 14 lbs gain, 15–25 lb gain, 26–35 lb gain, and greater than 35 lb gain <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: G1: SGA: 7% LGA:13% (<i>P</i> < 0.05) G2: SGA: 7% LGA:16% (<i>P</i> < 0.05) G3: SGA: 6% LGA:18% (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 28 G2: 34 G3: 41</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Odds of LGA by maternal weight gain groups</p> <p>Groups G1: Odds of LGA for weight gain > 25lbs G2: OR of LGA for weight gain < 15lbs G3: Reference weight gain 15-25 lbs</p> <p>Results G1: Odds of LGA are higher for women in this group G2: Odds of LGA are lower for women in this group Numerical value for ORs not reported in study</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Education Poverty (enrollment in Medicaid, WIC, food stamp programs) Smoking Chronic hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Kiel et al., 2007
(continued)

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 show absolute risk of preeclampsia, cesarean delivery, LGA, and SGA by GWG category for each obesity class. All 3 figures show similar patterns of increasing risk of preeclampsia, cesarean delivery, and LGA birth and decreasing risk of SGA birth with increasing GWG. Collectively, minimal risk for all 4 outcomes corresponds to GWG categories where risk of LGA and SGA births intersect. This equates to GWG of 10 to 25 lb for class I obese women, a gain of 0 to 9 lb for class II obese women, and weight loss of 0 to 9 lb for class III obese women. Adjusted odds ratios and 95% CIs for preeclampsia, cesarean delivery, SGA, and LGA by GWG category and obesity class. Compared with women who gained 15 to 25 lb during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births. Women who gained more than 25 lbs had higher odds for same 3 pregnancy outcomes and lower odds for SGA births. <p>Other infant outcomes: NR</p>		

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kitajima et al., 2001</p> <p>Country and setting: Japan, university hospital</p> <p>Enrollment period: 1992 to 1999</p> <p>Funding: NR</p> <p>Study Objective: To determine whether elevated midpregnancy maternal serum lipid levels predict newborn weight at term and risk of LGA infants in women with positive diabetic screen but normal glucose tolerance test</p> <p>Time frame: 1992 to 1999</p> <p>Duration of the study: Entry of pn care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 146</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 146 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Japanese pregnant women who had positive diabetic screen test results (at least 135 mg/dL of plasma glucose level at 1 hour after 50-g oral glucose challenge) and a normal 75-g oral GTT at 24 to 32 weeks' gestation at Nagasaki University Hospital between November 1992 and October 1999 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with pregestational or gestational diabetes mellitus to eliminate therapeutic biases in association between maternal metabolic variables and fetal growth Women with hypertensive disorder, thyroid disorder, lupus, and antiphospholipid syndrome, because those conditions are associated with fetal growth restriction due to placental insufficiency rather than metabolic factors Subjects who delivered before 37 weeks' gestation and cases of fetal congenital malformation or multifetal gestation 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 21.2 +/-2.7 G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 32+/-1.4 G2: NR</p> <p>Parity: G1: Nulliparous 44% G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): Total weight gain: G1: 9.6+/- 3.3 kg G2: NR Categorized: <ul style="list-style-type: none"> • Continuous Collected from: <ul style="list-style-type: none"> • Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	Birth weight: G1: 3012g+/- 359 G2: NR Gestational diabetes, %: NR Cesarean delivery, %: NR Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: NR Other infant outcomes: NR	Outcomes Description: Odds ratio (95% CI) for LGA Groups G1: for each 1 kg increase in MWG Results G1: 1.08 (0.81-1.44) Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> • Pre-gravid BMI • Maternal plasma glucose levels Infant and child confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> • Gestational age • Infant sex 	Background: Good Sample selection: Good Definition of maternal weight gain: Poor Definition of outcomes: Good Source of information on exposure, outcomes, and confounders: Poor Followup: Good Analysis comparability: Fair Analysis of outcomes: Good Interpretation: Good Sum of Good/Fair/Poor: 6 Good, 1 Fair, 2 Poor Final Quality Score: Fair

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kramer et al., 1990</p> <p>Country and setting: Canada, university hospital</p> <p>Enrollment Period: 1980 to 1986</p> <p>Funding: National Health Research and Development Program, Health and Welfare Canada</p> <p>Study Objective: (1) Which maternal and fetal variables appear to have independent causal impacts on intrauterine growth? (2) For a given fetal growth status, which maternal and fetal variables affect proportionality?</p> <p>Time frame: 1980 to 1986</p> <p>Duration of the study: Entry in to prenatal care up to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 8,719</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 8715 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Live-born, singleton infants without evidence of congenital intrauterine infection, chromosomal anomalies, or other major malformations and for whom gestational age calculated from last normal menstrual period agreed within ± 7 days with an early second-trimester (usually 16 to 18 weeks) Ultrasonographic estimate based on fetal biparietal diameter <p>Exclusion criteria:</p> <ul style="list-style-type: none"> See above 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported NR <p>G1: 57.8 kg (10.8) G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> They used prepregnancy wt and ht separately NR <p>Age (mean, yrs): G1: 28.6 (4.7) G2: NR</p> <p>Parity: G1: 0.72 (0.86) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: Cigarettes/d: G1: 3.2 (7.5) G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: Pg related HTN: G1: 7.7% G2: NR</p> <p>Additional characteristics: Education, y completed: G1: 13.0 (3.3) G2: NR</p> <p>Marital status: G1: 90.6% G2: NR</p> <p>Parity % primiparas: G1: 48.0 G2: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 8715 G2: NR</p> <p>Total weight gain: G1: 14.2kg (5.5) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery, using net weight gain (total weight minus wt of infant) 	<p>Birth weight: G1: 3385g (547) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Bivariate associations between selected maternal and fetal variables and fetal growth and proportionality: Correlation coefficient for net gestational weight gain (kg) and fetal growth ratio = 0.12 ($P < 0.001$); for prepregnancy weight (kg) 0.21 ($P < 0.001$) <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Correlation coefficients for Net prepregnancy weight gain (kg) and length = -0.04 ($P < 0.01$) Head circumference = -0.01 (NS); BMI 0.04 ($P < 0.001$); Ponderal index = 0.04 ($P < 0.001$) Weight/height circumference = 0.01 (NS) 	<p>Outcomes Description: Odds ratio (95% CI) for LGA</p> <p>Groups G1: for each 5 kg decrease in net gestational WG</p> <p>Results G1: 0.73 (0.68-0.79)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Pregravid weight, smoking, parity, maternal diabetes, height, previous LBW infant, severe pregnancy-induced hypertension</p> <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Sex of the infant 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Muscati et al., 1996</p> <p>Country and setting: Canada, public health department</p> <p>Enrollment Period: 1979 to 1989</p> <p>Funding: NR</p> <p>Study Objective: To examine association of extent and timing of pregnancy weight gain with infant birth weight and postpartum weight retention</p> <p>Time frame: 1979 to 1989</p> <p>Duration of the study: Pregnancy through 6 weeks postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 371</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 371 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • White, low income, non-smoking women • Pregnant women <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Prematurity < 37 weeks • Adolescents < 16 years • Women > 40 years • Maternal health problems • Women who consume alcohol or drugs • Pregnancy complications such as proteinuria, hypertension, diabetes, negative weight gain, missing values 	<p>Pregravid weight: Family physicians' records G1: 62.8 +/- 16.0 kg G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Pregravid weight status categorized into 3 groups as a percentage of standard weight: underweight < 90%, normal 90-120%, and overweight > 120% <p>Age (mean, yrs): G1: 24.5 +/- 5.6 G2: NR</p> <p>Parity: G1: Primiparous 52% G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: PPWR: 5.3 +/- 5.7 kg G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: 16.1 +/- 6.4 kg G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: From Table 1: Pearson's Correlation Coefficient and determination coefficient of maternal weight gain with PP weight retention and Infant BW. Maternal PP weight retention and Preg weight gain: [Total amount $r = 0.808$, R square 65.3%, $P < 0.001$], [Up to week 20 $r = 0.682$, R square 46.5%, $P < 0.001$], [Weeks 21-30 $r = 0.411$, R square 16.9%, $P < 0.001$], [Week 31 - term $r = 0.414$, R square 17.1%, $P < 0.001$]</p> <p>Other infant outcomes: Pregnancy Weight Gain and Infant Birth Weight (from Table 1): [Total amount $r = 0.216$, R square 4.7%, $P < 0.001$], [Up to week 20 $r = 0.114$, R-square 1.3%, $P < 0.05$], [Weeks 21-30 $r = 0.157$, R square 2.5%, $P < 0.01$], [Week 31 - term $r = 0.160$, R square 2.6%, $P < 0.01$]</p>	<p>Outcomes Description: Odds ratio for LGA per weight gain increase</p> <p>Groups G1: OR for LGA per 1 kg increase in WG up to week 20 G2: OR for LGA per 1 kg increase in WG from weeks 21 to 30 G3: OR for LGA per 1 kg increase in WG from weeks 31 to term</p> <p>Results G1: 1.17 ($P < 0.001$) G2: 1.16 ($P < 0.01$) G3: 1.02 ($P = NS$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Parity, pregravid standard weight, pregravid excess weight</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Birth length, infant sex</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Parker and Abrams, 1992</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: Sept 1980 to Dec 1988</p> <p>Funding: UC Committee on Research & MCH and Resources Development, Health Resources and Services Administration</p> <p>Study Objective: To test whether gains outside IOM reference ranges were associated with increased risks of suboptimal pregnancy outcome (SGA, LGA, cesarean delivery) and to determine whether locally developed ranges were more applicable to study population</p> <p>Time frame: Sept 1980 to Dec 1988</p> <p>Duration of the study: From entry into prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 6,690</p> <p>Group Description: G1: Overall G2: NR</p> <p>Group N: G1: 6,690 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Consecutive live singleton births at Moffitt Hospital between September 1980 and December 1988 with gestational ages of 37 to 42 weeks <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Maternal transfers or transports and deliveries complicated by fetal malformations, maternal diabetes, or maternal hypertension 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 56.8 kg(SD 11.0) G2: NR</p> <p>Pregravid BMI: G1: Underweight: 27.7%, Normal weight 61.8%, Overweight: 5.6%, Obese 4.9% G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 27.7 (5.5) G2: NR</p> <p>Parity: Primiparous: G1: 58.8% G2: NR</p>	<p>Race, %: White G1: 44.0 G2: NR</p> <p>Black G1: 8.3 G2: NR</p> <p>Hispanic G1: 9.4 G2: NR</p> <p>Asian/Pacific Islander G1: 21.4 G2: NR</p> <p>Other G1: 12.0 G2: NR</p> <p>Smoking, %: G1: 12.0 G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 6690 G2: NR</p> <p>Total weight gain: G1: 15.2kg (5.2) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM Weight gain ranges based on percentiles from previous study of UC population with good pregnancy outcomes: 25th - 75th, 10-90th percentiles. For 25-75th, weight gain range = 12-17kg for underweight women (BMI < 19.8); <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3408g (462) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Odds ratios (95% CIs) of LGA by weight gain</p> <p>Groups G1: Compared to UCSF Cohort 25-75th percentile of WG G2: Compared to UCSF 10-90th percentile of WG</p> <p>Results G1: 1.89 (1.51-2.37) G2: 1.87 (1.39-2.52)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Height Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Pezzarossa et al., 1996</p> <p>Country and setting: Italy, not stated</p> <p>Enrollment Period: Not stated</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of gestational weight gain on neonatal birthweight in women who were diagnosed with gestational diabetes after 3second week gestation</p> <p>Time frame: Not stated</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 192</p> <p>Group Description: G1: Normal G2: GDM</p> <p>Group N: G1: 132 G2: 60</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Caucasian women who had 1 or more risk factors for GDM: BMI > 28.6, gestational weight gain > 12kg, previous GDM, or previous neonatal macrosomia and underwent a diagnostic oral glucose tolerance test for GDM after 3second week of gestation - women with positive tests formed GDM group while women with negative test results formed normal singleton <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Smoking • Hypertension • Underweight (BMI < 19.6) • Previous metabolic treatment • Diabetic counseling 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: 25.7 (0.5) G2: 25.4 (0.8)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 29.1 (0.4) G2: 28.07 (0.6)</p> <p>Parity: NR</p>	<p>Race, %: White G1: 100 G2: 100 Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 132 G2: 60</p> <p>Total weight gain: G1: 13.4 (0.5) G2: 12.2 (0.6)</p> <p>Categorized: <ul style="list-style-type: none"> Continuous </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: used weight at last prenatal visit </p>	<p>Birth weight: G1: 3576.8 (41.3) G2: 3678.7 (69.3)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: macrosomia</p>	<p>Outcomes Description: Relative risks for LGA</p> <p>Groups G1: MWG < 9 kg G2: MWG 9-14 kg</p> <p>Results G1: similar between non-diabetic and GDM groups G2: GDM group has 2 times higher risk than non-diabetics Numerical results not reported</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Pre-gravid BMI Fasting plasma glucose <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Sunehag et al., 1991</p> <p>Country and setting: Sweden, prenatal clinics</p> <p>Enrollment Period: October 1994 to December 1987</p> <p>Funding: Grants from Gillberg Foundation, Swedish Diabetes Association, and Family Ernfors Foundation</p> <p>Study Objective: To assess perinatal morbidity in clinic with policy of liberal insulin treatment in pregnancies complicated by diabetes and to find predictive factors for adverse perinatal outcome</p> <p>Time frame: October 1994 to December 1987</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 133 women confirmed to have GDM</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 133 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women at risk for GDM <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Twin pregnancies • Incomplete case records 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Not stated - records? <p>Pregravid BMI: G1: 25.6 (4.7) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous > 23.9 <p>Age (mean, yrs): G1: 32 (range 19-43) G2: NR</p> <p>Parity: % primiparous: G1: 30.8% G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 30.8 G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): G1: 133 G2: NR Total weight gain: G1: 12.5 (6.3) kg G2: NR Categorized: <ul style="list-style-type: none"> • Continuous Collected from: <ul style="list-style-type: none"> • Not stated - records? Ascertained by: <ul style="list-style-type: none"> • Not stated 	Birth weight: G1: 3.7 (0.6) G2: NR Gestational diabetes, %: NR Cesarean delivery, %: G1: 27 G2: NR Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: NA Other infant outcomes: NA	Outcomes Description: Association between LGA and MWG Groups G1: LGA vs MWG > 18 kg Results G1: $\chi^2 = 8.2$ ($P < 0.005$) Maternal confounders and effect modifiers accounted for in analysis: NA Infant and child confounders and effect modifiers accounted for in analysis: NA	Background: Good Sample selection: Fair Definition of maternal weight gain: Poor Definition of outcomes: Fair Source of information on exposure, outcomes, and confounders: Poor Followup: Fair Analysis comparability: Fair Analysis of outcomes: Fair Interpretation: Poor Sum of Good/Fair/Poor: 1 Good, 5 Fair, 3 Poor Final Quality Score: Poor

Evidence Table 21. Maternal weight and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Wataba et al., 2006</p> <p>Country and setting: Japan, academic medical center</p> <p>Enrollment Period: 1981 to 1999</p> <p>Funding: NR</p> <p>Study Objective: To analyze association of pregnancy complications with prepregnant body mass index and weight gain during pregnancy in Japanese women</p> <p>Time frame: 1981 to 1999</p> <p>Duration of the study: Entry into PNC up til delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Perinatal data base and look at medical records retrospectively Retrospective <p>Total Study N: 21,718</p> <p>Group Description: G1: Nulliparous G2: Parous women</p> <p>Group N: G1: 10413 G2: 11305</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancy delivering term baby at Osaka Med Center and Research Institute for Maternal and Child Health in 1981-1999 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> None reported 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> In data base, but don't know if self reported <p>Pregravid BMI: G1: 20.5 (2.6) G2: 21.1 (3.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Categorical in 2 kg/m² point intervals from prepregnancy weight; categorical into low, medium, high BMI groups (< 18, 18-23.9, > 24) <p>Age (mean, yrs): G1: 27.8 (4.1) G2: 30.45 (3.9)</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 21. Maternal weight and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 10413 G2: 11305</p> <p>Total weight gain: G1: kg/wk: 0.25 (SD 0.09) G2: kg/wk: 0.24 (0.09) <i>P</i> < 0.01</p> <p>Categorized:</p> <ul style="list-style-type: none"> Categorical in kg/wk using prepregnancy weight and weight at delivery divided by gestational age of infant at birth <p>Collected from:</p> <ul style="list-style-type: none"> Rate of weight gain determined by: total weight gain divided by weeks ga <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: and subtracting prepregnancy weight 	<p>Birth weight: G1: SGA: 5.4% LGA 5.2% G2: SGA 6.5% LGA 5.2%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> NR <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Odds ratio for LGA (95% CIs)</p> <p>Groups Nulliparous G1: Low BMI (< 18), WG > 0.40 kg/wk G2: Medium BMI (18-23.9), WG 0.20-0.25 kg/wk G3: WG 0.25-0.30 kg/wk (Reference) G4: Medium BMI, WG 0.30-0.35 kg/wk G5: Medium BMI, WG 0.35-0.40 kg/wk G6: Medium BMI, WG > 0.40 kg/wk</p> <p>Parous G7: Low BMI (< 18), WG > 0.40 kg/wk G8: WG 0.20-0.25 kg/wk (Reference for low/med BMI) G9: Medium BMI (18-23.9), WG 0.25-0.30 kg/wk G10: Medium BMI, WG 0.30-0.35 kg/wk G11: Medium BMI, WG 0.35-0.40 kg/wk G12: Medium BMI, WG > 0.40 kg/wk G13: High BMI (≥ 24), WG 0.15-0.20 kg/wk G14: WG ≥ 0.30 kg/wk (Reference for high BMI)</p> <p>Results G1: 2.25 (1.03-4.94) G2: 1.41 (1.31-1.76) G3: 1.0 G4: 1.76 (1.38-2.23) G5: 2.34 (1.77-3.10) G6: 2.58 (1.71-3.89) G7: 2.16 (0.63- 7.44) G8: 1.0 G9: 1.48 (1.15-2.33) G10: 1.64 (1.18-2.27) G11: 2.23 (1.51-3.31) G12: 3.94 (2.56-6.03) G13: 2.27 (1.31-3.95) G14: 1.0</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Preeclampsia, C-section, 1-minute Apgar score < 4</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age(continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) <i>(P < 0.05)</i></p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% (<i>P < 0.01</i>)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: SGA (%)</p> <p>Groups G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: >35 lbs</p> <p>Results G1: 4 G2: 3.9 G3: 5.6 G4: 3.1 G5: 3.8</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Caulfield et al., 1998</p> <p>Country and setting: USA, hospital obstetric database</p> <p>Enrollment Period: 1987 to 1989</p> <p>Funding: NR</p> <p>Study Objective: To examine relation between gestational weight gain and risk of delivering a small for gestational age infant by race</p> <p>Time frame: 1987-1989</p> <p>Duration of the study: Entry into pn care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,870</p> <p>Group Description: G1: BMI < 19.8 Black G2: BMI < 19.8 White G3: BMI 19.8 to 26.0 Black G4: BMI 19.8 to 26.0 White G5: BMI > 26.0 Black G6: BMI > 26.0 White</p> <p>Group N: G1: 523 G2: 267 G3: 1,479 G4: 796 G5: 615 G6: 190</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancies White or black ethnicity At least 28 weeks' gestation One delivery per woman (randomly chosen) Information on anthropometric data <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Improbable data Non-black or non-white ethnicity 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 13.3 (5.7) G2: 14.6 (5.1) G3: 13.6 (6.7) G4: 15.3 (5.4) G5: 12.4 (7.7) G6: 14.5 (7.3)</p> <p>Pregravid BMI:</p> <p>G1: 18.4 (1.0) G2: 18.5 (1.0) G3: 22.7 (1.8) G4: 22.1 (1.8)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 21.7 (4.8) G2: 27.1 (6.6) G3: 22.7 (5.3) G4: 29.8 (5.8) G5: 24.9 (6.0) G6: 28.2 (5.5)</p> <p>Parity: G1: % primiparous: 52.4 G2: 55.4 G3: 50.1 G4: 48.0 G5: 36.9 G6: 46.9</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 32.8 G2: 20.6 G3: 35.4 G4: 20.0 G5: 28.8 G6: 25.4</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 4.3 G2: 3.0 G3: 6.0 G4: 5.7 G5: 11.9 G6: 17.0</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: 13.3 (5.7) G2: 14.6 (5.1) G3: 13.6 (6.7) G4: 15.3 (5.4) G5: 12.4 (7.7) G6: 14.5 (7.3)</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between selfreport prepregnancy weight and last recorded weight </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Odds ratio (95% CI) for SGA per 50g/wk increase in rate of weight gain by BMI</p> <p>Groups G1: Underweight G2: Normal weight G3: Overweight</p> <p>Results G1: 0.87 (0.78-0.97) G2: 0.90 (0.84-0.96) G3: 0.93 (0.86-1.01)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pregravid BMI Height Hypertension Provider type Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Infant sex</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 6 Good, 3 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cedergren, 2006</p> <p>Country and setting: Sweden, Medical Birth Registry</p> <p>Enrollment Period: January 1, 1994 - December 31, 2002</p> <p>Funding: Ostergotland County Council</p> <p>Study Objective: To estimate effects of high and low gestational weight gain in different maternal BMI classes on obstetric and neonatal outcomes</p> <p>Time frame: January 1, 1994 to December 31, 2002</p> <p>Duration of the study: First visit to maternity health care center to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 245,526</p> <p>Group Description: BMI</p> <p>G1: < 20 G2: 20 to 24.9 G3: 25 to 29.9 G4: 30 to 34.9 G5: ≥ 35</p> <p>Group N: G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton, term pregnancies Information on maternal height, maternal weight in early pregnancy, and gestational weight gain <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported If unknown, standardized measurement is made during first visit to maternity health care center <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> < 20, 20.0-24.9, 25.0-29.9, 30-34.9, ≥ 35 <p>Age (mean, yrs):</p> <p>G1: 15 to 19 years: 3.8% 20 to 24: 23.0% 25 to 29: 38.7% 30 to 34: 25.7% 35 to 39: 7.7% ≥ 40: 1.1%</p> <p>G2: 15 to 19 years: 1.9% 20 to 24: 15.9% 25 to 29: 37.7% 30 to 34: 31.1% 35 to 39: 11.3% ≥ 40: 1.9%</p> <p>G3: 15 to 19 years: 1.5% 20 to 24: 15.7% 25 to 29: 36.1% 30 to 34: 31.2% 35 to 39: 12.9% ≥ 40: 2.5%</p> <p>G4: 15 to 19 years: 1.5% 20 to 24: 17.4% 25 to 29: 35.6% 30 to 34: 30.0% 35 to 39: 13.0% ≥ 40: 2.4%</p> <p>G5: 15 to 19 years: 1.1% 20 to 24: 17.3% 25 to 29: 38.0% 30 to 34: 29.6% 35 to 39: 11.7% ≥ 40: 2.3%</p>	<p>Race, %: White G1: 96.6 G2: NR Black NR Hispanic NR Asian/Pacific Islander G1: 1.4 G2: NR Other G1: 2.0 G2: NR</p> <p>Smoking, %: G1: % nonsmoking: 81.6 G2: 85.2 G3: 83.1 G4: 79.9 G5: 78.4 Group 6</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Total weight gain: G1: < 8kg: 6.9% 8-15.9kg: 65.2% ≥ 16kg: 28.0% G2: < 8kg: 8.4% 8-15.9kg: 67.1% ≥ 16kg: 30.4% G3: < 8kg: 15.7% 8-15.9kg: 54.4% ≥ 16kg: 29.9% G4: < 8kg: 30.2% 8-15.9kg: 48.7% ≥ 16kg: 21.1% G5: < 8kg: 44.6% 8-15.9kg: 40.9% ≥ 16kg</p> <p>Categorized: <ul style="list-style-type: none"> < 8kg, 8-16, > 16 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between maternal weights measured when woman attended delivery unit and maternal weight recorded at first visit to maternity health care center </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Odds ratios (95% CIs) for SGA (< 2 SD below the mean)</p> <p>Groups Weight gain < 8 kg G1: BMI < 20 G2: BMI 20-24.9 G3: BMI 25-29.9 G4: BMI 30-34.9 G5: BMI ≥ 35</p> <p>Weight gain > 16 kg G6: BMI < 20 G7: BMI 20-24.9 G8: BMI 25-29.9 G9: BMI 30-34.9 G10: BMI ≥ 35</p> <p>Weight gain 8-16 kg (Reference)</p> <p>Results G1: 2.35 (1.92-2.88) G2: 1.99 (1.77-2.23) G3: 1.75 (1.48-2.07) G4: 1.68 (1.26-2.25) G5: 1.71 (1.03-2.85)</p> <p>G6: 0.50 (0.41-0.61) G7: 0.50 (0.45-0.56) G8: 0.57 (0.47-0.68) G9: 0.61 (0.40-0.93) G10: 0.50 (0.20-1.24)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Year of birth</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Cheng et al., 2004</i></p> <p>Country and setting: <i>Missouri - birth certificate data</i></p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: <i>To estimate whether maternal weight changes between pregnancy influence risk for small for gestational age births</i></p> <p>Time frame: NR</p> <p>Duration of the study: <i>1989 to 1997</i></p>	<p>Design:</p> <ul style="list-style-type: none"> Case-control Retrospective <p>Total Study N:</p> <ul style="list-style-type: none"> Cases: 6,973 (8,062 used but percentages based on those with information) Controls: 7,141 (8,062 used but percentages based on those with information) <p>Group Description: G1: Cases G2: Controls</p> <p>Group N: G1: 8,062 G2: 8,062</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Second born infants: cases had second born SGA infants (less than the 10th percentile of birth weight) Controls were randomly selected by year of birth from remaining cohort of mothers with 2 live births during study period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported NR <p>Pregravid BMI: G1: < 19.8: 26% 19.8 to 26.0: 47% >26: 22% G2: < 19.8: 14% 19.8 to 26.0: 51% >26: 30%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized: IOM Guidelines</p> <p>Age (mean, yrs): G1: < 20: 15% 20 to 34: 80% ≥ 35: 5% G2: < 20: 10 % 20 to 34: 83% ≥ 35: 6%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 86 G2: 85 Black G1: 13 G2: 13 Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 40 G2: 17</p> <p>Diabetes mellitus, %: G1: 2 G2: 2</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % married: G1: 67% G2: 77%</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 8,062 G2: 8,062</p> <p>Total weight gain: G1: < 0.2kg/wk: 17% ≥ 0.2kg/wk: 78% G2: < 0.2kg/wk: 11% ≥ 0.2kg/wk: 86% <i>P < 0.001 cases vs. controls</i></p> <p><i>Categorized:</i> Rate - kG/wk</p> <p><i>Collected from:</i></p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records Birth certificate <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 2 G2: 2</p> <p>Group 3 Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> NA <p>Other infant outcomes</p> <ul style="list-style-type: none"> NA 	<p>Outcomes Description: Odds ratio (95% CI) for SGA by weight gain categories</p> <p>Groups SGA G1: WG < 0.2 kg/wk G2: WG ≥ 0.2 kg/wk (Reference)</p> <p>SGA for low weight gain (< 0.2 kg/wk) by BMI G1: Underweight G2: Normal weight G3: Overweight G4: Obese</p> <p>Results SGA G1: 1.9 (1.8-2.2) G2: 1.022%</p> <p>SGA by BMI G1: (1.2-2.4) G2: (1.9-2.7) G3: (1.6-2.9) G4: (1.4-2.1)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, education, Medicaid status, pregravid BMI, smoking, previous SGA, adequacy of prenatal care, maternal cardiac disease, preeclampsia, year of birth of second infant</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 2 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cherry et al., 1993</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: NR-to examine effect of zinc on birth outcomes</p> <p>Time frame: NR</p> <p>Duration of the study: 9 months-from time of enrollment in to prenatal care up to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • RCT <p>Total Study N: 599</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 599 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Adolescents in prenatal clinic at Charity Hospital of New Orleans <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Measured by study investigators <p>G1: 53% were 90-110% Expected Weight (EW); 26% < 90% EW; 21% were > 110% EW G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Calculated weight for age and height <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race,%: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking,%: NR</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Grams gained per week per cm height <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Table 1 provided data above-LBW, wt for length of infant, % of infants in high risk nursery</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Percentage SGA for each shifting of EW category.</p> <p>Groups Light: < 90% EW Normal: 90 to 110% of EW Heavy: > 110% EW</p> <p>G1: Normal to Heavy G2: Light to Normal G3: Heavy to Heavy G4: Normal to Normal G5: Light to Light G6: Heavy to Normal G7: Normal to Light</p> <p>Results G1: 22% G2: 39% G3: 38% G4: 41% G5: 62% G6: 60% G7: 65%</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Poor</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 3 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cnattingius et al., 1998</p> <p>Country and setting: Sweden, Medical birth register</p> <p>Enrollment Period: 1992-1993</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of prepregnancy BMI on risk of late fetal death, early neonatal death, preterm delivery, and delivery of an infant who was SGA</p> <p>Time frame: 1992-1993</p> <p>Duration of the study: Immediately after birth (from birth register)</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 167,750</p> <p>Group Description: G1: Total sample G2: NR</p> <p>Group N: G1: 167750 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton births • Registered on Swedish Birth Registry • Women with information on prepregnancy BMI info • Women born in Sweden, Denmark, Norway, Finland, or Iceland <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: < 20: 13.5% 20-24.9: 60.4% 25-29.9: 19.9% ≥ 30: 6.2% G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • < 20.0 20-24.9 25-29.9 ≥ 30.0 <p>Age (mean, yrs): G1: ≤ 19: 2.3% 20-24: 20.3% 25-29: 39.9% 30-34: 25.9% ≥ 35: 11.7% G2: NR</p> <p>Parity: G1: Nulliparous: 40.6% G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: Nonsmoking: 77.4% G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 91,484 G2: NR</p> <p>Total weight gain: G1: < 0.25 kg/wk: 9.3%; 0.25-0.34 kg/wk: 32.9%; 0.35-0.44: 29.4%; ≥ 0.45: 20.6% G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> Rate: kg/wk </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between prepregnancy weight and weight at delivery </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> % late fetal death: 0.28% % early neonatal death: 0.18% 	<p>Outcomes Description: Odds ratios (95% CIs) for SGA</p> <p>Groups G1: WG < 0.25 kg/wk G2: WG 0.25-0.34 kg/wk G3: WG 0.35-0.44 kg/wk G4: ≥ 0.45 kg/wk (Reference)</p> <p>Results G1: 3.0 (2.5-3.5) G2: 1.9 (1.6-2.2) G3: 1.3 (1.1-1.5) G4: 1.0</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pre-gravid BMI Height Education Mother living with father Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Dawes and Grudzinskas, 1991</p> <p>Country and setting: UK, hospital</p> <p>Enrollment Period: 12 months</p> <p>Funding: Grant from Royal College of General Practitioners</p> <p>Study Objective: To examine patterns of maternal weight gain in relation to sociodemographic factors and pregnancy outcome</p> <p>Time frame: 12 months</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 988</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 988 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Alternate women who delivered at Radcliffe Hospital within 12 month period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Not stated 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal careweight measured at first visit <p>G1: 62.7 (11.15) G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 26.6 (5.1) G2: NR</p> <p>Parity:</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 988 G2: NR</p> <p>Total weight gain: G1: 10.71 (4.3) average weekly weight gain: 0.38 (0.16) G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> • Continuous </p> <p>Collected from: <ul style="list-style-type: none"> • Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3.32 (0.54) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Average weekly weight gain < 0.20 kg as a predictor of SGA</p> <p>Groups G1: Sensitivity G2: Specificity</p> <p>Results G1: 12.9% G2: 91.3%</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, parity, pre-gravid BMI, weight, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 6 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ekblad and Grenman, 1992</p> <p>Country and setting: Finland, hospital</p> <p>Enrollment Period: July 1, 1985 - December 31, 1985 (6 months)</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of abnormal maternal weight or weight gain on pregnancy outcome</p> <p>Time frame: July 1, 1985 to December 31, 1985 (6 months)</p> <p>Duration of the study: Prepregnancy to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: retrospective data from records, prospective weight and height at delivery <p>Total Study N: Total n = 357</p> <ul style="list-style-type: none"> 191 women with abnormal prepregnant weight ($\geq 20\%$ under or over ideal weight for height) or abnormal pregnancy weight gain ($\geq 20\text{kg}$ or $\leq 5\text{kg}$) 166 controls <p>Group Description: G1: $\geq 20\%$ over normal weight for height G2: $\geq 20\%$ under normal weight for height G3: weight gain $\leq 5\text{kg}$ G4: weight gain $\geq 20\text{kg}$ G5: control Group 6</p> <p>Group N: G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Birth at hospital within study period selected those with abnormal maternal prepregnancy weight or abnormal weight gain during pregnancy, as well as next mother in sequential order with normal prepregnancy weight and weight gain during pregnancy to serve as a control <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Not stated 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records - not stated if self reported <p>G1: 83.9 (10.1) G2: 46.7 (3.4) G3: 73.1 (16.5) G4: 65.0 (12.2) G5: 58.3 (6.5)</p> <p>Pregravid BMI: G1: 39.5 (3.4) G2: 17.2 (0.9) G3: 26.1 (6.1) G4: 23.6 (4.1) G5: 21.6 (2.0)</p> <p>Imputed: <ul style="list-style-type: none"> No </p> <p>Categorized: <ul style="list-style-type: none"> Continuous $\geq 20\%$ over or under normal weight for height </p> <p>Age (mean, yrs): G1: 28 (5.1) G2: 25.5 (5.1) G3: 29.5 (5.1) G4: 28.7 (4.7) G5: 28.7 (4.4)</p> <p>Parity: G1: prior deliveries: 1.0 (1.0) G2: 0.8 (0.8) G3: 1.2 (1.1) G4: 0.8 (1.0) G5: 0.9 (1.0)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Total weight gain: G1: 11.8 (6.2) <i>P</i> < 0.05 compared to controls G2: 13.4 (4.5) G3: 3.0 (3.5) <i>P</i> < 0.0005 compared to controls G4: 23.2 (22.8) <i>P</i> < 0.0005 compared to controls G5: 13.2 (3.4)</p> <p>Categorized: <ul style="list-style-type: none"> ≤ 5kg or ≥ 20kg </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3712 g (614) <i>P</i> < 0.05 compared to controls G2: 3293 (362) <i>P</i> < 0.05 compared to controls G3: 3284 (880) G4: 3803 (538) <i>P</i> < 0.005 compared to controls G5: 3538 (535)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: Elective 7% Emergency 14% Total 21% G2: Elective 4% Emergency 4% Total 8% G3: Elective 3% Emergency 3% Total 6% G4: Elective 5% Emergency 18% Total 23% G5: Elective 13% Emergency 9% Total 22%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Infant birthweight by maternal weight gain group</p> <p>Groups Infant weight percentile for mothers with normal prepregnancy weight and normal weight gain G1: < 2.5% G2: 2.5-10% G3: 10-50% G4: 50-90% G5: 90-97.5% G6: > 97.5%</p> <p>Infant weight percentile for mothers with weight gain ≤5 kg G7: < 2.5% G8: 2.5-10% G9: 10-50% G10: 50-90% G11: 90-97.5% G12: > 97.5%</p> <p>Infant weight percentile for mothers with weight gain ≥20 kg G13: < 2.5% G14: 2.5-10% G15: 10-50% G16: 50-90% G17: 90-97.5% G18: > 97.5%</p> <p>Results G1: 1% G2: 6% G3: 35% G4: 43% G5: 13% G6: 2%</p> <p>G7: 3% G8: 14% G9: 32% G10: 34% G11: 14% G12: 3% G13: 0% G14: 2% G15: 42% G16: 29% G17: 20% G18: 7%</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 4 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Ekblad and Grenman,
1992 (continued)

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		Maternal confounders and effect modifiers accounted for in analysis: NA	
		Infant and child confounders and effect modifiers accounted for in analysis: NA	

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jensen et al., 2005</p> <p>Country and setting: Denmark, university hospitals</p> <p>Enrollment Period: Gestation through birth</p> <p>Funding: Many different funds</p> <p>Study Objective: To investigate effect of gestational weight gain in obese glucose tolerant women</p> <p>Time frame: Gestation through birth</p> <p>Duration of the study: NR</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 481</p> <p>Group Description:</p> <p>G1: GWG < 5.0 kg G2: GWG 5.0-9.9kg G3: GWG 10.0-14.9 kg G4: GWG ≥ 15.0kg</p> <p>Group N:</p> <p>G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Prepregnancy BMI ≥ 30 • Normal 2h 75g oral glucose tolerance test (OGTT) during third trimester (according to WHO criteria) • Only first pregnancy during study period included <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Well defined chronic disease • Twin pregnancies • Women with GDM (n = 323) • Known diet treatment (n = 10) • Incomplete data on weight gain during pregnancy (n-153) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Records • Patient report of pregravid BMI <p>Pregravid BMI:</p> <p>G1: 34.3 (32.2-39.9) G2: 33.9 (31.5-36.5) G3: 32.9 (31.2-35.6) G4: 32.7 (31.3-34.7)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs):</p> <p>G1: 29.8 (26.4-33.1) G2: 29.1 (26.3-33.1) G3: 30.0 (26.6-33.2) G4: 27.9 (24.8-31.8)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White G1: 84.4 G2: 85.8 G3: 82.7 G4: 89.9</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 29.7 G2: 25.8 G3: 30.2 G4: 26.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 93 G2: 134 G3: 132 G4: 122</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> < 5.0, 5.0-9.9, 10.0-14.9, ≥ 15.0 Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Not stated by authors </p>	<p>Birth weight: G1: 3500 (3200-3840) G2: 3645 (3200-4000) G3: 3750 (3390-4125) G4: 3762 (3400-4120)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Rates of SGA by weight gain groups</p> <p>Groups G1: MWG < 5.0 kg (Reference) G2: MWG 5.0-9.9 kg G3: MWG 10.0-14.9 kg G4: MWG ≥ 15.0 kg</p> <p>Results No significant difference in rates of SGA by maternal weight gain group. Numerical results not reported in article</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Pregravid BMI 2h OGTT result Parity Smoking Ethnicity Clinical Center <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kabiru and Raynor, 2004</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1999 to 2002</p> <p>Funding: NR</p> <p>Study Objective: To investigate effect of increase in body mass index category on obstetric outcomes</p> <p>Time frame: 1999 to 2002</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 5,131</p> <p>Group Description:</p> <p>G1: No change in BMI between first prenatal visit and delivery</p> <p>G2: 1 category increase in BMI between first prenatal visit and delivery</p> <p>G3: > 1 category increase in BMI between first prenatal visit and delivery</p> <p>Group N:</p> <p>G1: 2,556</p> <p>G2: 2,252</p> <p>G3: 323</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancies <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple pregnancies • BMI < 20 • Missing BMI data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Measured at first prenatal visit <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • 20-24.9, 25-29.9, 30-34.9, 35-39.9, ≥ 40 <p>Age (mean, yrs):</p> <p>G1: 24.7 (6.1)</p> <p>G2: 24.4 (5.7)</p> <p>G3: 25.2 (5.9) <i>P</i> < 0.001</p> <p>Parity:</p> <p>G1: Gravidity (mean): 1.9 (1.9)</p> <p>G2: 1.5 (1.7)</p> <p>G3: 1.2 (1.7) <i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 1.9</p> <p>G2: 2.6</p> <p>G3: 2.8</p> <p>Black</p> <p>G1: 84.1</p> <p>G2: 82.8</p> <p>G3: 88.2</p> <p>Hispanic</p> <p>G1: 13.9</p> <p>G2: 14.6</p> <p>G3: 9.0</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>NR</p> <p>Smoking, %:</p> <p>NR</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>Mean weight gain:</p> <p>G1: 8.6 pounds (8.4)</p> <p>G2: 22.2 pounds (10.2)</p> <p>G3: 55.3 pounds (23.8)</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 579 G2: 942 G3: 189 G4: 819 G5: 790 G6: 104</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> > 35 pounds for normal BMI, > 25 pounds for overweight BMI, > 15 pounds for obese BMI <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not stated, most likely difference between weight at first prenatal visit and weight at delivery 	<p>Birth weight: G1: 2886.0 (756) G2: 3174.9 (600) G3: 3099.5 (673) <i>P</i> < 0.001 G4: 3116 (713) G5: 3269 (698) G6: 3371 (733) <i>P</i> = 0.015</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 8.2 G2: 12.6 G3: 21.0 <i>P</i> < 0.001 G4: 13.0 G5: 14.3 G6: 19.3 <i>P</i> = 0.256</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Percentage SGA by BMI category</p> <p>Groups G1: No change in BMI category G2: 1 category increase in BMI G3: > 1 category increase in BMI</p> <p>% SGA among overweight G4: No change in BMI category G5: 1 category increase in BMI G6: > 1 category increase in BMI</p> <p>Results G1: 19.5% G2: 13.5% G3: 9.5% G4: 14.2% G5: 9.9% G6: 11.5%</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kiel et al., 2007</p> <p>Country and setting: United States, birth registry</p> <p>Enrollment period: 1990 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of gestational weight change on pregnancy outcomes in obese women</p> <p>Time frame: 1990 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 120,170</p> <p>Group Description:</p> <p>G1: Obese Class I (BMI 30–34.9) (n = 70,536)</p> <p>G2: Obese Class II (BMI 35–39.9) (n = 30,609)</p> <p>G3: Obese Class III (BMI 40 and More) (n = 19,025)</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women residing in Missouri who delivered (at 37 or more weeks of gestation) liveborn, singleton infants during 1990–2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NR 	<p>Pregavid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregavid BMI:</p> <p>G1: Total: Class I obese: 59% Class II obese: 25% Class III obese: 16%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NIH guidelines <p>Age (mean, yrs):</p> <p>G1: <26: 46% 26-35: 47% Older than 35: 8%</p> <p>G2: <26: 44% 26-35: 48% Older than 35: 8%</p> <p>G3: <26: 40% 26-35: 52% Older than 35: 9%</p> <p>Parity: Nulliparous: G1: 34% G2: 33% G3: 32%</p>	<p>Race, %: White G1: 78 G2: 77 G3: 73</p> <p>Black G1: 22 G2: 23 G3: 27</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 22</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: GWG (lb) Less than 2: 3% 2 to 14: 15% 15 to 25: 26% More than 25: 56% G2: GWG (lb) Less than 2: 8% 2 to 14: 22% 15 to 25: 27% More than 25: 43% G3: GWG (lb) Less than 2: 15%</p> <p>Categorized: <ul style="list-style-type: none"> 10-lb or less loss 2 to 9 lbs loss, no weight change, 2 to 9 lbs gain, 10 to 14 lbs gain, 15–25 lb gain, 26–35 lb gain, and greater than 35 lb gain </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: NR</p>	<p>Birth weight: G1: SGA: 7% LGA: 13% (<i>P</i> < 0.05) G2: SGA: 7% LGA: 16% (<i>P</i> < 0.05) G3: SGA: 6% LGA: 18% (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 28 G2: 34 G3: 41</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Odds of SGA for weight gain groups</p> <p>Groups G1: Odds of SGA for weight gain > 25lbs G2: OR of SGA for weight gain < 15lbs G3: Reference Weight gain 15-25 lbs</p> <p>Results G1: lower for women in this group G2: higher for women in this group Numerical value for ORs not reported in study</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Education Poverty (enrollment in Medicaid, WIC, food stamp programs) Smoking Chronic hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Kiel et al., 2007
(continued)

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 show absolute risk of preeclampsia, cesarean delivery, LGA, and SGA by GWG category for each obesity class. All 3 figures show similar patterns of increasing risk of preeclampsia, cesarean delivery, and LGA birth and decreasing risk of SGA birth with increasing GWG. Collectively, minimal risk for all 4 outcomes corresponds to GWG categories where risk of LGA and SGA births intersect. This equates to GWG of 10 to 25 lb for class I obese women, a gain of 0 to 9 lb for class II obese women, and weight loss of 0 to 9 lb for class III obese women. Adjusted odds ratios and 95% CIs for preeclampsia, cesarean delivery, SGA, and LGA by GWG category and obesity class. Compared with women who gained 15 to 25 lb during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births. Women who gained more than 25 lbs had higher odds for same 3 pregnancy outcomes and lower odds for SGA births. <p>Other infant outcomes: NR</p>		

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kramer et al., 1990</p> <p>Country and setting: Canada, university hospital</p> <p>Enrollment Period: 1980 to 1986</p> <p>Funding: National Health Research and Development Program, Health and Welfare Canada</p> <p>Study Objective: (1) Which maternal and fetal variables appear to have independent causal impacts on intrauterine growth? (2) For a given fetal growth status, which maternal and fetal variables affect proportionality?</p> <p>Time frame: 1980 to 1986</p> <p>Duration of the study: Entry in to prenatal care up to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 8,719</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 8715 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Live-born, singleton infants without evidence of congenital intrauterine infection, chromosomal anomalies, or other major malformations and for whom gestational age calculated from last normal menstrual period agreed within ± 7 days with an early second-trimester (usually 16 to 18 weeks) Ultrasonographic estimate based on fetal biparietal diameter <p>Exclusion criteria:</p> <ul style="list-style-type: none"> See above 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported NR <p>G1: 57.8 kg (10.8) G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> They used prepregnancy wt and ht separately NR <p>Age (mean, yrs): G1: 28.6 (4.7) G2: NR</p> <p>Parity: G1: 0.72 (0.86) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: Cigarettes/d: G1: 3.2 (7.5) G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: Pg related HTN: G1: 7.7% G2: NR</p> <p>Additional characteristics: Education, y completed: G1: 13.0 (3.3) G2: NR</p> <p>Marital status: G1: 90.6% G2: NR</p> <p>Parity % primiparas: G1: 48.0 G2: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 8715 G2: NR</p> <p>Total weight gain: G1: 14.2kg (5.5) G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> Continuous </p> <p>Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery, using net weight gain (total weight minus wt of infant) </p>	<p>Birth weight: G1: 3385g (547) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Bivariate associations between selected maternal and fetal variables and fetal growth and proportionality: Correlation coefficient for net gestational weight gain (kg) and fetal growth ratio = 0.12 ($P < 0.001$); for prepregnancy weight (kg) 0.21 ($P < 0.001$) <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Correlation coefficients for Net prepregnancy weight gain (kg) and length = -0.04 ($P < 0.01$) Head circumference = -0.01 (NS); BMI 0.04 ($P < 0.001$); Ponderal index = 0.04 ($P < 0.001$) Weight/height circumference = 0.01 (NS) 	<p>Outcomes Description: Odds ratio (95% CI) for SGA for weight gain groups</p> <p>Groups G1: OR and 95% CI, for SGA for each 5 kg decrease in net gestational WG</p> <p>Results G1: 1.32 (1.20-1.44)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Pregravid weight, infant sex, smoking, parity, maternal diabetes, height, previous LBW infant, severe pregnancy-induced hypertension</p> <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Sex of the infant 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Lang et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment period: August 1977-March 1980</p> <p>Funding: NR</p> <p>Study Objective: To estimate effects of 23 factors on prevalence of premature labor and fetal growth retardation across birthweight spectrum</p> <p>Time frame: August 1977 to March 1980</p> <p>Duration of the study: Pregnancy through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 11,505</p> <p>Group Description: G1: Prevalence of preterm labor G2: Prevalence of SGA</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton • Livebirths • Had data on birthweight, gestational age, and sex • Infants with gestational age from 22 to 45 weeks • Birthweights no more than 50% higher than 90th percentile for sex and gestational age <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Women with menstrual abnormalities for whom gestational dating was problematic • Stillbirths • Incomplete data • Preterm delivery • Women with preexisting diabetes mellitus, hypertension, epilepsy, asthma 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Not stated by authors <p>G1: NR</p> <ul style="list-style-type: none"> • < 100 pounds: 11.2 • 100-125: 5.9 • 126-160: 5.1 • 161-180: 7.3 • > 180: 4.4 <p>G2: NR</p> <ul style="list-style-type: none"> • < 100 pounds: 24.9 • 100-125: 12.6 • 126-160: 7.7 • 161-180: 6.5 • > 180: 5.9 <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NR <p>Age (mean, yrs): G1:</p> <ul style="list-style-type: none"> • < 15: 14.8 • 16-19: 11.2 • 20-24: 8.2 • 25-34: 4.6 • ≥ 35: 5.5 <p>G2:</p> <ul style="list-style-type: none"> • < 15: 25.0 • 16-19: 17.6 • 20-24: 14.3 • 25-34: 9.4 • ≥ 35: 7.2 <p>Parity: G1: 6.4 G2: 12.3</p>	<p>Race, %:</p> <p>White G1: 5.3 G2: 9.1</p> <p>Black G1: 9.6 G2: 17.7</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 5.0 G2: 14.0</p> <p>Smoking, %: % smoked throughout pregnancy: G1: 8.3 G2: 17.9</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Weekly rate of weight gain <p>Collected from:</p> <ul style="list-style-type: none"> Not stated by authors <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Odds ratios (95% CIs) for SGA be weight gain groups</p> <p>Groups G1: WG ≤ 0.40 lbs/wk G2: WG 0.40-0.65 lbs/wk G3: WG 0.65-0.90 lbs/wk (Reference) G4: WG > 0.90 lbs/wk</p> <p>Results G1: 2.8 (2.2-3.6) G2: 1.6 (1.4-1.9) G3: 1.0 (Reference) G4: 0.6 (0.5-0.7)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Maternal height Prepregnancy weight Maternal education Health insurance Planned pregnancy Previous induced abortion Previous spontaneous abortion Previous still birth Maternal morbidity Caffeine intake Marijuana prenatal care smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Infant sex</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 3 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Muscati et al., 1996</p> <p>Country and setting: Canada, public health department</p> <p>Enrollment Period: 1979 to 1989</p> <p>Funding: NR</p> <p>Study Objective: To examine association of extent and timing of pregnancy weight gain with infant birth weight and postpartum weight retention</p> <p>Time frame: 1979 to 1989</p> <p>Duration of the study: Pregnancy through 6 weeks postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 371</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 371 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • White, low income, non-smoking women • Pregnant women <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Prematurity < 37 weeks • Adolescents < 16 years • Women > 40 years • Maternal health problems • Women who consume alcohol or drugs • Pregnancy complications such as proteinuria, hypertension, diabetes, negative weight gain, missing values 	<p>Pregravid weight: Family physicians' records G1: 62.8 +/- 16.0 kg G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Pregravid weight status categorized into 3 groups as a percentage of standard weight: underweight < 90%, normal 90-120%, and overweight > 120% <p>Age (mean, yrs): G1: 24.5 +/- 5.6 G2: NR</p> <p>Parity: G1: Primiparous 52% G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: PPWR: 5.3 +/- 5.7 kg G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: 16.1 +/- 6.4 kg G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Collected from:</p> <ul style="list-style-type: none"> • Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: From Table 1: Pearson's Correlation Coefficient and determination coefficient of maternal weight gain with PP weight retention and Infant BW. Maternal PP weight retention and Preg weight gain: [Total amount $r = 0.808$, R square 65.3%, $P < 0.001$], [Up to week 20 $r = 0.682$, R square 46.5%, $P < 0.001$], [Weeks 21-30 $r = 0.411$, R square 16.9%, $P < 0.001$], [Week 31 - term $r = 0.414$, R square 17.1%, $P < 0.001$]</p> <p>Other infant outcomes: Pregnancy Weight Gain and Infant Birth Weight (from Table 1): [Total amount $r = 0.216$, R square 4.7%, $P < 0.001$], [Up to week 20 $r = 0.114$, R-square 1.3%, $P < 0.05$], [Weeks 21-30 $r = 0.157$, R square 2.5%, $P < 0.01$], [Week 31 - term $r = 0.160$, R square 2.6%, $P < 0.01$]</p>	<p>Outcomes Description: Odds ratios for SGA by weight gain groups</p> <p>Groups G1: per 1 kg increase in WG up to week 20 G2: per 1 kg increase in WG from weeks 21 to 30 G3: per 1 kg increase in WG from weeks 31 to term</p> <p>Results G1: 0.93 ($P = NS$) G2: 0.85 ($P < 0.01$) G3: 0.89 ($P < 0.01$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Parity • Pregravid standard weight • Pregravid excess weight, <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Birth length • Infant sex 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Parker and Abrams, 1992</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: Sept 1980 to Dec 1988</p> <p>Funding: UC Committee on Research & MCH and Resources Development, Health Resources and Services Administration</p> <p>Study Objective: To test whether gains outside IOM reference ranges were associated with increased risks of suboptimal pregnancy outcome (SGA, LGA, cesarean delivery) and to determine whether locally developed ranges were more applicable to study population</p> <p>Time frame: Sept 1980 to Dec 1988</p> <p>Duration of the study: From entry into prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 6,690</p> <p>Group Description: G1: Overall G2: NR</p> <p>Group N: G1: 6,690 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Consecutive live singleton births at Moffitt Hospital between September 1980 and December 1988 with gestational ages of 37 to 42 weeks <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Maternal transfers or transports and deliveries complicated by fetal malformations, maternal diabetes, or maternal hypertension 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 56.8 kg(SD 11.0) G2: NR</p> <p>Pregravid BMI: G1: Underweight: 27.7%, Normal weight 61.8%, Overweight: 5.6%, Obese 4.9% G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 27.7 (5.5) G2: NR</p> <p>Parity: Primiparous: G1: 58.8% G2: NR</p>	<p>Race, %: White G1: 44.0 G2: NR</p> <p>Black G1: 8.3 G2: NR</p> <p>Hispanic G1: 9.4 G2: NR</p> <p>Asian/Pacific Islander G1: 21.4 G2: NR</p> <p>Other G1: 12.0 G2: NR</p> <p>Smoking, %: G1: 12.0 G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 6690 G2: NR</p> <p>Total weight gain: G1: 15.2kg (5.2) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM Weight gain ranges based on percentiles from previous study of UC population with good pregnancy outcomes: 25th - 75th, 10-90th percentiles. For 25-75th, weight gain range = 12-17kg for underweight women (BMI < 19.8); <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3408g (462) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Odds ratios (95% CIs) of SGA for low WG</p> <p>Groups G1: Compared to UCSF Cohort 25-75th percentile of WG G2: Compared to UCSF 10-90th percentile of WG</p> <p>Results G1: 2.06 (1.62-2.63) G2: 1.82 (1.35-2.47)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pregravid BMI Height Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Steward and Moser, 2004</p> <p>Country and setting: USA, vital statistics data</p> <p>Enrollment Period: 1993</p> <p>Funding: Ohio State University Graduate School and College of Nursing</p> <p>Study Objective: To determine prevalence of IUGR in full term infants and to identify sociodemographic and maternal characteristics associated with IUGR</p> <p>Time frame: 1993</p> <p>Duration of the study: Prenatal to birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cross-sectional • Retrospective <p>Total Study N: 2,933 (from 14,463 births in county in 1993)</p> <p>Group Description: G1: Normal birth weight G2: IUGR</p> <p>Group N: G1: 1569 G2: 1364</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Birth weight > 2500g • Reported gestational age ≥ 38 weeks • Singleton birth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Chromosomal abnormality • Congenital anomaly 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Birth statistics <p>G1: 144.4 (33.3) G2: 134.4 (31.0)</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 27.0 (5.8) G2: 25.4 (5.9)</p> <p>Parity: NR</p>	<p>Race, %: White G1: 77.9 G2: 61.0 <i>P</i> < 0.001</p> <p>Black G1: 18.4 G2: 33.7</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander G1: 3.6 G2: 5.3</p> <p>Other NR</p> <p>Smoking, %: G1: 19.6 G2: 34.5 <i>P</i> < 0.001</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 1.7 G2: 1.5</p> <p>Additional characteristics: Adequate PNC G1: 53% G2: 45.9% (<i>P</i> < 0,001)</p> <p>Prev LBW G1: 0.7 G2: 1.0</p> <p>Prenatal risk G1: 24.4 G2: 26.9</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: 32.3 pounds G2: 29.2 <i>P</i> < 0.001</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Collected from:</p> <ul style="list-style-type: none"> • Self-reported • Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Self-reported • Birth certificate data 	<p>Birth weight: G1: 3484.9 (414.9) G2: 2781.4 (131.9)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: IUGR in full term newborn infants with birth weights > 2500g</p>	<p>Outcomes Description: Odds ratio (95% CI) for SGA</p> <p>Groups SGA defined as FGR < 0.85</p> <p>Results G1: 0.98 (0.97-0.98)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race • Maternal education • Marital status • Prepregnancy weight • Adequacy of prenatal care • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Infant sex 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 6 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Takimoto et al., 2006</p> <p>Country and setting: Japan, obstetric units</p> <p>Enrollment Period: 2001 to 2002</p> <p>Funding: Ministry of Health, Labour, and Welfare, Health, and Labour Research Grant, Research on Children and Families</p> <p>Study Objective: To identify adequate weight gain ranges during pregnancy in Japanese women</p> <p>Time frame: 2001 to 2002</p> <p>Duration of the study: Pregnancy through delivery (all info derived from delivery records)</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cross-sectional <p>Total Study N: 112,257</p> <p>Group Description: G1: Study cohort G2: NR</p> <p>Group N: G1: 46,659 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Vaginal birth • Singleton pregnancy • Low risk • Term <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Cesarean deliveries (n = 30,559) • Delivery method unknown (n = 2258) • Multiple gestations (n = 8387) • Preterm deliveries < 37 weeks (n = 19623) • Post-term deliveries > 41 weeks (n = 623) • Stillbirths and neonatal deaths (n = 2558) • Maternal deaths (n = 11) • Congenital anomalies of the infant (n = 2449) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Taken from records not stated whether it was self-reported or measured <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NR <p>Age (mean, yrs): G1: 29.9 (4.8) G2: NR</p> <p>Parity: % primiparous: G1: 53.5 G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 6.3 G2: NR</p> <p>Diabetes mellitus, %: G1: 1.2 G2: NR</p> <p>Hypertension, %: G1: 2.0 G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 46,659 G2: NR</p> <p>Total weight gain: G1: 9.9 (4.3) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> Gestational age specific percentile values of weight gain: under the 25th, 25th-49th, 50th-74th, 75th-89th, ≥ 90th <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: not stated 	<p>Birth weight: G1: 2982 (472) G2: NR</p> <p>Gestational diabetes, %: G1: 1.2 G2: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Macrosomia IUGR 	<p>Outcomes Description: Odds ratios (95% CI) for SGA by weight gain groups</p> <p>Groups G1: Total MWG < 25th percentile for GA G2: Total MWG 25-49th percentile for GA G3: Total MWG 50-74th percentile for GA (Reference) G4: Total MWG 75-89th percentile for GA G5: Total MWG ≥90th percentile for GA</p> <p>Results G1: 2.87 (2.56-3.21) G2: 1.49 (1.35-1.66) G3: 1.0 G4: 0.55 (0.55-0.72) G5: 0.45 (0.45-0.63)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pre-pregnancy weight <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Infant sex 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 6 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Wataba et al., 2006</p> <p>Country and setting: Japan, academic medical center</p> <p>Enrollment Period: 1981 to 1999</p> <p>Funding: NR</p> <p>Study Objective: To analyze association of pregnancy complications with prepregnant body mass index and weight gain during pregnancy in Japanese women</p> <p>Time frame: 1981 to 1999</p> <p>Duration of the study: Entry into PNC up til delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Perinatal data base and look at medical records retrospectively Retrospective <p>Total Study N: 21,718</p> <p>Group Description: G1: Nulliparous G2: Parous women</p> <p>Group N: G1: 10413 G2: 11305</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancy delivering term baby at Osaka Med Center and Research Institute for Maternal and Child Health in 1981-1999 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> None reported 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> In data base but don't know if self reported <p>Pregravid BMI: G1: 20.5 (2.6) G2: 21.1 (3.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Categorical in 2 kg/m² point intervals from prepregnancy weight; categorical into low, medium, high BMI groups (< 18, 18-23.9, > 24) <p>Age (mean, yrs): G1: 27.8 (4.1) G2: 30.45 (3.9)</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 10413 G2: 11305</p> <p>Total weight gain: G1: kg/wk: 0.25 (SD 0.09) G2: kg/wk: 0.24 (0.09) <i>P</i> < 0.01</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Categorical in kg/wk using prepregnancy weight and weight at delivery divided by gestational age of infant at birth <p>Collected from:</p> <ul style="list-style-type: none"> • Rate of weight gain determined by: total weight gain divided by weeks ga <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery: and subtracting prepregnancy weight 	<p>Birth weight: G1: SGA: 5.4% LGA 5.2% G2: SGA 6.5% LGA 5.2%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> • NR <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Odds ratios (95% CIs) for SGA by weight gain categories</p> <p>Groups</p> <p>Parous, Low BMI (< 18) G1: WG < 0.15 kg/wk G2: WG 0.15-0.20 kg/wk G3: WG 0.20-0.25 kg/wk G4: WG 0.25-0.30 kg/wk (Reference)</p> <p>Parous, Medium BMI (18-23.9) G5: WG < 0.15 kg/wk G6: WG 0.15-0.20 kg/wk G7: WG 0.20-0.25 kg/wk (Reference)</p> <p>Parous, High BMI (> 24) G8: WG < 0.15 kg/wk G9: WG 0.15-0.20 kg/wk (Reference)</p> <p>Nulliparous, Low BMI (< 18) G10: WG < 0.15 kg/wk G11: WG 0.15-0.20 kg/wk G12: WG 0.20-0.25 kg/wk G13: WG 0.25-0.30 kg/wk (Reference)</p> <p>Nulliparous, Medium BMI (18-23.9) G14: WG < 0.15 kg/wk G15: WG 0.15-0.20 kg/wk G16: WG 0.20-0.25 kg/wk G17: WG 0.25-0.30 (Reference)</p> <p>Nulliparous, High BMI (> 24) G18: WG < 0.05 kg/wk G19: WG 0.15-0.20 kg/wk (Reference)</p> <p>Results G1: 5.42 (2.86-10.27) G2: 2.78 (1.53-5.06) G3: 1.39 (0.82-2.42) G4: 1.0</p> <p>G5: 2.21 (1.67-2.93) G6: 1.68 (1.23-2.07) G7: 1.0</p> <p>G8: 2.82 (1.17-6.78) G9: 1.0</p> <p>G10: 6.20 (2.72-14.09) G11: 2.58 (1.14-5.87) G12: 2.46 (1.19-5.08) G13: 1.0</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Wataba et al., 2006
(continued)

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		G14: 2.64 (1.88-3.71) G15: 1.60 (1.15-2.23) G16: 1.39 (1.03-1.87) G17: 1.0	
		G18: 7.06 (2.11-23.61) G19: 1.0	
		Maternal confounders and effect modifiers accounted for in analysis: Preeclampsia, C-section	
		Infant and child confounders and effect modifiers accounted for in analysis: 1-minute Apgar score < 4	

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Wen et al., 1990</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: January 1983 to December 1987</p> <p>Funding: NIH contract N01-HD-4-2811</p> <p>Study Objective: To determine effect of factors related to LBW on IUGR and preterm delivery</p> <p>Time frame: January 1983 to December 1987</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 17,149</p> <p>Group Description:</p> <p>G1: Total G2: IUGR G3: Preterm delivery</p> <p>Group N:</p> <p>G1: 100% G2: 7.4% G3: 12.6%</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women seen for prenatal care and delivered of infants at study location <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Diabetes Pregnancies involving multiple births Fetal death Congenital malformation 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal careweight at first prenatal visit was used <p>G1: Prepregnancy weight (kg) < 50: 10.6%, 50-60: 32.6%, 61-72: 28.7%, 73-84: 14.5%, > 85: 13.6%</p> <p>G2: (Pregpregnancy?) Maternal weight (kg) < 50: 12.9%, 50-60: 8.5%, 61-72: 6.4%, 73-84: 5.5%, > 85: 4.8%</p> <p>G3: (Pregpregnancy?) Maternal wei</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NR <p>Age (mean, yrs):</p> <p>G1: < 17: 7.5%, 17-19: 22.7%, 20-25: 43.1%, 26-30: 17.5%, 31-35: 7.0%, > 36: 2.3%</p> <p>G2: < 17: 8.0%, 17-19: 6.6%, 20-25: 7.4%, 26-30: 7.6%, 31-35: 8.2%, > 36: 8.6%</p> <p>G3: < 17: 15.4%, 17-19: 13.0%, 20-25: 11.6%, 26-30: 12.9%, 31-35: 14.3%, > 36: 13.4%</p> <p>Parity:</p> <p>G1: Parity 0: 44.1, 1: 29.9, > 1: 26.0</p> <p>G2: Parity 0: 8.4, 1: 6.3, > 1: 6.6</p> <p>G3: Parity 0: 12.5, 1: 12.3, > 1: 12.8</p>	<p>Race, %:</p> <p>White G1: 29.7 G2: NR</p> <p>Black G1: 70.3 G2: NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 29.4 G2: 10.3 G3: 13.3</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics:</p> <p>G1: Married: 38.0% G2: Married: 6.6% G3: Married: 10.6%</p> <p>Additional characteristics:</p> <p>Education:</p> <p>G1: < 12: 41.1%, 12: 41.6%, > 12: 15.8% G2: < 12: 7.7%, 12: 7.3%, > 12: 7.6% G3: < 12: 12.8%, 12: 12.1%, > 12: 12.2%</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>G1: Weight gain/week (after the 20th week) in kg: < 0.24: 12.2%, 0.24-0.57: 54.4%, 0.58-0.74: 19.2%, ≥ 0.75: 14.3%</p> <p>G2: Weight gain/week (after the 20th week) in kg: < 0.24: 9.9%, 0.24-0.57: 7.9%, 0.58-0.74: 5.2%, ≥ 0.75: 5.7%</p> <p>G3: Weight gain/</p> <p>Categorized:</p> <ul style="list-style-type: none"> Ave weight gain per week after 20th week <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Maternal weight at delivery not available, so total weight gain not calculated 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Odds ratios for SGA by weight gain groups</p> <p>Groups G1: MWG < 0.24 kg/wk G2: MWG 0.24-0.57 kg/wk G3: MWG 0.58-0.74 kg/wk (Reference) G4: MWG ≥ 0.75 kg/wk</p> <p>Results G1: 2.24 (<i>P</i> < 0.05) G2: 1.55 (<i>P</i> < 0.05) G3: 1.0 G4: 1.25 (NS)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Marital status Eucation Previous preterm delivery Alcohol use Drug use Maternal height Maternal weight Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Infant sex</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Zhou and Olsen, 1997</p> <p>Country and setting: Denmark, two communities</p> <p>Enrollment Period: April 1984 to April 1987</p> <p>Funding: Danish National Research Foundation and Sygekassernes Helsefond</p> <p>Study Objective: To study association between gestational weight gain and different birth weight indicators considering prepregnancy BMI</p> <p>Time frame: April 1984 to April 1987</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 7122</p> <p>Group Description: G1: Entire study G2: NR</p> <p>Group N: G1: 7122 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women who provided detailed information on lifestyle during pregnancy Singletons Non-diabetic women who gave birth between weeks 37 and 42 for whom weight gain was reported <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: % < 19.8: 27.2; %19.8-26: 63.7; %26+: 9.1 G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): % < 25: G1: 30.3 G2: NR</p> <p>Parity: %nulliparous: G1: 48.9 G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: %non-smoking: G1: 60.0 G2: NR</p> <p>Diabetes mellitus, %: G1: 0 G2: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 22. Gestational weight gain and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 7122 G2: NR</p> <p>Total weight gain: G1: % < 11kg: 35.2; %12-15: 35.5; %16+: 29.3 G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> ≤ 11, 12-15, ≥ 16 kg </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between last measured weight prior to delivery and prepregnancy weight </p>	<p>Birth weight: G1: %LBW: 1.7; %normal: 96.8; %HBW: 1.5 G2: NR</p> <p>Gestational diabetes, %: G1: 0 G2: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Low birth weight (< 2500g) High birth weight (> 4500g) Growth retarded were newborns with a birth weight below 3000g in spite of a placenta weight higher than 66 percentile (491g) 	<p>Outcomes Description: Percentage growth retardation (birth weight < 3,000g and placental weight > 490g) by weight gain category and BMI</p> <p>Groups Weight gain < 11 kg G1: Underweight (Reference) G2: Normal G3: Overweight</p> <p>Weight gain 12-15 kg G4: Underweight G5: Normal G6: Overweight</p> <p>Weight gain > 16 kg G7: Underweight G8: Normal G9: Overweight</p> <p>Results G1: 1.0 G2: 0.6 (0.4-0.8) G3: 0.6 (0.4-1.1) G4: 0.3 (0.2-0.5) G5: 0.4 (0.3-0.6) G6: 0.4 (0.1-1.0) G7: 0.3 (0.2-0.5) G8: 0.2 (0.1-0.3) G9: 0.2 (0.1-0.6)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Alcohol Diabetes Term delivery Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Infant sex 	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 23. Gestational weight gain and Apgar Scores

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cedergren, 2006</p> <p>Country and setting: Sweden, Medical Birth Registry</p> <p>Enrollment Period: January 1, 1994 - December 31, 2002</p> <p>Funding: Ostergotland County Council</p> <p>Study Objective: To estimate effects of high and low gestational weight gain in different maternal BMI classes on obstetric and neonatal outcomes</p> <p>Time frame: January 1, 1994 to December 31, 2002</p> <p>Duration of the study: First visit to maternity health care center to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 245,526</p> <p>Group Description: BMI</p> <p>G1: < 20 G2: 20 to 24.9 G3: 25 to 29.9 G4: 30 to 34.9 G5: ≥ 35</p> <p>Group N: G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton, term pregnancies Information on maternal height, maternal weight in early pregnancy, and gestational weight gain <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported If unknown, standardized measurement is made during first visit to maternity health care center <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> < 20, 20.0-24.9, 25.0-29.9, 30-34.9, ≥ 35 <p>Age (mean, yrs):</p> <p>G1: 15 to 19 years: 3.8% 20 to 24: 23.0% 25 to 29: 38.7% 30 to 34: 25.7% 35 to 39: 7.7% ≥ 40: 1.1%</p> <p>G2: 15 to 19 years: 1.9% 20 to 24: 15.9% 25 to 29: 37.7% 30 to 34: 31.1% 35 to 39: 11.3% ≥ 40: 1.9%</p> <p>G3: 15 to 19 years: 1.5% 20 to 24: 15.7% 25 to 29: 36.1% 30 to 34: 31.2% 35 to 39: 12.9% ≥ 40: 2.5%</p> <p>G4: 15 to 19 years: 1.5% 20 to 24: 17.4% 25 to 29: 35.6% 30 to 34: 30.0% 35 to 39: 13.0% ≥ 40: 2.4%</p> <p>G5: 15 to 19 years: 1.1% 20 to 24: 17.3% 25 to 29: 38.0% 30 to 34: 29.6% 35 to 39: 11.7% ≥ 40: 2.3%</p>	<p>Race, %: White G1: 96.6 G2: NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander G1: 1.4 G2: NR</p> <p>Other G1: 2.0 G2: NR</p> <p>Smoking, %: G1: % nonsmoking: 81.6 G2: 85.2 G3: 83.1 G4: 79.9 G5: 78.4 Group 6</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 23. Gestational weight gain and Apgar Scores (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Total weight gain: G1: < 8kg: 6.9% 8-15.9kg: 65.2% ≥ 16kg: 28.0% G2: < 8kg: 8.4% 8-15.9kg: 67.1% ≥ 16kg: 30.4% G3: < 8kg: 15.7% 8-15.9kg: 54.4% ≥ 16kg: 29.9% G4: < 8kg: 30.2% 8-15.9kg: 48.7% ≥ 16kg: 21.1% G5: < 8kg: 44.6% 8-15.9kg: 40.9% ≥ 16kg</p> <p>Categorized: <ul style="list-style-type: none"> < 8kg, 8-16, > 16 </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between maternal weights measured when woman attended delivery unit and maternal weight recorded at first visit to maternity health care center </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Association of weight gain and Apgar scores</p> <p>Groups 5 minute Apgar Score < 7 Weight gain < 8 kg, 8-16 kg, and > 16 kg for each BMI class below G1: BMI < 20 G2: BMI 20-24.9 G3: BMI 25-29.9 G4: BMI 30-34.9 G5: BMI ≥ 35</p> <p>Results No association between low weight gain and Apgar score, despite BMI of mother</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> BMI Age Parity Smoking in early pregnancy <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Year of birth 	<p>Background: Fair</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 23. Gestational weight gain and Apgar Scores (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Johnson et al., 1992</p> <p>Country and setting: USA, prenatal clinics</p> <p>Enrollment Period: January 1, 1987- December 31, 1989</p> <p>Funding: NR</p> <p>Study Objective: To determine influences of increased maternal prepregnancy weight and increased gestational weight gain on pregnancy outcome</p> <p>Time frame: January 1, 1987 to December 31, 1989</p> <p>Duration of the study: Initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,191</p> <p>Group Description: G1: BMI < 19.8 G2: 19.8-26.0 G3: 27-29 G4: > 29 G5: All</p> <p>Group N: G1: 755 G2: 1,621 G3: 329 G4: 486 G5: 3191</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Delivery at or beyond 38 weeks of gestation Singletons Received prenatal care and delivered in Shands Hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Fetal abnormalities Oligohydramnios Polyhydramnios Medical or surgical complications (GI disorders, sickle cell hemoglobinopathy, hepatitis, hematologic disorders, malignant disease, renal disease, neurologic disease, pulmonary disease, psychiatric disorders, tuberculosis) Incomplete risk variable data or outcome variable information 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> National Academy of Sciences <p>Age (mean, yrs): G1: NR</p> <ul style="list-style-type: none"> < 20 years: 36.6% 20-26 years: 44.8% > 26 years: 18.7% <p>G2: NR</p> <ul style="list-style-type: none"> < 20 years: 30.8% 20-26 years: 46.5% > 26 years: 22.6% <p>G3:</p> <ul style="list-style-type: none"> < 20 years: 25.8% 20-26 years: 48.9% > 26 years: 25.2% <p>G4:</p> <ul style="list-style-type: none"> < 20 years: 16.5% 20-26 years: 53.9% > 26 years: 29.6% <p>G5:</p> <ul style="list-style-type: none"> < 20 years: 29.5% 20-26 years: 47.5 % > 26 years: 23.0% <p>Parity: G1: % first: 49.3 G2: 43.1 G3: 37.4 G4: 31.1 G5: 42.1</p>	<p>Race, %: White G1: 64.5 G2: 60.0 G3: 49.8 G4: 51.9 G5: 58.7</p> <p>Black G1: 33.6 G2: 37.9 G3: 48.9 G4: 47.5 G5: 39.5</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 1.9 G2: 2.1 G3: 1.2 G4: 0.6 G5: 1.7</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Hypertension, %: G1: 3.4 G2: 4.6 G3: 5.8 G4: 10.7 G5: 5.4</p> <p>Additional characteristics: G1: % married: 42.6 G2: 46.1 G3: 40.4 G4: 49.4 G5: 45.2</p> <p>Additional characteristics: NR</p>

Evidence Table 23. Gestational weight gain and Apgar Scores (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 755 G2: 1621 G3: 329 G4: 486 G5: 3191</p> <p>Total weight gain: G1:</p> <ul style="list-style-type: none"> < 16kg: 7.8% 16-25kg: 18.5% 26-35kg: 35.1% > 35kg: 38.5% <p>G2:</p> <ul style="list-style-type: none"> < 16kg: 11.7% 16-25kg: 18.0% 26-35kg: 28.8% > 35kg: 41.5% <p>G3:</p> <ul style="list-style-type: none"> < 16kg: 19.8% 16-25kg: 19.1% 26-35kg: 28.3% > 35kg: 32.8% <p>G4:</p> <ul style="list-style-type: none"> < 16kg: 32.3% 16-25kg: 22.0%; <p>Categorized:</p> <ul style="list-style-type: none"> Quartiles National Academy of Sciences (below, within, or above recommended range) <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self report and weight at last prenatal visit (mean 6.1 days prior to delivery) 	<p>Birth weight: G1:</p> <ul style="list-style-type: none"> < 2500g: 4.8% 2500-4000g: 89.1% > 4000g: 6.1% <p>G2:</p> <ul style="list-style-type: none"> < 2500g: 2.0% 2500-4000g: 85.2% > 4000g: 12.8% <p>G3:</p> <ul style="list-style-type: none"> < 2500g: 1.5% 2500-4000g: 83.0% > 4000g: 15.5% <p>G4:</p> <ul style="list-style-type: none"> < 2500g: 0.2% 2500-4000g: 82.5% > 4000g: 17.3% <p>Gestational diabetes, %: G1: 1.9 G2: 2.3 G3: 6.1 G4: 5.3 G5: 3.1</p> <p>Cesarean delivery, %: G1: NR G2: NR G3: NR G4: NR G5: 11.9</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Frequency of macrosomia = 12.2% Frequency of cesarean = 11.9% Frequency of LBW = 2.9% 	<p>Outcomes Description: Rate of 1-minute and 5-minute Apgar Scores ≤ 7 by weight gain categories</p> <p>Groups 1-minute and 5-minute Apgar score ≤ 7 G1: total weight gain < 16lb G2: total weight gain 16 - 25lb G3: total weight gain 26-35lb G4: total weight gain >35lb</p> <p>Results Increased OR for gestational weight gain, persists after adjusting (no further details provided)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Race Parity BMI category GDM Hypertension Height (tertile) Prepregnancy weight quartile Other variables entered by stepwise regression model <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> NR 	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 9 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 23. Gestational weight gain and Apgar Scores (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Johnson et al., 1992
(continued)

Evidence Table 23. Gestational weight gain and Apgar Scores (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
	<ul style="list-style-type: none">• Frequency of postdate pregnancy = 9.8%• Frequency of labor abnormalities (40% were unscheduled cesareans) = 7.8%• Frequency of oxytocin induction = 13.7%• Frequency of oxytocin augmentation = 16.1%• Frequency of meconium staining = 21.5%	
	<p>Other infant outcomes: NA</p>	

Evidence Table 23. Gestational weight gain and Apgar Scores (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Nixon et al., 1998</p> <p>Country and setting: USA, county nurse-midwifery services</p> <p>Enrollment Period: January 1991 to December 1994</p> <p>Funding: American College of Nurse Midwives</p> <p>Study Objective: To compare outcomes of term infants of average birth weight with outcomes of large infants using computer database</p> <p>Time frame: January 1991 to December 1994</p> <p>Duration of the study: First prenatal visit through birth collected retrospectively</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 2,228</p> <p>Group Description: G1: 2500 - 3999g G2: ≥ 4000g</p> <p>Group N: G1: 1906 G2: 322</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Gestational age ≥ 37 weeks Birth weight ≥ 2500g Live infant at onset of labor Birth occurred in hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with gestational diabetes that required insulin therapy 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 138 (31) G2: 158 (36) ($P < 0.0001$)</p> <p>Pregravid BMI: G1: 24 (5) G2: 26 (5.8) ($P < 0.0001$)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous IOM guidelines <p>Age (mean, yrs): G1: 25 (6) G2: 27.5 (6) ($P < 0.0001$)</p> <p>Parity: % parous: G1: 56.3 G2: 69.9 ($P < 0.00001$)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % shoulder dystocia: G1: 0.6 G2: 5.9 ($P < 0.001$)</p> <p>% NICU: G1: 4.3 G2: 6.6 ($P = ns$)</p>

Evidence Table 23. Gestational weight gain and Apgar Scores (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 1906 G2: 322</p> <p>Total weight gain: G1: 30.7+/-15 G2: 37.2+/-15 (P < 0.0001)</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> • Apgar scores 	<p>Outcomes Description: Apgar scores less than 7</p> <p>Groups 1-minute Apgar score < 7 Continuous weight gain measure</p> <p>Results Gestational weight gain not a predictor of Apgar scores < 7 (details NR)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Parity • BMI <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 23. Gestational weight gain and Apgar Scores (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Wataba et al., 2006</p> <p>Country and setting: Japan, academic medical center</p> <p>Enrollment Period: 1981 to 1999</p> <p>Funding: NR</p> <p>Study Objective: To analyze association of pregnancy complications with prepregnant body mass index and weight gain during pregnancy in Japanese women</p> <p>Time frame: 1981 to 1999</p> <p>Duration of the study: Entry into PNC up til delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Perinatal data base and look at medical records retrospectively Retrospective <p>Total Study N: 21,718</p> <p>Group Description: G1: Nulliparous G2: Parous women</p> <p>Group N: G1: 10413 G2: 11305</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancy delivering term baby at Osaka Med Center and Research Institute for Maternal and Child Health in 1981-1999 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> None reported 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> In data base, on't know if self reported <p>Pregravid BMI: G1: 20.5 (2.6) G2: 21.1 (3.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Categorical in 2 kg/m² point intervals from prepregnancy weight; categorical into low, medium, high BMI groups (< 18, 18-23.9, > 24) <p>Age (mean, yrs): G1: 27.8 (4.1) G2: 30.45 (3.9)</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 23. Gestational weight gain and Apgar Scores (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 10413 G2: 11305</p> <p>Total weight gain: G1: kg/wk: 0.25 (SD 0.09) G2: kg/wk: 0.24 (0.09) P < 0.01</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Categorical in kg/wk using prepregnancy weight and weight at delivery divided by gestational age of infant at birth <p>Collected from:</p> <ul style="list-style-type: none"> • Rate of weight gain determined by: total weight gain divided by weeks ga <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery: and subtracting prepregnancy weight 	<p>Birth weight: G1: SGA: 5.4% LGA 5.2% G2: SGA 6.5% LGA 5.2%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> • NR <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Rate of 1 minute Apgar scores <4 by weight gain categories</p> <p>Groups 1 minute Apgar score < 4 Rate of weight gain, categorized differently across different BMI groups</p> <p>Results AOR for nulliparous women with low BMI with weekly weight gain of < 15kg/wk versus women with weight gain of 0.25-0.3kg/wk: 12.24 (2.04 - 73.43)</p> <p>AOR for parous women with medium BMI, with weekly weight gain of 0.35-0.4kg/wk versus women with weight gain 0.2-0.25kg/wk: 2.21 (1.08-4.53)</p> <p>No other relationships were significant</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Parity • Baseline BMI <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 4 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 24. Gestational weight gain and perinatal mortality

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bracero and Byrne, 1997</p> <p>Country and setting: Hospital charts - Maimonides Medical Center, Brooklyn, NY</p> <p>Enrollment Period:</p> <p>Funding: NR</p> <p>Study Objective: To determine optimal weight gain in singleton pregnancy and evaluate current recommendations</p> <p>Time frame:</p> <p>Duration of the study: Jan 1, 1987 to Jan 1, 1993</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 20,971</p> <p>Group Description: G1: Total population G2: NR</p> <p>Group N: G1: 20,971 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Delivery at Maimonides Medical Center Singleton pregnancy No documentation of congenital anomaly, pregnancy was not terminated by abortion Documentation on chart of prepregnancy maternal weight, amount of maternal weight gain during pregnancy, and gender of infant <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Infants with any type of congenital anomaly (international classification of diseases (ICD-9-CM) codes 740.0-759.9 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: median BMI = 23.19 (range 14.46-40.07) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: % < 15 years: < 0.1; 15-19 yrs: 4.8; 20-24: 25.1; 25-29: 31.1; 30-34: 24.3; 35-39: 11.8; 40-44: 2.8; 45-49: 0.1; > 50: < 0.1 G2: NR</p> <p>Parity: % primigravida: G1: 25.1 G2: NR</p>	<p>Race, %: White G1: 92.1 G2: NR</p> <p>Black G1: 4.2 G2: NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander G1: 0.9 G2: NR</p> <p>Other G1: 2.1 G2: NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % married: G1: 12.4 G2: NR</p> <p>Additional characteristics: Type of service: G1: Ward, 22.5% Private: 77.5% G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 24. Gestational weight gain and perinatal mortality (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: % weight gain: lost weight, 0.4; 1 to 5lbs, 0.9; 6 to 10, 2.3; 11 to 15, 5.4; 16 to 20, 12.0; 21 to 25, 17.2; 26 to 30, 21.1; 31 to 35, 14.8; 36 to 40, 11.5; 41 to 45, 6.1; ≥ 46, 8.3 G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM ordinal categories in 5 pound intervals <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: using last measurement obtained as an outpatient 	<p>Birth weight: G1: $r = .210$ correlation with maternal weight gain G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Optimal weight gain defined as 36 to 40 pounds for underweight women, 31 to 40 pounds for women of ideal prepregnancy weight, 26 to 30 pounds for overweight women</p> <p>Other infant outcomes: Adverse outcomes:</p> <ul style="list-style-type: none"> Still birth Neonatal death Preterm delivery/low birth weight Perinatal morbidity 	<p>Outcomes Description: Perinatal mortality %</p> <p>Groups: G1: Suboptimal weight gain G2: Optimal weight gain</p> <p>Results: G1: 0.6 G2: 0.2 $P < 0.0001$</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 8 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 24. Gestational weight gain and perinatal mortality (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Naeye, 1990</p> <p>Country and setting: USA, hospitals affiliated with medical schools</p> <p>Enrollment Period: 1959 to 1966</p> <p>Funding: NR</p> <p>Study Objective: To evaluate relationship of maternal pregravid BMI to pregnancy outcome</p> <p>Time frame: 1959 to 1966</p> <p>Duration of the study: First prenatal visit to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 56,857</p> <p>Group Description: G1: BMI < 20 G2: BMI 20-24 G3: BMI 25-30 G4: BMI > 30</p> <p>Group N: G1: 12,669 G2: 28,810 G3: 10,160 G4: 5,218</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Data from Collaborative Perinatal Study <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Deliveries taking place outside of CPS hospitals 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> < 20, 20-24, 25-30, > 30 <p>Age (mean, yrs): G1: 10-18: 19.3% 35-50: 2.4% G2: 10-18: 17.8% 35-50: 5.9% G3: 10-18: 9.8% 35-50: 12.9% G4: 10-18: 7.8% 35-50: 16.3%</p> <p>Parity: NR</p>	<p>Race, %: White NR Black G1: 34.7 G2: 45.8 G3: 55.3 G4: 54.1 Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 49.1 G2: 44.9 G3: 40.0 G4: 39.8</p> <p>Diabetes mellitus, %: G1: (GDM and preexisting DM) 0.6 G2: 1.0 G3: 1.1 G4: 5.0</p> <p>Hypertension, %: G1: 7.2 G2: 7.4 G3: 8.9 G4: 8.8</p> <p>Additional characteristics: NR</p>

Evidence Table 24. Gestational weight gain and perinatal mortality (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Low weight gain defined as < 0.8 kg/month after first trimester <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: (GDM and preexisting DM) 0.6 G2: 1.0 G3: 1.1 G4: 5.0</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: % preterm births: BMI < 20: 20.8%, BMI 20-24: 19.6% (<i>P</i> < 0.01 compared to BMI < 20), BMI 25-30: 22.5 (<i>P</i> < 0.005 compared to BMI < 20), BMI > 30: 30.7% (<i>P</i> < 0.001 compared to BMI < 20)</p>	<p>Outcomes Description: Attributable risk estimates for perinatal death for low pregnancy weight gain</p> <p>Groups: Low weight gain defined as < 0.8 kg/week after the first trimester for pregravid BMI groups below: G1: BMI < 20 G2: BMI 20-24 G3: BMI 25-30 G4: BMI > 30</p> <p>Results: G1: 0.03 (95% CI, 0.02-0.05) G2: 0.02 (95% CI, 0.01-0.03) G3: 0.01 (95% CI, 0.00-0.02) G4: 0.00</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age 35-40 Diabetes mellitus Hypertensive disorders Black Preterm birth Major congenital malformations Twins Neonatal respiratory distress syndrome <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 2 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 24. Gestational weight gain and perinatal mortality (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Nohr et al., 2005</p> <p>Country and setting: Denmark, National Birth Cohort</p> <p>Enrollment Period: May, 1998 to April, 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine association between high prepregnancy BMI and fetal death, allowing for the effects of gestational age, weight gain, and maternal diseases in pregnancy</p> <p>Time frame: May, 1998 to April, 2001</p> <p>Duration of the study: Approximately 16 weeks gestational age through end of pregnancy</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 55432</p> <p>Group Description:</p> <p>G1: < 18.5 G2: 18.5-24.9 G3: 25-29.9 G4: ≥ 30</p> <p>Group N:</p> <p>G1: 2458 G2: 36986 G3: 10650 G4: 4411</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women who had participated in first telephone interview <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing information on BMI (n = 886) Missing information on gestational age (n = 30) Termination of pregnancy after first telephone interview or at an estimated gestational age less than 28 days (n = 11) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce <p>Age (mean, yrs):</p> <p>G1: < 25 years: 19.0% 25-29: 42.2% 30-34: 29.5% ≥ 35: 9.3%</p> <p>G2: < 25 years: 11.9% 25-29: 41.2% 30-34: 34.9% ≥ 35: 12.0%</p> <p>G3: < 25 years: 13.9% 25-29: 41.8% 30-34: 33.3% ≥ 35: 10.9%</p> <p>G4: < 25 years: 16.8% 25-29: 40.9% 30-34: 32.3% ≥ 35: 10.0%</p> <p>Parity:</p> <p>G1: %primiparous: 46.8 G2: 46.7 G3: 43.6 G4: 42.7</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: % non-smoking: 72.5 G2: 84.1 G3: 83.3 G4: 82.1</p> <p>Diabetes mellitus, %:</p> <p>G1: 0.3 G2: 0.6 G3: 1.6 G4: 5.0</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 24. Gestational weight gain and perinatal mortality (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 2,458 G2: 36,986 G3: 10,650 G4: 4,411</p> <p>Total weight gain: G1: 459 g/wk G2: 487 g/wk G3: 462 g/wk G4: 347 g/wk</p> <p>Categorized:</p> <ul style="list-style-type: none"> Weight gain was defined as average weekly increase between self reported weights in first and second pregnancy interviews for women who provided a first interview between 9-24 weeks, those who provided a second interview between 26 and 38 completed weeks of gestation, and those who had at least 6 weeks between 2 interviews <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 0.3 G2: 0.6 G3: 1.6 G4: 5.0</p> <p>Cesarean delivery, %:</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Adjusted odds ratio for perinatal mortality</p> <p>Groups: Weight per week for BMI groups: G1: Underweight <18.5 G2: 18.5 ≤ normal weight < 25 G3: 25 ≤ overweight < 30 G4: Obese ≥ 30</p> <p>Results: Weight gain in pregnancy was not significantly associated with the risk of stillbirth for any BMI groups</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Height Parity Socio-occupational status Physical exercise Smoking Alcohol and coffee consumption <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 7 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 25. Gestational weight gain and neonatal distress

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cedergren, 2006</p> <p>Country and setting: Sweden, Medical Birth Registry</p> <p>Enrollment Period: January 1, 1994 - December 31, 2002</p> <p>Funding: Ostergotland County Council</p> <p>Study Objective: To estimate effects of high and low gestational weight gain in different maternal BMI classes on obstetric and neonatal outcomes</p> <p>Time frame: January 1, 1994 to December 31, 2002</p> <p>Duration of the study: First visit to maternity health care center to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 245,526</p> <p>Group Description: BMI</p> <p>G1: < 20 G2: 20 to 24.9 G3: 25 to 29.9 G4: 30 to 34.9 G5: ≥ 35</p> <p>Group N: G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton, term pregnancies Information on maternal height, maternal weight in early pregnancy, and gestational weight gain <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported If unknown, standardized measurement is made during first visit to maternity health care center <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> < 20, 20.0-24.9, 25.0-29.9, 30-34.9, ≥ 35 <p>Age (mean, yrs):</p> <p>G1: 15 to 19 years: 3.8% 20 to 24: 23.0% 25 to 29: 38.7% 30 to 34: 25.7% 35 to 39: 7.7% ≥ 40: 1.1%</p> <p>G2: 15 to 19 years: 1.9% 20 to 24: 15.9% 25 to 29: 37.7% 30 to 34: 31.1% 35 to 39: 11.3% ≥ 40: 1.9%</p> <p>G3: 15 to 19 years: 1.5% 20 to 24: 15.7% 25 to 29: 36.1% 30 to 34: 31.2% 35 to 39: 12.9% ≥ 40: 2.5%</p> <p>G4: 15 to 19 years: 1.5% 20 to 24: 17.4% 25 to 29: 35.6% 30 to 34: 30.0% 35 to 39: 13.0% ≥ 40: 2.4%</p> <p>G5: 15 to 19 years: 1.1% 20 to 24: 17.3% 25 to 29: 38.0% 30 to 34: 29.6% 35 to 39: 11.7% ≥ 40: 2.3%</p>	<p>Race, %: White G1: 96.6 G2: NR Black NR Hispanic NR Asian/Pacific Islander G1: 1.4 G2: NR Other G1: 2.0 G2: NR</p> <p>Smoking, %: G1: % nonsmoking: 81.6 G2: 85.2 G3: 83.1 G4: 79.9 G5: 78.4 Group 6</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 25. Gestational weight gain and neonatal distress (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28,186 G2: 143,365 G3: 60,626 G4: 17,248 G5: 6,296</p> <p>Total weight gain: G1: < 8kg: 6.9% 8-15.9kg: 65.2% ≥ 16kg: 28.0% G2: < 8kg: 8.4% 8-15.9kg: 67.1% ≥ 16kg: 30.4% G3: < 8kg: 15.7% 8-15.9kg: 54.4% ≥ 16kg: 29.9% G4: < 8kg: 30.2% 8-15.9kg: 48.7% ≥ 16kg: 21.1% G5: < 8kg: 44.6% 8-15.9kg: 40.9% ≥ 16kg</p> <p>Categorized:</p> <ul style="list-style-type: none"> < 8kg, 8-16, > 16 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between maternal weights measured when woman attended delivery unit and maternal weight recorded at first visit to maternity health care center 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> AOR for fetal distress (95% CI) <p>Groups GWG<8 g, 8-15.9 kg, ≥ 16kg for BMI groups (8.-15.9 ref) G1: BMI < 20 G2: BMI 20-24.9 G3: BMI 25-29.9 G4: BMI 30-34.9 G5: BMI ≥ 35</p> <p>Results GWG<8kg G1: 1.05 (0.54-2.03) G2: 1.06 (0.81-1.40) G3: 0.96 (0.70-1.32) G4: 1.21 (0.79-1.85) G5: 0.59 (0.28-1.25)</p> <p>GWG≥ 16kg G1: 0.86 (0.57-1.29) G2: 1.08 (0.92-1.26) G3: 1.31 (1.05-1.53) G4: 1.02 (0.65-1.62) G5: 2.15 (1.10-4.20)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Year of birth</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 26. Gestational weight gain and neonatal hypoglycemia

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hedderson et al., 2006</p> <p>Country and setting: USA, Kaiser Permanente Medical Care Program</p> <p>Enrollment Period: January 1, 1996 - June 31, 1998</p> <p>Funding: R01 DK 54834 from National Institute of Diabetes and Digestive and Kidney Diseases, grant from American Diabetes Association and Kaiser Community Benefit research support</p> <p>Study Objective: To examine whether pregnancy weight gains outside IOM recommendations and rates of maternal weight gain are associated with neonatal complications</p> <p>Time frame: January 1, 1996 to June 31, 1998</p> <p>Duration of the study: First prenatal care visit to 30 days post delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Case-control Retrospective <p>Total Study N: 45,245</p> <p>Group Description: G1: Controls G2: Macrosomia G3: Hypoglycemia G4: Hyperbilirubinemia</p> <p>Group N: G1: 652 G2: 391 G3: 328 G4: 432</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton livebirth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> No pregestational diabetes or history of gestational diabetes (screened at 24-28 weeks gestation - meeting National Diabetes Data Group criteria for GDM) 	<p>Pregavid weight:</p> <ul style="list-style-type: none"> Self-reported in some cases used measured weight recorded in chart closes to woman's last menstrual period but no more than 12 months before her last menstrual period <p>Pregavid BMI: G1: < 19.8: 13.5% 19.8-24.9: 56.4% 25.0-29.0: 12.4% > 29.0: 17.6% G2: < 19.8: 5.1% 19.8-24.9: 51.2% 25.0-29.0: 16.6% > 29.0: 27.1% G3: < 19.8: 10.1% 19.8-24.9: 50.0% 25.0-29.0: 17.1% > 29.0: 22.9% G4: < 19.8: 13.9% 19.8-24.9: 57.9% 25.0-29.0: 13.2% > 29.0: 57.1%</p> <p>Imputed: • No</p> <p>Categorized: • IOM guidelines</p> <p>Age (mean, yrs): G1: < 25 years: 22.1% 25-29: 24.2% 30-34: 33.6% ≥ 35: 20.1% G2: < 25 years: 15.9% 25-29: 28.0% 30-34: 31.7% ≥ 35: 24.3% G3: < 25 years: 24.1% 25-29: 25.3% 30-34: 26.8% ≥ 35: 23.8% G4: < 25 years: 17.1% 25-29: 29.4% 30-34: 32.6% ≥ 35: 20.8%</p> <p>Parity: % primiparous: G1: 56.9 G2: 31.2 G3: 50.0 G4: 59.3</p>	<p>Race, %: White G1: 54.0 G2: 67.8 G3: 47.6 G4: 42.6</p> <p>Black G1: 10.0 G2: 5.1 G3: 11.3 G4: 4.4</p> <p>Hispanic G1: 17.2 G2: 15.1 G3: 20.4 G4: 15.5</p> <p>Asian/Pacific Islander G1: 8.1 G2: 3.6 G3: 6.7 G4: 20.1</p> <p>Other G1: 10.7 G2: 8.4 G3: 14.0 G4: 17.4</p> <p>Smoking, %: G1: %nonsmoking during pregnancy: 92.0; %smoked but quit: 4.2; %smoked 3.9 G2: %nonsmoking during pregnancy: 90.8; %smoked but quit: 5.3; %smoked 4.0 G3: %nonsmoking during pregnancy: 92.6; %smoked but quit: 1.5; %smoked 5.8 G4: %nonsmoking during pregnancy: 94.2; %smoked but quit: 4.9; %smoked 1.0</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Screening glucose value less than 140: G1: 85.0%: > 140: 15.0% G2: 81.6%: > 140: 18.4% G3: 81.4%: > 140: 18.6% G4: 83.3%: > 140: 16.7%</p>

Evidence Table 26. Gestational weight gain and neonatal hypoglycemia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): Total weight gain: Categorized: <ul style="list-style-type: none"> According to IOM Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records rate of maternal weight gain was calculated as total pregnancy weight gain minus infant birth weight divided by weeks of gestation when last weight was measured; rate of maternal weight gain before the third trimester was calculated using the weight measured at or before the screening test for GDM (24-28 wks of gestation) minus prepregnancy weight divided by weeks of gestation Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between final recorded weight at last prenatal visit (within 2 weeks of delivery date) and prepregnancy weight </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> AOR for neonatal hypoglycemia (95% CI) <p>Groups:</p> <p>G1: Rate of maternal weight gain (kg/wk): -0.26-0.21</p> <p>G2: Rate of maternal weight gain (kg/wk): 0.22-0.31</p> <p>G3: Rate of maternal weight gain (kg/wk): 0.32-0.39</p> <p>G4: Rate of maternal weight gain (kg/wk): 0.40-1.03</p> <p>Results:</p> <p>G1: 0.87 (0.57-1.32)</p> <p>G2: 1.00</p> <p>G3: 0.74 (0.49-1.14)</p> <p>G4: 1.91 (1.33-2.82)</p> <p>Below IOM recommendations 0.91 (0.59-1.41)</p> <p>Within IOM recommendations 1.00</p> <p>Above IOM recommendations 1.39 (1.02-1.90)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Screening glucose value from 1 hour after 50g oral glucose challenge test Difference between age at delivery and gestational age at last weight measured <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 26. Gestational weight gain and neonatal hypoglycemia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stotland et al., 2006</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: 1980 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine relationship between gestational weight gain and adverse neonatal outcomes among infants born at term (37 weeks or more)</p> <p>Time frame: 1980 to 2001</p> <p>Duration of the study: Entry into PN care up till delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 20465</p> <p>Group Description:</p> <p>G1: Gain below IOM recommendations</p> <p>G2: Gain within IOM recommendations</p> <p>G3: Gain above IOM recommendations</p> <p>Group N:</p> <p>G1: 4,114</p> <p>G2: 7,490</p> <p>G3: 8,861</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Pregnancies complicated by multiple gestations, congenital anomalies, chronic hypertension, gestational or pregestational diabetes Birth before 37 weeks Maternal transport Missing data on any of variables considered in multivariable analysis 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: < 19.8: 25.8% 19.8-26.0: 19.4% 26.1-29.0: 9.2% > 29.0: 20.6%</p> <p>G2: < 19.8: 49.1% 19.8-26.0: 34.8% 26.1-29.0: 23.3% > 29.0: 25.5%</p> <p>G3: < 19.8: 25.0% 19.8-26.0: 45.8% 26.1-29.0: 67.5% > 29.0: 53.9% <i>P</i> < 0.001</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: < 20 years: 23.4% 20-29 years: 19.3% 30-39 years: 19.9% > 40 years: 25.3%</p> <p>G2: < 20 years: 31.3% 20-29 years: 36.6% 30-39 years: 37.6% > 40 years: 36.3%</p> <p>G3: < 20 years: 45.4% 20-29 years: 44.0% 30-39 years: 42.5% > 40 years: 38.4% <i>P</i> < 0.001</p> <p>Parity:</p> <p>% Nulliparous:</p> <p>G1: 17.3</p> <p>G2: 36.2</p> <p>G3: 46.6</p> <p><i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 16.2</p> <p>G2: 35.8</p> <p>G3: 48.0</p> <p>Black</p> <p>G1: 25.5</p> <p>G2: 29.4</p> <p>G3: 45.1</p> <p>Hispanic</p> <p>G1: 19.2</p> <p>G2: 34.8</p> <p>G3: 46.0</p> <p>Asian/Pacific Islander</p> <p>G1: 24.3</p> <p>G2: 43.3</p> <p>G3: 32.4</p> <p>Other</p> <p>G1: 21.7</p> <p>G2: 37.9</p> <p>G3: 40.4</p> <p><i>P</i> for all race categories < 0.001</p> <p>Smoking, %:</p> <p>G1: 23.5</p> <p>G2: 30.8</p> <p>G3: 45.8 <i>P</i> < 0.001</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 26. Gestational weight gain and neonatal hypoglycemia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 4114 G2: 7490 G3: 8861</p> <p>Total weight gain:</p> <p><i>Categorized:</i></p> <ul style="list-style-type: none"> According to IOM percentiles and dichotomous <p><i>Collected from:</i></p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: %SGA: 36.1; %AGA: 20.2; %LGA: 8.5 G2: %SGA: 39.4; %AGA: 37.5; %LGA: 26.5 G3: %SGA: 24.5; %AGA: 42.4; %LGA: 65.1 <i>P</i> < 0.001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 14.7 G2: 32.1 G3: 53.2</p> <p>Instrumental delivery, %: Operative vaginal delivery: G1: 18.0% G2: 37.5% G3: 44.5%</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Birth trauma 5 min Apgar score less than 7 Assisted ventilation SGA LGA NICU admission SCN admission Neonatal infection Seizure Hypoglycemia Polycythemia MAS RDS Tachypnea Hospital stay > 5 days Hospital stay > 10 days 	<p>Outcomes Description: AOR for neonatal hypoglycemia (95% CI)</p> <p>Groups: G1: GWG > 7 kg G2: GWG 11.5-16 kg G3: GWG >18 kg</p> <p>Results Hypoglycemia G1: 1.86 (0.91-3.81) G2: 1.0 G3: 1.67 (1.13-2.46)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Pregnancy induced hypertension Date of delivery Mode of delivery Length of first stage of labor Length of second stage of labor Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age <p>Birth weight</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 27. Gestational weight gain and hyperbilirubinemia

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hedderson et al., 2006</p> <p>Country and setting: USA, Kaiser Permanente Medical Care Program</p> <p>Enrollment Period: January 1, 1996 - June 31, 1998</p> <p>Funding: R01 DK 54834 from National Institute of Diabetes and Digestive and Kidney Diseases, grant from American Diabetes Association and Kaiser Community Benefit research support</p> <p>Study Objective: To examine whether pregnancy weight gains outside IOM recommendations and rates of maternal weight gain are associated with neonatal complications</p> <p>Time frame: January 1, 1996 to June 31, 1998</p> <p>Duration of the study: First prenatal care visit to 30 days post delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Case-control • Retrospective <p>Total Study N: 45,245</p> <p>Group Description: G1: Controls G2: Macrosomia G3: Hypoglycemia G4: Hyperbilirubinemia</p> <p>Group N: G1: 652 G2: 391 G3: 328 G4: 432</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton livebirth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • No pregestational diabetes or history of gestational diabetes (screened at 24-28 weeks gestation - meeting National Diabetes Data Group criteria for GDM) 	<p>Pregavid weight:</p> <ul style="list-style-type: none"> • Self-reported in some cases used measured weight recorded in chart closes to woman's last menstrual period but no more than 12 months before her last menstrual period <p>Pregavid BMI: G1: < 19.8: 13.5% 19.8-24.9: 56.4% 25.0-29.0: 12.4% > 29.0: 17.6% G2: < 19.8: 5.1% 19.8-24.9: 51.2% 25.0-29.0: 16.6% > 29.0: 27.1% G3: < 19.8: 10.1% 19.8-24.9: 50.0% 25.0-29.0: 17.1% > 29.0: 22.9% G4: < 19.8: 13.9% 19.8-24.9: 57.9% 25.0-29.0: 13.2% > 29.0: 57.1%</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: < 25 years: 22.1% 25-29: 24.2% 30-34: 33.6% ≥ 35: 20.1% G2: < 25 years: 15.9% 25-29: 28.0% 30-34: 31.7% ≥ 35: 24.3% G3: < 25 years: 24.1% 25-29: 25.3% 30-34: 26.8% ≥ 35: 23.8% G4: < 25 years: 17.1% 25-29: 29.4% 30-34: 32.6% ≥ 35: 20.8%</p> <p>Parity: % primiparous: G1: 56.9 G2: 31.2 G3: 50.0 G4: 59.3</p>	<p>Race, %: White G1: 54.0 G2: 67.8 G3: 47.6 G4: 42.6</p> <p>Black G1: 10.0 G2: 5.1 G3: 11.3 G4: 4.4</p> <p>Hispanic G1: 17.2 G2: 15.1 G3: 20.4 G4: 15.5</p> <p>Asian/Pacific Islander G1: 8.1 G2: 3.6 G3: 6.7 G4: 20.1</p> <p>Other G1: 10.7 G2: 8.4 G3: 14.0 G4: 17.4</p> <p>Smoking, %: G1: %nonsmoking during pregnancy: 92.0; %smoked but quit: 4.2; %smoked 3.9 G2: %nonsmoking during pregnancy: 90.8; %smoked but quit: 5.3; %smoked 4.0 G3: %nonsmoking during pregnancy: 92.6; %smoked but quit: 1.5; %smoked 5.8 G4: %nonsmoking during pregnancy: 94.2; %smoked but quit: 4.9; %smoked 1.0</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Screening glucose value less than 140: G1: 85.0%: > 140: 15.0% G2: 81.6%: > 140: 18.4% G3: 81.4%: > 140: 18.6% G4: 83.3%: > 140: 16.7%</p>

Evidence Table 27. Gestational weight gain and hyperbilirubinemia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records rate of maternal weight gain was calculated as total pregnancy weight gain minus infant birth weight divided by weeks of gestation when last weight was measured; rate of maternal weight gain before the third trimester was calculated using the weight measured at or before the screening test for GDM (24-28 wks of gestation) minus prepregnancy weight divided by weeks of gestation <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between final recorded weight at last prenatal visit (within 2 weeks of delivery date) and prepregnancy weight 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> AOR for hyperbilirubinemia (95% CI) <p>Groups:</p> <p>G1: Rate of maternal weight gain (kg/wk): -0.26-0.21</p> <p>G2: Rate of maternal weight gain (kg/wk): 0.22-0.31</p> <p>G3: Rate of maternal weight gain (kg/wk): 0.32-0.39</p> <p>G4: Rate of maternal weight gain (kg/wk): 0.40-1.03</p> <p>Results:</p> <p>G1: 0.74 (0.49-1.11)</p> <p>G2: 1.00</p> <p>G3: 0.91 (0.62-1.34)</p> <p>G4: 1.58 (1.10-2.28)</p> <p>Below IOM recommendations 0.98 (0.65-1.47)</p> <p>Within IOM recommendations 1.00</p> <p>Above IOM recommendations 1.43 (1.06-1.93)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Screening glucose value from 1 hour after 50g oral glucose challenge test Difference between age at delivery and gestational age at last weight measured <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 28. Gestational weight gain and neonatal hospitalization

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Murakami et al., 2004</p> <p>Country and setting: Japan, hospital</p> <p>Enrollment Period: 2001</p> <p>Funding: NR</p> <p>Study Objective: To estimate risk of perinatal morbidity of mother and infant with respect to maternal prepregnancy BMI and weight gain in Japanese women</p> <p>Time frame: 2001</p> <p>Duration of the study: Prenatal through birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 633</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 633 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Live, singletons delivered between 24 to 42 weeks gestation <p>Exclusion criteria:</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: 20.9 (2.8) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • WHO International Taskforce <p>Age (mean, yrs): G1: 29.1 (4.5) G2: NR</p> <p>Parity: G1: 0.6 (0.7) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 8.5 G2: NR</p> <p>Diabetes mellitus, %: G1: 2.1 G2: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: Preeclampsia Mild: 5.4% Severe: 4.1% G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 28. Gestational weight gain and neonatal hospitalization (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 633 G2: NR</p> <p>Total weight gain: G1: 10.5 (3.4) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> < 8.5kg, 8.5-12.5, > 12.5 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: last measurement was taken at hospitalization prior to delivery 	<p>Birth weight: G1: 3,052.6 (483.8) G2: NR</p> <p>Gestational diabetes, %: G1: 2.1 G2: NR</p> <p>Cesarean delivery, %: G1: 10.3 G2: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Adjusted ORs of hospitalization of infant (95% CI)</p> <p>Groups: Gesational weight gain G1: < 8.5 kg G2: 8.5-12.5 kg G3: > 12.5 kg</p> <p>Hospitalization of infant G1: 1.60 (0.88-2.88) G2: 1.00 G3: 0.93 (0.46-1.88)</p> <p>Outcomes Set 2: NR</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pre-gravid BMI Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 8 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 29. Gestational weight gain and other infant morbidity

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Spector et al., 2007</p> <p>Country and setting: United States, hospital</p> <p>Enrollment period: January 1, 1996 and August 20, 2002</p> <p>Funding: National Cancer Institute grant R01CA79940. University of Minnesota supported by Children's Cancer Research Fund (Minneapolis, MN) and grants U10CA13539 and U10CA98543</p> <p>Study Objective: Report association between birth characteristics and maternal reproductive history with infant leukemia</p> <p>Time frame: January 1, 1996 and August 20, 2002</p> <p>Duration of the study: Entry to prenatal care until child's first birthday</p>	<p>Design:</p> <ul style="list-style-type: none"> • Case-control • Retrospective <p>Total Study N: 495</p> <p>Group Description: G1: Cases G2: Controls G3: P value</p> <p>Group N: G1: 240 G2: 255</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Infants diagnosed with leukemia at < 1 year of age. <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • No telephone • Down syndrome • Biological mother not available for interview in English 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: 25.2 (5.07) G2: 25.1 (5.52) G3: 0.83</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • WHO International Taskforce <p>Age (mean, yrs): G1: 29 (5.54) G2: 30 (5.58) G3: 0.06</p> <p>Parity: NR</p>	<p>Race, %: White G1: 79.5 G2: 85.5 G3: 0.003</p> <p>Black G1: 2.1 G2: 5.5</p> <p>Hispanic G1: 10.5 G2: 3.5</p> <p>Asian/Pacific Islander G1: 8.0 G2: 5.5</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 29. Gestational weight gain and other infant morbidity (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 240 G2: 255</p> <p>Total weight gain: G1: 15.3 (7.52) G2: 14.6 (7.62) G3: 0.31</p> <p>Categorized:</p> <ul style="list-style-type: none"> Quartiles <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> Self-reported 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Finally, no observation observed between infant leukemia and maternal prepregnancy BMI or weight gain during pregnancy <p>Other infant outcomes: NR</p>	<p>Outcomes Description: AORs for acute lymphoblastic leukemia (95% CI)</p> <p>Groups: G1: GWG ≤ 9.07 kg G2: GWG 9.53-13.61 kg G3: GWG: 13.61-18.14 kg G4: GWG: > 18.14 kg</p> <p>Results: G1: 1.0 G2: 1.16 (0.68-1.99) G3: 1.25 (0.71-2.21) G4: 1.50 (0.84-2.68)</p> <p>P for trend=0.23</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal education <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 7 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 29. Gestational weight gain and other infant morbidity (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stotland et al., 2006</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: 1980 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine relationship between gestational weight gain and adverse neonatal outcomes among infants born at term (37 weeks or more)</p> <p>Time frame: 1980 to 2001</p> <p>Duration of the study: Entry into PN care up till delivery</p> <p>Quality: Fair</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 20465</p> <p>Group Description:</p> <p>G1: Gain below IOM recommendations</p> <p>G2: Gain within IOM recommendations</p> <p>G3: Gain above IOM recommendations</p> <p>Group N:</p> <p>G1: 4,114</p> <p>G2: 7,490</p> <p>G3: 8,861</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Pregnancies complicated by multiple gestations, congenital anomalies, chronic hypertension, gestational or pregestational diabetes Birth before 37 weeks Maternal transport Missing data on any of variables considered in multivariable analysis 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: < 19.8: 25.8% 19.8-26.0: 19.4% 26.1-29.0: 9.2% > 29.0: 20.6%</p> <p>G2: < 19.8: 49.1% 19.8-26.0: 34.8% 26.1-29.0: 23.3% > 29.0: 25.5%</p> <p>G3: < 19.8: 25.0% 19.8-26.0: 45.8% 26.1-29.0: 67.5% > 29.0: 53.9% <i>P</i> < 0.001</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: < 20 years: 23.4% 20-29 years: 19.3% 30-39 years: 19.9% > 40 years: 25.3%</p> <p>G2: < 20 years: 31.3% 20-29 years: 36.6% 30-39 years: 37.6% > 40 years: 36.3%</p> <p>G3: < 20 years: 45.4% 20-29 years: 44.0% 30-39 years: 42.5% > 40 years: 38.4% <i>P</i> < 0.001</p> <p>Parity:</p> <p>% Nulliparous:</p> <p>G1: 17.3</p> <p>G2: 36.2</p> <p>G3: 46.6</p> <p><i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 16.2</p> <p>G2: 35.8</p> <p>G3: 48.0</p> <p>Black</p> <p>G1: 25.5</p> <p>G2: 29.4</p> <p>G3: 45.1</p> <p>Hispanic</p> <p>G1: 19.2</p> <p>G2: 34.8</p> <p>G3: 46.0</p> <p>Asian/Pacific Islander</p> <p>G1: 24.3</p> <p>G2: 43.3</p> <p>G3: 32.4</p> <p>Other</p> <p>G1: 21.7</p> <p>G2: 37.9</p> <p>G3: 40.4</p> <p><i>P</i> for all race categories < 0.001</p> <p>Smoking, %:</p> <p>G1: 23.5</p> <p>G2: 30.8</p> <p>G3: 45.8 <i>P</i> < 0.001</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 29. Gestational weight gain and other infant morbidity (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 4114 G2: 7490 G3: 8861</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOMpercentiles and dichotomous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: %SGA: 36.1; %AGA: 20.2; %LGA: 8.5 G2: %SGA: 39.4; %AGA: 37.5; %LGA: 26.5 G3: %SGA: 24.5; %AGA: 42.4; %LGA: 65.1 <i>P</i> < 0.001</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: 14.7 G2: 32.1 G3: 53.2</p> <p>Instrumental delivery,%: Operative vaginal delivery: G1: 18.0% G2: 37.5% G3: 44.5%</p> <p>Episiotomy,%: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Birth trauma 5 min Apgar score less than 7 , Aassisted ventilation SGA LGA NICU admission SCN admission Neonatal infection Seizure Hypoglycemia Polycythemia MAS RDS Tachypnea Hospital stay > 5 days Hospital stay > 10 days 	<p>Outcomes Description: AOR for morbidity (95% CI)</p> <p>Groups: G1: GWG > 7 kg G2: GWG 11.5-16 kg G3: GWG >18 kg</p> <p>Results Seizure G1: 10.66 (2.17-52.36) G3: 6.19 (1.32-28.96)</p> <p>Polycythemia G1: 1.32 (0.66-2.62) G3: 1.59 (1.13-2.22)</p> <p>MAS (meconium aspiration syndrome)/ RDS (respiratory distress syndrome) or tachypnea G1: 1.93 (0.82-4.53) G3: 1.86 (1.13-3.05)</p> <p>RDS (respiratory distress syndrome) or tachypnea G1: 0.56 (0.29-1.06) G3: 1.04 (0.79-1.38)</p> <p>Hospital stay more than 5 days/ Hospital stay more than 10 days G1: 1.44 (1.02-2.04) G3: 1.07 (0.90-1.28)</p> <p>Hospital stay more than 10 days G1: 1.13 (0.51-2.53) G3: 1.22 (0.81-1.84)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Pregnancy induced hypertension Date of delivery Mode of delivery Length of first stage of labor Length of second stage of labor Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age Birth weight</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 30. Gestational weight gain and infant BMI

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kramer et al., 1990</p> <p>Country and setting: Canada, university hospital</p> <p>Enrollment Period: 1980 to 1986</p> <p>Funding: National Health Research and Development Program, Health and Welfare Canada</p> <p>Study Objective: (1) Which maternal and fetal variables appear to have independent causal impacts on intrauterine growth? (2) For a given fetal growth status, which maternal and fetal variables affect proportionality?</p> <p>Time frame: 1980 to 1986</p> <p>Duration of the study: Entry in to prenatal care up to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 8,719</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 8715 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Live-born, singleton infants without evidence of congenital intrauterine infection, chromosomal anomalies, or other major malformations and for whom gestational age calculated from last normal menstrual period agreed within ± 7 days with an early second-trimester (usually 16 to 18 weeks) Ultrasonographic estimate based on fetal biparietal diameter <p>Exclusion criteria:</p> <ul style="list-style-type: none"> See above 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported NR <p>G1: 57.8 kg (10.8) G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> They used prepregnancy wt and ht separately NR <p>Age (mean, yrs): G1: 28.6 (4.7) G2: NR</p> <p>Parity: G1: 0.72 (0.86) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: Cigarettes/d: G1: 3.2 (7.5) G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: Pg related HTN: G1: 7.7% G2: NR</p> <p>Additional characteristics: Education, y completed: G1: 13.0 (3.3) G2: NR</p> <p>Marital status: G1: 90.6% G2: NR</p> <p>Parity % primiparas: G1: 48.0 G2: NR</p>

Evidence Table 30. Gestational weight gain and infant BMI (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 8715 G2: NR</p> <p>Total weight gain: G1: 14.2kg (5.5) G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> Continuous </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery, using net weight gain (total weight minus wt of infant) </p>	<p>Birth weight: G1: 3385g (547) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Bivariate associations between selected maternal and fetal variables and fetal growth and proportionality: Correlation coefficient for net gestational weight gain (kg) and fetal growth ratio = 0.12 ($P < 0.001$); for prepregnancy weight (kg) 0.21 ($P < 0.001$) <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Correlation coefficients for Net prepregnancy weight gain (kg) and length = -0.04 ($P < 0.01$) Head circumference = -0.01 (NS); BMI 0.04 ($P < 0.001$); Ponderal index = 0.04 ($P < 0.001$) Weight/height circumference = 0.01 (NS) 	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Infant BMI (kg/m^2) <p>Groups: NA, net gestational weight (total weight gain minus weight of infant) as continuous variable</p> <p>Results: Correlation of net gestational weight gain with infant BMI $R=0.037$, $P<0.01$</p> <p>Net gestational weight gain did not meet criterion threshold for stepwise regression</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> NA <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> NA 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 30. Gestational weight gain and infant BMI (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Vohr et. al, 1995</p> <p>Country and setting: USA, hospital</p> <p>Enrollment period:</p> <p>Funding: National Institute of Child Health and Human Development Grant 2P50-HD11343</p> <p>Study Objective: To determine effects of maternal factors, including prepregnancy maternal adiposity, weight gain during pregnancy, degree of abnormality of oral glucose tolerance test, glycemia during pregnancy, and treatment with insulin vs. diet therapy, on neonatal body weight, adiposity, and blood pressure on IGDM and control infants</p> <p>Time frame: NR</p> <p>Duration of the study: 21 months</p>	<p>Design:</p> <ul style="list-style-type: none"> Case-control Prospective <p>Total Study N: 262</p> <p>Group Description: G1: Controls - LGA G2: Controls - AGA G3: GDM mothers- LGA G4: GDM mothers - AGA Group 5 Group 6</p> <p>Group N: G1: 74 G2: 69 G3: 57 G4: 62 Group 5 Group 6</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> GDM criteria based on screen at 24-28 weeks of gestation. Women were diagnosed with GDM if an initial 1-hour 50 - g glucose screen value > 130 mg/dl followed by two abnormal values in a 100-g oral glucose tolerance test. An equal number of infants were selected based on mother's GDM status and LGA/AGA status at birth. All mothers of LGA babies were recruited for participation, and both GDM and control mothers of AGA infants were approached at random <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Infants with anomalies or requiring intensive care 	<p>Pregravid weight: Self-reported G1: 67 kg (14) G2: 61 kg (12) G3: 71 kg (17) G4: 71 kg (18)</p> <p>Pregravid BMI: G1: 25 (5) G2: 23 (4) G3: 27 (6) G4: 28 (7)</p> <p>Imputed: No</p> <p>Categorized: Continuous</p> <p>Age (mean, yrs): G1: 29 (5) G2: 27 (6) G3: 30 (6) G4: 31 (5)</p>	<p>Race, %: Black G1: 5.7% of total study population</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p>

Evidence Table 30. Gestational weight gain and infant BMI (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 74 G2: 69 G3: 57 G4: 62</p> <p>Total weight gain: G1: 18 kg (7) <i>P</i> < 0.05 G2: 15 kg (6) G3: 15 kg (7) <i>P</i> < 0.05 G4: 11 kg (7) <i>P</i> < 0.05</p> <p>Categorized: <ul style="list-style-type: none"> • Continuous </p> <p>Collected from: <ul style="list-style-type: none"> • Does not state </p> <p>Ascertained by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> • Infant BMI (kg/m²) <p>Groups: Weight gain as a continuous variable for G1: GDM mothers G2: Control mothers</p> <p>Results: Estimates of 1-kg increase in gestational weight on infant BMI G1: 0.06, <i>P</i>=0.001 G2: 0.05, <i>P</i>=0.003</p> <p>Correlation between weight gain and infant BMI overall: .022, <i>P</i>=0.01</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • NR <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • NR 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Brown et al., 2002</i></p> <p>Country and setting: <i>USA, primary care clinics</i></p> <p>Enrollment Period: <i>1989 to 1993</i></p> <p>Funding: <i>NIH</i></p> <p>Study Objective: <i>To identify effects of maternal weight change by trimester of pregnancy on weight, length, head circumference, and ponderal index (PI; in kg/m³) of newborns</i></p> <p>Time frame: <i>1989 - 1993</i></p> <p>Duration of the study: <i>From preconception or entry into prenatal care through 6 to 8 weeks postpartum</i></p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 389</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 389 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women aged 22-35 years enrolled in Group Health managed care organization • Intended to become pg within enrollment period • Had not been attempting pg for > 3 mo • Had delivered last infant > 12 mo before enrollment • Did not intend to use contraceptives during study • Delivery of live, singleton infants • Pg lasting > 241 days from conception <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • History of hypertension, renal disease, DM, heart disease, infertility • No data on preconceptional weight and height within 6 months of conception or 2 weeks after conception • Missing data on weight with 25 days of end of each trimester 	<p>Pregavid weight:</p> <ul style="list-style-type: none"> • Measured by study investigators • Weight was measured < 6 months before conception for 364 women by study investigators <p>G1: 61.2 ± 9.4 (50.7, 73.2) G2: NR</p> <p>Pregavid BMI: G1: 22.5 ± 3.2 (19.2, 26.9) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 29.4 ± 3.1 (25.3, 33.7) G2: NR</p> <p>Parity: G1: 0.5 ± 0.7 (0, 1) G2: NR</p>	<p>Race, %: White G1: 97 G2: NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 389 G2: NR</p> <p>Total weight gain: G1: 15.6 ± 4.1 (10.5–21.4)² G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Collected by investigatorsRoutine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3575g ± 448 (3033–4167) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: Although nonsignificant, a trend was noted that suggested, among women with lower pre-conception weight, an increased effect of first-trimester weight gain on weight of their newborns (51 kg pre-conception weight, 51 g/kg weight gain; 62 kg pre-conception weight)</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Ponderal index, beta coefficients <p>Groups: G1: Increase in Ponderal Index per 1 kg increase in first trimester weight gain G2: Increase in Ponderal Index per 1 kg increase in second trimester weight gain G3: Increase in Ponderal Index per 1 kg increase in third trimester weight gain</p> <p>Results: G1: β = 0.21 (P < 0.0003) G2: β = 0.05 PI (P < 0.4) G3: β = 0.12 (P < 0.03)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pre-gravid BMI Mother's height <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Sex (female) 	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 8 Good, 1 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ekblad and Grenman, 1992</p> <p>Country and setting: Finland, hospital</p> <p>Enrollment Period: July 1, 1985 - December 31, 1985 (6 months)</p> <p>Funding: NR</p> <p>Study Objective: To evaluate effects of abnormal maternal weight or weight gain on pregnancy outcome</p> <p>Time frame: July 1, 1985 to December 31, 1985 (6 months)</p> <p>Duration of the study: Pregnancy to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: retrospective data from records, prospective weight and height at delivery <p>Total Study N: Total n = 357</p> <ul style="list-style-type: none"> 191 women with abnormal prepregnant weight ($\geq 20\%$ under or over ideal weight for height) or abnormal pregnancy weight gain ($\geq 20\text{kg}$ or $\leq 5\text{kg}$) 166 controls <p>Group Description: G1: $\geq 20\%$ over normal weight for height G2: $\geq 20\%$ under normal weight for height G3: weight gain $\leq 5\text{kg}$ G4: weight gain $\geq 20\text{kg}$ G5: control Group 6</p> <p>Group N: G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Birth at hospital within study period selected those with abnormal maternal prepregnancy weight or abnormal weight gain during pregnancy, as well as next mother in sequential order with normal prepregnancy weight and weight gain during pregnancy to serve as a control <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Not stated 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Records - not stated if self reported <p>G1: 83.9 (10.1) G2: 46.7 (3.4) G3: 73.1 (16.5) G4: 65.0 (12.2) G5: 58.3 (6.5)</p> <p>Pregravid BMI: G1: 39.5 (3.4) G2: 17.2 (0.9) G3: 26.1 (6.1) G4: 23.6 (4.1) G5: 21.6 (2.0)</p> <p>Imputed: <ul style="list-style-type: none"> No </p> <p>Categorized: <ul style="list-style-type: none"> Continuous $\geq 20\%$ over or under normal weight for height </p> <p>Age (mean, yrs): G1: 28 (5.1) G2: 25.5 (5.1) G3: 29.5 (5.1) G4: 28.7 (4.7) G5: 28.7 (4.4)</p> <p>Parity: G1: prior deliveries: 1.0 (1.0) G2: 0.8 (0.8) G3: 1.2 (1.1) G4: 0.8 (1.0) G5: 0.9 (1.0)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 77 G2: 28 G3: 30 G4: 56 G5: 166</p> <p>Total weight gain: G1: 11.8 (6.2) <i>P</i> < 0.05 compared to controls G2: 13.4 (4.5) G3: 3.0 (3.5) <i>P</i> < 0.0005 compared to controls G4: 23.2 (22.8) <i>P</i> < 0.0005 compared to controls G5: 13.2 (3.4)</p> <p>Categorized: <ul style="list-style-type: none"> • ≤ 5kg or ≥ 20kg </p> <p>Collected from: <ul style="list-style-type: none"> • Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3712 g (614) <i>P</i> < 0.05 compared to controls G2: 3293 (362) <i>P</i> < 0.05 compared to controls G3: 3284 (880) G4: 3803 (538) <i>P</i> < 0.005 compared to controls G5: 3538 (535)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: Elective 7% Emergency 14% Total 21% G2: Elective 4% Emergency 4% Total 8% G3: Elective 3% Emergency 3% Total 6% G4: Elective 5% Emergency 18% Total 23% G5: Elective 13% Emergency 9% Total 22%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Mean symphysis-fundus height:</p> <p>Group: G1: weight gain ≤ 5kg G2: weight gain ≥ 20kg G3: control: 5-20 kg</p> <p>Results G1: 30.8 cm ± 4.0 G2: 32.8 cm ± 3.4 G3: 35.0 cm ± 3.9</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 4 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Guihard-Costa et al., 2004</p> <p>Country and setting: France, hospital database</p> <p>Enrollment Period: 1980-1990</p> <p>Funding: NR</p> <p>Study Objective: To determine relative influences of maternal factors on infant skinfold thickness and other outcomes</p> <p>Time frame: 1980-1990</p> <p>Duration of the study: Pregnancy to birth</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 13,972</p> <p>Group Description:</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Liveborn singletons • Term infants (37 to 41 weeks) • Both parents born in France • No maternal smoking during gestation • All data available, specifically subscapular skinfold thickness • French metropolitan mothers <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • French mothers born in French Caribbean Islands or outside of France 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): Total weight gain: Categorized: <ul style="list-style-type: none"> Continuous Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Not stated - from database </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Crown-heel length, head circumference, subscapular skinfold thickness</p> <p>Groups: NA, weight gain continuous variable, results reported in standardized coefficients (SC). SCs are regression coefficients calculated as if all of the independent variables had a variance of 1</p> <p>Results: G1: SC for effect of MWG on crown-heel length G2: SC for effect of MWG on head circumference G3: SC for effect of MWG on subscapular skinfold thickness</p> <p>G1: SC 0.142 G2: SC 0.120 G3: SC 0.146</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pre-gravid BMI Height <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kirchengast and Hartmann, 2003</p> <p>Country and setting: Singleton births that took place at University Clinic for Gynecology and Obstetrics in Vienna, Austria</p> <p>Enrollment period: NR</p> <p>Funding: NR</p> <p>Study Objective: Examine impact of biological factors such as young maternal age and maternal somatic characteristics on pregnancy outcome among group of adolescent mothers who gave birth between 39th and 41st week of gestation after period of intensive psychological support</p> <p>Time frame: NR</p> <p>Duration of the study: 1985 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 8,011</p> <p>Group Description: G1: 12 to 16 years G2: 17 to 19 years G3: 20 to 29 years</p> <p>Group N: G1: 215 G2: 1,336 G3: 6,460</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women ages 12 to 29 • All prenatal check-ups of mother-child passport were performed • Delivery of single infant without congenital malformations • Receiving psychosocial support by family and/or specially trained social worker within young adolescent group (12 to 16 years) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Coincident medical diseases such as diabetes mellitus or nephropathy • Drug or alcohol abuse • Twin birth • IVF • Registered maternal diseases before and during pregnancy • Hypertension (BP < 150/90 mmHG) • Protein or glucose in urine • Pregnancy related immunization 	<p>Pregravid weight: Estimated by means of retrospective method and first weight determination, which was carried out at first prenatal visit (8th week of gestation)</p> <p>G1: 56.0 G2: 57.2 G3: 59.2</p> <p>Pregravid BMI: G1: 21.45 G2: 21.59 G3: 22.10</p> <p>Imputed: <ul style="list-style-type: none"> • Yes </p> <p>Categorized: <ul style="list-style-type: none"> • Continuous </p> <p>Age (mean, yrs): G1: 14.5 G2: 17.8 G3: 24.1</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Age at menarche: G1: 12.2 G2: 12.9 G3: 13.3</p> <p>Gynecological age: G1: 3.4 G2: 5.3 G3: 10.8</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 215 G2: 1,336 G3: 6,460</p> <p>Total weight gain: G1: 13.1 G2: 13.1 G3: 13.1 (P = .10)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3237.6 (significantly different from 17-19 and 20-29)</p> <p>G2: 3298.3 (significantly different from < 17 and 20-29)</p> <p>G3: 3368.9 (significantly different from < 17 and 17-19) (F = 24.1, P < .0001)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Chronological age Age at menarche Gynecological age Height Distancia spinarum Distancia christarum Prepregnancy weight Weight at end of pregnancy <p>Other infant outcomes</p> <ul style="list-style-type: none"> Birth length Head circumference Acromial circumference Diameter frontooccipitale 	<p>Outcomes Description: Change in infant size characteristics per 1 kg increase in MWG</p> <p>Groups NA, weight gain as continuous variable</p> <p>Results G1: Birth length (cm) G2: Head circumference (cm) G3: Acromial circumference (cm) G4: Diameter frontooccipitalis (cm)</p> <p>G1: $\beta = 0.55$ (0.43-0.68) G2: $\beta = 0.33$ (0.23-0.42) G3: $\beta = 0.47$ (0.39-0.55) G4: $\beta = 0.12$ (0.07-0.18)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, age at menarche, pregravid weight, height, distancia cristarum</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kramer et al., 1990</p> <p>Country and setting: Canada, university hospital</p> <p>Enrollment Period: 1980 to 1986</p> <p>Funding: National Health Research and Development Program, Health and Welfare Canada</p> <p>Study Objective: (1) Which maternal and fetal variables appear to have independent causal impacts on intrauterine growth? (2) For a given fetal growth status, which maternal and fetal variables affect proportionality?</p> <p>Time frame: 1980 to 1986</p> <p>Duration of the study: Entry in to prenatal care up to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 8,719</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 8715 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Live-born, singleton infants without evidence of congenital intrauterine infection, chromosomal anomalies, or other major malformations and for whom gestational age calculated from last normal menstrual period agreed within ±7 days with an early second-trimester (usually 16 to 18 weeks) Ultrasonographic estimate based on fetal biparietal diameter <p>Exclusion criteria:</p> <ul style="list-style-type: none"> See above 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reportedNR <p>G1: 57.8 kg (10.8) G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> They used prepregnancy wt and ht separately NR <p>Age (mean, yrs): G1: 28.6 (4.7) G2: NR</p> <p>Parity: G1: 0.72 (0.86) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: Cigarettes/d: G1: 3.2 (7.5) G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: Pg related HTN: G1: 7.7% G2: NR</p> <p>Additional characteristics: Education, y completed: G1: 13.0 (3.3) G2: NR</p> <p>Marital status: G1: 90.6% G2: NR</p> <p>Parity % primiparas: G1: 48.0 G2: NR</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 8715 G2: NR</p> <p>Total weight gain: G1: 14.2kg (5.5) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery, using net weight gain (total weight minus wt of infant) 	<p>Birth weight: G1: 3385g (547) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Bivariate associations between selected maternal and fetal variables and fetal growth and proportionality: Correlation coefficient for net gestational weight gain (kg) and fetal growth ratio = 0.12 ($P < 0.001$); for prepregnancy weight (kg) 0.21 ($P < 0.001$) <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Correlation coefficients for Net prepregnancy weight gain (kg) and length = -0.04 ($P < 0.01$) Head circumference = -0.01 (NS); BMI 0.04 ($P < 0.001$); Ponderal index = 0.04 ($P < 0.001$) Weight/height circumference = 0.01 (NS) 	<p>Outcomes Description: Length, head circumference, BMI, Ponderal Index, weight/head circumference</p> <p>Groups: NA, weight gain continuous variable</p> <p>Results: Correlation coefficients between MWG and: G1: Length G2: Head circumference G3: BMI G4: Ponderal Index G5: Weight/Head circumference G1: -0.04 ($P < 0.01$) G2: -0.01 ($P < 0.01$) G3: 0.04 ($P < 0.01$) G4: 0.04 ($P < 0.01$) G5: 0.01</p> <p>Net gestational weight gain was associated with correlation coefficients of -0.04 for length, -0.01 for head circumference, 0.04 for BMI, 0.04 for Ponderal Index, and 0.01 for weight/head circumference. Results were significant ($P < 0.01$) for length, BMI, and Ponderal Index</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Parity GDM Pregnancy induced hypertension Obesity (How defined or categorized?) previous lbw, Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Birth weight Sex of the infant 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Shepard et al., 1996</p> <p>Country and setting: Norway and Sweden, multicenter study</p> <p>Enrollment Period: January 1, 1986 to March 31, 1988</p> <p>Funding: NICHD</p> <p>Study Objective: To examine impact of BMI, proportional weight gain, and other variables on fetal growth</p> <p>Time frame: January 1, 1986 to March 31, 1988</p> <p>Duration of the study: Early pregnancy (before 17 wks gestation) through 37 wks gestation</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: Retrospective records for pregravid weight, prospective for fetal growth <p>Total Study N: 369</p> <p>Group Description: G1: Low BMI, ≤ 19.9 G2: Average BMI, 20-23.3 G3: High BMI, > 23.3</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Random 10% sample of NICHD SGA study cohort (n = 571) of women with data on prepregnant weight and weight gain and ultrasound measurements <p>Exclusion criteria: NR</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> records <p>G1: 53.1 (0.6) G2: 59.8 (0.5) G3: 72.3 (0.7) <i>P</i> = 0.0001</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Quetelet's Index: ≤ 19.9; 20-23.3; > 23.3 <p>Age (mean, yrs): G1: 29.1 (0.3) G2: 29.9 (0.4) G3: 30.0 (0.4) <i>P</i> = 0.14</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: # daily cigarette, 17 weeks: 3.7 (0.5) G2: 2.5 (0.4) G3: 3.3 (0.1) <i>P</i> = 0.17</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 31. Gestational weight gain and other infant growth characteristics (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>G1: Overall proportional weight gain (%): 23.1</p> <p>G2: 20.3</p> <p>G3: 16.7 $P = 0.0001$</p> <p>Categorized:</p> <ul style="list-style-type: none"> Measured at 3 study time periods - expressed as a proportion of prepregnant weight gained during that time <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> Overall proportional weight gain 	<p>Birth weight:</p> <p>G1: 3517.1 (50.9)</p> <p>G2: 3677.9 (37.5)</p> <p>G3: 3837.1 (52.0)</p> <p>$P = 0.0001$</p> <p>Gestational diabetes, %:</p> <p>NR</p> <p>Cesarean delivery, %:</p> <p>NR</p> <p>Instrumental delivery, %:</p> <p>NR</p> <p>Episiotomy, %:</p> <p>NR</p> <p>Other maternal outcomes:</p> <p>NA</p> <p>Other infant outcomes:</p> <p>NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Estimates of fetal growth rate in 3 time periods, model for weeks 17 to 25 adjusted for maternal BMI; model for weeks 25 to 33 adjusted for maternal BMI, maternal age, previous SGA, and male infant; model for 33-37 weeks adjusted for maternal BMI and female infant <p>Groups:</p> <p>NA, continuous weight gain measure</p> <p>Results:</p> <p>Increase in mean abdominal fetal growth rate (mm/day) per 5% increase in proportional weight gain in this period:</p> <ul style="list-style-type: none"> Weeks 17-25, $\beta = 0.35$ ($P = 0.49$) Weeks 25-33, $\beta = 0.88$ ($P = 0.02$) Weeks 33-37, $\beta = 1.53$ ($P = 0.02$) <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Pre-gravid BMI Previous SGA <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Infant sex 	<p>Background:</p> <p>Good</p> <p>Sample selection:</p> <p>Fair</p> <p>Definition of maternal weight gain:</p> <p>Fair</p> <p>Definition of outcomes:</p> <p>Good</p> <p>Source of information on exposure, outcomes, and confounders:</p> <p>Fair</p> <p>Followup:</p> <p>Good</p> <p>Analysis comparability:</p> <p>Fair</p> <p>Analysis of outcomes:</p> <p>Fair</p> <p>Interpretation:</p> <p>Fair</p> <p>Sum of Good/Fair/Poor:</p> <p>3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score:</p> <p>Fair</p>

Evidence Table 32. Gestational weight gain and childhood weight status

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Li, 2007</p> <p>Country and setting: USA, national survey</p> <p>Enrollment Period: 1959 to 1966</p> <p>Funding: NR</p> <p>Study Objective: To evaluate developmental trajectories of overweight in children and assess early life influences</p> <p>Time frame: 1986 to 2000</p> <p>Duration of the study: 20 years</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 1739</p> <p>Group Description: G1: Early overweight G2: Late overweight G3: Never overweight</p> <p>Group N: G1: 10.9% G2: 5.2% G3: 83.9%</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Data from National Longitudinal Survey of Youth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Mother reported high blood pressure or diabetes, gestational week less than 28 weeks or birthweight less than < 0.5 or equal or more than 6 kg. 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> Yes <p>Categorized:</p> <ul style="list-style-type: none"> < 25, 25-29, > 29 <p>Age (mean, yrs): Age at birth <25: 40.9%% 25 to 29: 50.5% 30 or more: 8.6%</p> <p>Parity: Birth order 1: 41.1% 2: 36.9% 3 or more: 22.0%</p>	<p>Race, %: White 77.8 Black 15.3 Hispanic 6.9</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NA</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 32. Gestational weight gain and childhood weight status (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight:</p> <p><2500 : 3.5%</p> <p>2500-3999: 81.6%</p> <p>4000 or more: 12.9%</p> <p>Gestational diabetes, %:</p> <p>0%</p> <p>Cesarean delivery, %:</p> <p>NR</p> <p>Instrumental delivery, %:</p> <p>NR</p> <p>Episiotomy, %:</p> <p>NR</p> <p>Other maternal outcomes:</p> <p>NR</p> <p>Other infant outcomes:</p> <p>NR</p>	<p>Outcomes Description:</p> <p>Overweight status for children for upto 12 years</p> <p>Groups:</p> <p>Maternal weight gain categories (kg):</p> <p>G1: < 15 lbs</p> <p>G2: 15-24 lbs</p> <p>G3: 25-34 lbs</p> <p>G4: 35-44 lbs</p> <p>G5: > 45 lbs</p> <p>Results:</p> <p>AOR (95% CI) for early onset overweight (early onset of overweight that persisted throughout childhood) compared with normal (low probability of overweight throughout childhood and was characterized as the never overweight class)</p> <p>G5: 1.7 (1.0-2.9)</p> <p>G3: 1.0 (reference)</p> <p>Other AOR for weight gain categories for early onset overweight not significant compared with weight gain 25-34 lbs</p> <p>No association between maternal weight gain and risk of late onset overweight (moderately high probability of overweight at age 2 years, low probability of overweight at age 4 and 6 years, but growing probability of overweight after age 8 years)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <p>Breastfeeding</p> <p>Education</p> <p>Time between last pregnancy weight and delivery</p> <p>Household income</p> <p>Marital status</p> <p>Paternal BMI</p> <p>Smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <p>Birth length</p> <p>Sex</p> <p>Child diet</p> <p>Child television viewing</p>	<p>Background:</p> <p>Good</p> <p>Sample selection:</p> <p>Fair</p> <p>Definition of maternal weight gain:</p> <p>Fair</p> <p>Definition of outcomes:</p> <p>Good</p> <p>Source of information on exposure, outcomes, and confounders:</p> <p>Poor</p> <p>Followup:</p> <p>Good</p> <p>Analysis comparability:</p> <p>Fair</p> <p>Analysis of outcomes:</p> <p>Good</p> <p>Interpretation:</p> <p>Fair</p> <p>Sum of Good/Fair/Poor:</p> <p>4 Good, 4 Fair, 1 Poor</p> <p>Final Quality Score:</p> <p>Fair</p>

Evidence Table 32. Gestational weight gain and childhood weight status (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Oken et al., 2007</p> <p>Country and setting: Reported elsewhere</p> <p>Enrollment period: NR</p> <p>Funding: Supported by grants from US National Institutes of Health (HD 34568, HL 64925, HL68041, HD 44807), the Robert Wood Johnson Foundation, Harvard Medical School, and Harvard Pilgrim Health Care Foundation</p> <p>Study Objective: Purpose of study to examine associations of gestational weight gain with child adiposity</p> <p>Time frame: NR</p> <p>Duration of the study: Entry to prenatal care thru delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 1,044</p> <p>Group Description: G1: Total</p> <p>Group N: G1: 1,044</p> <p>Inclusion criteria: Women delivering live singleton infant and enrolled for continuation of study beyond 6 months after delivery</p> <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing information on prepregnancy weight, parental BMI, or infant birthweight, or who did not have a weight recorded within 4 weeks preceding delivery 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 24.6 (SD 5.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 15-24: 6% 25-34: 62% 35-44: 32%</p> <p>Parity: G1: Nulliparous: 48% Parous: 52%</p>	<p>Race, %:</p> <p>White G1: 74%</p> <p>Black G1: 11%</p> <p>Hispanic G1: 6%</p> <p>Other G1: 10%</p> <p>Smoking, %: G1: Never: 67% Quit before pregnancy 20% Smoked in early pregnancy 10%</p> <p>Diabetes mellitus, %: G1: 4%</p>

Evidence Table 32. Gestational weight gain and childhood weight status (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: 15.6 kg (5.4)</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 4%</p> <p>Cesarean delivery, %: G1: 23% G2: 12% G3: 35% G4: 53%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> • Association of MWG with child adiposity-related outcomes at age 3 years, before and after adjustment for potential confounding and pathway variables. Effect increments are for a 5 kg increment in total weight gain. <p>Groups: MWG for 5 kg increments</p> <p>Results: AOR (95%CI) BMI≥95th percentile vs BMI<50th percentile associated with a 5 kg increase in gestational weight gain: 1.52 (1.19-1.94)</p> <p>Child BMI z-score at age 3 years for AOR listed above (95% CI):</p> <p>0.11 (0.05, 0.17)Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Breastfeeding • Education • Time between last pregnancy weight and delivery • Household income • Marital status • Paternal BMI • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Birth length • Sex • Child diet • Child television viewing 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 32. Gestational weight gain and childhood weight status (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ong et al., 2000</p> <p>Country and setting: UK, Avon longitudinal study of pregnancy and childhood</p> <p>Enrollment Period: Births from April 1991-December 1992 followed to age 5 years</p> <p>Funding: Medical Research Council, Wellcome Trust, Department of Health, Department of the Environment</p> <p>Study Objective: To identify predictors of postnatal catch up growth from birth to 2 years and its relation to size and obesity at 5 years</p> <p>Time frame: Births from April 1991-December 1992 followed to age 5 years</p> <p>Duration of the study: Birth to 5 years, maternal data collected retrospectively</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: Maternal data retrospective, infant prospective <p>Total Study N: 848</p> <p>Group Description:</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> 10% sample of births in longitudinal study cohort with information on weight measurements <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Obstetric records, not stated whether it was self reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 32. Gestational weight gain and childhood weight status (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: obstetric records - not stated 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Catch-up and catch-down growth <p>Groups: Maternal weight gain, continuous measure</p> <p>Result: Children were grouped into three growth categories (catch-up, no change, and catch-down) based on a gain in weight (SD score > 0.67 for catch-up; SD score < 0.67 for catch-down).</p> <p>Maternal weight gain was not a significant predictor of catch-up growth between 0 and 2 years</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 7 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 32. Gestational weight gain and childhood weight status (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Sowan and Stember, 2000</p> <p>Country and setting: USA, sample from Infant Growth Study Database</p> <p>Enrollment Period: NR</p> <p>Funding: AAUW, NRSA, NIH, NINR</p> <p>Study Objective: To facilitate an understanding of influence of parental characteristics on development of infant obesity</p> <p>Time frame: NR</p> <p>Duration of the study: Birth through 15 months postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 630</p> <p>Group Description: NR</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Normal infant at birth (i.e. no organic etiology) • Mother able to communicate in English <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Infants weighing less than 2500g at birth • Preterm infants (< 37 weeks) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 32. Gestational weight gain and childhood weight status (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous, 5 pound increments <p>Collected from:</p> <ul style="list-style-type: none"> • Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> • Self-reported 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> • Infant obesity (BMI > gender and age specific 84th percentile based on Infant Growth Study population) <p>Groups: Maternal weight gain in 5 pound increments</p> <p>Results: Model AOR (95%CI) for infant obesity (BMI > gender and age specific 84th percentile based on Infant Growth Study population norms) at 1, 4, 7, and 10 months: NS</p> <p>AOR (95%CI) for obesity at 14 months: .8 (0.7-1.0)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race • Pre-gravid BMI • Marital status • Psychosocial factors • Sociocultural factors • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Infant gender • Birth BMI • BMI at previous month 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 33. Gestational weight gain and childhood hospitalization

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Yuan et al., 2001</p> <p>Country and setting: Denmark, birth cohort from midwife centers</p> <p>Enrollment Period: April 1984 to April 1987</p> <p>Funding: Grant from Medical Research Council</p> <p>Study Objective: To examine whether maternal prenatal lifestyle factors were associated with risk of hospitalization with infectious disease during early childhood and whether a possible association was modified by fetal growth reduction</p> <p>Time frame: April 1984 to April 1987</p> <p>Duration of the study: Prenatal period through early childhood (6 to 12 yrs)</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 10,440</p> <p>Group Description: G1: Cohort G2: NR</p> <p>Group N: G1: 10,400 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Children born to mothers attending midwife centers at approximately 36th week gestation in 2 study areas in Denmark <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Stillbirths • Multiple births • Children with congenital malformations 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported, may be from hospital records - not specifically stated <p>Pregravid BMI: G1: < 18: 5.8%; 18-20: 42.8%; 21-23: 33.5%; ≥ 24: 17.9%</p> <p>G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • < 18, 18-20, 21-23, > 24 <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 44.3 G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 33. Gestational weight gain and childhood hospitalization (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 7550 G2: NR</p> <p>Total weight gain: G1: < 10kg: 19.1%; 10-12: 24.6%; 13-15: 26.0%; ≥ 16: 30.3% G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> < 10, 10-12, 13-15, ≥ 16 kg <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Adjusted incidence rate ratio (IRR) of hospitalization with infectious disease (95% CI) <p>Groups: G1: < 13kg G2: ≥ 13kg</p> <p>Results: G1: 1.05 (0.76-1.47) G2: 1.42 (1.09-1.86)</p> <p>All gestational weight gain 1.29 (1.05-1.59)</p> <p>Stratification of analyses by either prepregnancy BMI or gestational weight gain did not show any difference in associations between maternal smoking, alcohol, tea, and fruit intake and hospitalization with infectious disease (of child from 6 months to 12 years)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Paternal age Social group Maternal cohabitation status Number of siblings at birth for infant Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 3 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Callaway et al., 2007</p> <p>Country and setting: Australia, hospital</p> <p>Enrollment period: Received antenatal care between 1981 and 1984, then followed 21 years later</p> <p>Funding: Authors thank National Health and Medical Research Council and Queensland Health for funding this project. L. K. C. was supported by a National Health and Medical Research Council Postgraduate Medical Scholarship at commencement of this work. D. A. L. is funded by a United Kingdom Department of Health Career Scientist Award</p> <p>Study Objective: To assess changes in body mass index (BMI; weight (kg)/height (m)²) over time in women with and without HDP</p> <p>Time frame: Received antenatal care between 1981 and 1984, then followed 21 years later</p> <p>Duration of the study: From prepregnancy to 21 years after index pregnancy</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 3,572</p> <p>Group Description: G1: Included G2: Excluded G3: <i>P</i> value</p> <p>Group N: G1: 3,572 G2: 3,651</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women delivered live singleton baby, who neither died nor was adopted prior to leaving hospital, and completed both initial phases of data collection <p>Exclusion criteria: NR</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Correlated with first prenatal visit weight $r = 0.95$ <p>Pregravid BMI: G1: 21.9 (3.8) G2: 22.0 (4.1) G3: 0.1</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 25.0 (5.1) G2: 24.1 (5.2) G3: < 0.001</p> <p>Parity: G1: nulliparous 35.7% G2: nulliparous 30.8% G3: < 0.001</p>	<p>Race, %: White G1: 94.9% G2: 89.8% G3: < 0.001</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: G1: 46.9% G2: 53.0% G3: < 0.001</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 3,572 G2: 3,651</p> <p>Total weight gain: G1: 14.8 (6.03? vs 14.6) G2: 14.9 (14.7) G3: 0.3</p> <p>Categorized: <ul style="list-style-type: none"> Continuous </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: NR</p>	<p>Birth weight: G1: 3,388 (518) G2: 3,382 (523) G3: 0.7</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Univariable association of MWG with mean change in BMI over 21 years: MWG < = 15: 5.06 (4.85, 5.27), MWG >15: 6.4 (6.19, 6.61) < 0.001. Women with HDP gained on average 2.01 kg (95% CI, 1.41 kg, 2.61 kg) more than women without HDP <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups G1: Maternal weight gain <=15kg G2: Maternal weight gain >15kg</p> <p>Results G1: Mean change (95%CI) in BMI at 21 years postpartum: 5.06 kg/m² (4.85-5.27) G2: Mean change (95%CI) in BMI at 21 years postpartum: 6.40 kg/m² (6.19-6.61) <i>P</i> < 0.001 G2 was associated with a mean change in BMI over 21 years of 0.19 kg/m² (95%CI: 0.16-0.22)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Baseline income Secondary school completion Ethnicity Maternal age at birth Parity Birth weight Gestational age Infant sex Maternal smoking during pregnancy Smoking at 21 years Sedentary lifestyle at 21 years Baseline maternal BMI Hypertensive disorders during pregnancy <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Infant sex 	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 7 Good, 1 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Harris et al., 1999</p> <p>Country and setting: UK, antenatal care project</p> <p>Enrollment Period: Not stated</p> <p>Funding: DevR fund of University of Greenwich; NHS Executive, South Thames</p> <p>Study Objective: To assess relative importance of heritable characteristics and lifestyle in development of maternal obesity after pregnancy</p> <p>Time frame: Not stated</p> <p>Duration of the study: First antenatal visit to 2.5 years post delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 74</p> <p>Group Description:</p> <p>G1: Women with long-term weight gains < 0.4kg</p> <p>G2: Women with long-term weight gains > 0.4kg</p> <p>G3: Total sample</p> <p>Group N:</p> <p>G1: 37</p> <p>G2: 37</p> <p>G3: 74</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women who had been enrolled in Antenatal Care Project who had been weighed during first trimester of pregnancy and had not become pregnant since birth of child carried during ANC project <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with missing data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured during first trimester of pregnancy at prenatal visit <p>G1: NR</p> <p>G2: NR</p> <p>G3: 66.23 (1.25)</p> <p>Pregravid BMI:</p> <p>G1: 25.0 (0.6)</p> <p>G2: 24.2 (0.7)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs):</p> <p>G1: 33.4 (0.8)</p> <p>G2: 33.7 (0.8)</p> <p>G3: 33.54 (0.56)</p> <p>Parity:</p> <p>G1: NR</p> <p>G2: NR</p> <p>G3: % nulliparous: 37.8</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: % continual smokers: 18.9</p> <p>G2: % continual smokers: 18.9</p> <p>G3: % smokers at first antenatal visit: 43.2</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics:</p> <p>G1: % married: 54.1</p> <p>G2: 56.8</p> <p>G3: 55.4</p> <p>Additional characteristics:</p> <p>G1: Duration of followup (days): 1141.2 (20.0)</p> <p>G2: 1181.8 (20.6)</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 37 G2: 37 G3: 74</p> <p>Total weight gain: G1: 13.14 (1.07) kg G2: 12.73 (0.82) G3: 12.93 (0.67)</p> <p>Categorized: <ul style="list-style-type: none"> Continuous </p> <p>Collected from: <ul style="list-style-type: none"> Self-reported </p> <p>Ascertained by: <ul style="list-style-type: none"> Self-reported </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Mean long term weight gain in association with pregnancy was 0.50 (0.71)kg, overall the mothers in sample not significantly heavier after pregnancy than were before (95%CI: -0.89-1.89); however, these long term weight gains were very variable ranging from 13.6kg in weight loss to 17.7 kg in weight gain</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups Continuous maternal weight gain, kg</p> <p>Results ANCOVA model with weight (kg) at 2.5 years postpartum as dependent variable and maternal weight gain (kg) as independent variable: $B = -0.031$ $\beta = -0.029$ $SEM = 0.120$ $P = 0.796$</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Marital status Increased dissatisfaction with body Increased access to food increased energy intake Decreased activity Smoking status <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Harris et al., 1997</p> <p>Country and setting: UK, city hospital</p> <p>Enrollment Period: 1992-1993</p> <p>Funding: DevR fund of University of Greenwich</p> <p>Study Objective: Investigated independent associations between parity and maternal body mass index and between parity and maternal weight gain</p> <p>Time frame: 1992 to 1993</p> <p>Duration of the study: Previous pregnancy through current pregnancy and birth</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 1,637 (523 included and 694 excluded)</p> <p>Group Description: G1: Included women G2: Excluded women</p> <p>Group N: G1: 523 G2: 694</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women who had singleton births at hospital between 1992 and 1993 with obstetric notes available for their previous pregnancy Women who were weighed regularly during pregnancy Parity of 1,2,3,4 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Pre-existing hypertension or diabetes (n = 3) Parity 5 (n = 2) or parity 6 (n = 2) 1992/1993 pregnancy began less than 12 months after birth of their previous child (n = 243) Missing data for 1 or more variables (n = 444) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Abstracted from each mother's obstetric notes <p>Pregravid BMI: G1: 23.45 (0.17) G2: 23.59 (0.18)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 29.6 (0.2) G2: 28.9 (0.2)</p> <p>Parity: G1: % parity = 1: 73.4% G2: 54.5%</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 22.4 G2: 27.0</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 0 G2: 0</p> <p>Additional characteristics: NR</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 523 G2: 694</p> <p>Total weight gain: G1: Rate of weight gain: 0.47 (0.01) G2: 0.44 (0.1)</p> <p>Categorized: <ul style="list-style-type: none"> • Continuous </p> <p>Collected from: <ul style="list-style-type: none"> • Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery: based on difference between first antenatal weight measurement and last antenatal measurement usually recorded within 1 week of delivery </p>	<p>Birth weight: G1: 3384.1 (21.2) G2: 3338.8 (20.2)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups G1: Maternal weight gain during previous pregnancy(kg), continuous G2: Interpregnancy weight change (kg), defined as the difference between weight at start of index pregnancy and weight at start of previous pregnancy</p> <p>Results ANCOVA model with G2 as dependent variable and G1 as independent variable: B = 0.262 β = 0.227, SEM = 0.52 $P < 0.001$</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Marital status • Smoking status • Alcohol • Parity • Age • Socioeconomic status • Nulliparous BMI • Birth weight • Gestational age at start of previous pregnancy • Gestational age at start of index pregnancy • Gestational age at start of first pregnancy • Interpregnancy interval <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age 	<p>Background: Poor</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Harris et al., 1997</p> <p>Country and setting: UK, hospital</p> <p>Enrollment Period: 1990-1993</p> <p>Funding: DevR Fund of University of Greenwich</p> <p>Study Objective: To investigate impact of pregnancy on long term weight gain of primiparous mothers and to identify potential risk factors for maternal obesity</p> <p>Time frame: 1990 to 1993</p> <p>Duration of the study: Initiation of prenatal care during first pregnancy to beginning of second pregnancy</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 243</p> <p>Group Description:</p> <p>G1: Mothers included in study</p> <p>G2: Mothers excluded from study</p> <p>Group N:</p> <p>G1: 243</p> <p>G2: 2,154</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton births • Multiparous women with 2 consecutive births at hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Incomplete obstetric records for 1 or more previous pregnancy (n = 863) • Not weighed regularly during both first and second pregnancies (n = 247) • Missing first trimester measurements of body weight in both pregnancies (n = 2,077) • Women who became pregnant with second child less than 12 months after birth of first child (n = 69) • Missing data on key variables (n = 8) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Used weight measurements recorded during first trimester of pregnancy (up to 13 weeks gestation) <p>Pregravid BMI:</p> <p>G1: 24.2 (0.5)</p> <p>G2: 23.5 (0.1)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs):</p> <p>G1: 26.2 (0.4)</p> <p>G2: 24.5 (0.1)</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: Nonsmoker: 76.6%</p> <p>G2: Nonsmoker: 70.0%</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %:</p> <p>G1: PIH: 23.4%</p> <p>G2: 24.5%</p> <p>Additional characteristics:</p> <p>Married:</p> <p>G1: 79.8%</p> <p>G2: 66.9%</p> <p>Left hospital breast feeding:</p> <p>G1: 59.1%</p> <p>G2: 53.4%</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 243 G2: 2154</p> <p>Total weight gain: G1: rate of weight gain (kg/week): 0.48 (0.01) G2: 0.48 (0.01)</p> <p>Categorized: <ul style="list-style-type: none"> Continuous </p> <p>Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3.3338 (0.0533) G2: 3.2886 (0.017)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 18.1 G2: 14.1</p> <p>Instrumental delivery, %: Assisted Non-Cesarean: G1: 13.8% G2: 13.3%</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Examining change in maternal body weight from beginning of first pregnancy to beginning of second pregnancy (interpregnancy weight change) and gestational weight gain during first pregnancy <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups G1: Maternal weight gain during first pregnancy as a continuous measure (kg) G2: Interpregnancy weight change (kg), defined as the difference between weight at start of first pregnancy and weight at start of the second pregnancy</p> <p>Results ANCOVA model with G2 as dependent variable and G1 as independent variable: $B = 0.176$ $\beta = 0.169$ $SEM = 0.070$ $P < 0.013$</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Marital status Lactation Smoking status Alcohol Height Nulliparous BMI Birth weight Gestational age at start of previous pregnancy Terminations between pregnancy Interpregnancy interval <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hunt et al., 1995</p> <p>Country and setting: USA, 2 separate sources: population-based family history database and participation in a study on obesity</p> <p>Enrollment Period: 1991-1992</p> <p>Funding: NIH grant DK44655</p> <p>Study Objective: To examine impact of pregnancy during weight gain on later weight status in morbidly obese women; i.e. to study role of pregnancy in development of obesity</p> <p>Time frame: 1991 to 1992</p> <p>Duration of the study: Beginning of first pregnancy up to time of study recruitment (includes multiple pregnancies per woman)</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: Controls = 115 Morbidly obese = 96</p> <p>Group Description: G1: Morbidly obese G2: Random control</p> <p>Group N: G1: 96 G2: 115</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women with 1 or more pregnancies Ages 30-59 Living in Utah <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Morbidly obese women were excluded if more than 13.6 kg over ideal weight between ages 20 and 24 or prior to first pregnancy occurring before age 20 Controls were excluded if not less than 13.6kg over ideal weight at ages 20-24 or prior to first pregnancy occurring before age 20 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported/validated by hospital records <p>G1: at ages 20-24: 64.4 (9.0) G2: at ages 20-24: 55.8 (7.0)</p> <p>Pregravid BMI:</p> <p>G1: at ages 20-24: 23.3 (2.9) G2: at ages 20-24: 20.6 (2.2)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NR <p>Age (mean, yrs): G1: 48.1 (8.6) G2: 44.0 (5.2)</p> <p>Parity: G1: Number of pregnancies: 4.2 (2.0) G2: Number of pregnancies: 4.3 (1.8)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Weight at 6 weeks after last delivery (kg): G1: 90.8 (18.8) G2: 65.0 (12.9)</p> <p>Additional characteristics: NR</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Other - please define <p>Collected from:</p> <ul style="list-style-type: none"> not collected <p>Ascertained by:</p> <ul style="list-style-type: none"> Self-reported/validated by hospital records 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups</p> <p>G1: Population-based sample</p> <p>G2: Morbidly obese women who were normal weight at age 20-24 years or prior to first pregnancy</p> <p>Results</p> <p>Regression of current weight on total number of pregnancies showed a 1.3kg/pregnancy increase in current weight ($P = 0.03$) with no difference between G1 and G2 ($P = 0.60$)</p> <p>Maternal weight gain was significantly greater in G2 than G1 for the first pregnancy only ($P < 0.05$)</p> <p>G2 had a net weight retention after the first pregnancy of 4.0 kg greater than G1 at 6 weeks postpartum</p> <p>G2 averaged 1.6 kg/pregnancy greater weight retention than G1 for additional pregnancies</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Weight at ages 20 to 24 Current age <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 6 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Linne et al., 2004</p> <p>Country and setting: Sweden, Stockholm Pregnancy and Weight Development study</p> <p>Enrollment Period: 1 and 15 year followup of women recruited in 1984-85</p> <p>Funding: NR</p> <p>Study Objective: Aim of this study was to evaluate how well prepregnancy BMI, gestational weight gain, and postpartum weight retention predict retention of weight 15 years later among parous women</p> <p>Time frame: 1 and 15 year followup of women recruited in 1984 to 1985</p> <p>Duration of the study: 15 years</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 563</p> <p>Group Description:</p> <p>G1: Total</p> <p>G2: Normal weight group (BMI < 25)</p> <p>G3: Overweight group (> 25)</p> <p>G4: Low weight gain < 12kg</p> <p>G5: Intermediate weight gain 12-15.6kg</p> <p>G6: High weight gain > 15.6kg</p> <p>Group N:</p> <p>G1: 563</p> <p>G2: 514</p> <p>G3: 45</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Participants in Stockholm Pregnancy and Weight Development study in 1984 and 1985 who agreed to participate in 15 year follow up study <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Death or moving abroad BMI = 47 1 woman who had her first child at age 49 	<p>Pregravid weight:</p> <p>NR</p> <p>G1: 59.8 (7.9)</p> <p>G2: 58.5 (6.3) kg,</p> <p>G3: 74.4 (7.6) kg</p> <p>G4: 58.3 (7.8)</p> <p>G5: 59.4 (7.7)</p> <p>G6: 61.8 (7.7) $P < 0.001$</p> <p>Pregravid BMI:</p> <p>G1: 21.5 (2.4) kg/m²</p> <p>G2: 21.0 (1.7)kg/m²,</p> <p>G3: 26.3 (1.1)</p> <p>G4: 21.4 (2.7)</p> <p>G5: 21.2 (2.1)</p> <p>G6: 21.9 (2.4) $P < 0.05$</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 25%</p> <p>G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics:</p> <p>G1: diet advice 61%</p> <p>G2: NR</p> <p>G3: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: NR G2: NR</p> <p>Total weight gain: G1: NR G2: 9.8 (1.9) G3: 14.0 (0.9) G4: 18.8 (2.3) P < 0.001</p> <p>G5: At 12 months, gained 1.1 +/- 0.4 kg from prepregnancy weight</p> <p>G6: At 12 months, gained 1.2 +/- 0.5 kg P = 0.64</p> <p>Categorized:</p> <ul style="list-style-type: none"> Tertiles based on weight gain during pregnancy and defined as low weight gain (< 12.0 kg), intermediate weight gain (between 12 and 15.6 kg), and high weight gain (> 15.6 kg) <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators details of initial SPAWN study methods NR here <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: G1: NR G2: 3,269 (509) G3: 3,507 (482) G4: 3,628 (492) P < 0.001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> At 15-year follow-up, overweight women had a mean waist circumference of 81 +/- 9.3 cm, and normal weight women had a mean waist circumference of 77 +/- 9.1 cm (P = 0.73). Hip circumference was 101.1 +/- 8.4 cm in overweight women and 98 +/- 8.5 cm in normal weight women (P = 0.28). At 6 months postpartum, normal weight women had retained 1.4 +/- 3.1 kg from prepregnancy weight, and overweight women had retained 2.0 +/- 6.7 kg (P < 0.40). 	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups Maternal weight gain was used a continuous measure (kg):</p> <p>Results G1: Pregravid BMI ≤ 25 G2: Pregravid BMI > 25 G2 had significantly greater weights at prepregnancy, delivery, 1 year postpartum, and 15 years postpartum compared to G1 (P < 0.001); however, G2 did not have a higher risk of postpartum retention than G1</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Alcohol use Smoking Number of pregnancies since index child Employment area <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Linne et al., 2004
(continued)

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<ul style="list-style-type: none"> • At 15-year follow-up, weight increase from before pregnancy was 7.7 +/- 7.0 kg in normal weight women and 6.2 +/- 12.1 kg in overweight women ($P = 0.36$). • A multiple regression was performed to predict weight at 15-year follow-up. It is evident that weight before pregnancy and weight at 1 year were most strongly correlated with body weight at 15-year follow-up. Multiple regression (using an enter model) showed that these variables explained 58.1% of variation in body weight at 15-year follow-up [$F(3.499) = 232.87, P < 0.001$]. Weight at 1 year had largest (Beta) (0.782), which was most important predictor of body weight at 15-year follow-up ($t = 24.38, P < 0.001$) 		
	<p>Other infant outcomes: NR</p>		

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Linne et al., 2003</p> <p>Country and setting: Stockholm, Pregnancy and Women's Nutrition study</p> <p>Enrollment Period: 15 year follow-up of women who delivered infants in 1984-85</p> <p>Funding: NR</p> <p>Study Objective: To investigate women who participated in Stockholm Pregnancy Weight Development study 15 years later, focusing on women whose weight trajectories changed after their pregnancies and in particular those women who were normal weight (BMI ≤ 25) before</p> <p>Time frame: 15 year follow-up of women who delivered infants in 1984 to 1985</p> <p>Duration of the study: Questionnaires administered at 2.5, 6, and 12 months and at 15 years postpartum (initial questionnaires given to women who delivered children in 1984 to 1985)</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cross-sectional • Combination: retrospective for factors occurring prior to/during pregnancy and prospective for weight gain following pregnancy <p>Total Study N: 563</p> <p>Group Description:</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women who took part in Stockholm Pregnancy and Weight Development Study, 1984 to 1985 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • BMI > 47 (n = 1) • First child at age 49 (n = 1) • Women who were overweight at both time points (prepreg and 15y followup) (n = 33) and women who were overweight and who lost weight and regained a BMI in normal range at 15y (n = 10) were excluded from analysis 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care • Maternity records from original study <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race,%: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking,%: NR</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Collected from:</p> <ul style="list-style-type: none"> • Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups</p> <p>G1: Women with normal BMI (20-25) at prepregnancy and 15 years postpartum</p> <p>G2: Women with normal BMI at prepregnancy who had overweight BMI (> 25) at 15 years postpartum</p> <p>Results</p> <p>G1: Mean (SD) maternal weight gain, 13.6 (3.7) kg</p> <p>G2: Mean (SD) maternal weight gain, 15.4 (4.4) kg</p> <p>t-Test: $P < 0.001$</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Muscati et al., 1996</p> <p>Country and setting: Canada, public health department</p> <p>Enrollment Period: 1979 to 1989</p> <p>Funding: NR</p> <p>Study Objective: To examine association of extent and timing of pregnancy weight gain with infant birth weight and postpartum weight retention</p> <p>Time frame: 1979 to 1989</p> <p>Duration of the study: Pregnancy through 6 weeks postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 371</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 371 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • White, low income, non-smoking women • Pregnant women <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Prematurity < 37 weeks • Adolescents < 16 years • Women > 40 years • Maternal health problems • Women who consume alcohol or drugs • Pregnancy complications such as proteinuria, hypertension, diabetes, negative weight gain, missing values 	<p>Pregravid weight: Family physicians' records G1: 62.8 +/- 16.0 kg G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Pregravid weight status categorized into 3 groups as a percentage of standard weight: underweight < 90%, normal 90-120%, and overweight > 120% <p>Age (mean, yrs): G1: 24.5 +/- 5.6 G2: NR</p> <p>Parity: G1: Primiparous 52% G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: PPWR: 5.3 +/- 5.7 kg G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: 16.1 +/- 6.4 kg G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Collected from:</p> <ul style="list-style-type: none"> • Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: From Table 1: Pearson's Correlation Coefficient and determination coefficient of maternal weight gain with PP weight retention and Infant BW. Maternal PP weight retention and Preg weight gain: [Total amount $r = 0.808$, R square 65.3%, $P < 0.001$], [Up to week 20 $r = 0.682$, R square 46.5%, $P < 0.001$], [Weeks 21-30 $r = 0.411$, R square 16.9%, $P < 0.001$], [Week 31 - term $r = 0.414$, R square 17.1%, $P < 0.001$]</p> <p>Other infant outcomes: Pregnancy Weight Gain and Infant Birth Weight (from Table 1): [Total amount $r = 0.216$, R square 4.7%, $P < 0.001$], [Up to week 20 $r = 0.114$, R-square 1.3%, $P < 0.05$], [Weeks 21-30 $r = 0.157$, R square 2.5%, $P < 0.01$], [Week 31 - term $r = 0.160$, R square 2.6%, $P < 0.01$]</p>	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups Maternal weight gain categories: G1: Weight gain \leq week 20 (kg) G2: Weight gain weeks 21-30 (kg)</p> <p>Results Regression model of weight retention (kg) at 6 weeks postpartum as the dependent variable and G1-G5 as independent variables: G1: $\beta = 0.86$ (SE: 0.05) $P < 0.001$ G2: $\beta = 0.68$ (SE: 0.07) $P < 0.001$ G3: $\beta = 0.49$ (SE: 0.07) $P < 0.001$ G4: $\beta = 0.58$ (0.13) $P = \text{NR}$ G5: $\beta = 0.77$ (0.04) $P = \text{NR}$</p> <p>Among women with AGA infants, women with 6 week postpartum weights greater than the median value (6.2kg, underweight; 5.7kg, normal weight; 3.1kg, overweight) had significantly greater total weight gains and weight gains during the first 20 weeks' gestation compared to women with 6 week postpartum weights of the median value or lower</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Standard weight for height (based on 1983 Metropolitan Life Insurance Tables) • Pregravid weight above standard (difference between actual weight and standard weight) • Parity <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age • Infant sex 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ohlin and Rossner, 1990</p> <p>Country and setting: Sweden, maternity clinics</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: To make a survey of weight changes after pregnancy; to analyze if and how different factors, such as parity, age, body weight, and lactation, correlate to post partum weight retention; and to analyze if any of these factors could be used as predictors fo</p> <p>Time frame: NR</p> <p>Duration of the study: Pregnancy through 1 year postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: retrospectively during pregnancy and prospectively up to 1 year after delivery <p>Total Study N: 1,423 at 1 year postpartum</p> <p>Group Description: G1: Total group entering study G2: NR</p> <p>Group N: G1: 2295 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women coming to maternity clinic for last routine control (6-15 weeks after delivery) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Twin births Insulin use during pregnancy Gastrointestinal problems with severe energy losses (heavy vomiting or diarrhea) Missing prepregnancy weight. Drop out frequency 1 year postpartum = 38% 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 59.6kg (8.5) G2: NR</p> <p>Pregravid BMI: G1: 21.5 (2.8) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce <p>Age (mean, yrs): G1: 29.5 (4.8) G2: NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 2295 G2: NR</p> <p>Total weight gain: G1: 14.1kg (4.3) G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> Continuous </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3442 (522) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Mean Change in body weight from pregnancy weight to 1 year postpartum (n = 1423) = 1.5kg (SD 3.6)$P < 0.001$. Overweight women (BMI > 23.8, n = 190) tended to retain more weight after the index time - 1.9kg +/- 5.3kg than lighter women (BMI < 23.9, n = 1233) - 1.5kg +/- 3.2kg (NS). There was a highly significant correlation between weight change and pregnancy weight gain (r = 0.36, $P < 0.001$). This correlation was slightly lower when using the first and last weight recorded in the maternity clinic (vs. self reported pregnancy weight), but still significant (r < 0.29, $P < 0.001$). Women gaining in the highest decentile (16.5kg) had a mean weight change of 3.3 +/- 3.9 kg while women in the lowest decentile (7.5kg) had a mean weight change of 0.0 +/- 3.3 kg. Using multiple stepwise regression analysis, weight gain during the third trimester explained 5% of the variation of weight change from pregnancy to 1 year postpartum: Beta = 3.6, the second trimester gains explained 2% of the change (beta = 2.8); and the first trimester explained 1% of the change (beta = 1.4). Total weight gain explained 8% of change (multiple r = 0.29), $P < 0.001$)</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups Maternal weight gain categories: G1: Continuous weight gain (kg) G2: Weight change (kg), defined as the difference between prepregnancy and 1 year postpartum weights</p> <p>Results Regression model for G2 as the dependent variable and G1 as the independent variable: B = 0.32 $P < 0.001$</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Lactation score Age Prepregnancy BMI Parity <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Parham et al., 1990</p> <p>Country and setting: USA, prenatal clinics</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: To explore relationship between pregnancy weight gain and postpartum weight and to identify variables associated with return to prepregnancy weight</p> <p>Time frame: NR</p> <p>Duration of the study: Entry into PNC up to 9 months postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Other observational: pregnant women vs non pregnant selected from the same clinic Retrospective <p>Total Study N: 260 (158 pregnant + 102 non pregnant)</p> <p>Group Description: G1: Prenatal patients G2: Control</p> <p>Group N: G1: 158 G2: 102</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Prenatal patients in 2 clinics serving low-income patients ; singleton births Non pregnant women who also had weight info during a 12 month period of time <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Incomplete or unusable data on weight changes during pregnancy and postpartum periods 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> < 20 (underweight), 20-25 (acceptable), > 25 (overweight) <p>Age (mean, yrs): G1: 23 G2: 23</p> <p>Parity: NR</p>	<p>Race, %: White G1: ~50 G2: ~50</p> <p>Black G1: ~25 G2: ~25</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 158 G2: NR</p> <p>Total weight gain: G1: 12.9 kg (SD 5.8) G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> < 9.1kg, 9.1-13.6, and > 13.6kg </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3,299 g (SD 628) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Mean maternal weight gain was 9.7kg ("maternal weight gain" in this study is weight at delivery minus baby's BW). Lower third of maternal weight gains ranged from -7.1 to 6.7 kg, with a mean of 3.7 [+ or -] 2.9 kg; middle third had a range of 6.8 to 11.9 kg (mean = 9.4 [+ or -] 1.3 kg); and the upper third had a range of 11.9 to 32.8 kg (mean = 16.0 [+ or -]3.7). Three maternal weight gain categories differed significantly in initial BMI ($P = .03$). Residual weight I was significantly correlated with maternal weight gain ($r = .84$, $P < .001$) and with prepregnancy BMI ($r = .14$, $P = .05$). Residual weight II was also significantly correlated with maternal weight gain ($r = .68$, $P < .001$) but not with prepregnancy BMI</p> <p>Other infant outcomes: Among underweight and normal-weight women, gains were roughly evenly distributed among 3 maternal gain tertiles, but 50% of overweight women had gains in lower tertile and only 24% in upper tertile. Groups did not differ significantly</p>	<p>Outcomes Description: Postpartum weight retention, percent change in BMI category between prepregnancy and 1-3 months postpartum</p> <p>Groups Maternal weight gain for population in tertiles, mean (se): G1: 3.7 (2.9) G2: 9.4 (1.3) G3: 16.0 (3.7)</p> <p>Results G1, G2: 83% No change; 7% Desirable change (i.e. underweight women becoming normal weight); 10% Undesirable change (~5% had an increase in BMI category and ~5% had a decrease in BMI category) G3: 42% no change; 19% desirable change; 39% Undesirable change (all increases in BMI category)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 1 Good, 5 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Soltani and Fraser, 2000</p> <p>Country and setting: UK, hospital</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: To investigate pattern of changes in weight gain and fat distribution during pregnancy and postpartum and whether this differed by maternal BMI measured in first trimester</p> <p>Time frame: NR</p> <p>Duration of the study: First prenatal visit to 6 months postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 77</p> <p>Group Description:</p> <p>G1: Total sample G2: Normal weight G3: Overweight G4: Obese</p> <p>Group N:</p> <p>G1: 77 G2: 29 G3: 23 G4: 25</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women attending first prenatal visit at Northern General Hospital <p>Exclusion criteria: NR</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured during first prenatal visit <p>G1: 73.0 (16.8) G2: 60.8 (5.6) G3: 72.0 (5.9) G4: 93.0 (10.6)</p> <p>Pregravid BMI:</p> <p>G1: 27.4 (5.9) G2: 22.7 (1.3) G3: 27.7 (1.4) G4: 34.5 (3.54)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: 26.71 (4.77) G2: 26.44 (5.32) G3: 26.91 (4.50) G4: 27.68 (3.83)</p> <p>Parity:</p> <p>G1: 0.78 (0.86) G2: 0.55 (0.87) G3: 0.81 (0.75) G4: 1.00 (0.96)</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 24% G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics:</p> <p>Fat mass (kg) at first visit:</p> <p>G1: 24.5 (9.9) G2: 16.5 (3.6) G3: 24.6 (3.9) G4: 36.1 (5.9)</p> <p>Waist:hip ratio:</p> <p>G1: 0.92 (0.08) G2: 0.88 (0.06) G3: 0.92 (0.08) G4: 0.96 (0.08)</p> <p>Total Skinfold Thickness (mm):</p> <p>G1: 117.09 (40.19) G2: 84.3 (25.31) G3: 125.02 (22.76) G4: 158.74 (21.52)</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 77 G2: 29 G3: 25</p> <p>Total weight gain: G1: 13-36 weeks: 10.8 (4.7) G2: 11.0 (3.2) G3: 11.9 (6.4) G4: 9.7 (4.3)</p> <p>Categorized: <ul style="list-style-type: none"> • Continuous </p> <p>Collected from: <ul style="list-style-type: none"> • Collected by study investigators </p> <p>Ascertained by: <ul style="list-style-type: none"> • NR </p>	<p>Birth weight: G1: 3443.0 (589.60) G2: 3331.5 (481.7) G3: 3423.7 (543.2) G4: 3670.4 (489.5)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups Pre gravid BMI categories: G1: Normal Weight G2: Underweight G3: Overweight G4: Obese</p> <p>Results G1: Patterns of changes in body weight (kg) and fat mass follow a monotonous trend; body weight and fatness increased during gestation, decreased substantially at 6 weeks postpartum, and then stayed the same or slightly decreased until 6 months postpartum G2: Showed similar pattern to G1. G3: Divergent pattern of weight gains and losses; body fat mass changes show a very scattered pattern G4: Divergent pattern of both weight and fat mass gains and losses; heavier and greater fat masses at 6 months postpartum compared to 13 weeks gestation; significantly lower fat mass loss and greater skinfold thickness gain between 36 weeks gestation and 6 months postpartum compared to normal weight women ($P < 0.05$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Walker et al., 2004</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1999 to 2001</p> <p>Funding: National Instituted of Nursing Research</p> <p>Study Objective: Longitudinal analysis of behavioral and psychosocial correlates of weight trends during first postpartum year</p> <p>Time frame: 1999 to 2001</p> <p>Duration of the study: Initiation of prenatal care to 12 months postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 382</p> <p>Group Description:</p> <p>G1: Total cohort G2: White G3: African American G4: Hispanic</p> <p>Group N:</p> <p>G1: 382 G2: 113 G3: 100 G4: 169</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women with healthy, term, singleton pregnancies with prenatal care funded through Medicaid Parity ≤ 3 English speaking ≥ 18 years free of prenatal complications (hypertension or diabetes) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported Other- please explain! <p>G1: NR G2: 65.44 (15.82) kg G3: 67.96 (13.99) G4: 67.26 (15.24)</p> <p>Pregravid BMI:</p> <p>G1: NR G2: 24.23 (5.78); Underwt% 18.75; Normal wt% 53.57; Overwt% 11.61; Obese % 16.07 G3: 25.39 (5.40); Under 11.34%; Normal 56.7%; Over 9.28%; Obese 22.68% G4: 26.75 (6.19); Under 7.78%; Normal 48.5%; Over 13.77%; Obese 29.94%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous IOM guidelines <p>Age (mean, yrs):</p> <p>G1: NR G2: 22.79 (4.72) G3: 22.40 (3.75) G4: 21.89 (3.36)</p> <p>Parity:</p> <p>G1: NR G2: Parity = 1 (%): 45.13 G3: 35.00% G4: 30.77%</p>	<p>Race, %:</p> <p>White G1: 29.6 G2: NR</p> <p>Black G1: 26.2 G2: NR</p> <p>Hispanic G1: 44.2 G2: NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 34. Gestational weight gain and postpartum weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 113 G2: 100 G3: 169</p> <p>Total weight gain: G1: kg 16.44 (6.51); below IOM rec 16.07%; within IOM rec 30.36%; more than IOM rec 53.57% G2: kg 15.20 (7.88); below IOM rec 25.53%; within IOM rec 17.02%; more than IOM rec 57.45% G3: kg 14.87 (7.76); below IOM rec 22.29%; within IOM rec</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous according to IOM <p>Collected from:</p> <ul style="list-style-type: none"> • Self-reported • Collected by study investigators gestational weight gain based on self report • Postpartum weight gain was measured by study investigators postdelivery, and at 6 wks, 3, 6, and 12 months postpartum <p>Ascertained by:</p> <ul style="list-style-type: none"> • Self-reported 	<p>Birth weight: NR</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: 10.62 G2: 15.00 G3: 16.57</p> <p>Instrumental delivery,%: NR</p> <p>Episiotomy,%: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Postpartum weight retention</p> <p>Groups Continuous maternal weight gain (kg)</p> <p>Results Each kg of maternal weight gain was associated with 0.314 kg/m² of postpartum BMI (<i>P</i> < 0.001)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Ethnicity • Time • Interaction of ethnicity and time • Pregravid BMI • Weight-related distress • Energy intake <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 35. Gestational weight gain and premenopausal breast cancer

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hilakivi-Clarke et al., 2005</p> <p>Country and setting: Finland, primary care</p> <p>Enrollment Period: Apr 1990-Dec 1993</p> <p>Funding: Supported by grants from National Cancer Institute, Susan G. Komen Breast Cancer Research Foundation, and Breast Cancer Research Foundation</p> <p>Study Objective: To investigate whether excessive maternal weight gain alters a woman's risk of developing premenopausal breast cancer</p> <p>Time frame: Apr 1990 to Dec 1993</p> <p>Duration of the study: 3 to 6 years after insertion of IUD</p> <p>Quality: Fair</p>	<p>Design:</p> <ul style="list-style-type: none"> Case-control Retrospective <p>Total Study N: 490</p> <p>Group Description: G1: Cases G2: Controls</p> <p>Group N: G1: 98 G2: 392</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Cases of reported breast cancer per survey, for each case- 4 controls matched for age and Mirena status chosen randomly from cohort <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing info on birth year, nulliparous women, development of breast cancer before pregnancy 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Change in BMI < 3.5, 3.5 to 7, > 7 units <p>Age (mean, yrs): G1: 46.7 G2: 46.7</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Family history of breast cancer: G1: 9.4% G2: 5.7%</p>

Evidence Table 35. Gestational weight gain and premenopausal breast cancer (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 98 G2: 392</p> <p>Total weight gain: G1: < 10 kg 23.4% 10-15 47.9% 16-20 21.3% 20+ 7.5% G2: < 10 kg 22.2% 10-15 50.3% 16-20 19.4% 20+ 8.2%</p> <p>Categorized: <ul style="list-style-type: none"> Categorical: < 10kg, 10-15, 16-20, > 20 </p> <p>Collected from: <ul style="list-style-type: none"> Self-reported data collected on weight gain during any pregnancy - not first or last specified </p> <p>Ascertained by: <ul style="list-style-type: none"> Self-reported </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> AOR for Premenopausal breast cancer (95% CI) <p>Groups: weight gain (kg) G1: < 10kg G2: 10-15 kg G1: 16-20 kg G2: >20 kg</p> <p>Results: G1: 1.0 reference G2: 0.8 (0.44,1.47) G2: NR G3: 1.0 (0.47, 2.04) G4: 0.8 (0.27, 2.13)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Education Age at menarche Age at first birth Family history of breast cancer Pregnancy weight gain Change in BMI during adult life <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 36. Gestational weight gain with reference to IOM recommendations and gestational diabetes

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Bianco et al., 1998</i></p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancy Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple gestations Extremes of age BMI between 27 and 34 Missing height Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) ($P < 0.05$)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> NR <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 ($P = NS$)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% ($P < 0.01$)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% ($P < 0.01$)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% ($P < 0.01$)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% ($P < 0.01$)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% ($P < 0.01$)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% ($P < 0.01$)</p>

Evidence Table 36. Gestational weight gain with reference to IOM recommendations and gestational diabetes (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p><i>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</i></p> <p><i>Collected from:</i></p> <ul style="list-style-type: none"> <i>Routine pre-natal care or maternity records</i> <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> <i>Not stated - from medical records</i> 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) (P < 0.05)</p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% (P < 0.01)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> • Preeclampsia • Placental abruption • Meconium • Failure to progress • Shoulder dystocia • Postpartum hemorrhage • Endomyometritis • Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> • Fetal growth restriction • Preterm delivery • Fetal demise • Fetal distress 	<p>Outcomes Description: Distribution of GDM, %:</p> <p>Groups Maternal weight gain categories among morbidly obese (BMI > 35): G1: Weight loss/no change G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: > 35 lbs</p> <p>Results G1: 15.7 G2: 15.0 G3: 14.4 G4: 13.4 G5: 12.5 P = NS</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Race, parity, clinic service, substance abuse, preexisting medical condition</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 36. Gestational weight gain with reference to IOM recommendations and gestational diabetes (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Edwards et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1997-1993</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy course and outcomes in obese and normal weight women and their associations with gestational weight change</p> <p>Time frame: 1997-1993</p> <p>Duration of the study: 1997-1993</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 1,443</p> <p>Group Description: G1: Obese G2: Normal Weight G3: total sample</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women and normal weight women identified from pregnancy and delivery summary records (normal weight matched to obese by race, age, parity) Singleton deliveries Live births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 103.5 G2: 61</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelinesobese (> 29) and normal weight (BMI 19.8-26.0) <p>Age (mean, yrs): G1: 27.1 G2: 25.4</p> <p>Parity: NR</p>	<p>Race, %: White G1: NR G2: NR G3: 69.0 (Total sample)</p> <p>Black G1: NR G2: NR G3: 21.0 (Total sample)</p> <p>Hispanic G1: NR G2: NR G3: 7.0 (Total sample)</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: NR G2: NR G3: 4.0 (Total sample)</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 36. Gestational weight gain with reference to IOM recommendations and gestational diabetes (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 683 G2: 660</p> <p>Total weight gain: G1: 9.5 G2: 14.5 $P \leq 0.001$</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3420 G2: 3285 $P \leq 0.001$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 25.6 G2: 9.1 $P < 0.001$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Percent with Gestational Diabetes by weight group</p> <p>Groups Obese BMI > 29 (kg): G1: Lost weight/no change G2: 0.5-6.5 G3: 7-11.5 G4: 12-16 G5: > 16</p> <p>Normal weight BMI 19.8-26 G6: < 11.5 G7: 11.5-16 G8: > 16</p> <p>Results Gestational diabetes, % G1: 13.3 G2: 24.3 G3: 11.9 G4: 16.7 G5: 17.3 P for linear trend (G1-G5) = 0.554</p> <p>G6: 2.3 G7: 3.3 G8: 2.9 P for linear trend (G6-G8) = 0.759</p> <p>Maternal confounders and effect modifiers accounted for in analysis: None</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: None</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 36. Gestational weight gain with reference to IOM recommendations and gestational diabetes (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Saldana et al., 2006</p> <p>Country and setting: United States, hospital</p> <p>Enrollment period: August 1, 1995 through May 31, 2000</p> <p>Funding: Supported in part by National Institute of General Medical Sciences (Grant R25GM55336), National Institute of Child Health and Development (Grant 28684), and North Carolina Clinical Nutrition Research (Grant DK56350)</p> <p>Study Objective: Objective of study to examine weight and its relationship to glucose intolerance during pregnancy</p> <p>Time frame: August 1, 1995 through May 31, 2000</p> <p>Duration of the study: Entry into prenatal care through end of second trimester</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 952</p> <p>Group Description: G1: Normal Glucose Tolerance G2: Impaired Glucose Tolerance G3: GDM</p> <p>Group N: G1: 809 G2: 48 G3: 95</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancy More than 16 years of age English speaking Access to phone Planned to continue care at 1 of study sites <p>Exclusion criteria:</p> <ul style="list-style-type: none"> From non-white or non-black racial group Having a second pregnancy in cohort Pre-existing diabetes No glucose screening data High screen without an oral glucose tolerance test 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 25 (0.24) G2: 28 (1.1) G3: 30 (0.82)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 26 (0.22) G2: 29 (0.91) G3: 28 (0.59)</p> <p>Parity: G1: 0.9 (0.04) G2: 1.1 (0.16) G3: 0.9 (0.10)</p>	<p>Race, %: White G1: 58% G2: 73% G3: 69%</p> <p>Black G1: 42% G2: 27% G3: 31%</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: G1: 25% G2: 26% G3: 25%</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Weight gain ratio (observed/recommended[compared with IOM range]) G1: 1.43 (0.04) G2: 1.48 (0.21) G3: 1.88 (0.15)</p> <p>Additional characteristics: NR</p>

Evidence Table 36. Gestational weight gain with reference to IOM recommendations and gestational diabetes (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): Groups (N): NR Total weight gain: G1: 9.1 (0.19) G2: 8.1 (0.90) G3: 9.4 (0.62) Categorized: <ul style="list-style-type: none"> 2 weight gain variables were created. Weight gain was calculated by subtracting prepregnancy weight from weight at end of second trimester (G2 weeks). Weight gain ratio calculated as ratio of observed weight gain to recommended Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> NR </p>	<p>Birth weight: NR Gestational diabetes, %: NR Cesarean delivery, %: NR Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: NR Other infant outcomes:</p>	<p>Outcomes Description: Mean and adjusted odds ratio (95% CI) for weight gain Groups G1: Normal glucose tolerance G2: Impaired glucose tolerance G3: Gestational diabetes mellitus BMI IOM Results Mean (SE) weight gain ratio (defined as observed weight gain/IOM recommended weight gain): G1: 1.43 (0.04) G2: 1.48 (0.21) G3: 1.88 (0.15) P < 0.05 AOR for weight gain ratio G1: 1.0 (reference) G3: 1.2 (0.9-1.4) Maternal confounders and effect modifiers accounted for in analysis: Race, age Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good Sample selection: Good Definition of maternal weight gain: Good Definition of outcomes: Good Source of information on exposure, outcomes, and confounders: Fair Followup: Good Analysis comparability: Good Analysis of outcomes: Fair Interpretation: Good Sum of Good/Fair/Poor: 7 Good, 2 Fair, 0 Poor Final Quality Score: Good</p>

Evidence Table 36. Gestational weight gain with reference to IOM recommendations and gestational diabetes (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Thorsdottir et al., 2002</i></p> <p>Country and setting: Maternity records, Department of Obstetrics and Gynecology at Landspítali University Hospital, Iceland</p> <p>Enrollment Period:</p> <p>Funding: NR</p> <p>Study Objective: To investigate relation between gestational weight gain in women of normal prepregnant weight and complications during pregnancy and delivery in a population with high gestational weight gain and birth weight</p> <p>Time frame: NR</p> <p>Duration of the study: 1998</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 614</p> <p>Group Description:</p> <p>G1: No complication</p> <p>G2: Complications in pregnancy or delivery</p> <p>G3: Complications in pregnancy</p> <p>G4: Complications in delivery</p> <p>Group N:</p> <p>G1: 452</p> <p>G2: 162</p> <p>G3: 56</p> <p>G4: 106</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women of normal prepregnancy weight randomly selected within 1 year (1998) • No history of diabetes, hypertension, CVD, or thyroid problems • Singleton births • 38 to 43 weeks gestation • 20 to 40 years of age • Routine fetal biometry at 18 to 20 week ultrasound • Received early and regular antenatal care <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 63.1 (6.2)</p> <p>G2: 62.0 (5.6) <i>P</i> = 0.059</p> <p>G3: 61.7 (4.8) <i>P</i> = 0.174</p> <p>G4: 62.2 (6.1) <i>P</i> = 0.274</p> <p>Pregravid BMI:</p> <p>G1: 22.2</p> <p>G2: 22.4 (1.6) <i>P</i> = 0.270</p> <p>G3: 22.4 (1.5) <i>P</i> = 0.338</p> <p>G4: 22.3 <i>P</i> = 0.584</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs):</p> <p>G1: 29</p> <p>G2: 29 <i>P</i> = 0.857</p> <p>G3: 29 <i>P</i> = 0.404</p> <p>G4: 29 <i>P</i> = 0.398</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Proportional weight gain, %:</p> <p>G1: 26.0</p> <p>G2: 28.0 <i>P</i> = 0.018</p> <p>G3: 30.0 <i>P</i> = 0.005</p> <p>G4: 27.0 <i>P</i> = 0.546</p> <p>Additional characteristics: NR</p>

Evidence Table 36. Gestational weight gain with reference to IOM recommendations and gestational diabetes (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Total weight gain: G1: 16.6 (4.9) G2: 17.4 (5.1) <i>P</i> = 0.080 G3: 18.4 (5.1) <i>P</i> = 0.013 G4: 16.9 (5.1) <i>P</i> = 0.887</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM < 11.5, 11.-16.0, ≥ 16.1, also quintiles < 12.5, 12.5-15.5, 15.6-17.8, 17.9-20.8, > 20.8 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery not stated - based on records? 	<p>Birth weight: G1: 3789 (469) G2: 3749 (565) <i>P</i> = 0.389 G3: 3643 (526) <i>P</i> = 0.032 G4: 3806 (578) <i>P</i> = 0.529</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Gestational diabetes, %</p> <p>Groups Maternal weight gain categories (kg): G1: < 11.5 G2: 11.5-16.0 G3: 16.1-20.0 G4: > 20.0</p> <p>Results Gestational diabetes, % G1: 2.9 G2: 0 G3: 0 G4: 0 <i>P</i> for trend < 0.015</p> <p>Maternal confounders and effect modifiers accounted for in analysis: None</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: None</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 37. Gestational weight gain with reference to IOM recommendations and hypertension

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Bianco et al., 1998</i></p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) ($P < 0.05$)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 ($P = NS$)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% ($P < 0.01$)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% ($P < 0.01$)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% ($P < 0.01$)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% ($P < 0.01$)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% ($P < 0.01$)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% ($P < 0.01$)</p>

Evidence Table 37. Gestational weight gain with reference to IOM recommendations and hypertension (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p><i>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</i></p> <p><i>Collected from:</i></p> <ul style="list-style-type: none"> <i>Routine pre-natal care or maternity records</i> <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> <i>Not stated - from medical records</i> 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) (P < 0.05)</p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% (P < 0.01)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: Pregnancy-induced hypertension</p> <p>Groups: G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: >35 lbs</p> <p>Results: G1: 11.8% G2: 13.7% G3: 13.7% G4: 12.4% G5: 21.3% (P = NS)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Devader et al., 2007</i></p> <p>Country and setting: <i>United States, birth certificate data</i></p> <p>Enrollment period: <i>1999 to 2001</i></p> <p>Funding: <i>NR</i></p> <p>Study Objective: <i>To investigate relationship between gestational weight gain and adverse pregnancy outcomes among women with normal prepregnancy BMI</i></p> <p>Time frame: <i>1999 to 2001</i></p> <p>Duration of the study: <i>Entry into prenatal care through delivery</i></p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 94,696</p> <p>Group Description: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs</p> <p>Group N: G1: 16,852 G2: 37,292 G3: 40,552</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • All mothers with normal prepregnancy BMI (19.8–26.0 kg/m²) who were 18 to 35 years of age at time of delivery and who delivered full-term (37 weeks or more) singleton infant during period January 1, 1999, to December 31, 2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Women aged younger than 18 years and older than 35 years • Non-Missouri residents • Preterm deliveries • Multiple gestations 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care • If missing, obtained from mother during postpartum hospital stay <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized: NR</p> <p>Age (mean, yrs): G1: Maternal age (y) 18 to 24*: 42.3% 25 to 30: 36.2% 31 to 35: 21.5% G2: Maternal age (y) 18 to 24*: 36.7% 25 to 30: 39.5% 31 to 35: 23.8% G3: Maternal age (y) 18 to 24*: 44.7% 25 to 30: 35.9% 31 to 35: 19.4%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 79.7 G2: 85.6 G3: 85.2 Black G1: 15.7 G2: 10.8 G3: 12.1 Hispanic NR Asian/Pacific Islander NR Other G1: 4.6 G2: 3.5 G3: 2.7</p> <p>Smoking, %: G1: 20.5 G2: 14.9 G3: 17.4</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 plot risk for each adverse pregnancy outcome by 10-lb increments in gestational weight gain. Women who gained 25 to 34 lbs during their pregnancy had lower risks for most outcomes when balancing risk for SGA status and other adverse pregnancy outcomes Women who gained 15 to 24 lbs had lowest risks for most outcomes, but increased their risk of having an SGA infant from 9.6% to 14.3% Women who gained more than 34 lbs had higher risks for all outcomes, although their risk of having an SGA infant decreased from 9.6% to 6.6% 	<p>Outcomes Description: AOR (95% CI) for preeclampsia</p> <p>Groups Maternal weight gain categories (lbs): G1: < 25 G2: 25-35 G3: > 35</p> <p>Results G1: 0.56 (0.49-0.64) G2: 1.00 (reference) G3: 1.88 (1.74-2.04)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Education Income Alcohol use Height Prior pregnancy Inadequate prenatal care use Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Child's gender Birth year 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

**Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Devader et al., 2007
(combined)

**Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia
(continued)**

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	Other infant outcomes: NR		

Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Edwards et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1997-1993</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy course and outcomes in obese and normal weight women and their associations with gestational weight change</p> <p>Time frame: 1997-1993</p> <p>Duration of the study: 1997-1993</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 1,443</p> <p>Group Description: G1: Obese G2: Normal Weight G3: total sample</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women and normal weight women identified from pregnancy and delivery summary records (normal weight matched to obese by race, age, parity) Singleton deliveries Live births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 103.5 G2: 61</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelinesobese (> 29) and normal weight (BMI 19.8-26.0) <p>Age (mean, yrs): G1: 27.1 G2: 25.4</p> <p>Parity: NR</p>	<p>Race, %: White G1: NR G2: NR G3: 69.0 (Total sample)</p> <p>Black G1: NR G2: NR G3: 21.0 (Total sample)</p> <p>Hispanic G1: NR G2: NR G3: 7.0 (Total sample)</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: NR G2: NR G3: 4.0 (Total sample)</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 683 G2: 660</p> <p>Total weight gain: G1: 9.5 G2: 14.5 $P \leq 0.001$</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3420 G2: 3285 $P \leq 0.001$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 25.6 G2: 9.1 $P < 0.001$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Preeclampsia</p> <p>Groups Obese BMI > 29 (kg): G1: Lost weight/ no change G2: 0.5-6.5 G3: 7-11.5 G4: 12-16 G5: > 16</p> <p>Normal weight BMI 19.8-26: G6: < 11.5 G7: 11.5-16.0 G8: > 16.0</p> <p>Results G1: 10.7 G2: 7.7 G3: 8.3 G4: 7.9 G5: 16.5 P for linear trend (for G1-G5) = 0.076</p> <p>G6: 2.8 G7: 2.9 G8: 6.6 P for linear trend (for G6-G8) = 0.048</p> <p>Maternal confounders and effect modifiers accounted for in analysis: None</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: None</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kiel et al., 2007</p> <p>Country and setting: United States, birth registry</p> <p>Enrollment period: 1990 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of gestational weight change on pregnancy outcomes in obese women</p> <p>Time frame: 1990 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 120,170</p> <p>Group Description:</p> <p>G1: Obese Class I (BMI 30–34.9) (n = 70,536)</p> <p>G2: Obese Class II (BMI 35–39.9) (n = 30,609)</p> <p>G3: Obese Class III (BMI 40 and More) (n = 19,025)</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women residing in Missouri who delivered (at 37 or more weeks of gestation) liveborn, singleton infants during 1990–2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: Total: Class I obese: 59% Class II obese: 25% Class III obese: 16%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NIH guidelines <p>Age (mean, yrs):</p> <p>G1: <26: 46% 26-35: 47% Older than 35: 8%</p> <p>G2: <26: 44% 26-35: 48% Older than 35: 8%</p> <p>G3: <26: 40% 26-35: 52% Older than 35: 9%</p> <p>Parity:</p> <p>Nulliparous: G1: 34% G2: 33% G3: 32%</p>	<p>Race, %:</p> <p>White G1: 78 G2: 77 G3: 73</p> <p>Black G1: 22 G2: 23 G3: 27</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 22</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: GWG (lb) Less than 2: 3% 2 to 14: 15% 15 to 25: 26% More than 25: 56% G2: GWG (lb) Less than 2: 8% 2 to 14: 22% 15 to 25: 27% More than 25: 43% G3: GWG (lb) Less than 2: 15%</p> <p>Categorized:</p> <ul style="list-style-type: none"> 10-lb or less loss 2 to 9 lbs loss, no weight change, 2 to 9 lbs gain, 10 to 14 lbs gain, 15–25 lb gain, 26–35 lb gain, and greater than 35 lb gain <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: G1: SGA: 7% LGA: 13% (<i>P</i> < 0.05) G2: SGA: 7% LGA: 16% (<i>P</i> < 0.05) G3: SGA: 6% LGA: 18% (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 28 G2: 34 G3: 41</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Odds ratios (95% CI) for preeclampsia</p> <p>Groups Maternal weight gain categories stratified by prepregnancy obesity status, Obese Class I (BMI 30–34.9), Obese Class II (BMI 35–39.9), Obese Class III (BMI ≥ 40): G1: ≤ -10lbs G2: -2 to -9 lbs G3: No change G4: 2-9 lbs G5: 10-14 lbs G6: 15-25 lbs G7: 26-35 lbs G8: > 35 lbs</p> <p>Results For Obese Class I: OR (95% CI) for preeclampsia were significantly lower (< 1.00, G6 was reference) for G2-G5 and significantly higher for G7-G8. For Obese Class II: OR (95% CI) for preeclampsia were significantly greater (> 1.00, G6 was reference) for G1 and G3- G5 and significantly lower for G8. For Obese Class III: OR (95% CI) for preeclampsia were significantly greater (> 1.00, G6 was reference) for G1-G3 and G5 and significantly lower for G7-G8</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Education Poverty (enrollment in Medicaid, WIC, food stamp programs) Tobacco use Chronic hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

**Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Kiel et al., 2007
(continued)

Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 show absolute risk of preeclampsia, cesarean delivery, LGA, and SGA by GWG category for each obesity class. All 3 figures show similar patterns of increasing risk of preeclampsia, cesarean delivery, and LGA birth and decreasing risk of SGA birth with increasing GWG. Collectively, minimal risk for all 4 outcomes corresponds to GWG categories where risk of LGA and SGA births intersect. This equates to GWG of 10 of 25 lb for class I obese women, a gain of 0 to 9 lb for class II obese women, and weight loss of 0 to 9 lb for class III obese women. Adjusted odds ratios and 95% CIs for preeclampsia, cesarean delivery, SGA, and LGA by GWG category and obesity class. Compared with women who gained 15 to 25 lb during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births. Women who gained more than 25 lbs had higher odds for same 3 pregnancy outcomes and lower odds for SGA births. <p>Other infant outcomes: NR</p>		

Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Thorsdottir et al., 2002</i></p> <p>Country and setting: Maternity records, Department of Obstetrics and Gynecology at Landspítali University Hospital, Iceland</p> <p>Enrollment Period:</p> <p>Funding: NR</p> <p>Study Objective: To investigate relation between gestational weight gain in women of normal prepregnant weight and complications during pregnancy and delivery in a population with high gestational weight gain and birth weight</p> <p>Time frame: NR</p> <p>Duration of the study: 1998</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 614</p> <p>Group Description:</p> <p>G1: No complication</p> <p>G2: Complications in pregnancy or delivery</p> <p>G3: Complications in pregnancy</p> <p>G4: Complications in delivery</p> <p>Group N:</p> <p>G1: 452</p> <p>G2: 162</p> <p>G3: 56</p> <p>G4: 106</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women of normal prepregnancy weight randomly selected within 1 year (1998) • No history of diabetes, hypertension, CVD, or thyroid problems • Singleton births • 38 to 43 weeks gestation • 20 to 40 years of age • Routine fetal biometry at 18 to 20 week ultrasound • Received early and regular antenatal care <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 63.1 (6.2)</p> <p>G2: 62.0 (5.6) <i>P</i> = 0.059</p> <p>G3: 61.7 (4.8) <i>P</i> = 0.174</p> <p>G4: 62.2 (6.1) <i>P</i> = 0.274</p> <p>Pregravid BMI:</p> <p>G1: 22.2</p> <p>G2: 22.4 (1.6) <i>P</i> = 0.270</p> <p>G3: 22.4 (1.5) <i>P</i> = 0.338</p> <p>G4: 22.3 <i>P</i> = 0.584</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs):</p> <p>G1: 29</p> <p>G2: 29 <i>P</i> = 0.857</p> <p>G3: 29 <i>P</i> = 0.404</p> <p>G4: 29 <i>P</i> = 0.398</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Proportional weight gain, %:</p> <p>G1: 26.0</p> <p>G2: 28.0 <i>P</i> = 0.018</p> <p>G3: 30.0 <i>P</i> = 0.005</p> <p>G4: 27.0 <i>P</i> = 0.546</p> <p>Additional characteristics: NR</p>

Evidence Table 38. Gestational weight gain with reference to IOM recommendations and pre-eclampsia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Total weight gain: G1: 16.6 (4.9) G2: 17.4 (5.1) <i>P</i> = 0.080 G3: 18.4 (5.1) <i>P</i> = 0.013 G4: 16.9 (5.1) <i>P</i> = 0.887</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM < 11.5, 11.-16.0, ≥ 16.1, also quintiles < 12.5, 12.5-15.5, 15.6-17.8, 17.9-20.8, > 20.8 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery, not stated - based on records 	<p>Birth weight: G1: 3789 (469) G2: 3749 (565) <i>P</i> = 0.389 G3: 3643 (526) <i>P</i> = 0.032 G4: 3806 (578) <i>P</i> = 0.529</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Maternal weight gain categories (kg): G1: < 11.5 G2: 11.5-16.0 G3: 16.1-20.0 G4: > 20.0</p> <p>Preeclampsia, % G1: 1.4 G2: 2.3 G3: 5.4 G4: 4.4 <i>P</i> for trend = 0.262</p> <p>Maternal confounders and effect modifiers accounted for in analysis: None</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: None</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR • Imputed: • No • Categorized: • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <ul style="list-style-type: none"> • Black NR • Hispanic NR • Asian/Pacific Islander NR • Other NR <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <ul style="list-style-type: none"> • Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <ul style="list-style-type: none"> • Categorize d: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs • Collected from: <ul style="list-style-type: none"> • Routine prenatal care or maternity records • Ascertain ed by: <ul style="list-style-type: none"> • Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) <i>(P < 0.05)</i></p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% <i>(P < 0.01)</i></p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> • Preeclampsia • Placental abruption • Meconium • Failure to progress • Shoulder dystocia • Postpartum hemorrhage • Endomyometritis • Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> • Fetal growth restriction • Preterm delivery • Fetal demise • Fetal distress 	<p>Outcomes Description: Cesarean delivery</p> <p>Groups G1: wt loss or 0 lbs G2: 1-15 lb G3: 16-25 lb G4: 26-35 lb G5: >35 lb</p> <p>Results G1: 25.5% G2: 26.8% G3: 28.8% G4: 35.0% G5: 33.8% <i>(P = NS)</i> No significant difference among morbidly obese women by weight gain categories.</p> <p>OR for Cesarean comparing morbidly to nonobese =2.3 (1.9, 2.8)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Macrosomia</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: DeVader et al., 2007</p> <p>Country and setting: United States, birth certificate data</p> <p>Enrollment period: 1999 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To investigate relationship between gestational weight gain and adverse pregnancy outcomes among women with normal prepregnancy BMI</p> <p>Time frame: 1999 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 94,696</p> <p>Group Description: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs</p> <p>Group N: G1: 16,852 G2: 37,292 G3: 40,552</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • All mothers with normal prepregnancy BMI (19.8 –26.0 kg/m²) who were 18 to 35 years of age at time of delivery and who delivered full-term (37 weeks or more) singleton infant during period January 1, 1999, to December 31, 2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Women aged younger than 18 years and older than 35 years • Non-Missouri residents • Preterm deliveries • Multiple gestations 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care • If missing, obtained from mother during postpartum hospital stay <p>Pregravid BMI: NR</p> <ul style="list-style-type: none"> • Imputed: • No • Categorized: NR <p>Age (mean, yrs): G1: Maternal age (y) 18 to 24*: 42.3% 25 to 30: 36.2% 31 to 35: 21.5% G2: Maternal age (y) 18 to 24*: 36.7% 25 to 30: 39.5% 31 to 35: 23.8% G3: Maternal age (y) 18 to 24*: 44.7% 25 to 30: 35.9% 31 to 35: 19.4%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 79.7 G2: 85.6 G3: 85.2</p> <ul style="list-style-type: none"> • Black G1: 15.7 G2: 10.8 G3: 12.1 • Hispanic NR • Asian/Pacific Islander NR • Other G1: 4.6 G2: 3.5 G3: 2.7 <p>Smoking, %: G1: 20.5 G2: 14.9 G3: 17.4</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: NR</p> <ul style="list-style-type: none"> • Categorize d: • According to IOM • Collected from: • Routine prenatal care or maternity records • Ascertain ed by: NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> • Figures 1 to 3 plot risk for each adverse pregnancy outcome by 10-lb increments in gestational weight gain. Women who gained 25 to 34 lbs during their pregnancy had lower risks for most outcomes when balancing risk for SGA status and other adverse pregnancy outcomes • Women who gained 15 to 24 lbs had lowest risks for most outcomes, but increased their risk of having an SGA infant from 9.6% to 14.3% • Women who gained more than 34 lbs had higher risks for all outcomes, although their risk of having an SGA infant decreased from 9.6% to 6.6% <p>Other infant outcomes:</p> <ul style="list-style-type: none"> • NR 	<p>Outcomes Description: AOR for cesarean delivery (additionally controlled for LGA and cephalopelvic disproportion)</p> <p>Groups G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs</p> <p>Results G1: 0.82 (0.78–0.87) G2: 1.0 G3: 1.35 (1.29–1.40)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Age, race, education, income, alcohol use, height, prior pregnancy, inadequate prenatal care use, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Child's gender, birth year</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Edwards et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1997-1993</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy course and outcomes in obese and normal weight women and their associations with gestational weight change</p> <p>Time frame: 1997-1993</p> <p>Duration of the study: 1997-1993</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 1,443</p> <p>Group Description: G1: Obese G2: Normal Weight G3: total sample</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women and normal weight women identified from pregnancy and delivery summary records (normal weight matched to obese by race, age, parity) Singleton deliveries Live births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 103.5 G2: 61</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> Imputed: No Categorized: IOM guidelinesobese (> 29) and normal weight (BMI 19.8-26.0) <p>Age (mean, yrs): G1: 27.1 G2: 25.4</p> <p>Parity: NR</p>	<p>Race, %: White G1: NR G2: NR G3: 69.0 (Total sample)</p> <ul style="list-style-type: none"> Black G1: NR G2: NR G3: 21.0 (Total sample) Hispanic G1: NR G2: NR G3: 7.0 (Total sample) Asian/Pacific Islander NR Other G1: NR G2: NR G3: 4.0 (Total sample) <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 683 G2: 660</p> <p>Total weight gain: G1: 9.5 G2: 14.5 $P \leq 0.001$</p> <ul style="list-style-type: none"> • Categorize d: • According to IOM • Collected from: <ul style="list-style-type: none"> • Routine pre-natal care or maternity records • Ascertain ed by: <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3420 G2: 3285 $P \leq 0.001$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 25.6 G2: 9.1 $P < 0.001$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Cesarean delivery</p> <p>Groups Obese G1: wt loss or 0 lbs G2: 1-14 lb G3: 15-25 lb G4: 26-35 lb G5: >35 lb</p> <ul style="list-style-type: none"> • Normal weight G1: <25 lb G2: 25-35 lb G3: >35 lb <p>Results Obese G1: 30.7% G2: 21.6% G3: 23.8% G4: 26.2% G5: 30.1%</p> <ul style="list-style-type: none"> • Normal weight G1: 5.7% G2: 12.1% G3: 8.6% • No significant difference in rates of cesarean delivery by IOM weight gain categories for normal weight or obese women • Obese women AOR =3.2 (2.3,4.4) for cesarean delivery <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Parity • Pre-gravid BMI • GDM • Pregnancy induced hypertension • Prenatal adequacy • Alcohol use • Drug use • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Jain et al, 2007</p> <p>Country and setting: United States, hospitals</p> <p>Enrollment period: 2002-2005</p> <p>Funding: Not reported</p> <p>Study Objective: To analyze risks of cesarean section, macrosomia, and breastfeeding at 10 weeks postpartum using logistic regression to estimate independent effects of prepregnancy BMI and gestational weight gain</p> <p>Time frame: 2002-2005</p> <p>Duration of the study: Entry into prenatal care to 10 weeks postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 7661</p> <p>Group Description: NR</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Term (> 37 weeks) and singleton for macrosomia and breastfeeding <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Cesarean analysis limited to women with cephalic presentation-records with missing data excluded 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <ul style="list-style-type: none"> NR Imputed: No Categorized: IOM guidelines <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race,%: NR</p> <p>Smoking,%: NR</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain:</p> <ul style="list-style-type: none"> • NR <p>d:</p> <ul style="list-style-type: none"> • Categorize • ≤ 15 lbs • 15-25 lbs • 25-35 lbs • 35+ lbs <p>from:</p> <ul style="list-style-type: none"> • Collected • Not outlined <p>d by:</p> <ul style="list-style-type: none"> • Ascertain • Birth certificate 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Cesarean delivery</p> <p>Groups G1: ≤ 15 lbs G2: 16 - < 25 lbs G3: 25 - < 35 lbs G4: ≥ 35 lbs G5: interaction term overweight/obese and gaining 25-35</p> <p>Results Primipara (AOR, 95% CI) G5: 0.71 (0.43-1.19)</p> <p>Multipara G5: 0.77 (1.37-1.59)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Pre-gravid BMI, parity</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 0 Good, 7 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kaiser and Kirby, 2001</p> <p>Country and setting: USA, university nurse-midwifery system</p> <p>Enrollment Period: 1994 to 1998</p> <p>Funding: NR</p> <p>Study Objective: To determine whether low risk maternity patients in a nurse-midwifery service with prepregnant BMI > 29.0 are at increased risk for cesarean delivery</p> <p>Time frame: 1994 to 1998</p> <p>Duration of the study: First prenatal visit to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 1,881</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 1881 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Healthy women who met criteria for nurse-midwifery care according to practice's guidelines Women who delivered preterm or attempted trials of labor All pregnancies were included for women who delivered more than once within study period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with chronic conditions (diabetes, hypertension, unstable asthma), prenatal complications (multiple gestations, fetal malformations, and gestational diabetes), repeat cesarean delivery Women with missing height or prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported Used measured weight at first prenatal visit (if less than 12 weeks gestation) if women did not know <p>Pregravid BMI: G1: NR BMI</p> <ul style="list-style-type: none"> ≤ 19.7: 13.2% 19.8-26.0: 50.7% 26.1-28.9: 12.0% ≥ 29.0: 24.0% <p>G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 21.1 (4.7) G2: NR</p> <p>Parity: G1: % primiparous: 36.5 G2: NR</p>	<p>Race, %: White G1: 14.9 G2: NR</p> <ul style="list-style-type: none"> Black G1: 77.1 G2: NR Hispanic G1: 6.6 G2: NR Asian/Pacific Islander G1: 1.4 G2: NR Other NR <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: married: 9.4 G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 1881 G2: NR</p> <p>Total weight gain:</p> <ul style="list-style-type: none"> • Categorize d: • Study by Parker and Abrams-weight gain cut offs are different • Collected from: • Routine prenatal care or maternity records • Ascertain ed by: • Based on last clinically measured weight prior to delivery: difference between prepregnant weight and prenatal visit closest to delivery (not longer than 3 weeks from delivery) 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 5.1 G2: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Odds ratios (95% CI) for cesarean delivery</p> <p>Groups G1: Below IOM G2: within IOM <ul style="list-style-type: none"> • G3: Above IOM Weight gain below IOM recommendations</p> <p>Results Crude OR G1: 0.82 (0.49, 1.36) G3: 1.0 (0.62, 1.63)</p> <ul style="list-style-type: none"> • AOR for weight gain above IOM recommendations: 2.04 (95% CI 1.02, 4.05) <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race • Pre-gravid BMI • Pre-eclampsia • Height • Previous live births • Failure to progress • Breech presentation • Birth weight <p>Infant and child confounders and effect modifiers accounted for in analysis: Birth weight</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kiel et al., 2007</p> <p>Country and setting: United States, birth registry</p> <p>Enrollment period: 1990 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of gestational weight change on pregnancy outcomes in obese women</p> <p>Time frame: 1990 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 120,170</p> <p>Group Description:</p> <p>G1: Obese Class I (BMI 30–34.9) (n = 70,536)</p> <p>G2: Obese Class II (BMI 35–39.9) (n = 30,609)</p> <p>G3: Obese Class III (BMI 40 and More) (n = 19,025)</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women residing in Missouri who delivered (at 37 or more weeks of gestation) liveborn, singleton infants during 1990–2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: Total: Class I obese: 59% Class II obese: 25% Class III obese: 16%</p> <ul style="list-style-type: none"> Imputed: No Categorized: NIH guidelines <p>Age (mean, yrs):</p> <p>G1: <26: 46% 26-35: 47% Older than 35: 8%</p> <p>G2: <26: 44% 26-35: 48% Older than 35: 8%</p> <p>G3: <26: 40% 26-35: 52% Older than 35: 9%</p> <p>Parity: Nulliparous: G1: 34% G2: 33% G3: 32%</p>	<p>Race, %: White G1: 78 G2: 77 G3: 73</p> <ul style="list-style-type: none"> Black G1: 22 G2: 23 G3: 27 Hispanic NR Asian/Pacific Islander NR Other G1: 22 <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: GWG (lb) Less than 2: 3% 2 to 14: 15% 15 to 25: 26% More than 25: 56%</p> <p>G2: GWG (lb) Less than 2: 8% 2 to 14: 22% 15 to 25: 27% More than 25: 43%</p> <p>G3: GWG (lb) Less than 2: 15%</p> <ul style="list-style-type: none"> • Categorized: • 10-lb or less loss • 2 to 9 lbs loss, no weight change, 2 to 9 lbs gain, 10 to 14 lbs gain, 15–25 lb gain, 26–35 lb gain, and greater than 35 lb gain • Collected from: • Routine pre-natal care or maternity records • Ascertained by: NR 	<p>Birth weight: G1: SGA: 7% LGA:13% (<i>P</i> < 0.05) G2: SGA: 7% LGA:16% (<i>P</i> < 0.05) G3: SGA: 6% LGA:18% (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 28 G2: 34 G3: 41</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Risk of cesarean delivery</p> <p>Groups G1: wt loss > 10 lbs G2: wt loss 2-9 lb G3: no change G4: 2-9 lb G5: 10-14 lb G6: 15-25 lb G7: 26-35 lb G8: >35 lb</p> <p>Results For all three classes of obese women, risks of cesarean delivery rise above an OR of 1 when weight gain exceeds 25 pounds</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race • Parity • Education • Poverty (enrollment in medicaid • WIC • Food stamp programs) • Tobacco use • Chronic hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

**Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Kiel et al., 2007
(continued)

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 show absolute risk of preeclampsia, cesarean delivery, LGA, and SGA by GWG category for each obesity class. All 3 figures show similar patterns of increasing risk of preeclampsia, cesarean delivery, and LGA birth and decreasing risk of SGA birth with increasing GWG. Collectively, minimal risk for all 4 outcomes corresponds to GWG categories where risk of LGA and SGA births intersect. This equates to GWG of 10 to 25 lb for class I obese women, a gain of 0 to 9 lb for class II obese women, and weight loss of 0 to 9 lb for class III obese women. Adjusted odds ratios and 95% CIs for preeclampsia, cesarean delivery, SGA, and LGA by GWG category and obesity class. Compared with women who gained 15 to 25 lb during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births. Women who gained more than 25 lbs had higher odds for same 3 pregnancy outcomes and lower odds for SGA births. 		
	<p>Other infant outcomes: NR</p>		

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Parker and Abrams, 1992</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: Sept 1980 to Dec 1988</p> <p>Funding: UC Committee on Research & MCH and Resources Development, Health Resources and Services Administration</p> <p>Study Objective: To test whether gains outside IOM reference ranges were associated with increased risks of suboptimal pregnancy outcome (SGA, LGA, cesarean delivery) and to determine whether locally developed ranges were more applicable to study population</p> <p>Time frame: Sept 1980 to Dec 1988</p> <p>Duration of the study: From entry into prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 6,690</p> <p>Group Description: G1: Overall G2: NR</p> <p>Group N: G1: 6,690 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Consecutive live singleton births at Moffitt Hospital between September 1980 and December 1988 with gestational ages of 37 to 42 weeks <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Maternal transfers or transports and deliveries complicated by fetal malformations, maternal diabetes, or maternal hypertension 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 56.8 kg(SD 11.0) G2: NR</p> <p>Pregravid BMI: G1: Underweight: 27.7%, Normal weight 61.8%, Overweight: 5.6%, Obese 4.9% G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 27.7 (5.5) G2: NR</p> <p>Parity: Primiparous: G1: 58.8% G2: NR</p>	<p>Race, %: White G1: 44.0 G2: NR</p> <ul style="list-style-type: none"> Black G1: 8.3 G2: NR Hispanic G1: 9.4 G2: NR Asian/Pacific Islander G1: 21.4 G2: NR Other G1: 12.0 G2: NR <p>Smoking, %: G1: 12.0 G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 6690 G2: NR</p> <p>Total weight gain: G1: 15.2kg (5.2) G2: NR</p> <ul style="list-style-type: none"> • Categorize d: • According to IOM Weight gain ranges based on percentiles from previous study of UC population with good pregnancy outcomes: 25th -75th, 10-90th percentiles. For 25-75th, weight gain range = 12-17kg for underweight women (BMI < 19.8); • Collected from: • Routine pre-natal care or maternity records • Ascertain ed by: • Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3408g (462) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Risks for cesarean delivery</p> <p>Groups G1: Below IOM G2: Above IOM</p> <p>Results AOR for all women weight gain >IOM (G2) =1.48 (1.25,1.76)</p> <ul style="list-style-type: none"> • For overweight women, there was no significant association between cesarean delivery and weight gain (AOR = 0.71 (0.40-1.26). • For non-overweight women, the association between cesarean delivery and weight gain in non-overweight women was 1.45 (1.21 - 1.73) <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race • Parity • Pre-gravid BMI • Height • Maternal high and low weight gain • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age • Birth weight 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stotland et al., 2004</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: Not stated</p> <p>Funding: Grant HD01262, Women's Reproductive Health Research Scholar</p> <p>Study Objective: To examine how association between excessive weight gain and cesarean birth is modified by infant birth weight in nondiabetic women</p> <p>Time frame: Not stated</p> <p>Duration of the study: During pregnancy until deliver</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 9,788</p> <p>Group Description:</p> <p>G1: All weight gain categories G2: Women gaining > IOM guidelines G3: Women gaining within IOM guidelines G4: Women gaining < IOM guidelines</p> <p>Group N:</p> <p>G1: 9,788 G2: 4,675 G3: 3,479 G4: 1,634</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton Term <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple gestation Preterm birth (< 37 completed weeks) Birth weight less than 2500g Multiparity Noncephalic presentation Gestational or pregestational diabetes Placenta previa Active herpes at delivery Abdominal cerclage Fetal anomaly requiring cesarean delivery Missing data on maternal prepregnancy bmi Missing data on gestational weight gain 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported Not stated - records <p>Pregravid BMI:</p> <ul style="list-style-type: none"> Imputed: No Categorized: IOM guidelines <p>Age (mean, yrs):</p> <p>G1: 26.6 G2: 26.5 G3: 26.8 G4: 26.2</p> <p>Parity: NR</p>	<p>Race, %: White G1: 45 G2: 50 G3: 43 G4: 37</p> <ul style="list-style-type: none"> Black G1: 11 G2: 11 G3: 9 G4: 14 Hispanic G1: 10 G2: 10 G3: 9 G4: 10 Asian/Pacific Islander G1: 19 G2: 15 G3: 24 G4: 24 Other G1: 11 G2: 10 G3: 12 G4: 12 <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 9788 G2: 4675 G3: 3479 G4: 1634</p> <p>Total weight gain:</p> <ul style="list-style-type: none"> • Categorize d: • According to IOM • Collected from: • Routine pre-natal care or maternity records • Ascertaine d by: • Based on last clinically measured weight prior to delivery: measured as (1) difference between prepregnancy weight and last measurement prior to delivery and (2) absolute GWG = subtraction of infant birth weight and placental weight from total maternal weight 	<p>Birth weight: G1: 3437 G2: 3562 G3: 3360 G4: 3242</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Cesarean delivery</p> <p>Groups G1: Below IOM G2: Above IOM</p> <p>Results AOR with birth weight in model G1: 0.99 (0.82,1.19) G2 :1.40 (1.22,1.59)</p> <ul style="list-style-type: none"> • BMI <19.8 G1 =0.96 (0.67,1.37) G2 =1.93 (1.45,2.53) • BMI 19.8-26 G1 =1.04 (0.81,1.33) G2 =1.26 (1.06,1.50) • BMI >26 G1 =0.74 (0.38,1.44) G2 =1.21 (0.83,1.78) <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race • Pre-gravid BMI • Year of delivery • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age • Birth weight • Infant sex 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 6 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Thorsdottir et al., 2002</p> <p>Country and setting: Maternity records, Department of Obstetrics and Gynecology at Landspítali University Hospital, Iceland</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: To investigate relation between gestational weight gain in women of normal prepregnant weight and complications during pregnancy and delivery in a population with high gestational weight gain and birth weight</p> <p>Time frame: NR</p> <p>Duration of the study: 1998</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 614</p> <p>Group Description: G1: No complication G2: Complications in pregnancy or delivery G3: Complications in pregnancy G4: Complications in delivery</p> <p>Group N: G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women of normal prepregnancy weight randomly selected within 1 year (1998) • No history of diabetes, hypertension, CVD, or thyroid problems • Singleton births • 38 to 43 weeks gestation • 20 to 40 years of age • Routine fetal biometry at 18 to 20 week ultrasound • Received early and regular antenatal care <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 63.1 (6.2) G2: 62.0 (5.6) $P = 0.059$ G3: 61.7 (4.8) $P = 0.174$ G4: 62.2 (6.1) $P = 0.274$</p> <p>Pregravid BMI:</p> <p>G1: 22.2 G2: 22.4 (1.6) $P = 0.270$ G3: 22.4 (1.5) $P = 0.338$ G4: 22.3 $P = 0.584$</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 29 G2: 29 $P = 0.857$ G3: 29 $P = 0.404$ G4: 29 $P = 0.398$</p> <p>Parity: NR</p>	<p>Race, %: White NR</p> <ul style="list-style-type: none"> • Black NR • Hispanic NR • Asian/Pacific Islander NR • Other NR <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Proportional weight gain, %: G1: 26.0 G2: 28.0 $P = 0.018$ G3: 30.0 $P = 0.005$ G4: 27.0 $P = 0.546$</p> <p>Additional characteristics: NR</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and cesarean delivery (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Total weight gain: G1: 16.6 (4.9) G2: 17.4 (5.1) <i>P</i> = 0.080 G3: 18.4 (5.1) <i>P</i> = 0.013 G4: 16.9 (5.1) <i>P</i> = 0.887</p> <ul style="list-style-type: none"> • Categorized: • According to IOM < 11.5, 11.-16.0, ≥ 16.1, also quintiles < 12.5, 12.5-15.5, 15.6-17.8, 17.9-20.8, > 20.8 • Collected from: • Routine pre-natal care or maternity records • Ascertained by: • Based on last clinically measured weight prior to delivery, not stated - based on records? 	<p>Birth weight: G1: 3789 (469) G2: 3749 (565) <i>P</i> = 0.389 G3: 3643 (526) <i>P</i> = 0.032 G4: 3806 (578) <i>P</i> = 0.529</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Percent cesarean deliveries</p> <p>Groups G1 <11.5 kg G2 11.5-16 kg G3 16.1-20 kg G4 >20 kg</p> <p>Results G1: 17.4% G2: 9.5% G3: 12.9 % G4: 13.1%</p> <ul style="list-style-type: none"> • No significant differences in cesarean delivery rates by IOM weight gain categories in normal weight women <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Parity • Height <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age • Birth weight 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 40. Gestational weight gain with reference to IOM recommendations and preterm birth

Study Description	Study Design Patient Population Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hickey et al., 1995</p> <p>Country and setting: USA university prenatal clinics</p> <p>Enrollment Period: Dec 1985 to Oct 1988</p> <p>Funding: NIH MCH grant</p> <p>Study Objective: To examine relationship between prenatal weight gain and spontaneous preterm delivery using IOM guidelins</p> <p>Time frame: Dec 1985 to Oct 1988</p> <p>Duration of the study: Entry into prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 1518</p> <p>Group Description: G1: Black women G2: White women</p> <p>Group N: G1: 677 G2: 338</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Low income Multiparous women Must have at least 1 risk factor: > 2 spontaneous abortions previous stillborn/neonatal death previous birth < 37 weeks previous birth < 2750g maternal height < 157cm maternal weight < 50kg hypertension history of phlebitis current alcohol use current smoking first visit after 26 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Outlying or missing prepregnancy weight Missing height Prepregnancy BMI > 26.0 Multiple births Missing data for type of preterm delivery Indicated preterm delivery 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 55.8 (8.4) G2: 54.1 (7.9)</p> <p>Pregravid BMI: G1: < 19.8: 37.7% 19.8-26.0: 62.3% G2: < 19.8: 43.3% 19.8-26.0: 57.7%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean yrs): G1: 24.8 (4.4) G2: 24.4 (4.4)</p> <p>Parity: G1: 1: 58.9%; 2: 41.1% G2: 1: 68.6%; 2: 31.4%</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 34.6 G2: 75.7</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 40. Gestational weight gain with reference to IOM recommendations and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: First trimester: 353 Second trimester: 474 Third trimester: 615 G2: First trimester: 175 Second trimester: 244 Third trimester: 301</p> <p>Total weight gain: G1: First trimester: Low BMI -2.61 (2.91); Normal BMI- 2.54 (3.68); Second trimester: Low BMI: 0.49 (0.19) Normal BMI: 0.46 (0.21) Third trimester: Low BMI- 0.46 (0.27) Normal BMI-0.45 (0.27) G2: First trimester: low BMI - 2.93 (3.39); normal</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM weight gain by trimester </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: using weight measured at last visit prior to delivery </p>	<p>Birth weight: NR</p> <p>Gestational diabetes %: NR</p> <p>Cesarean delivery %: NR</p> <p>Instrumental delivery %: NR</p> <p>Episiotomy %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Low first trimester weight gain: < 2.3kg for low BMI women and < 1.6kg for normal BMI women Low second and low third trimester weight gain: < 0.38kg/wk for low BMI women and < 0.37 kg/wk for normal BMI women <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Spontaneous preterm birth: 12.4% in black women and 8.0% in white women 	<p>Outcomes Description: Odds ratio(95% CI) for spontaneous preterm; and pattern of weight gain</p> <p>Groups G1: Low rate of weight gain first trimester- underweight (BMI < 19.8) & < 2.3 kg and normal weight (BMI 19.8-26)& < 1.6 kg G2: Low rate of weight gain in second trimester (Underwt & < 0.38 kg/wk or normal wt & < 0.37 kg/wk) G3: Low rate of weight gain in third trimester (Underwt & < 0.38 kg/wk or normal wt & < 0.37 kg/wk)</p> <p>Results OR (95% CI) for Spontaneous Preterm G1 1.27 (0.7 2.3) G2 1.23 (0.7 2.18) G3 2.46 (1.53 3.92)</p> <p>Pattern of weight gain G1 only 2.94 (0.73 11.98) G2 only 1.08 (0.1 11.23) G3 only 11.54 (2.93 45.28) G1 & G2 4.89 (0.85 28.14) G1 & G3 4.49 (0.96 20.96) G2 & G3 7.37 (1.66 32.76) All trimesters 4.18 (0.75 23.35)</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 40. Gestational weight gain with reference to IOM recommendations and preterm birth

Study Description	Study Design Patient Population Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Hickey et al., 1995
(continued)

**Evidence Table 40. Gestational weight gain with reference to IOM recommendations and preterm birth
(continued)**

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		<p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race • Pre-gravid BMI • Height • Alcohol use • History of previous infant less than 2750g • Number of days between last weight observation and delivery • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <p>Infant sex</p>	

Evidence Table 40. Gestational weight gain with reference to IOM recommendations and preterm birth (continued)

Study Description	Study Design Patient Population Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, Year: Schieve et al., 2000</p> <p>Country and setting: USA National Maternal and Infant Health Survey</p> <p>Enrollment Period: 1988</p> <p>Funding: NR</p> <p>Study Objective: To examine associations between rate of pregnancy weight gain and preterm delivery among women of varying prepregnancy body mass indices (BMI)</p> <p>Time frame: 1988</p> <p>Duration of the study: From initiation of prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: medical charts but then women were asked to self report info after pregnancy <p>Total Study N: 3,511</p> <p>Group Description: G1: Preterm G2: Term</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton births delivered between 28 and 43 weeks' gestation with data available for 3 or more prenatal weight measurements between 14 and 28 weeks' gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with weight gain per week of > 5.0 lb. or less than - 2.5lb. Women missing data for prepregnancy weight or height 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean yrs):</p> <p>G1: Age at delivery (y): 15–19 12.5%* 20–29 56.0% 30–50 31.6%</p> <p>G2: Age at delivery (y) 15–19 8.3% 20–29 60.3% 30–50 31.4%</p> <p>Parity: Parity 0 G1: 49.9% 1 31.8% 2 or more 18.3% G2: 47.7% 1 30.8% 2 or more 21.6%</p>	<p>Race, %: White G1: 67.1% G2: 81.1%</p> <p>Black G1: 20.9% G2: 9.1%</p> <p>Hispanic G1: 12.1% G2: 9.8%</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: G1: 38.2 G2: 32.4</p> <p>Diabetes mellitus, %: G1: 6.4 G2: 4.4</p> <p>Hypertension, %: G1: 10.9 G2: 6.6</p> <p>Additional characteristics: Marital status: G1: Married 72.1% Not married 27.9% G2: Married 84.2% Not married 15.8%</p> <p>Additional characteristics: Maternal education G1: Less than high school 17.8% High school 43.0% More than high school 39.3% G2: Less than high school 12.7% High school 39.9% More than high school 47.4%</p>

Evidence Table 40. Gestational weight gain with reference to IOM recommendations and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM pounds per week: Low - 0.5 or less/week; average 0.5-1.5 lb/week; high > 1.5 lb/week <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to deliveryNR 	<p>Birth weight: NR</p> <p>Gestational diabetes</p> <p>%: G1: 6.4 G2: 4.4</p> <p>Cesarean delivery,%:</p> <p>Instrumental delivery</p> <p>%: NR</p> <p>Episiotomy</p> <p>%: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Adjusted odds ratio for preterm birth</p> <p>Groups G1: Low < 0.5 less/week; G2: Average 0.5-1.5 lb/week G3: High > 1.5 lb/week</p> <p>Results Low BMI: G1=6.7 (1.1 40.6) G2=0.8 (0.4 1.4) G3=1.0 (0.4 2.6)</p> <p>Average BMI: G1=3.6 (1.6 8.0) G2 (Reference) G3=1.0 (0.6 1.9)</p> <p>High BMI: G1=1.6 (0.7 3.5) G2=1.1 (0.6 2.1) G3=0.1 (0.03 0.6)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Marital status Education Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 6 Good, 3 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 40. Gestational weight gain with reference to IOM recommendations and preterm birth (continued)

Study Description	Study Design Patient Population Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, Year: Siega-Riz et al., 1994</p> <p>Country and setting: USA public health clinics</p> <p>Enrollment Period: 1983 to 1986</p> <p>Funding: March of Dimes NIGMS-predoc grant</p> <p>Study Objective: To describe gestational weight gain patterns by prepregnancy weight and trimester of pregnancy and to examine risk of preterm birth associated with prepregnancy weight and gestational weight gain using various definitions of adequacy based on IOM</p> <p>Time frame: 1983 to 1986</p> <p>Duration of the study: Entry into prenatal care up to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 5854</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women attending 8 public health clinics in West Los Angeles area • Only included first pregnancy for which women received care <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Women who left prenatal care setting after at least 2 visits with no birth outcome available • Mismatched prenatal and outcome files • Erroneous gestational age • Pregnancy complications (diabetes • hypertension • Stillbirths • Multiple pregnancies • Implausible values 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: Underweight: 12%; Normal weight: 60%; Overweight: 17.7%; Obese: 10.5%</p> <p>G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • Yes <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean yrs): G1: 24.3 G2: NR</p> <p>Parity: Primiparous: G1: 35% G2: NR</p>	<p>Race, %: White NR Black NR Hispanic G1: 80 G2: NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Married: G1: 61% G2: NR</p> <p>Less than 12 years of education: G1: 71% G2: NR</p>

Evidence Table 40. Gestational weight gain with reference to IOM recommendations and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: Underweight women: 14.3kg; Normal weight: 13.7 kg; Overweight: 12kg; Obese: 11.7kg G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3424 G2: NR</p> <p>Gestational diabetes %: NR</p> <p>Cesarean delivery %: NR</p> <p>Instrumental delivery %: NR</p> <p>Episiotomy %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Risk of preterm birth</p> <p>Groups Total weight gain expressed as a ratio of observed: expected based on the IOM recommendation for a given gestational age</p> <p>Results- outcomes by groups Preterm birth (< 37 weeks)</p> <ul style="list-style-type: none"> Adequacy of weight gain in the third trimester was predictive of preterm birth - the data suggested a threshold effect for all weight status groups with a marked decrease in risk at 90-110% of the IOM recommendation With the rate of weight gain less than 60% of the IOM value women in all four groups had more than double the risk of delivering preterm which was statistically significant for all but the obese category Excessive rate of weight gain was significantly associated with a preterm birth only for women of normal prepregnancy weight status at a value greater than 200% of the IOM value <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Pre-gravid BMI <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 4 Good, 3 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 40. Gestational weight gain with reference to IOM recommendations and preterm birth (continued)

Study Description	Study Design Patient Population Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, Year: Stotland et al., 2006</p> <p>Country and setting: USA academic medical center</p> <p>Enrollment Period: 1976 to 2001</p> <p>Funding: NIH</p> <p>Study Objective: To study how relationship between gestational weight gain and spontaneous preterm birth interacts with maternal race or ethnicity and previous preterm birth status</p> <p>Time frame: 1976 to 2001</p> <p>Duration of the study: From entry into prenatal care until delivery (actually used a perinatal data base and looked at info)</p> <p>Quality: Fair</p>	<p>Design:</p> <ul style="list-style-type: none"> Perinatal data base review Retrospective <p>Total Study N: 15,101</p> <p>Group Description: G1: Total G2: White G3: African American G4: Latina G5: Asian</p> <p>Group N: G1: 15,101 G2: 6,513 G3: 1,533 G4: 1,614 G5: 3,440</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women of low or normal prepregnancy BMI delivering singleton during study period with complete data on all variables considered <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple gestations Hypertension Diabetes Delivery before 24 weeks of gestation Congenital anomalies Missing data on any key variables Prepregnancy BMI of 26 or greater Transport from another hospital 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported data base <p>Pregravid BMI: G1: Low 29.6%; Normal 70.4% G2: Low 25.9%; Normal 74.1% G3: Low 23.0%; Normal 77% G4: Low 19%; Normal 81% G5: Low 42.2%; 57.9%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines Low (< 19.8) Normal (19.8-25.9) but this is not explicitly stated <p>Age (mean yrs): G1: 28.19 G2: 29.43 G3: 24.25 G4: 26.17 G5: 29.10</p> <p>Parity: Nulliparous G1: 53.8% G2: 57.5 G3: 48.0 G4: 49.0 G5: 52.9</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 10.9% G2: 14.5% G3: 21.4% G4: 6.7% G5: 4.5%</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Previous preterm birth (%) G1: NR G2: 4.4 G3: 4.1 G4: 8.3 G5: 5.58 G6: 2.91</p> <p>Additional characteristics: NR</p>

Evidence Table 40. Gestational weight gain with reference to IOM recommendations and preterm birth (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 15,101 G2: 6,513 G3: 1,533 G4: 1,614 G5: 3,440</p> <p>Total weight gain: G1: Below IOM: 20.5%; % Within IOM 39.1%; Above 40.4% <i>P</i> < .001 G2: Below 15.5%; Within 38.5%; above 46.1% <i>P</i> < .001 G3: Below 16.9%; Within 30.9%; Above 41.2% <i>P</i> < .001 G4: Below 21.1%; Within 37.4%; Above 41.5% <i>P</i> < .001 G5: Below 25.4%; Within</p> <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous • According to IOM3-way categorical variable • low (less than 0.27 kg/wk) • normal (between 0.27 and 0.52 kg/wk) • and high (greater than 0.52kg/wk) <p>Collected from:</p> <ul style="list-style-type: none"> • Rate of weight gain was determined by:total weight gain divided by GA minus 2 weeks <p>Ascertained by:</p> <ul style="list-style-type: none"> • Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes %: NR</p> <p>Cesarean delivery %: NR</p> <p>Instrumental delivery %: NR</p> <p>Episiotomy %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> • Spontaneous PTB for • All women 4.0% • White 3.6% • Blacks 6.8% • Latinas 4.4% • Asians 3.6% <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Odds ratio of spontaneous preterm birth</p> <p>Groups G1: low rate of weight gain <.27 kg/wk G2: ref 0.27-0.52 kg/wk G3: high rate of weight gain >0.52 kg/wk</p> <p>Results Crude OR G1: 2.6 (95% CI 2.1–3.2) G3: 1.0 (95% CI 0.8–1.2)</p> <p>AOR G1: 2.5 (95% CI 2.0–3.1) G3: 1.0 (95% CI 0.8–1.3)</p> <p>No differences in results by parity combined with Hx PTB</p> <p>Slightly higher risks for Af Am and high wt gain close to sign for Af Am</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race-EMM • Parity-EMM • Pre-gravid BMI • History of previous PTB • Year of delivery • Number of days between last weighing and DOB • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight: Routine pre-natal care G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) ($P < 0.05$)</p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% ($P < 0.01$)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: Increase in birthweight</p> <p>Groups G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: >35 lbs</p> <p>Results G1: 3,302 G2: 3,192 G3: 3,337 G4: 3,506 G5: 3,453 ($P < 0.05$)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hickey et al., 1997</p> <p>Country and setting: USA, public health programs</p> <p>Enrollment Period: Jan 1993 to Dec 1994</p> <p>Funding: MCH grant, University of Alabama School of Public Health/NIH Intramural Basic Sciences Research grant</p> <p>Study Objective: Examine differences in birth weight among term infants of black and white women with weight gains in upper or lower half of recommended ranges</p> <p>Time frame: Jan 1993 to Dec 1994</p> <p>Duration of the study: From first visit to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 5198</p> <p>Group Description: G1: Black G2: White</p> <p>Group N: G1: 2219 G2: 3699</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women enrolled in Medicaid Maternity Waiver programs operated in 24 counties by Alabama Department of Public Health during study period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Delivered before 37 weeks or after 42 weeks • Maternal age ≤ 17 years • Last prenatal weight recording more than 3 weeks before delivery • Maternal risk factors (diabetic, cardiac, genetic, and obstetric conditions/complications) requiring external referral • Multiple fetuses • Stillborn/neonatal death • Missing or outlying anthropometric data • Missing data for ethnicity • Missing gestational age • Congenital anomalies • Missing birth weight • Invalid country code 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 70.8 (19.6) G2: 65.8 (17.6)</p> <p>Pregravid BMI: G1: 26.6 (7.1) G2: 24.8 (6.3)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 23.7 (5.0) G2: 23.4 (4.6)</p> <p>Parity:</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR</p> <p>Smoking, %: G1: 9.2 G2: 35.1</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): Total weight gain: Categorized: <ul style="list-style-type: none"> According to IOMgain below range (for pregravid BMI), gain in lower range, gain in upper range, gain above range Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	Birth weight: NR Gestational diabetes, %: NR Cesarean delivery, %: NR Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: NA Other infant outcomes: NA	Outcomes Description: Birth Weight (gms) by IOM Categories Groups G1: Below IOM Range G2: Lower end of IOM Range G3: Upper end of IOM range G4: Gain above IOM range Results BMI < 19.8 G1: Black: 2840 White: 3002 G2: Black: 2995 White: 3151 G3: Black: 3017 White: 3200 G4: Black: 3163 White: 3353 BMI 19.8-26.0 G1: Black: 3052 White: 3176 G2: Black: 3105 White: 3199 G3: Black: 3180 White: 3307 G4: Black: 3228 White: 3389 BMI > 26.0 G1: Black: 3126 White: 3385 G2: Black: 3192 White: 3376 G3: Black: 3312 White: 3402 G4: Black: 3300 White: 3504	Background: Good Sample selection: Good Definition of maternal weight gain: Poor Definition of outcomes: Good Source of information on exposure, outcomes, and confounders: Fair Followup: Good Analysis comparability: Fair Analysis of outcomes: Good Interpretation: Fair Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor Final Quality Score: Fair

**Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Hickey et al., 1997
(continued)

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		<p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Education • Height • Street drugs • Alcohol use • Time between last prenatal weight observation and delivery • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age • Infant sex 	

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hickey et al., 1996</p> <p>Country and setting: USA, university prenatal clinics</p> <p>Enrollment Period: Dec 1985 to Oct 1988</p> <p>Funding: Maternal and Child Health grant</p> <p>Study Objective: To examine association between prenatal weight gain patterns and birth weight using IOM guidelines</p> <p>Time frame: Dec 1985 to Oct 1988</p> <p>Duration of the study: During prenatal care to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 415</p> <p>Group Description: G1: Black G2: White</p> <p>Group N: G1: 275 G2: 140</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women who identified as black or white, were nonobese, and were para 1 or 2 and who enrolled in prenatal care clinic with at least one or more of following risk factors: > 2 spontaneous abortions, previous stillborn/neonatal death, previous birth < 37 weeks GA, previous birth < 2750g, maternal height < 157cm, maternal weight < 50kg, hypertension, history of phlebitis, current alcohol use, current smoking <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with missing or outlying prepregnancy weight data Prepregnancy BMI exceeding 26.0 Multiple births Delivery before 37 weeks gestation Prenatal weight observations that did not fall within time frames specified at beginning and end of any trimester 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 55.2 (9.0) G2: 53.8 (7.7)</p> <p>Pregravid BMI:</p> <p>G1: < 19.8: 42.9% 19.8-26.0: 57.1% G2: < 19.8: 41.4% 19.8-26.0: 58.6%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 25.8 (4.2) G2: 25.2 (4.3)</p> <p>Parity: G1: 1: 61.4%; 2: 38.6% G2: 1: 68.6%; 2: 31.4%</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR</p> <p>Smoking, %: G1: 35.6 G2: 77.9</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 0.7 G2: 0.0</p> <p>Additional characteristics: NR</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 415 G2: 415 G3: 275 G4: 275 G5: 140 G6: 140</p> <p>Total weight gain: G1: First trimester: 2.6 (3.2) Second trimester: 0.50 (0.17) Third trimester: 0.47 (0.24) G2: First trimester: 2.4 (3.5) Second trimester: 0.49 (0.22) Third trimester: 0.46 (0.26) G3: Total weight gain: 14.2 (4.4) First trimester: 2.4</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> First trimester weight gain (kg) was compared to IOM guideline for low BMI women = 2.3kg and normal BMI women = 1.6kg Second and third trimester weight gain (kg/wk) was compared to IOM guideline for low BMI women = 0.49 kg/wk and normal BMI women = 0.44 kg/wk <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Birth weight</p> <p>Groups</p> <p>G1: First Trimester <2.6 kg for underwt & <1.6 kg for normal wt G2: Second Trimester <0.38 kg/wk for underwt & <0.37 kg/wk for normal wt G3: <0.38 kg/wk for underwt & <0.37 kg/wk for normal wt</p> <p>Results Association of low trimester gain with birthweight G1: All women -18 g $p=.65$ Black -15 g $P = .76$ White -42 g $P = .53$ G2: All women -166g $p<.001$ Black -164 g $P = .005$ White -158 g $P = .05$ G3: All women -111g $p=.008$ Black -77 g $P = .14$ White -194 g $P = .004$</p> <p>No association with low weight gain in only the first or second trimester. G3: All -164 g $P = .01$ Black -80 g $P = .38$ White -300 g $P = .005$</p> <p>Association with low weight gain during more than one trimester G1 & G2: All -236 g $P = .01$ Black -265 g $P = .04$ White -169 g $P = .25$ G1 & G3: No significant diff G2 & G3: All -206 g $P = .01$ Black -178 g $P = .08$ White -268 g $P = .06$ G1, G2 & G3: All -284 g $P = .002$ Black -252g $P = .03$ White -379g $P = .008$</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
Author, year: Hickey et al., 1996 (continued)	<ul style="list-style-type: none"> • Prenatal weight observations that did not fall within time frames specified at beginning and end of all 3 trimesters 		

**Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight
(continued)**

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		<p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race • Pre-gravid BMI • Height • Alcohol use • Third trimester number of weeks between last weight observation and delivery • History of previous infant < 2750 g • Smoking • Gestational age • Infant sex <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age • Infant sex 	

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hickey et al., 1993</p> <p>Country and setting: USA, prenatal clinics</p> <p>Enrollment Period: December 1985 to October 1998</p> <p>Funding: NIH, Maternal and Child Health Department, and Agency for Health care policy and research grants</p> <p>Study Objective: To examine association of prenatal weight gain below, within, and above IOM guidelines with birth weight and fetal growth restriction among low income, high risk black and white women</p> <p>Time frame: December 1985 to October 1998</p> <p>Duration of the study: Entry to prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination, perinatal database <p>Total Study N: 1,168</p> <p>Group Description: G1: black G2: white</p> <p>Group N: G1: 803 G2: 365</p> <p>Inclusion criteria: At least 1 of following risk factors:</p> <ul style="list-style-type: none"> History of more than 2 spontaneous abortions Previous fetal or neonatal death Previous live birth before 37 weeks' gestation Previous infant weighing less than 2750g Maternal height less than 157cm Prepregnancy weight less than 50kg First prenatal visit before 26 weeks' gestation Hypertension (systolic bp above 140mmHg or diastolic bp above 90 mmHg) Current use of cigarettes or alcohol 15% random sample of multiparous women in clinic population was also included after it was determined that 70% of these women exhibited one or more of the risk factors (listed above) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 63.9 (17.1) G2: 61.0 (16.0)</p> <p>Pregravid BMI:</p> <p>G1: < 19.8: 27.5% 19.8-26.0: 43.6% > 26.0-29.0: 10.5% > 29.0: 18.4%</p> <p>G2: < 19.8: 32.3% 19.8-26.0: 46.0% > 26.0-29.0: 8.0% > 29.0: 13.7%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 25.2 (4.4) G2: 24.8 (4.4)</p> <p>Parity: Para 1: G1: 1: 59.3% G2: 1: 68.2%</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: G1: 37.1 G2: 73.4</p> <p>Diabetes mellitus, %: G1: 5.8 G2: 9.6</p> <p>Hypertension, %: G1: 2.7 G2: 1.1</p> <p>Additional characteristics: Married: G1: 24.9% G2: 65.6%</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 803 G2: 365</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> According to IOM Collected from: <ul style="list-style-type: none"> Collected by study investigators Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self report and last measure weight (76,4% made within 2 weeks prior to delivery) </p>	<p>Birth weight: G1: 3227 (440) G2: 3358 (467)</p> <p>Gestational diabetes, %: G1: 5.8 G2: 9.6</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Adjusted birthweight</p> <p>Groups BMI ≤ 29 G1: gain < range G2: gain in the range G3: gain > range</p> <p>BMI >29 G4: gain <6.0 kg G5: gain >6.0 kg</p> <p>Results G1 Black 3027 White 3246 G2 Black 3177 White 3233 G3 Black 3293 White 3523 G4 Black 3214 White 3500 G5 Black 3553 White 3596</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal height Education Parity Marital status Smoking Alcohol use Hypertension GDM Gestational age at delivery SES Time between last weight and delivery <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Infant sex 	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Luke et al., 1996</p> <p>Country and setting: USA, clinic</p> <p>Enrollment Period: March 1, 1974 to June 15, 1979</p> <p>Funding: NR</p> <p>Study Objective: Reanalysis of original data to examine contribution of maternal weight gain to infant birth weight and retained maternal weight in immediate postpartum period, and effect of weight gains below, at, and above IOM guidelines on both infant birt</p> <p>Time frame: March 1, 1974 to June 15, 1979</p> <p>Duration of the study: Prenatal visit through 2 days postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 487</p> <p>Group Description: G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI > 26.0</p> <p>Group N: G1: 104 G2: 268 G3: 115</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Referred for nutrition counseling > 37- < 43 weeks gestation Singleton pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with history of or concurrent metabolic disease, such as diabetes, seizure disorder, hypertension, cardiac disease, asthma, or drug dependence Women developing antepartum complications such as preeclampsia, GDM, or multiple gestation 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 47.9 (5.1) G2: 58.7 (6.3) G3: 83.9 (16.9)</p> <p>Pregravid BMI: G1: 18.3 (1.0) G2: 22.6 (1.7) G3: 31.7 (5.3)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 23.1 (5.5) G2: 23.8 (5.5) G3: 27.4 (6.2)</p> <p>Parity: % primipara: G1: 60.6 G2: 48.1 G3: 27.0</p>	<p>Race, %: White NR Black G1: 48.1 G2: 48.8 G3: 63.5 Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 17.3 G2: 15.3 G3: 13.0</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 104 G2: 268 G3: 115</p> <p>Total weight gain: G1: 12.6 (0.7) G2: 13.2 (0.4) G3: 11.7 (0.7) Significantly different from mean for normal BMI group at $P < 0.05$</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: total weight gain: difference between last measurement and pregravid weight; net weight gain: difference between pregravid weight and last measured weight minus infant birth weight 	<p>Birth weight: G1: 3,067 (44) $P < 0.05$ significantly different from mean for normal BMI G2: 3308 (27) G3: 3300 (43)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Net gain (kg): 9.5 (0.6), 9.9 (0.4), 7.8 (0.6) significantly different from mean for normal BMI group at $P < 0.05$ Retained weight (kg): 6.6 (0.6), 6.6 (0.4), 4.2 (0.6) significantly different from mean for normal BMI group at $P < 0.05$ Percent retained weight (%): 11.4 (0.9), 9.4 (0.5), 4.4 (0.8) significantly different from mean for normal BMI group at $P < 0.05$ <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Adjusted birthweight</p> <p>Groups G1: Gain <IOM G2: gain equal to IOM G3: gain > IOM</p> <p>Results G1: BMI <19.8 2873g* BMI 19.8-26.0 3157 g* BMI >26 3138 g G2: BMI <19.8 3190 g BMI 19.8-26 3298g BMI >26 3338g G3 BMI <19.8 3489g* BMI 19.8-26 3494g* BMI >26 3347g * significantly different from gains within range within each BMI grouping</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Maternal age Parity Black ethnicity Smoking Gestational duration <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> fetal sex 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: May, 2007</p> <p>Country and setting: United States, WIC clinics</p> <p>Enrollment period: As of February 2001</p> <p>Funding: NR</p> <p>Study Objective: Study was designed to test predictors of infant birth weight based on categories of prepregnancy BMI, GWG, and smoking</p> <p>Time frame: As of February 2001</p> <p>Duration of the study: NR</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 233</p> <p>Group Description: G1: Total NR</p> <p>Group N: G1: 233 NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton live birth with gestation length between 36 to 44 weeks <p>Exclusion criteria: NR</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 70.3kg (20.4)</p> <p>Pregravid BMI: G1: 26.7kg (7.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 24.7 (5.3)</p> <p>Parity: G1: 29.2% Primipara</p>	<p>Race, %: White G1: 58.8</p> <p>Black G1: NR</p> <p>Hispanic G1: 31.8</p> <p>Asian/Pacific Islander G1: NR</p> <p>Other G1: 9.4</p> <p>Smoking, %: G1: 23.6%</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): NR Total weight gain: NR Categorized: <ul style="list-style-type: none"> According to IOM Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Self-reported 	Birth weight: NR Gestational diabetes, %: NR Cesarean delivery, %: NR Instrumental delivery, %: NR Episiotomy, %: NR Other maternal outcomes: NR Other infant outcomes: NR	Outcomes Description: Birthweight Beta's from multiple linear regression Groups G1: Below IOM G2: Greater IOM Results G1: -162 g G2: -153 g Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> Maternal BMI Smoking Infant and child confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> Gestational age 	Background: Good Sample selection: Fair Definition of maternal weight gain: Poor Definition of outcomes: Fair Source of information on exposure, outcomes, and confounders: Poor Followup: Fair Analysis comparability: Fair Analysis of outcomes: Fair Interpretation: Fair Sum of Good/Fair/Poor: 1 Good, 6 Fair, 2 Poor Final Quality Score: Fair

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Nielsen et al., 2006</p> <p>Country and setting: USA, clinic</p> <p>Enrollment Period: 1990 to 2000</p> <p>Funding: NR</p> <p>Study Objective: To examine whether such weight gains improve birth outcomes in a cohort of disadvantaged African American adolescents</p> <p>Time frame: 1990 to 2000</p> <p>Duration of the study: First prenatal care visit to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 815</p> <p>Group Description:</p> <p>G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI > 26.0</p> <p>Group N:</p> <p>G1: 193 G2: 431 G3: 191</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Adolescents ≤ 17 years at conception African American pregnancies <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: 18.3 (1.1) G2: 22.4 (1.6) G3: 30.9 (4.6)</p> <p>Imputed:</p> <ul style="list-style-type: none"> Yes <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: mean age at infant birth (SD): 16.9 (1.2) G2: 16.8 (1.1) G3: 17.0 (1.1)</p> <p>Parity:</p> <p>% primiparous:</p> <p>G1: 83.9 G2: 85.2 G3: 74.9</p>	<p>Race, %:</p> <p>White NR</p> <p>Black G1: 100 G2: 100 G3: 100</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 11.4 G2: 9.7 G3: 10.5</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 193 G2: 431 G3: 191</p> <p>Total weight gain: G1: < IOM: 30.3%; lower half of IOM: 18.1%; upper half of IOM: 21.9%; > IOM: 29.7% G2: < IOM: 31.3%; lower half of IOM: 16.1%; upper half of IOM: 17.6%; > IOM: 35.0% G3: < IOM: 16.5%; lower half of IOM: 9.4%; upper half of IOM: 10.6%; > IOM: 63.5</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between final recorded weight within 4 weeks delivery and self-reported prepregnancy weight </p>	<p>Birth weight: G1: 2899 (595) G2: 3083 (645) <i>P</i> < 0.005 compared to BMI < 19.8 G3: 3181 (673) <i>P</i> < 0.005 compared to BMI < 19.8</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Size for gestational age (small, average, large) Birth weight category (suboptimal < 3000g, optimal 3000-4000g, above optimal > 4000g) 	<p>Outcomes Description: Adjusted birthweight in grams</p> <p>Groups G1: <IOM G2: lower half IOM range G3: Upper half IOM range G4: >IOM</p> <p>Results Adjusted birthweight <19.8 grams G1: 2986 g G2: 3167 g G3:3198 g G4:3277 g All significantly different from each other except G2 & G3</p> <p>Adjusted birthweight 19.8 to 26 grams G1: 3018 g G2: 3166 g G3: 3255 g G4: 3318 g All significantly different from each other</p> <p>Adjusted birthweight >26 grams G1: 3127 g G2: 3351 g G3: 3384 g G4: 3434 g G1 significantly different from the others, G2 ,G3 & G4 not significantly different from each other</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Parity Pre-gravid BMI Pre-eclampsia Time between last weight measure and delivery Height Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Infant sex 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Good</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 6 Good, 3 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ogunyemi et al., 1999</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1990 to 1995</p> <p>Funding: NR</p> <p>Study Objective: To test IOM guidelines in a predominantly rural black population</p> <p>Time frame: 1990 to 1995</p> <p>Duration of the study: 582 women who delivered and then their medical record was abstracted</p>	<p>Design:</p> <ul style="list-style-type: none"> • Other observational : 582 women consecutive women who delivered • Retrospective <p>Total Study N: 582</p> <p>Group Description: G1: Underweight G2: Normal G3: Overweight G4: Obese</p> <p>Group N: G1: 78 G2: 223 G3: 78 G4: 203</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Single child • > 37 weeks gestation • Black • Registration for prenatal care within first trimester of pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Difference between recalled pregravid weight and measured first trimester weight was $\geq 10\%$ 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 20.3 G2: 22.1 G3: 23.7 G4: 25.4 ($P < 0.01$)</p> <p>Parity: G1: # nulliparous: 53 G2: 54 G3: 42 G4: 26 ($P < 0.01$)</p>	<p>Race, %: White NR</p> <p>Black G1: 100 G2: 100 G3: 100 G4: 100</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: n = 0 G2: n = 4 G3: n = 3 G4: n = 8 ($P = 0.02$)</p> <p>Hypertension, %: G1: n = 1 G2: n = 2 G3: n = 4 G4: n = 14 ($P < 0.01$)</p> <p>Additional characteristics: NR</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 196 G2: 181 G3: 205</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: weight at last prenatal visit 	<p>Birth weight: G1: 3,029 G2: 3,210 G3: 3,283 (<i>P</i> < 0.01)</p> <p>Gestational diabetes, %: G1: n = 0 G2: n = 4 G3: n = 3 G4: n = 8 (<i>P</i> = 0.02)</p> <p>Cesarean delivery, %: G1: n = 20 G2: n = 10 G3: n = 17 (<i>P</i> = 0.02)</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Asthma, preeclampsia Vomiting C-section <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Low birth weight Fetal distress NICU 	<p>Outcomes Description: Birthweight</p> <p>Groups G1: Low <IOM G2: Normal =IOM G3: High >IOM</p> <p>Results G1: 3,029 G2: 3,210 G3: 3,283 <i>P</i> < 0.01</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Good</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Scholl et al., 1995</p> <p>Country and setting: USA, Camden Study</p> <p>Enrollment Period: September 1985 to May 1990</p> <p>Funding: NIH</p> <p>Study Objective: To determine whether risk of maternal overweight associated with an excessive rate of gestational weight gain needs to be balanced against risk of impaired fetal growth associated with low rate of gain</p> <p>Time frame: September 1985 to May 1990</p> <p>Duration of the study: During pregnancy through 6 months postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 274</p> <p>Group Description: G1: Low rate of GWG G2: Moderate rate of GWG G3: Excessive rate of GWG</p> <p>Group N: G1: 59 G2: 138 G3: 77</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women with pregravid BMI 19.8-26.0 • Enrolled before January 1988 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing information from delivery to 6 months postpartum • Pregravid under or over weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White G1: 8.5 G2: 10.9 G3: 10.4 Black G1: 61.0 G2: 59.4 G3: 62.3 Hispanic G1: 30.5 G2: 29.7 G3: 27.3 Asian/Pacific Islander NR</p> <p>Smoking, %: G1: 30.5 G2: 26.8 G3: 26.9</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 59 G2: 138 G3: 77</p> <p>Total weight gain: G1: Gestation duration (wk)38.5 (0.28) $P < 0.05$, low vs. moderate plus excessive weight gain G2: 39.2 (0.17) G3: 39.4 (0.24)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM rate of gestational weight gain measured between 20 to 36 weeks: low GWG = < 0.34kg/wk; moderate GWG = $0.34-0.68$ kg/wk; excessive GWG = > 0.68 kg/wk <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: G1: 3,049 (56.94) $P < 0.05$, low vs. moderate plus excessive weight gain G2: 3,208 (36.33) G3: 39.4 (0.24)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Birthweight (g)</p> <p>Groups Rate between 20-36 wks G1: low rate <0.34 kg/wk G2: moderate rate $0.34-0.68$ kg/wk G3: Excessive rate >0.68 kg/wk</p> <p>Results G1: 3049 (56.94) $P < 0.05$, low vs. moderate plus excessive weight gain G2: 3208 (36.33) G3: 39.4 (0.24)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stevens-Simon and McAnarney, 1992</p> <p>Country and setting: USA, adolescent maternity program</p> <p>Enrollment Period: 1986 to 1989</p> <p>Funding: Grant from Bureau of Maternal and Child Health</p> <p>Study Objective: To clarify advantages and disadvantages of large gestational weight gain among pregnant adolescents</p> <p>Time frame: 1986 to 1989</p> <p>Duration of the study: Entry into prenatal care through 6 weeks PP check up</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 141 (107 included in postpartum analyses)</p> <p>Group Description: G1: Slow gainers G2: Average gainers G3: Rapid gainers</p> <p>Group N: G1: 28 G2: 66 G3: 47</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Consecutively enrolled poor, black, 12-19 year olds • Prenatal care prior to 2third week gestation • No chronic disease • No regular medications • No known uterine anomalies • Live birth • Singletons <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 58.6 (11.1) G2: 160.9 (7.0) G3: 163.9 (5.5)</p> <p>Pregravid BMI:</p> <p>G1: 23.1 (3.5) G2: 23.5 (4.4) G3: 23.5 (4.2)</p> <ul style="list-style-type: none"> • Imputed: • No • Categorized: • Continuous <p>Age (mean, yrs): G1: 16.9 G2: 16.6 G3: 16.2</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 41. Gestational weight gain with reference to IOM recommendations and infant birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28 G2: 66 G3: 47</p> <p>Total weight gain: G1: 7.7 (average rate 0.2 kg/wk) G2: 12.4 (average rate 0.3 kg/wk) G3: 19.8 (average rate 0.5 kg/wk)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM slow gain: < 0.23kg/wk; average gain: 0.23-0.4kg/week; rapid gain: > 0.4kg/week <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 2745 (694) G2: 3097 (457) G3: 3351 (482) <i>P</i> < 0.0001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Birth weight</p> <p>Groups G1: slow <0.23 kg/wk G2: average 0.23-4 kg/wk G3: rapid >0.4 kg/wk</p> <p>Results G1: 2745 (694) G2: 3097 (457) G3: 3351 (482) <i>P</i> < 0.0001 No difference in pre-gravid by weight gain groups</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) ($P < 0.05$)</p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% ($P < 0.01$)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: LBW (%)</p> <p>Groups G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: >35 lbs</p> <p>Results G1: 2.0 G2: 11.1 G3: 8.3 G4: 5.2 G5: 3.8</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Bracero and Byrne, 1997</i></p> <p>Country and setting: <i>Hospital charts - Maimonides Medical Center, Brooklyn, NY</i></p> <p>Enrollment Period:</p> <p>Funding: NR</p> <p>Study Objective: <i>To determine optimal weight gain in singleton pregnancy and evaluate current recommendations</i></p> <p>Time frame:</p> <p>Duration of the study: <i>Jan 1, 1987 to Jan 1, 1993</i></p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 20,971</p> <p>Group Description: G1: Total population G2: NR</p> <p>Group N: G1: 20,971 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Delivery at Maimonides Medical Center Singleton pregnancy No documentation of congenital anomaly, pregnancy was not terminated by abortion Documentation on chart of prepregnancy maternal weight, amount of maternal weight gain during pregnancy, and gender of infant <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Infants with any type of congenital anomaly (international classification of diseases (ICD-9-CM) codes 740.0-759.9 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: median BMI = 23.19 (range 14.46-40.07) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: % < 15 years: < 0.1; 15-19 yrs: 4.8; 20-24: 25.1; 25-29: 31.1; 30-34: 24.3; 35-39: 11.8; 40-44: 2.8; 45-49: 0.1; > 50: < 0.1 G2: NR</p> <p>Parity: % primigravida: G1: 25.1 G2: NR</p>	<p>Race, %: White G1: 92.1 G2: NR</p> <p>Black G1: 4.2 G2: NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander G1: 0.9 G2: NR</p> <p>Other G1: 2.1 G2: NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % married: G1: 12.4 G2: NR</p> <p>Additional characteristics: Type of service: G1: Ward, 22.5% Private: 77.5% G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: % weight gain: lost weight, 0.4; 1 to 5lbs, 0.9; 6 to 10, 2.3; 11 to 15, 5.4; 16 to 20, 12.0; 21 to 25, 17.2; 26 to 30, 21.1; 31 to 35, 14.8; 36 to 40, 11.5; 41 to 45, 6.1; ≥ 46, 8.3 G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM ordinal categories in 5 pound intervals <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: using last measurement obtained as an outpatient 	<p>Birth weight: G1: r = .210 correlation with maternal weight gain G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Optimal weight gain defined as 36 to 40 pounds for underweight women, 31 to 40 pounds for women of ideal prepregnancy weight, 26 to 30 pounds for overweight women</p> <p>Other infant outcomes: Adverse outcomes:</p> <ul style="list-style-type: none"> Still birth Neonatal death Preterm delivery/low birth weight Perinatal morbidity 	<p>Outcomes Description: Percentage of LBW by weight gain categories</p> <p>Groups Maternal weight gain categories: G1: Maternal weight gain under the IOM guidelines G2: Maternal weight gain within the IOM guidelines G3: Maternal weight gain over the IOM guidelines G4: Optimal weight gain (36-40 lbs for BMI < 19.8; 31-40 lbs for BMI 19.8-26.0; 26-30 lbs for BMI > 26.0) G5: Suboptimal weight gain (< 36 lbs for BMI < 19.8; < 31 lbs for BMI 19.8-26.0; < 26 lbs for BMI > 26.0)</p> <p>Results G1: 10.1% G2: 3.3% G3: 2.5% (<i>P</i> < 0.001 comparing G1-G3) G4: 4.9% G5: 1.8% (<i>P</i> < 0.001 vs. G4)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 8 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cogswell et al., 1994</p> <p>Country and setting: USA, Pregnancy Nutrition Surveillance System</p> <p>Enrollment Period: 1990-1991</p> <p>Funding: NR</p> <p>Study Objective: To determine association between increased gestational weight gain and birth weight outcomes for low income women</p> <p>Time frame: 1990-1991</p> <p>Duration of the study: Women in WIC but everything is self reported so it is when they were first enrolled in WIC until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 53,541</p> <p>Group Description: G1: Average weight G2: Overweight G3: Very overweight</p> <p>Group N: G1: 33,809 G2: 7,661 G3: 12,071</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> White, black and hispanic women who delivered single, liveborn, term infants <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Low or high values for; birth weight, prepregnancy BMI, or weight gain during pregnancy Missing data on one or more study variables Underweight women Only 1 infant was used in analysis for women who delivered more than once during study period 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 11-17 yr: 11.9% 18-34yr: 85.0% 35-54 yr: 3.1% G2: 11-17 yr: 6.9% 18-34yr: 88.7% 35-54 yr: 4.4% G3: 11-17 yr: 4.0% 18-34yr: 90.1% 35-54 yr: 6.0%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 75.1 G2: 72.4 G3: 74.5 Black G1: 13.8 G2: 14.1 G3: 16.1 Hispanic G1: 11.1 G2: 13.5 G3: 9.4 Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 29.9 G2: 28.3 G3: 25.7</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 33,809 G2: 7,661 G3: 12,071</p> <p>Total weight gain: G1: < 15 lb: 6.2% 15-19: 5.8% 20-24: 11.2% 25-29: 14.4% 30-34: 17.1% 35-39: 13.9% ≥ 40: 31.4% G2: < 15 lb: 11.4% 15-19: 7.8% 20-24: 13.0% 25-29: 12.7% 30-34: 15.9% 35-39: 11.2% ≥ 40: 28.1% G3: < 15 lb: 25.1% 15-19: 10.1% 20-24: 1</p> <p>Categorized:</p> <ul style="list-style-type: none"> • 4 lbs increments starting at 15 lbs <p>Collected from:</p> <ul style="list-style-type: none"> • Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> • Self-reported 	<p>Birth weight: G1: < 2500g: 2.7% 2500-4000g: 87.5% > 4000-4500: 8.5% > 4500g: 1.4% G2: < 2500g: 2.5% 2500-4000g: 83.9% > 4000-4500: 11.7% > 4500g: 2.0% G3: < 2500g: 2.1% 2500-4000g: 81.1% > 4000-4500: 13.2% > 4500g: 3.6%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: AOR (95% CI) for low birth weight</p> <p>Groups Maternal weight gain categories (lbs) stratified by pregravid BMI: Normal weight (BMI 19.8-26.0): G1: < 15 G2: 15-19 G3: 20-24 G4: 25-29 G5: 30-34 G6: 35-39 G7: ≥ 40 Overweight (BMI > 26.0-29.0): G8: < 15 G9: 15-19 G10: 20-24 G11: 25-29 G12: 30-34 G13: 35-39 G14: > = 40 Obese (BMI > 29.0): G15: < 15 G16: 15-19 G17: 20-24 G18: 25-29</p> <p>Results G1: 2.1 (1.6-2.6) G2: 1.4 (1.1-1.8) G3: 1.0 (0.8-1.3) G4: 1.0 (reference) G5: 0.8 (0.6-1.0) G6: 0.6 (0.5-0.8) G7: 0.5 (0.4-0.6)</p> <p>G8: 1.1 (0.7-1.9) G9: 1.0 (reference) G10: 0.7 (0.4-1.2) G11: 0.8 (0.5-1.4) G12: 0.5 (0.3-0.8) G13: 0.6 (0.3-1.1) G14: 0.4 (0.3-0.7)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race • height • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age • Sex of infant 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 4 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Edwards et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1997-1993</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy course and outcomes in obese and normal weight women and their associations with gestational weight change</p> <p>Time frame: 1997-1993</p> <p>Duration of the study: 1997-1993</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 1,443</p> <p>Group Description: G1: Obese G2: Normal Weight G3: total sample</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women and normal weight women identified from pregnancy and delivery summary records (normal weight matched to obese by race, age, parity) Singleton deliveries Live births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 103.5 G2: 61</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelinesobese (> 29) and normal weight (BMI 19.8-26.0) <p>Age (mean, yrs): G1: 27.1 G2: 25.4</p> <p>Parity: NR</p>	<p>Race, %: White G1: NR G2: NR G3: 69.0 (Total sample)</p> <p>Black G1: NR G2: NR G3: 21.0 (Total sample)</p> <p>Hispanic G1: NR G2: NR G3: 7.0 (Total sample)</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: NR G2: NR G3: 4.0 (Total sample)</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 683 G2: 660</p> <p>Total weight gain: G1: 9.5 G2: 14.5 $P \leq 0.001$</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3420 G2: 3285 $P \leq 0.001$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 25.6 G2: 9.1 $P < 0.001$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Percentage of LBW by weight gain categories</p> <p>Groups Maternal weight gain categories (kg) Obese BMI > 29: G1: Lost weight/no change G2: 0.5-6.5 G3: 7-11.5 G4: 12-16 G5: > 16</p> <p>Normal BMI 19.8-26 G6: < 11.5kg G7: 11.5-16 G8: > 16kg</p> <p>Results G1: 12.8% G2: 8.9% G3: 7.9% G4: 6.8% G5: 8.7% P (for G1-G5) = 0.405</p> <p>G6: 8.5% G7: 5.6% G8: 8.9% P (for G6-G8) = 0.183</p> <p>AOR (95%CI) for birthweight < 2500g among obese women (BMI > 29.0): G3: 1.0 (reference) G1: 4.2 (0.9-19.6)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pre-gravid BMI GDM Pregnancy induced hypertension Prenatal adequacy Alcohol use Drug use Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hellerstedt et al., 1997</p> <p>Country and setting: United States, medical center</p> <p>Enrollment Period: 1977-1993</p> <p>Funding: NR</p> <p>Study Objective: To examine association between infant birth outcomes and maternal pregravid obesity, gestational weight gain, and prenatal smoking</p> <p>Time frame: 1977 to 1993</p> <p>Duration of the study: Entry into prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 1,343</p> <p>Group Description: G1: Obese G2: Normal weight</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Obese and normal-weight women delivering singleton during study period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing data • Siblings • Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 103.5 kg (13.7) G2: 61.1kg (5.9)</p> <p>Pregravid BMI: G1: 38.3 (4.6) G2: 22.8 (1.6)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: NR</p> <ul style="list-style-type: none"> • 16-34 years: 91% • ≥ 35 years: 8.8% <p>G2: NR</p> <ul style="list-style-type: none"> • 16-34 years: 93.5% • ≥ 35 years: 5.8% <p>Parity: G1: NR</p> <ul style="list-style-type: none"> • 0: 31.8% • 1-3: 64.7% • ≥ 4: 3.5% <p>G2: NR</p> <ul style="list-style-type: none"> • 0: 33.3% • 1-3: 64.9% • ≥ 4: 1.8% 	<p>Race, %: White G1: 68.8 G2: 69.1</p> <p>Black G1: 20.4 G2: 20.6</p> <p>Hispanic G1: 6.6 G2: 6.5</p> <p>Asian/Pacific Islander G1: Native Am: 3.8 G2: Native Am: 3.2</p> <p>Other NR</p> <p>Smoking, %: G1: 26.4 G2: 26.2</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Percentage of LBW by weight gain categories and smoking status</p> <p>Groups Maternal weight gain categories stratified by pregravid BMI and smoking status:</p> <p>Obese (BMI > 29.0): G1: Smokers, < IOM G2: Smokers, within IOM G3: Smokers, > IOM</p> <p>G4: Nonsmokers, < IOM G5: Nonsmokers, within IOM G6: Nonsmokers, > IOM</p> <p>Normal weight (BMI 19.8-26.0): G7: Smokers, < IOM G8: Smokers, within IOM G9: Smokers, > IOM</p> <p>G10: Nonsmokers, < IOM G11: Nonsmokers, within IOM G12: Nonsmokers, > IOM</p> <p>Obese: G13: Lost/no gain G14: 0.5-6.5 kg G15: 7-11.5 kg G16: 12-16 kg G17: > 16 kg</p> <p>Normal weight: G18: < 11.5kg G19: 11.5-16kg G20: > 16kg</p> <p>Results G1: 17.3% G2: 10.0% G3: 12.3%</p> <p>G4: 10.5% G5: 7.8% G6: 2.6%</p> <p>G7: 17.5% G8: 3.5% G9: 3.6%</p> <p>G10: 12.4% G11: 6.0% G12: 5.3%</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

**Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Hellerstedt et al., 1997
(continued)

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		<p>G13: 16.0% G14: 11.1% G15: 8.3% G16: 4.0% G17: 6.0% P = 0.003 for G13-G17</p>	
		<p>G18: 14.2% G19: 5.4% G20: 4.9% P = 0.001 for G18-G20</p>	
		<p>For obese women, compared to nonsmokers who gained 7-11.5 kg, smokers who gained < 7 kg were at significantly higher risk of LBW: AOR: 7.7 (95% CI, 1.5-40.0)</p>	
		<p>Maternal confounders and effect modifiers accounted for in analysis: Maternal age, pregravid BMI, infant sex, race, parity, prenatal alcohol use, prenatal illicit drug use, adequacy of prenatal care, gestational hypertension, GDM</p>	
		<p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age 	

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Hickey et al., 1997</i></p> <p>Country and setting: <i>USA, public health programs</i></p> <p>Enrollment Period: <i>Jan 1993 to Dec 1994</i></p> <p>Funding: <i>MCH grant, University of Alabama School of Public Health/NIH Intramural Basic Sciences Research grant</i></p> <p>Study Objective: <i>Examine differences in birth weight among term infants of black and white women with weight gains in upper or lower half of recommended ranges</i></p> <p>Time frame: <i>Jan 1993 to Dec 1994</i></p> <p>Duration of the study: <i>From first visit to delivery</i></p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 5198</p> <p>Group Description: G1: Black G2: White</p> <p>Group N: G1: 2219 G2: 3699</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women enrolled in Medicaid Maternity Waiver programs operated in 24 counties by Alabama Department of Public Health during study period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Delivered before 37 weeks or after 42 weeks • Maternal age ≤ 17 years • Last prenatal weight recording more than 3 weeks before delivery • Maternal risk factors (diabetic, cardiac, genetic, and obstetric conditions/complications) requiring external referral • Multiple fetuses • Stillborn/neonatal death • Missing or outlying anthropometric data • Missing data for ethnicity • Missing gestational age • Congenital anomalies • Missing birth weight • Invalid country code 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 70.8 (19.6) G2: 65.8 (17.6)</p> <p>Pregravid BMI: G1: 26.6 (7.1) G2: 24.8 (6.3)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 23.7 (5.0) G2: 23.4 (4.6)</p> <p>Parity:</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 9.2 G2: 35.1</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM gain below range (for pregravid BMI), gain in lower range, gain in upper range, gain above range <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Adjusted odds ratio (95% CI) for LBW by weight gain categories</p> <p>Groups Maternal weight gain categories stratified by race: Black Women: G1: Below range (< 12.5kg for BMI< 19.8; < 13.9kg for BMI 19.8-26.0; < 7.0kg for BMI > 26.0) G2: In lower range (12.5-15.2kg for BMI< 19.8; 11.5-13.8kg for BMI 19.8-26.0; 7.0-9.2kg for BMI > 26.0) G3: In upper range (15.3-18kg for BMI< 19.8; 13.9-16.0kg for BMI 19.8-26.0; 9.3-11.5kg for BMI > 26.0)</p> <p>Results G1: 2.6 (1.2-5.6) G2: 1.0 (reference) G3: 1.2 (0.4-3.3) G4: 1.4 (0.6-3.6) G5: 1.5 (0.8-2.6) G6: 1.0 (reference) G7: 0.4 (0.2-0.9) G8: 0.7 (0.3-1.2)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Education Height Drug use Alcohol use Time between last prenatal weight observation and delivery Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Infant sex 	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hulseley et al., 2005</p> <p>Country and setting: USA, birth certificates linked to PRAMS data</p> <p>Enrollment Period: 1998 to 1999</p> <p>Funding: NR</p> <p>Study Objective: To describe proportion of low birth weight that could be potentially prevented by programs focusing on maternal prepregnant BMI and/or weight gain during pregnancy</p> <p>Time frame: 1998 to 1999</p> <p>Duration of the study: Cross-sectional women surveyed after delivery (PRAMS)</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cross-sectional • Retrospective <p>Total Study N: 87,293</p> <p>Group Description:</p> <p>G1: Total</p> <p>G2: BMI < 19.8 (U-BMI)</p> <p>G3: BMI 19.8-26 (N-BMI)</p> <p>G4: BMI 26.1-29.0 OW-BMI</p> <p>G5: BMI > 29.0 (O-BMI)</p> <p>Group N:</p> <p>G1: 87,293 (100%)</p> <p>G2: 16.2% (Note: corrected Discrepancy between Table 1 values and Results text/Table 2&3 values)</p> <p>G3: 52.6%(Note: corrected Discrepancy between Table 1 values and Results text/Table 2&3 values)</p> <p>G4: 11.5%(Note: correcte</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Ddata consist of birth certificates linked to PRAMS for South Carolina resident women delivering in South Carolina during 1998 and 1999 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • BW < 500 g 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White</p> <p>G1: 56.3</p> <p>G2: 18.6</p> <p>G3: 55.7</p> <p>G4: 10.9</p> <p>G5: 19.2 ($P < 0.0001$)</p> <p>Black</p> <p>G1: 43.7</p> <p>G2: 11.9</p> <p>G3: 49.3</p> <p>G4: 14.3</p> <p>G5: 24.6</p> <p>Hispanic</p> <p>NR</p> <p>Asian/Pacific Islander</p> <p>NR</p> <p>Other</p> <p>NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %:</p> <p>G1: 4.1</p> <p>G2: 3.7</p> <p>G3: 36.4</p> <p>G4: 21.1</p> <p>G5: 38.8 $P < 0.09$</p> <p>Hypertension, %:</p> <p>G1: 4.8</p> <p>G2: 7.8</p> <p>G3: 36.4</p> <p>G4: 15.2</p> <p>G5: 40.6 ($P < 0.56$)</p> <p>Additional characteristics: NR</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>G1: NR</p> <ul style="list-style-type: none"> Adequate: 72.3% Less than adequate: 27.7 <p>G2: NR</p> <ul style="list-style-type: none"> Adequate: 14.9% Less than adequate: 19.6 <p>G3:</p> <ul style="list-style-type: none"> Adequate: 52.1% Less than adequate: 53.9 <p>G4:</p> <ul style="list-style-type: none"> Adequate: 13.6% Less than adequate: 5.9 <p>G5:</p> <ul style="list-style-type: none"> Adequate: 19.4% Less than adequate: 20.7 <p>Categorized:</p> <ul style="list-style-type: none"> According to IOMLTA = less than adequate; AWG = adequate weight gain 	<p>Birth weight: NR</p> <p>Gestational diabetes, %:</p> <p>G1: 4.1 G2: 3.7 G3: 36.4 G4: 21.1 G5: 38.8 <i>P</i> < 0.09</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Adjusted odds ratio for low birth weight by categories of weight gain</p> <p>Groups Pregravid BMI and gestational weight gain categories: G1: BMI < 19.8 and < IOM G2: BMI 19.8-26.0 and < IOM G3: BMI 19.8-26.0 and within IOM G4: BMI 26.1-29.0 and < IOM G5: BMI > 29.0 and < IOM G6: BMI > 29.0 and within IOM</p> <p>Results AOR (95% CI) for very low birth weight (500-1,499g): G1: 2.06 (1.26-2.87) G2: 1.82 (1.22-2.29) G3: 1.00 (reference) G4: 2.05 (0.90-4.44) G5: 1.25 (0.61-1.61) G6: 1.74 (1.23-2.42)</p> <p>AOR (95% CI) for moderately low birth weight (1500-2499g): G1: 4.83 (2.98-7.83) G2: 1.77 (1.23-2.60) G3: 1.00 (reference) G4: 0.28 (0.11-1.83) G5: 1.09 (0.67-2.13)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Ethnicity, intendedness of pregnancy, Medicaid status, WIC status, prenatal care, diabetes, hypertension</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 4 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

**Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Hulseley et al., 2005
(continued)

**Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight
(continued)**

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
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Collected from:

- To determine LTA and AWG:for each BMI group, weight gain at 20 weeks was determined from formula (12.6 lbs for U-BMI; 10.6 lbs for N-BMI;6.8 lbs for OW-BMI; and 3.8 lbs for O-BMI). Next, lowest total weight gain expected from the weight gain range for women delivering at term, for each BMI, was obtained(for U-BMI, 28 lbs; N-BMI, 25 lbs; OW-BMI, 15 lbs; andO-BMI, 15 lbs). The weight gain expected at 20 weeks was then subtracted from the total weight gain to arrive at weight gain after 20 weeks. This was then divided by 20 to determine the expected weight gain per week after the 20th week of gestation.Weight gain after the 20th week of gestation is linear toterm. Each delivery was then categorized as having LTA or AWG adjusted for gestational age and prepregnant BMI.

Ascertained by:

- Self-reported

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Nida et al., 1996</p> <p>Country and setting: United States, multi-center</p> <p>Enrollment Period: April 1988 to March 1995</p> <p>Funding: Funding for the PRAMS Program is provided in part by the Centers for Disease Control and Prevention, Atlanta, GA (Grant No. U50/CCU602873-07), and Maternal and Child Health Bureau, Department of Health and Human Services</p> <p>Study Objective: To examine pre-pregnancy weight, prenatal weight gain and their relationship to low (< 2,500 grams) birth weight</p> <p>Time frame: April 1988-March 1995</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: NR. PRAMS data in OK collects data on 200 mothers/month. Report reflects data with 71% response rate</p> <p>Group Description: G1: Low BMI/less than recommended weight gain G2: Normal BMI/within recommended weight gain G3: High BMI/over recommended wt gain</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> New mothers of singleton births from state's live birth registry <p>Exclusion criteria: NR</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: Age < 20: 21.2% (15.5-26.9) 20-24: 35.5% (29.2-41.8) 25-29: 24.2% (18.7-29.7) 30-34: 15.2% (10.9-19.5) 35+: 3.9% (1.7-6.1) [numbers in () are 95% CI]</p> <p>G2: Age < 20: 10.9% (8.5-13.3) 20-24: 30.0% (26.9-33.1) 25-29: 31.6% (28.7-34.5) 30-34: 19.2% (16.7-21.8) 35+: 8.3% (6.5-10.1)</p> <p>G3: Age < 20: 12.5% (8.7-16.2) 20-24: 33.9% (29.0-38.8) 25-29: 29.2% (24.7-33.7) 30-34: 17.5% (14.0-21.0) 35+: 6.9% (4.6-9.3)</p> <p>Parity: NR</p>	<p>Race, %: White G1: 84.7 (79.9-89.7) G2: 85.1 (82.5-87.6) G3: 75.5 (71.0-80.0)</p> <p>Black G1: 9.8 (5.5 - 14.1) G2: 5.8 (4.0-7.6) G3: 11.4 (7.7-15.1)</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: Native Am 3.9 (1.4-6.5) G2: Native Am 7.5 (5.7-9.3) G3: Native Am 12.6 (9.3-15.9)</p> <p>Smoking, %: G1: Prenatal smoking: 26.2% (20.5-31.9) G2: 19.5 % (16.8-22.2) G3: 21.6 (17.2-26.0)</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: Education < 12 years: 21.7% (15.6-27.8); 12+ years: 78.3% (72.2-84.4) G2: Education < 12 years: 13.2% (10.5-15.9), 12+ years: 86.8% (84.1-89.5) G3: Education: < 12 years: 14.8% (10.8-18.8) 12+ years: 85.2% (81.2-89.2)</p> <p>Additional characteristics: NR</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> Self-reported 	<p>Birth weight:</p> <p>G1: Percent LBW: 10.2%/ 6%/ 4.7%</p> <p>G2: 8.4%/ 3.9%/ 4.5%</p> <p>G3: 6.1%/ 3.8%/ 5.1%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> LBW by smoking status by BMI and prenatal weight gain <p>Groups:</p> <p>G1: Low BMI/less than recommended weight gain</p> <p>G2: Normal BMI/within recommended weight gain</p> <p>G3: High BMI/over recommended wt gain</p> <p>Results:</p> <p>Low BMI: less than rec weight gain</p> <p>G1: 16.9 (12.2-21.6)</p> <p>G2: 7.7 (6.1-9.3)</p> <p>Low BMI: within recommended</p> <p>G1: 12.7 (9.4-16.0)</p> <p>G2: 4.2 (3.4-5.0)</p> <p>Low BMI: more than recommended</p> <p>G1: 6.5 (14.3-8.7)</p> <p>G2: 3.6 (2.8-4.4)</p> <p>Normal BMI: less than recommended</p> <p>G1: 12.9 (9.6-16.2)</p> <p>G2: 6.9 (5.7-8.1)</p> <p>Normal BMI: within recommended</p> <p>G1: 6.9 (5.3-8.5)</p> <p>G2: 3.2 (2.8-3.6)</p> <p>Normal BMI; more than recommended</p> <p>G1: 8.9 (7.1-10.7)</p> <p>G2: 3.3 (2.9-3.7)</p> <p>High BMI: less than recommended</p> <p>G1: 7.7 (4.0-11.4)</p> <p>G2: 5.4 (3.8-7.0)</p> <p>High BMI: within recommended</p> <p>G1: 4.6 (2.6-6.6)</p> <p>G2: 3.4 (2.6-4.2)</p> <p>High BMI: more than recommended</p> <p>G1: 7.5 (5.2-9.9)</p> <p>G2: 4.5 (3.7-5.3)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Poor</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 0 Good, 4 Fair, 5 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Ogunyemi et al., 1999</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1990 to 1995</p> <p>Funding: NR</p> <p>Study Objective: To test IOM guidelines in a predominantly rural black population</p> <p>Time frame: 1990 to 1995</p> <p>Duration of the study: 582 women who delivered and then their medical record was abstracted</p>	<p>Design:</p> <ul style="list-style-type: none"> Other observational : 582 women consecutive women who delivered Retrospective <p>Total Study N: 582</p> <p>Group Description: G1: Underweight G2: Normal G3: Overweight G4: Obese</p> <p>Group N: G1: 78 G2: 223 G3: 78 G4: 203</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Single child > 37 weeks gestation Black Registration for prenatal care within first trimester of pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Difference between recalled pregravid weight and measured first trimester weight was $\geq 10\%$ 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 20.3 G2: 22.1 G3: 23.7 G4: 25.4 ($P < 0.01$)</p> <p>Parity: G1: # nulliparous: 53 G2: 54 G3: 42 G4: 26 ($P < 0.01$)</p>	<p>Race, %: White NR Black G1: 100 G2: 100 G3: 100 G4: 100 Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: n = 0 G2: n = 4 G3: n = 3 G4: n = 8 ($P = 0.02$)</p> <p>Hypertension, %: G1: n = 1 G2: n = 2 G3: n = 4 G4: n = 14 ($P < 0.01$)</p> <p>Additional characteristics: NR</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 196 G2: 181 G3: 205</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> According to IOM Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: weight at last prenatal visit </p>	<p>Birth weight: G1: 3,029 G2: 3,210 G3: 3,283 ($P < 0.01$)</p> <p>Gestational diabetes, %: G1: n = 0 G2: n = 4 G3: n = 3 G4: n = 8 ($P = 0.02$)</p> <p>Cesarean delivery, %: G1: n = 20 G2: n = 10 G3: n = 17 ($P = 0.02$)</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: asthma, preeclampsia, vomiting, c-section</p> <p>Other infant outcomes: low birth weight, fetal distress, NICU</p>	<p>Outcomes Description: Adjusted odds ratio for low birth weight by weight gain categories</p> <p>Groups Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM</p> <p>BMI IOM</p> <p>Results AOR (95% CI) for very low birth weight: G1: 1.8 (0.6-4.7) G2: 1.1 (0.4-4.7) G3: 1.0 (Reference)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pregravid BMI Pre-eclampsia C-section Previous cesarean Tobacco use Previous fetal death Hypertension Asthma Previous LBW Vomiting NICU <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Fair</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Good</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Schieve, 1998</p> <p>Country and setting: Pregnancy Nutrition Surveillance System - data from WIC clinics (99%) from Indiana, Kansas, Massachusetts, Minnesota, Nebraska, North Dakota, New York, Tennessee, and Vermont</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To examine associations between pregnancy weight gain outside and within ranges recommended by IOM and birth weight by both prepregnant BMI and race ethnicity</p> <p>Time frame: NR</p> <p>Duration of the study: 1990 to 1993</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 173,066</p> <p>Group Description: NR</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • White, black, and hispanic women who visited WIC clinics prenatally and subsequently delivered liveborn, singleton infants • Delivered between 39 and 41 weeks <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing data for infant birth weight (n = 4223) • Prepregnant BMI (n = 31477) • Pregnancy weight gain (n = 7542) • Maternal age (n = 43) • Maternal education (n = 3819) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported • NR <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized: IOM Guidelines</p> <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 112,524 G2: 33,101 G3: 27,441</p> <p>Total weight gain: G1: 32.5 G2: 30.5 G3: 30.2</p> <p><i>Categorized:</i> <i>According to IOM >10 pounds below lower bound of IOM recommended range for woman's prepregnant BMI, 1-9 pounds below lower bound of IOM lower bound, in lower half of IOM recommended range, in upper half of IOM range, 1-9 pounds above IOM range, >10 pounds above IOM upper bound</i></p> <p><i>Collected from:</i></p> <ul style="list-style-type: none"> • Self-reported <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> • Self-reported 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> • NA <p>Other infant outcomes</p> <ul style="list-style-type: none"> • NA 	<p>Outcomes Description: Distribution of LBW, %:</p> <p>Groups Maternal weight gain categories stratified by pregravid BMI (IOM underweight, normal weight, overweight, and obese) and race (non-Hispanic white, non-Hispanic black, and Hispanic):</p> <p>G1: > = 10 lbs below IOM G2: 1-9 lbs below IOM G3: Lower half of IOM G4: Upper half of IOM G5: 1-9 lbs above IOM</p> <p>G6 > = 10lbs above IOM</p> <p>Results G1: 2.7 (2.1-3.5), 1.6 (1.3-1.9), 1.0, 0.7 (0.6-0.9), 0.4 (0.3,0.6), 0.4 (0.3,0.6) G2: 3.2 (2.1-5.1), 2.8 (1.9-4.2), 1.0, 1.3 (0.8-2.1), 0.5 (0.2-1.03), 0.7 (0.4-1.5) G3: 2.8 (1.7-4.7), 1.1 (0.6-1.8) G4: 1.4 (0.5-4.2); 0.4 (0.2-1.2); 1.0; 2.1 (1.1-4.0); 2.8 (1.4-5.4); 7.3 (4.0-13.2) G5: no data for first category 0.6 (0.05-5.6); 1.0; 0.7 (0.06-7.3); 1.8 (0.3-13.2); 10.8 (2.3-51.4) G6: no data for first category;0.8 (0.1-4.9); 1.0; 1.8 (0.4-8.0); 3.3 (0.8-14.1); 6.1 (1.6-24.1) Group: average BMI: ≥ 10 lb< IOM, 1-9 lb< IOM, lower IOM, upper IOM, 1-9 lb >IOM, ≥ 10 lb>IOM G1: 2.5 (2.0-3.0); 1.5 (1.3-1.8); 1.0; 0.8 (0.6-0.9); 0.6 (0.5-0.7); 0.3 (0.3-0.4) G2: 2.5 (1.9-3.3); 1.7 (1.3-2.2); 1.0; 0.7 (0.5-1.03); 0.7 (0.5-1.03); 0.6 (0.4-0.9) G3: 1.8 (1.3-2.6); 1.2 (0.9-1.6); 1.0; 0.8 (0.5-1.2); 0.6 (0.4-0.9); 0.4 (0.3-0.7) G4: 0.5 (0.3-0.9); 0.7 (0.5-0.9); 1.0; 1.7 (1.3-2.2); 2.3 (1.8-3.0); 4.2 (3.3-5.2) G5: 0.8 (0.2-2.8); 1.3 (0.5-3.2); 1.0; 1.5 (0.6-3.7); 3.6 (1.7-7.7); 5.2 (2.5-10.8) G6: 0.2 (0.1-0.99); 0.8 (0.4-1.5); 1.0; 1.3 (0.7-2.4); 1.9 (1.1-3.3); 4.6 (2.8-7.5) Group: high BMI: ≥ 10 lb< IOM, 1-9 lb< IOM, lower IOM, upper IOM, 1-9 lb >IOM, ≥ 10 lb>IOM G1: 1.1 (0.6-2.3); 1.2 (0.7-1.9); 1.0; 0.7 (0.4-1.1); 0.5 (0.3-0.8); 0.5 (0.3-0.7) G2: 1.7 (0.8-3.6); 0.9 (0.4-1.7); 1.0; 0.3 (0.2-0.8); 0.5 (0.3-0.9); 0.6 (0.3-0.97) G3: 1.5 (0.6-4.0); 1.1 (0.5-2.3); 1.0; 0.9 (0.4-1.9); 0.4 (0.2-0.9); 0.4 (0.2-0.8) G4: 0.8 ((0.3-0.9); 0.2 (0.04-0.7); 1.0; 1.1 (0.6-2.1); 1.6 (0.97-2.7); 3.5 (2.2-5.6) G5: 0.7 (0.1-6.0); 0.3 (0.03-2.3); 1.0; 1.7 (0.5-5.1); 1.6 (0.5-4.4); 2.9 (1.1-7.3)</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

**Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Schieve, 1998
(continued)

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		<p>G6: 0.9 (0.1-7.5); 0.3 (0.04-2.9); 1.0; 0.8 (0.2-3.2); 1.4 (0.5-4.1); 5.2 (2.1-13.3)</p> <p>Group: obese BMI: ≥ 10 lb< IOM, 1-9 lb< IOM, lower IOM, upper IOM, 1-9 lb >IOM, ≥ 10 lb>IOM</p> <p>G1: 1.6 (1.04-2.4); 1.3 (0.9-2.0); 1.0; 1.1 (0.7-1.7); 0.8 (0.5-1.2); 0.8 (0.6-1.2)</p> <p>G2: 2.6 (1.5-4.5); 1.3 (0.7-2.3); 1.0; 1.3 (0.7-2.5); 1.1 (0.6-1.9); 1.0 (0.6-1.7)</p> <p>G3: 1.0 (0.4-2.5); 0.8 (0.4-1.8); 1.0; 0.8 (0.3-1.7); 0.2 (0.08-0.6); 0.5 (0.3-1.1)</p> <p>G4: 0.7 (0.5-0.95); 0.5 (0.4-0.7); 1.0; 1.2 (0.9-1.6); 1.3 (1.03-1.7); 2.2 (1.8-2.8)</p> <p>G5: 0.4 (0.2-1.1); 0.6 (0.3-1.4); 1.0; 0.9 (0.4-2.1); 1.5 (0.8-2.9); 2.8 (1.6-4.8)</p> <p>G6: 0.8 (0.3-2.3); 0.8 (0.3-1.8); 1.0; 1.3 (0.6-2.8); 1.4 (0.7-2.7); 2.9 (1.6-5.2)</p> <p>Results for confounders and effect modifiers</p> <p>G1: Non-hispanic white adjusted mean birth weight (g)</p> <p>G2: Non-hispanic black adjusted mean birth weight (g)</p> <p>G3: Hispanic adjusted mean birth weight (g)</p> <p>Characteristic: low BMI: ≥ 10 lb< IOM 1-9 lb< IOM lower IOM (reference) upper IOM 1-9 lb >IOM ≥ 10 lb>IOM</p> <p>G1: 3,073 3,161 3,274 (ref) 3,346 3,412 3,531</p> <p>G2: 2,981 3,060 3,184 (ref) 3,240 3,340 3,387 (all adjusted mean birth weights are significantly different from reference category, lower IOM $P < 0.05$)</p> <p>G3: 3,070 3,175 3,218 (ref) 3,309 3,381 3,493 (all adjusted mean birth weights are significantly different from reference category, lower IOM $P < 0.05$)</p>	

**Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Schieve, 1998
(continued)

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		Average BMI: ≥ 10 lb < IOM 1-9 lb < IOM lower IOM (reference) upper IOM 1-9 lb > IOM ≥ 10 lb > IOM G1: 3,221 3,314 3,389 (ref) 3,455 3,509 3,618 G2: 3,115 3,184 3,254 (ref) 3,314 3,373 3,445 (all adjusted mean birth weights are significantly different from reference category, lower IOM $P < 0.05$) G3: 3,240 3,291 3,366 (ref) 3,400 3,463 3,568 (all adjusted mean birth weights are significantly different from reference category, lower IOM $P < 0.05$) Characteristic: hiGh BMI: ≥ 10 lb < IOM 1-9 lb < IOM lower IOM (reference) upper IOM 1-9 lb > IOM ≥ 10 lb > IOM G1: 3,305 3,335 3,421 (ref) 3,476;3,539 3,630 G2: 3,188 3,241 3,304 (ref) 3,349 3,403 3,490 (adjusted mean birth weights for first, second, fifth, and sixth categories are significantly different from reference category, lower IOM $P < 0.05$) G3: 3,272 3,331 3,384 (ref) 3,420 3,471 3,593 (adjusted mean birth weights for first, second, fifth, and sixth categories are significantly different from reference category, lower IOM $P < 0.05$)	

**Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Schieve, 1998
(continued)

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		<p>Obese BMI: ≥ 10 lb < IOM 1-9 lb < IOM lower IOM (reference) upper IOM 1-9 lb > IOM ≥ 10 lb > IOM G1: 3,431 3,485 3,528 (ref) 3,575 3,620 3,700 G2: 3,280 3,353 3,393 (ref) 3,412 3,461 3,525 (adjusted mean birth weights for first, second, fifth, and sixth categories are significantly different from reference category, lower IOM $P < 0.05$) G3: 3,350 3,420 3,445 (ref) 3,517 3 (adjusted mean birth weights for first, fourth, fifth, and sixth categories are significantly different from reference category, lower IOM $P < 0.05$) 555 3,615</p>	
		<p>Maternal confounders and effect modifiers accounted for in analysis:</p>	
		<ul style="list-style-type: none"> • Age • Height • Education • Trimester of the Special Supplemental Nutrition Program for Women, Infants, and Children 	
		<p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stevens-Simon and McAnarney, 1992</p> <p>Country and setting: USA, adolescent maternity program</p> <p>Enrollment Period: 1986 to 1989</p> <p>Funding: Grant from Bureau of Maternal and Child Health</p> <p>Study Objective: To clarify advantages and disadvantages of large gestational weight gain among pregnant adolescents</p> <p>Time frame: 1986 to 1989</p> <p>Duration of the study: Entry into prenatal care through 6 weeks PP check up</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 141 (107 included in postpartum analyses)</p> <p>Group Description: G1: Slow gainers G2: Average gainers G3: Rapid gainers</p> <p>Group N: G1: 28 G2: 66 G3: 47</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Consecutively enrolled poor, black, 12-19 year olds • Prenatal care prior to 2third week gestation • No chronic disease • No regular medications • No known uterine anomalies • Live birth • Singletons <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 58.6 (11.1) G2: 160.9 (7.0) G3: 163.9 (5.5)</p> <p>Pregravid BMI: G1: 23.1 (3.5) G2: 23.5 (4.4) G3: 23.5 (4.2)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 16.9 G2: 16.6 G3: 16.2</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28 G2: 66 G3: 47</p> <p>Total weight gain: G1: 7.7 (average rate 0.2 kg/wk) G2: 12.4 (average rate 0.3 kg/wk) G3: 19.8 (average rate 0.5 kg/wk)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM slow gain: < 0.23kg/wk; average gain: 0.23-0.4kg/week; rapid gain: > 0.4kg/week <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 2745 (694) G2: 3097 (457) G3: 3351 (482) <i>P</i> < 0.0001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Distribution of LBW, %:</p> <p>Groups Maternal weight gain categories (kg/wk): G1: < 0.23 G2: 0.23-0.40 G3: > 0.40</p> <p>Results G1: 21.4 G2: 10.6 G3: 4.3 <i>P</i> = NS</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Strauss and Dietz, 1999</p> <p>Country and setting: USA, National Collaborative Perinatal Project and Child Health and Development Study</p> <p>Enrollment Period: NCPP: 1959 to 1976 CHDS: 1959 to 1973</p> <p>Funding: Grants from NIH and Massachusetts Dept of Public Health</p> <p>Study Objective: To examine relationship between maternal weight gain and risk of intrauterine growth retardation</p> <p>Time frame: NCPP: 1959 to 1976 CHDS: 1959 to 1973</p> <p>Duration of the study: First visit (prior to 14 weeks since LMP) to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: Total = 10,756 NCPP = 5,403 CHDS = 5,353</p> <p>Group Description: G1: NCPP G2: CHDS</p> <p>Group N: G1: 4,771 G2: 5,333</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women enrolled in NCPP or CHDS Patients enrolled within 14 weeks of last menstrual period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with missing trimester weight gain data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 22.8 (4.1) G2: 22.7 (3.6)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous WHO International Taskforce < 20, ≥ 20 - < 25, ≥ 25 <p>Age (mean, yrs): G1: 25.2 (5.8) G2: 27.4 (5.7) sig dif from NCPP $P < 0.001$</p> <p>Parity: G1: % primiparous: 28 G2: 38 sig dif from NCPP $P < 0.001$</p>	<p>Race, %: White NR Black G1: 30 G2: 16 sig dif from NCPP $P < 0.001$ Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 39 G2: 28 sig dif from NCPP $P < 0.001$</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: % single mothers: 10.4 G2: 2.1 sig dif from NCPP $P < 0.001$</p>

Evidence Table 42. Gestational weight gain with reference to IOM recommendations and low birth weight (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 4771 G2: 5333</p> <p>Total weight gain: G1: 10.4 (4.5) G2: 11.5 (4.6) <i>P</i> < 0.001</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM low weight gain in first trimester: < 0.1kg/wk; low weight gain in second and third trimesters: < 0.3kg/wk; low pregnancy weight gain: < 6.8 kg <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery first trimester weight gain: prepregnancy to 13 to 16 wk since LMP; second trimester: end of first trimester to 26-29 wk since LMP; third trimester: end of second trimester to delivery 	<p>Birth weight: G1: 3287 (469) G2: 3401 (470) <i>P</i> < 0.001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> First trimester weight gain (kg/wk): in NCPP, 0.14 (0.23); in CHDS, 0.19 (0.24) Second trimester weight gain (kg/wk): in NCPP, 0.36 (0.17); in CHDS, 0.41 (0.16) Third trimester weight gain (kg/wk): in NCPP, 0.27 (0.20); in CHDS, 0.30 (0.16) <p>Other infant outcomes: % IUGR: in NCPP, 4.5%; in CHDS, 2.2%</p>	<p>Outcomes Description: Adjusted odds ratios(95% CI) for < 2500g:</p> <p>Groups Maternal weight gain categories stratified by pregravid BMI: BMI < 20.0: G1: Low 1st trimester gain (< 0.1kg/wk) G2: Low 2nd trimester gain (< 0.3kg/wk) G3: Low 3rd trimester gain (< 0.3kg/wk)</p> <p>BMI 20.0-25.0: G4: Low 1st trimester gain G5: Low 2nd trimester gain G6: Low 3rd trimester gain</p> <p>BMI > 25.0: G7: Low 1st trimester gain G8: Low 2nd trimester gain G9: Low 3rd trimester gain</p> <p>Results AOR (95% CI) for < 2500g: G1: 0.88 (0.50-1.57) G2: 2.68 (1.46-4.94) G3: 2.07 (1.22-3.51) G4: 1.31 (0.88-1.95) G5: 1.92 (1.29-2.87) G6: 2.12 (1.48-3.04) G7: 1.02 (0.50-2.08) G8: 1.88 (1.03-3.43) G9: 1.53 (0.86-2.74)</p> <p>Reference group-normal rate of weight gain in the trimester</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Race, GDM, toxemia, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancy Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple gestations Extremes of age BMI between 27 and 34 Missing height Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> NR <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: LGA (%)</p> <p>Groups G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: >35 lbs</p> <p>Results G1: 12.0 G2: 11.8 G3: 18.8 G4: 25.8 G5: 23.8 <i>P</i> < 0.01</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Fair</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 3 Fair, 4 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Caulfield et al., 1998</p> <p>Country and setting: USA, hospital obstetric database</p> <p>Enrollment Period: 1987 to 1989</p> <p>Funding: NR</p> <p>Study Objective: To examine relation between gestational weight gain and risk of delivering a small for gestational age and large for gestational age infant by race</p> <p>Time frame: 1987-1989</p> <p>Duration of the study: Entry into pn care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,870</p> <p>Group Description: G1: BMI < 19.8 Black G2: BMI < 19.8 White G3: BMI 19.8 to 26.0 Black G4: BMI 19.8 to 26.0 White G5: BMI > 26.0 Black G6: BMI > 26.0 White</p> <p>Group N: G1: 523 G2: 267 G3: 1,479 G4: 796 G5: 615 G6: 190</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancies White or black ethnicity At least 28 weeks' gestation One delivery per woman (randomly chosen) Information on anthropometric data <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Improbable data Non-black or non-white ethnicity 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 13.3 (5.7) G2: 14.6 (5.1) G3: 13.6 (6.7) G4: 15.3 (5.4) G5: 12.4 (7.7) G6: 14.5 (7.3)</p> <p>Pregravid BMI:</p> <p>G1: 18.4 (1.0) G2: 18.5 (1.0) G3: 22.7 (1.8) G4: 22.1 (1.8)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 21.7 (4.8) G2: 27.1 (6.6) G3: 22.7 (5.3) G4: 29.8 (5.8) G5: 24.9 (6.0) G6: 28.2 (5.5)</p> <p>Parity: G1: % primiparous: 52.4 G2: 55.4 G3: 50.1 G4: 48.0 G5: 36.9 G6: 46.9</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 32.8 G2: 20.6 G3: 35.4 G4: 20.0 G5: 28.8 G6: 25.4</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 4.3 G2: 3.0 G3: 6.0 G4: 5.7 G5: 11.9 G6: 17.0</p> <p>Additional characteristics: NR</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: 13.3 (5.7) G2: 14.6 (5.1) G3: 13.6 (6.7) G4: 15.3 (5.4) G5: 12.4 (7.7) G6: 14.5 (7.3)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between selfreport prepregnancy weight and last recorded weight 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> AOR for LGA (95% CI) <p>Groups: G1: Underweight, BMI < 19.8 G2: Normal weight, BMI 19.8-26.0 G3: Overweight, BMI > 26.0</p> <p>Black women: G4: No weight gain < IOM G5: No weight gain > IOM</p> <p>White women: G6: No weight gain < IOM G7: No weight gain > IOM</p> <p>Results: AOR (95%CI) for LGA and rate of weight gain (per 50 g/wk): G1: 1.25 (1.11-1.41) G2: 1.14 (1.08-1.20) G3: 1.13 (1.07-1.20)</p> <p>Expected Absolute Change (as % of baseline) in Incidence of LGA associated with modifiable risk factor (G4-G7): G4: +1.28 (+26) G5: -0.77 (-16) G6: +2.58 (+17) G7: -2.87 (-19)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Height Hypertension Provider type Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Female infant</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 6 Good, 3 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
Author, year: Devader et al., 2007	Design: <ul style="list-style-type: none"> Cohort Retrospective 	Pregravid weight: <ul style="list-style-type: none"> Routine pre-natal care If missing, obtained from mother during postpartum hospital stay 	Race, %: White G1: 79.7 G2: 85.6 G3: 85.2
Country and setting: United States, birth certificate data	Total Study N: 94,696	Pregravid BMI: NR	Black G1: 15.7 G2: 10.8 G3: 12.1
Enrollment period: 1999 to 2001	Group Description: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs	Imputed: <ul style="list-style-type: none"> No 	Hispanic NR
Funding: NR	Group N: G1: 16,852 G2: 37,292 G3: 40,552	Categorized: NR	Asian/Pacific Islander NR
Study Objective: To investigate relationship between gestational weight gain and adverse pregnancy outcomes among women with normal prepregnancy BMI	Inclusion criteria: <ul style="list-style-type: none"> All mothers with normal prepregnancy BMI (19.8–26.0 kg/m²) who were 18 to 35 years of age at time of delivery and who delivered full-term (37 weeks or more) singleton infant during period January 1, 1999, to December 31, 2001 	Age (mean, yrs): G1: Maternal age (y) 18 to 24*: 42.3% 25 to 30: 36.2% 31 to 35: 21.5% G2: Maternal age (y) 18 to 24*: 36.7% 25 to 30: 39.5% 31 to 35: 23.8% G3: Maternal age (y) 18 to 24*: 44.7% 25 to 30: 35.9% 31 to 35: 19.4%	Other G1: 4.6 G2: 3.5 G3: 2.7
Time frame: 1999 to 2001	Exclusion criteria: <ul style="list-style-type: none"> Women aged younger than 18 years and older than 35 years Non-Missouri residents Preterm deliveries Multiple gestations 	Parity: NR	Smoking, %: G1: 20.5 G2: 14.9 G3: 17.4
Duration of the study: Entry into prenatal care through delivery			Diabetes mellitus, %: NR
			Hypertension, %: NR
			Additional characteristics: NR

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: NR</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: NR</p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 plot risk for each adverse pregnancy outcome by 10-lb increments in gestational weight gain. Women who gained 25 to 34 lbs during their pregnancy had lower risks for most outcomes when balancing risk for SGA status and other adverse pregnancy outcomes Women who gained 15 to 24 lbs had lowest risks for most outcomes, but increased their risk of having an SGA infant from 9.6% to 14.3% Women who gained more than 34 lbs had higher risks for all outcomes, although their risk of having an SGA infant decreased from 9.6% to 6.6% 	<p>Outcomes Description: AOR for Women With Normal Prepregnancy BMI (19.8 –26.0 kg/m²) by GWG Category, Missouri Birth Certificates, 1999–2001 (95% CI)</p> <p>Groups: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs</p> <p>Results: AOR (95%CI) for LGA: G1: 0.40 (0.37-0.44) G2: 1.00 (reference) G3: 2.43 (2.30-2.56)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Education Income Alcohol use Height Prior pregnancy Inadequate prenatal care use Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Child's gender Birth year 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hellerstedt et al., 1997</p> <p>Country and setting: United States, medical center</p> <p>Enrollment Period: 1977-1993</p> <p>Funding: NR</p> <p>Study Objective: To examine association between infant birth outcomes and maternal pregravid obesity, gestational weight gain, and prenatal smoking</p> <p>Time frame: 1977 to 1993</p> <p>Duration of the study: Entry into prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 1,343</p> <p>Group Description: G1: Obese G2: Normal weight</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Obese and normal-weight women delivering singleton during study period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing data • Siblings • Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 103.5 kg (13.7) G2: 61.1kg (5.9)</p> <p>Pregravid BMI: G1: 38.3 (4.6) G2: 22.8 (1.6)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: NR</p> <ul style="list-style-type: none"> • 16-34 years: 91% • ≥ 35 years: 8.8% <p>G2: NR</p> <ul style="list-style-type: none"> • 16-34 years: 93.5% • ≥ 35 years: 5.8% <p>Parity: G1: NR</p> <ul style="list-style-type: none"> • 0: 31.8% • 1-3: 64.7% • ≥ 4: 3.5% <p>G2: NR</p> <ul style="list-style-type: none"> • 0: 33.3% • 1-3: 64.9% • ≥ 4: 1.8% 	<p>Race, %: White G1: 68.8 G2: 69.1</p> <p>Black G1: 20.4 G2: 20.6</p> <p>Hispanic G1: 6.6 G2: 6.5</p> <p>Asian/Pacific Islander G1: Native Am: 3.8 G2: Native Am: 3.2</p> <p>Other NR</p> <p>Smoking, %: G1: 26.4 G2: 26.2</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): <i>Total weight gain:</i></p> <p><i>Categorized:</i></p> <ul style="list-style-type: none"> • <i>According to IOM</i> <p><i>Collected from:</i></p> <ul style="list-style-type: none"> • <i>Routine pre-natal care or maternity records</i> <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> • <i>Based on last clinically measured weight prior to delivery</i> 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: LGA (%)</p> <p>Groups Maternal weight gain categories stratified by pregravid BMI and smoking status:</p> <p>Obese (BMI > 29.0): G1: Smokers, < IOM G2: Smokers, within IOM G3: Smokers, > IOM</p> <p>G4: Nonsmokers, < IOM G5: Nonsmokers, within IOM G6: Nonsmokers, > IOM</p> <p>Normal weight (BMI 19.8-26.0): G7: Smokers, < IOM G8: Smokers, within IOM G9: Smokers, > IOM</p> <p>G10: Nonsmokers, < IOM G11: Nonsmokers, within IOM G12: Nonsmokers, > IOM</p> <p>Obese: G13: Lost/no gain G14: 0.5-6.5 kg G15: 7-11.5 kg G16: 12-16 kg G17: > 16 kg</p> <p>Normal weight: G18: < 11.5kg G19: 11.5-16kg G20: > 16kg</p> <p>Results Frequencies of LGA, %: G1: 5.3 G2: 10.0 G3: 12.3 G4: 12.2 G5: 11.7 G6: 22.2 G7: 0 G8: 1.8 G9: 9.1 G10: 4.4 G11: 8.1 G12: 14.3</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Hellerstedt et al., 1997
(continued)

Evidence Table 39. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		G13: 9.3 G14: 10.5 G15: 11.3 G16: 17.5 G17: 21.8 P = 0.001 for G13-G17	
		G18: 2.8 G19: 6.7 G20: 13.1 P < 0.001 for G18-G20	
		Compared with infants of obese nonsmokers who gained 7-11.5kg, the only group at significantly higher risk of LGA was non smokers who gained > 11.5kg: AOR: 2.3 (95%CI: 1.2-4.5)	
		Maternal confounders and effect modifiers accounted for in analysis: Maternal age, pregravid BMI, infant sex, race, parity, prenatal alcohol use, prenatal illicit drug use, adequacy of prenatal care, gestational hypertension, GDM	
		Infant and child confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> • Gestational age 	

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kiel et al., 2007</p> <p>Country and setting: United States, birth registry</p> <p>Enrollment period: 1990 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of gestational weight change on pregnancy outcomes in obese women</p> <p>Time frame: 1990 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 120,170</p> <p>Group Description:</p> <p>G1: Obese Class I (BMI 30–34.9) (n = 70,536)</p> <p>G2: Obese Class II (BMI 35–39.9) (n = 30,609)</p> <p>G3: Obese Class III (BMI 40 and More) (n = 19,025)</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women residing in Missouri who delivered (at 37 or more weeks of gestation) liveborn, singleton infants during 1990–2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: Total: Class I obese: 59% Class II obese: 25% Class III obese: 16%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NIH guidelines <p>Age (mean, yrs):</p> <p>G1: <26: 46% 26–35: 47% Older than 35: 8%</p> <p>G2: <26: 44% 26–35: 48% Older than 35: 8%</p> <p>G3: <26: 40% 26–35: 52% Older than 35: 9%</p> <p>Parity: Nulliparous: G1: 34% G2: 33% G3: 32%</p>	<p>Race, %: White G1: 78 G2: 77 G3: 73</p> <p>Black G1: 22 G2: 23 G3: 27</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 22</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: GWG (lb) Less than 2: 3% 2 to 14: 15% 15 to 25: 26% More than 25: 56% G2: GWG (lb) Less than 2: 8% 2 to 14: 22% 15 to 25: 27% More than 25: 43% G3: GWG (lb) Less than 2: 15%</p> <p>Categorized:</p> <ul style="list-style-type: none"> 10-lb or less loss 2 to 9 lbs loss, no weight change, 2 to 9 lbs gain, 10 to 14 lbs gain, 15–25 lb gain, 26–35 lb gain, and greater than 35 lb gain <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: G1: SGA: 7% LGA: 13% (<i>P</i> < 0.05) G2: SGA: 7% LGA: 16% (<i>P</i> < 0.05) G3: SGA: 6% LGA: 18% (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 28 G2: 34 G3: 41</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Absolute risk and OR (95% CI) of pregnancy outcomes for various classes of obese women (class I, II, III)</p> <p>Groups: Maternal weight gain categories stratified by prepregnancy obesity status, Obese Class I (BMI 30–34.9), Obese Class II (BMI 35–39.9), Obese Class III (> = BMI 40): G1: < = -10lbs G2: -2 to -9 lbs G3: No change G4: 2-9 lbs G5: 10-14 lbs G6: 15-25lbs G7: 26-35lbs G8: > 35 lbs</p> <p>Result: For Obese Class I: OR (95% CI) for LGA were significantly lower (< 1.00, G6 was reference) for G1- G5 and significantly higher for G7-G8.</p> <p>For Obese Class II: OR (95% CI) for LGA were significantly lower (< 1.00, G6 was reference) for G1- G5 and significantly higher for G7-G8.</p> <p>For Obese Class III: OR (95% CI) for LGA were significantly lower (< 1.00, G6 was reference) for G1- G4 and significantly higher for G7-G8</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Education Poverty (enrollment in Medicaid, WIC, food stamp programs) Tobacco use Chronic hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Kiel et al., 2007
(continued)

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 show absolute risk of preeclampsia, cesarean delivery, LGA, and SGA by GWG category for each obesity class. All 3 figures show similar patterns of increasing risk of preeclampsia, cesarean delivery, and LGA birth and decreasing risk of SGA birth with increasing GWG. Collectively, minimal risk for all 4 outcomes corresponds to GWG categories where risk of LGA and SGA births intersect. This equates to GWG of 10 of 25 lb for class I obese women, a gain of 0 to 9 lb for class II obese women, and weight loss of 0 to 9 lb for class III obese women. Adjusted odds ratios and 95% CIs for preeclampsia, cesarean delivery, SGA, and LGA by GWG category and obesity class. Compared with women who gained 15 to 25 lb during their pregnancies, those who gained less weight had significantly lower odds of preeclampsia, cesarean delivery, and LGA births, but higher odds for SGA births. Women who gained more than 25 lbs had higher odds for same 3 pregnancy outcomes and lower odds for SGA births. <p>Other infant outcomes: NR</p>		

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Parker and Abrams, 1992</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: Sept 1980 to Dec 1988</p> <p>Funding: UC Committee on Research & MCH and Resources Development, Health Resources and Services Administration</p> <p>Study Objective: To test whether gains outside IOM reference ranges were associated with increased risks of suboptimal pregnancy outcome (SGA, LGA, cesarean delivery) and to determine whether locally developed ranges were more applicable to study population</p> <p>Time frame: Sept 1980 to Dec 1988</p> <p>Duration of the study: From entry into prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 6,690</p> <p>Group Description: G1: Overall G2: NR</p> <p>Group N: G1: 6,690 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Consecutive live singleton births at Moffitt Hospital between September 1980 and December 1988 with gestational ages of 37 to 42 weeks <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Maternal transfers or transports and deliveries complicated by fetal malformations, maternal diabetes, or maternal hypertension 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 56.8 kg(SD 11.0) G2: NR</p> <p>Pregravid BMI:</p> <p>G1: Underweight: 27.7%, Normal weight 61.8%, Overweight: 5.6%, Obese 4.9% G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 27.7 (5.5) G2: NR</p> <p>Parity: Primiparous: G1: 58.8% G2: NR</p>	<p>Race, %: White G1: 44.0 G2: NR</p> <p>Black G1: 8.3 G2: NR</p> <p>Hispanic G1: 9.4 G2: NR</p> <p>Asian/Pacific Islander G1: 21.4 G2: NR</p> <p>Other G1: 12.0 G2: NR</p> <p>Smoking, %: G1: 12.0 G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 6690 G2: NR</p> <p>Total weight gain: G1: 15.2kg (5.2) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM %: Weight gain ranges based on percentiles from previous study of UC population with good pregnancy outcomes: 25th - 75th, 10-90th percentiles. For 25-75th, weight gain range = 12-17kg for underweight women (BMI < 19.8); <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3408g (462) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> AOR for LGA (95% CI) <p>Groups: G1: < IOM range G2: Within IOM range G3: > IOM</p> <p>Results: AOR (95% CI) for LGA: G3: 1.92 (1.52-2.43) G2: 1.00 (reference)</p> <p>Incidence of LGA in nonobese women, %: G1: 3.25 G2: 6.14 G3: 13.11</p> <p>Incidence of LGA in obese women, %: G1: 5.88 G2: 17.53</p> <p>AOR for LGA and high weight gain UCSF 25-75 1.89 (1.51-2.37) UCSF 10-90 1.87 (1.39-2.52) IOM 1.92 (1.52-2.43)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Height Maternal high and low weight gain Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age <p>Birth weight</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stevens-Simon and McAnarney, 1992</p> <p>Country and setting: USA, adolescent maternity program</p> <p>Enrollment Period: 1986 to 1989</p> <p>Funding: Grant from Bureau of Maternal and Child Health</p> <p>Study Objective: To clarify advantages and disadvantages of large gestational weight gain among pregnant adolescents</p> <p>Time frame: 1986 to 1989</p> <p>Duration of the study: Entry into prenatal care through 6 weeks PP check up</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 141 (107 included in postpartum analyses)</p> <p>Group Description: G1: Slow gainers G2: Average gainers G3: Rapid gainers</p> <p>Group N: G1: 28 G2: 66 G3: 47</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Consecutively enrolled poor, black, 12-19 year olds • Prenatal care prior to 2third week gestation • No chronic disease • No regular medications • No known uterine anomalies • Live birth • Singletons <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 58.6 (11.1) G2: 160.9 (7.0) G3: 163.9 (5.5)</p> <p>Pregravid BMI: G1: 23.1 (3.5) G2: 23.5 (4.4) G3: 23.5 (4.2)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 16.9 G2: 16.6 G3: 16.2</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28 G2: 66 G3: 47</p> <p>Total weight gain: G1: 7.7 (average rate 0.2 kg/wk) G2: 12.4 (average rate 0.3 kg/wk) G3: 19.8 (average rate 0.5 kg/wk)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM slow gain: < 0.23kg/wk; average gain: 0.23-0.4kg/week; rapid gain: > 0.4kg/week <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 2745 (694) G2: 3097 (457) G3: 3351 (482) <i>P</i> < 0.0001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Distribution of LGA, %:</p> <p>Groups Maternal weight gain categories (kg/wk): G1: < 0.23 G2: 0.23-0.40 G3: > 0.40</p> <p>Results G1: 3.6 G2: 4.5 G3: 12.8 <i>P</i> = NS</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stotland et al., 2006</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: 1980 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine relationship between gestational weight gain and adverse neonatal outcomes among infants born at term (37 weeks or more)</p> <p>Time frame: 1980 to 2001</p> <p>Duration of the study: Entry into PN care up till delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 20465</p> <p>Group Description:</p> <p>G1: Gain below IOM recommendations</p> <p>G2: Gain within IOM recommendations</p> <p>G3: Gain above IOM recommendations</p> <p>Group N:</p> <p>G1: 4,114</p> <p>G2: 7,490</p> <p>G3: 8,861</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Pregnancies complicated by multiple gestations, congenital anomalies, chronic hypertension, gestational or pregestational diabetes Birth before 37 weeks Maternal transport Missing data on any of variables considered in multivariable analysis 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: < 19.8: 25.8%</p> <p>19.8-26.0: 19.4%</p> <p>26.1-29.0: 9.2%</p> <p>> 29.0: 20.6%</p> <p>G2: < 19.8: 49.1%</p> <p>19.8-26.0: 34.8%</p> <p>26.1-29.0: 23.3%</p> <p>> 29.0: 25.5%</p> <p>G3: < 19.8: 25.0%</p> <p>19.8-26.0: 45.8%</p> <p>26.1-29.0: 67.5%</p> <p>> 29.0: 53.9%</p> <p><i>P</i> < 0.001</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: < 20 years: 23.4%</p> <p>20-29 years: 19.3%</p> <p>30-39 years: 19.9%</p> <p>> 40 years: 25.3%</p> <p>G2: < 20 years: 31.3%</p> <p>20-29 years: 36.6%</p> <p>30-39 years: 37.6%</p> <p>> 40 years: 36.3%</p> <p>G3: < 20 years: 45.4%</p> <p>20-29 years: 44.0%</p> <p>30-39 years: 42.5%</p> <p>> 40 years: 38.4%</p> <p><i>P</i> < 0.001</p> <p>Parity:</p> <p>% Nulliparous:</p> <p>G1: 17.3</p> <p>G2: 36.2</p> <p>G3: 46.6</p> <p><i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 16.2</p> <p>G2: 35.8</p> <p>G3: 48.0</p> <p>Black</p> <p>G1: 25.5</p> <p>G2: 29.4</p> <p>G3: 45.1</p> <p>Hispanic</p> <p>G1: 19.2</p> <p>G2: 34.8</p> <p>G3: 46.0</p> <p>Asian/Pacific Islander</p> <p>G1: 24.3</p> <p>G2: 43.3</p> <p>G3: 32.4</p> <p>Other</p> <p>G1: 21.7</p> <p>G2: 37.9</p> <p>G3: 40.4</p> <p><i>P</i> for all race categories < 0.001</p> <p>Smoking, %:</p> <p>G1: 23.5</p> <p>G2: 30.8</p> <p>G3: 45.8 <i>P</i> < 0.001</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 43. Gestational weight gain with reference to IOM recommendations and large for gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 4114 G2: 7490 G3: 8861</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOMpercentiles and dichotomous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: %SGA: 36.1; %AGA: 20.2; %LGA: 8.5 G2: %SGA: 39.4; %AGA: 37.5; %LGA: 26.5 G3: %SGA: 24.5; %AGA: 42.4; %LGA: 65.1 <i>P</i> < 0.001</p> <p>Gestational diabetes,%: NR</p> <p>Cesarean delivery,%: G1: 14.7 G2: 32.1 G3: 53.2</p> <p>Instrumental delivery,%: Operative vaginal delivery: G1: 18.0% G2: 37.5% G3: 44.5%</p> <p>Episiotomy,%: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Birth trauma 5 min Apgar score less than 7 Aassisted ventilation SGA LGA NICU admission SCN admission Neonatal infection Seizure Hypoglycemia Polycythemia MAS RDS Tachypnea Hospital stay > 5 days Hospital stay > 10 days 	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Risk of adverse neonatal outcomes by gestational weight gain by IOM guidelines, adjusted ORs compared to women with GWG within IOM guidelines and risk of adverse neonatal outcomes by extremes of GWG compared to women with weight gain 11.5-16.0kg <p>Groups: G1: < IOM G2: Within IOM G3: > IOM G4: < 7kg G5: > 18kg</p> <p>Results: Unadjusted Rates of LGA: G1: 3.85 <i>P</i> < 0.001 vs. G2 G2: 6.62 G3:13.76 <i>P</i> < 0.001 vs. G2 G4: 5.26 G5: 14.60 <i>P</i> < 0.05 vs. G2</p> <p>AOR (95% CI) for LGA: G1: 0.58 (0.47-0.72) G2: 1.00 (reference) G3: 1.98 (1.74-2.25) G4: 0.50 (0.33-0.78) G5: 2.28 (2.00-2.62)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Pregnancy induced hypertension Date of delivery Mode of delivery Length of first stage of labor Length of second stage of labor Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age <p>Birth weight</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Cogswell et al., 1994</p> <p>Country and setting: USA, Pregnancy Nutrition Surveillance System</p> <p>Enrollment Period: 1990-1991</p> <p>Funding: NR</p> <p>Study Objective: To determine association between increased gestational weight gain and birth weight outcomes for low income women</p> <p>Time frame: 1990-1991</p> <p>Duration of the study: Women in WIC but everything is self reported so it is when they were first enrolled in WIC until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 53,541</p> <p>Group Description: G1: Average weight G2: Overweight G3: Very overweight</p> <p>Group N: G1: 33,809 G2: 7,661 G3: 12,071</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> White, black and hispanic women who delivered single, liveborn, term infants <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Low or high values for; birth weight, prepregnancy BMI, or weight gain during pregnancy Missing data on one or more study variables Underweight women Only 1 infant was used in analysis for women who delivered more than once during study period 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 11-17 yr: 11.9% 18-34yr: 85.0% 35-54 yr: 3.1% G2: 11-17 yr: 6.9% 18-34yr: 88.7% 35-54 yr: 4.4% G3: 11-17 yr: 4.0% 18-34yr: 90.1% 35-54 yr: 6.0%</p> <p>Parity: NR</p>	<p>Race, %: White G1: 75.1 G2: 72.4 G3: 74.5 Black G1: 13.8 G2: 14.1 G3: 16.1 Hispanic G1: 11.1 G2: 13.5 G3: 9.4 Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 29.9 G2: 28.3 G3: 25.7</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 33,809 G2: 7,661 G3: 12,071</p> <p>Total weight gain: G1: < 15 lb: 6.2% 15-19: 5.8% 20-24: 11.2% 25-29: 14.4% 30-34: 17.1% 35-39: 13.9% ≥ 40: 31.4% G2: < 15 lb: 11.4% 15-19: 7.8% 20-24: 13.0% 25-29: 12.7% 30-34: 15.9% 35-39: 11.2% ≥ 40: 28.1% G3: < 15 lb: 25.1% 15-19: 10.1% 20-24: 1</p> <p>Categorized:</p> <ul style="list-style-type: none"> 4 lbs increments starting at 15 lbs <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> Self-reported 	<p>Birth weight: G1: < 2500g: 2.7% 2500-4000g: 87.5% > 4000-4500: 8.5% > 4500g: 1.4% G2: < 2500g: 2.5% 2500-4000g: 83.9% > 4000-4500: 11.7% > 4500g: 2.0% G3: < 2500g: 2.1% 2500-4000g: 81.1% > 4000-4500: 13.2% > 4500g: 3.6%</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: AOR (95% CI) for high birth weight</p> <p>Groups Maternal weight gain categories (lbs) stratified by pregravid BMI: Normal weight (BMI 19.8-26.0): G1: < 15 G2: 15-19 G3: 20-24 G4: 25-29 G5: 30-34 G6: 35-39 G7: ≥ 40 Overweight (BMI > 26.0-29.0): G8: < 15 G9: 15-19 G10: 20-24 G11: 25-29 G12: 30-34 G13: 35-39 G14: ≥ 40 Obese (BMI > 29.0): G15: < 15 G16: 15-19 G17: 20-24 G18: 25-29</p> <p>Results AOR (95% CI) for high birth weight: G1: 1.0 (0.5-2.0) G2: 0.4 (0.2-1.0) G3: 0.6 (0.3-1.1) G4: 1.0 (reference) G5: 1.1 (0.7-1.8) G6: 1.5 (1.0-2.3) G7: 3.3 (2.3-4.7)</p> <p>G8: 0.8 (0.2-2.6) G9: 1.0 (reference) G10: 1.1 (0.4-3.5) G11: 2.1 (0.8-5.7) G12: 2.4 (0.9-6.4) G13: 1.6 (0.6-4.6) G14: 4.0 (1.6-10.1)</p> <p>G15: 0.7 (0.5-1.1) G16: 1.0 (reference) G17: 1.1 (0.7-1.7) G18: 1.3 (0.8-2.0) G19: 1.9 (1.3-2.9) G20: 2.1 (1.3-3.2) G21: 2.3 (1.6-3.3)</p>	

**Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Cogswell et al., 1994
(continued)

**Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia
(continued)**

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		<p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Race • height • Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Gestational age • Sex of infant 	

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Edwards et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1997-1993</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy course and outcomes in obese and normal weight women and their associations with gestational weight change</p> <p>Time frame: 1997-1993</p> <p>Duration of the study: 1997-1993</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 1,443</p> <p>Group Description: G1: Obese G2: Normal Weight G3: total sample</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women and normal weight women identified from pregnancy and delivery summary records (normal weight matched to obese by race, age, parity) Singleton deliveries Live births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 103.5 G2: 61</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelinesobese (> 29) and normal weight (BMI 19.8-26.0) <p>Age (mean, yrs): G1: 27.1 G2: 25.4</p> <p>Parity: NR</p>	<p>Race, %: White G1: NR G2: NR G3: 69.0 (Total sample)</p> <p>Black G1: NR G2: NR G3: 21.0 (Total sample)</p> <p>Hispanic G1: NR G2: NR G3: 7.0 (Total sample)</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: NR G2: NR G3: 4.0 (Total sample)</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 683 G2: 660</p> <p>Total weight gain: G1: 9.5 G2: 14.5 $P \leq 0.001$</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3420 G2: 3285 $P \leq 0.001$</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 25.6 G2: 9.1 $P < 0.001$</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Birthweight $\geq 4000g$ <p>Groups: Maternal weight gain categories (kg) Obese > 29: G1: Lost weight/no change G2: 0.5-6.5 G3: 7-11.5 G4: 12-16 G5: > 16 Normal BMI 19.8-26 G6: < 11.5kg G7: 11.5-16 G8: > 16kg</p> <p>Results: Birthweight $\geq 4000g$, %: G1: 12.0 G2: 12.5 G3: 13.3 G4: 15.4 G5: 24.4 P (for G1-G5) = 0.026</p> <p>G6: 5.7 G7: 6.6 G8: 16.9 P (for G6-G8) < 0.001</p> <p>AOR (95%CI) for birthweight $\geq 4000g$ among obese women (BMI > 29.0): G3: 1.0 (reference) G8: 2.8 (1.4-5.6)</p> <p>AOR (95%CI) for birthweight $\geq 4000g$ among normal weight women (BMI 19.8-26.0): G7: 1.0 (reference) G8: 2.4 (1.3-4.7)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Pre-gravid BMI GDM Pregnancy induced hypertension Prenatal adequacy Alcohol use Drug use Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hedderson et al., 2006</p> <p>Country and setting: USA, Kaiser Permanente Medical Care Program</p> <p>Enrollment Period: January 1, 1996 - June 31, 1998</p> <p>Funding: R01 DK 54834 from National Institute of Diabetes and Digestive and Kidney Diseases, grant from American Diabetes Association and Kaiser Community Benefit research support</p> <p>Study Objective: To examine whether pregnancy weight gains outside IOM recommendations and rates of maternal weight gain are associated with neonatal complications</p> <p>Time frame: January 1, 1996 to June 31, 1998</p> <p>Duration of the study: First prenatal care visit to 30 days post delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Case-control Retrospective <p>Total Study N: 45,245</p> <p>Group Description: G1: Controls G2: Macrosomia G3: Hypoglycemia G4: Hyperbilirubinemia</p> <p>Group N: G1: 652 G2: 391 G3: 328 G4: 432</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton livebirth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> No pregestational diabetes or history of gestational diabetes (screened at 24-28 weeks gestation - meeting National Diabetes Data Group criteria for GDM) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported in some cases used measured weight recorded in chart closes to woman's last menstrual period but no more than 12 months before her last menstrual period <p>Pregravid BMI: G1: < 19.8: 13.5% 19.8-24.9: 56.4% 25.0-29.0: 12.4% > 29.0: 17.6% G2: < 19.8: 5.1% 19.8-24.9: 51.2% 25.0-29.0: 16.6% > 29.0: 27.1% G3: < 19.8: 10.1% 19.8-24.9: 50.0% 25.0-29.0: 17.1% > 29.0: 22.9% G4: < 19.8: 13.9% 19.8-24.9: 57.9% 25.0-29.0: 13.2% > 29.0: 57.1%</p> <p>Imputed: <ul style="list-style-type: none"> No </p> <p>Categorized: <ul style="list-style-type: none"> IOM guidelines </p> <p>Age (mean, yrs): G1: < 25 years: 22.1% 25-29: 24.2% 30-34: 33.6% ≥ 35: 20.1% G2: < 25 years: 15.9% 25-29: 28.0% 30-34: 31.7% ≥ 35: 24.3% G3: < 25 years: 24.1% 25-29: 25.3% 30-34: 26.8% ≥ 35: 23.8% G4: < 25 years: 17.1% 25-29: 29.4% 30-34: 32.6% ≥ 35: 20.8%</p> <p>Parity: % primiparous: G1: 56.9 G2: 31.2 G3: 50.0 G4: 59.3</p>	<p>Race, %: White G1: 54.0 G2: 67.8 G3: 47.6 G4: 42.6</p> <p>Black G1: 10.0 G2: 5.1 G3: 11.3 G4: 4.4</p> <p>Hispanic G1: 17.2 G2: 15.1 G3: 20.4 G4: 15.5</p> <p>Asian/Pacific Islander G1: 8.1 G2: 3.6 G3: 6.7 G4: 20.1</p> <p>Other G1: 10.7 G2: 8.4 G3: 14.0 G4: 17.4</p> <p>Smoking, %: G1: %nonsmoking during pregnancy: 92.0; %smoked but quit: 4.2; %smoked 3.9 G2: %nonsmoking during pregnancy: 90.8; %smoked but quit: 5.3; %smoked 4.0 G3: %nonsmoking during pregnancy: 92.6; %smoked but quit: 1.5; %smoked 5.8 G4: %nonsmoking during pregnancy: 94.2; %smoked but quit: 4.9; %smoked 1.0</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Screening glucose value less than 140: G1: 85.0%; > 140: 15.0% G2: 81.6%; > 140: 18.4% G3: 81.4%; > 140: 18.6% G4: 83.3%; > 140: 16.7%</p>

Evidence Table 48. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records rate of maternal weight gain was calculated as total pregnancy weight gain minus infant birth weight divided by weeks of gestation when last weight was measured; rate of maternal weight gain before the third trimester was calculated using the weight measured at or before the screening test for GDM (24-28 wks of gestation) minus prepregnancy weight divided by weeks of gestation <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between final recorded weight at last prenatal visit (within 2 weeks of delivery date) and prepregnancy weight 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> AOR for birthweight>4500g (95% CI) <p>Groups:</p> <p>G1: < IOM recommendations G2: Within IOM recommendations G3: > IOM recommendations</p> <p>Results:</p> <p>% Distribution of maternal weight gain categories among women with macrosomia: G1: 4.0 G2: 16.3 G3: 79.7 P< 0.05 (compared to controls)</p> <p>AOR (95% CI) for macrosomia: G1: 0.38 (0.20-0.70) G2: 1.00 reference G3: 3.05 (2.19-4.26)</p> <p>OR (95% CI) for macrosomia: Underweight women (BMI < 19.8) G2: 1.00 (reference) G3: 2.70 (0.83-8.61)</p> <p>Normal weight women (BMI 19.8-26.0) G2: 1.00 (reference) G3: 3.60 (2.27-5.83)</p> <p>Overweight/obese women (BMI > 26.0) G2: 1.00 (reference) G3: 2.00 (1.14-3.47)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Screening glucose value from 1 hour after 50g oral glucose challenge test Difference between age at delivery and gestational age at last weight measured <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kabali, C and Werler, MM, 2007</p> <p>Country and setting: Canada and United States, multicenter</p> <p>Enrollment period: 1996 to 2002</p> <p>Funding: National Institute of Dental and Craniofacial Research, grant # DE11393</p> <p>Study Objective: To establish whether excessive pre-pregnancy weight as measured by BMI, excessive PWG, or their combined effects are risk factors for delivering large babies</p> <p>Time frame: 1996 to 2002</p> <p>Duration of the study: Entry into prenatal care through pregnancy</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 815</p> <p>Group Description: G1: Total Study</p> <p>Group N: G1: 815</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Controls were selected by pediatric practice (or one of similar size and location) of each case by identifying next four children seen in practice whose ages were within 2 months of case's age. <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Diabetic women • Multiple gestations • Missing weight, height, or weight gain data • Women with outlying data 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: <24 years 208 (25.5%) 24 to 34 years 478 (58.7%) 35 to 45 years 129 (15.8%)</p> <p>Parity: G1: Primiparae (56.2%)</p>	<p>Race, %: White G1: (67.7)</p> <p>Black G1: (11.3)</p> <p>Hispanic G1: (16.2)</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: (4.8)</p> <p>Smoking, %: G1: throughout pregnancy - yes: 8.2%</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: NR</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> NR </p> <p>Ascertained by: <ul style="list-style-type: none"> Self-reported </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes:</p>	<p>Outcomes Description: OR for maternal BMI and weight gain in relation to risk of macrosomia (95% CI)</p> <p>Groups: G1: < IOM G2: Within IOM G3: > IOM</p> <p>Results: AOR G1: 1.0 (0.4, 1.9) G2: ref G3: 1.5 (0.7, 2.5)</p> <p>Combined effect with BMI OR (AOR similar but not all could be calculated) Underweight/G1: 0.7 (0.2, 3.3) Underweight/G2: 1.0 (0.3, 3.5) Underweight/ G3: 1.7 (0.4, 6.4)</p> <p>Normal/G1: 0.7 (0.3, 1.8) Normal/G2 Ref Normal/ G3: 1.1 (0.5, 2.3)</p> <p>Overweight/G1: 1.2 (0.4, 3.8) Overweight/G2: 0.8 (0.2, 2.7) Overweight/G3: 2.4 (1.2, 4.8)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Marital status Family income Alcohol intake Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age <p>Child's sex</p>	

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Rode et al., 2007</p> <p>Country and setting: Smoke-free Newborn Study, University Hospital, Denmark</p> <p>Enrollment period: November 1996 to October 1998</p> <p>Funding: NR</p> <p>Study Objective: To investigate association between maternal weight gain and birthweight</p> <p>Time frame: November 1996 to October 1998</p> <p>Duration of the study: 12 to 18 weeks gestation through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 2248</p> <p>Group Description: G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI 26.1-29.0 G4: BMI > 29.0</p> <p>Group N: G1: 385 G2: 1,531 G3: 177 G4: 385</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women who answered questionnaire at both 12 to 18 weeks and 37 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple gestation Women who delivered prior to 37 weeks 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <ul style="list-style-type: none"> NR <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized: IOM Guidelines</p> <p>Age (mean, yrs): G1: Less than 25:15.3% 25-30: 45.7% 30-35: 33.5% >35: 5.5% G2: Less than 25:17.5% 25-30: 36.7% 30-35: 34.5% >35: 11.3% G3: Less than 25:15.3% 25-30: 45.7% 30-35: 33.5% >35: % G4: Less than 25: 20.0% 25-30: 39.4% 30-35: 29.7% >35: 11.0% $P < 0.001$</p> <p>Parity: % nulliparous: G1: 52.2 G2: 58.6 G3: 51.4 G4: 49.0 $P = 0.02$</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: %nonsmokers: G1: 58.3 G2: 65.5 G3: 61.1 G4: 67.3</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % married/cohabiting: G1: 92.3 G2: 91.4 G3: 94.2 G4: 92.7</p> <p>Additional characteristics: NR</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 385 G2: 1,531 G3: 177 G4: 385</p> <p>Total weight gain: G1: < 1kg: 0% 1-5: 0.5% 6-10: 16.1% 11-15: 45.7% 16-20: 30.1% >20: 7.5% G2: < 1kg: 0.3% 1-5: 1.6% 6-10: 16.9% 11-15: 41.5% 16-20: 29.1% >20: 10.5% G3: < 1kg: 1.7% 1-5: 4.5% 6-10: 24.9% 11-15: 40.1% 16-20: 24.3% >20: 4.5% G4:</p> <p><i>Categorized: According to IOM</i></p> <p><i>Collected from:</i> <ul style="list-style-type: none"> Self-reported </p> <p><i>Ascertained by:</i> <ul style="list-style-type: none"> Self-reported </p>	<p>Birth weight: G1: less than 2500g: 1.8% 2500-2999: 10.9% 3000-3999: 72.7% 4000-4499: 11.4% ≥ 4500: 3.1% G2: less than 2500g: 1.1% 2500-2999: 7.1% 3000-3999: 69.6% 4000-4499: 18.2% ≥ 4500: 4.0% G3: less than 2500g: 2.3% 2500-2999: 4.5% 3000-3999</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes NR</p> <p>Other infant outcomes <ul style="list-style-type: none"> Birthweight </p>	<p>Outcomes Description: <ul style="list-style-type: none"> AOR for birthweight ≥ 4000g (95% CI) </p> <p>Groups: Maternal weight gain categories stratified by pregravid BMI status: BMI less than 19.8 G1: < IOM G2: Within IOM G3: > IOM</p> <p>BMI 19.8–26.0 G4: < IOM G5: Within IOM G6: > IOM</p> <p>BMI 26.1–29.0 G7: < IOM G8: Within IOM G9: > IOM</p> <p>Results: AOR (95%CI) for birthweight > = 4000g: G1: 0.8 (0.4-1.6) G2: 1.0 (reference) G3: 1.7 (0.8-3.6)</p> <p>G4: 0.7 (0.5-0.999) G5: 1.0 (reference) G6: 1.9 (1.5-2.5)</p> <p>G7: 0.6 (0.1-3.1) G8: 1.0 (reference) G9: 1.8 (0.8-3.9)</p> <p>G10: 0.8 (0.4-1.7) G11: 1.0 (reference) G12: 0.9 (0.4-2.0)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> Pre-eclampsia Caffeine consumption Smoking </p> <p>Infant and child confounders and effect modifiers accounted for in analysis: Gestational age</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 6 Good, 2 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Schieve, 1998</p> <p>Country and setting: Pregnancy Nutrition Surveillance System - data from WIC clinics (99%) from Indiana, Kansas, Massachusetts, Minnesota, Nebraska, North Dakota, New York, Tennessee, and Vermont</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To examine associations between pregnancy weight gain outside and within ranges recommended by IOM and birth weight by both prepregnant BMI and race ethnicity</p> <p>Time frame: NR</p> <p>Duration of the study: 1990 to 1993</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 173,066</p> <p>Group Description: NR</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> White, black, and hispanic women who visited WIC clinics prenatally and subsequently delivered liveborn, singleton infants Delivered between 39 and 41 weeks <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data for infant birth weight (n = 4223) Prepregnant BMI (n = 31477) Pregnancy weight gain (n = 7542) Maternal age (n = 43) Maternal education (n = 3819) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported NR <p>Pregravid BMI:</p> <ul style="list-style-type: none"> NR <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized: IOM Guidelines</p> <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia
(continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 112,524 G2: 33,101 G3: 27,441</p> <p>Total weight gain: G1: 32.5 G2: 30.5 G3: 30.2</p> <p><i>Categorized:</i> <i>According to IOM >10 pounds below lower bound of IOM recommended range for woman's prepregnant BMI, 1-9 pounds below lower bound of IOM lower bound, in lower half of IOM recommended range, in upper half of IOM range, 1-9 pounds above IOM range, >10 pounds above IOM upper bound</i></p> <p><i>Collected from:</i></p> <ul style="list-style-type: none"> • Self-reported <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> • Self-reported 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> • NA <p>Other infant outcomes</p> <ul style="list-style-type: none"> • NA 	<p>Outcomes Description: Macrosomia (>4500g)</p> <p>Groups Maternal weight gain categories stratified by pregravid BMI (IOM underweight, normal weight, overweight, and obese) and race (non-Hispanic white, non-Hispanic black, and Hispanic):</p> <p>G1: > = 10 lbs below IOM G2: 1-9 lbs below IOM G3: Lower half of IOM G4: Upper half of IOM G5: 1-9 lbs above IOM G6 > = 10lbs above IOM</p> <p>Results Within every BMI-race ethnicity stratum, the odds of delivering a > 4500g infant tended to increase as weight gain increased. This trend was statistically significant for all strata; however, the trend diminished with decreasing BMI. Women in G6 were 2.2–10.8 times more likely to deliver a > 4500 g infant compared to women in G3, irrespective of BMI status.</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> • Age • Height • Education • Trimester of the Special Supplemental Nutrition Program for Women, Infants, and Children <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Thorsdottir et al., 2002</p> <p>Country and setting: Maternity records, Department of Obstetrics and Gynecology at Landspítali University Hospital, Iceland</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: To investigate relation between gestational weight gain in women of normal prepregnant weight and complications during pregnancy and delivery in a population with high gestational weight gain and birth weight</p> <p>Time frame: NR</p> <p>Duration of the study: 1998</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 614</p> <p>Group Description:</p> <p>G1: No complication G2: Complications in pregnancy or delivery G3: Complications in pregnancy G4: Complications in delivery</p> <p>Group N:</p> <p>G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women of normal prepregnancy weight randomly selected within 1 year (1998) • No history of diabetes, hypertension, CVD, or thyroid problems • Singleton births • 38 to 43 weeks gestation • 20 to 40 years of age • Routine fetal biometry at 18 to 20 week ultrasound • Received early and regular antenatal care <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 63.1 (6.2) G2: 62.0 (5.6) <i>P</i> = 0.059 G3: 61.7 (4.8) <i>P</i> = 0.174 G4: 62.2 (6.1) <i>P</i> = 0.274</p> <p>Pregravid BMI:</p> <p>G1: 22.2 G2: 22.4 (1.6) <i>P</i> = 0.270 G3: 22.4 (1.5) <i>P</i> = 0.338 G4: 22.3 <i>P</i> = 0.584</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs):</p> <p>G1: 29 G2: 29 <i>P</i> = 0.857 G3: 29 <i>P</i> = 0.404 G4: 29 <i>P</i> = 0.398</p> <p>Parity: NR</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Proportional weight gain, %: G1: 26.0 G2: 28.0 <i>P</i> = 0.018 G3: 30.0 <i>P</i> = 0.005 G4: 27.0 <i>P</i> = 0.546</p> <p>Additional characteristics: NR</p>

Evidence Table 44. Gestational weight gain with reference to IOM recommendations and macrosomia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 452 G2: 162 G3: 56 G4: 106</p> <p>Total weight gain: G1: 16.6 (4.9) G2: 17.4 (5.1) <i>P</i> = 0.080 G3: 18.4 (5.1) <i>P</i> = 0.013 G4: 16.9 (5.1) <i>P</i> = 0.887</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM < 11.5, 11.-16.0, ≥ 16.1, also quintiles < 12.5, 12.5-15.5, 15.6-17.8, 17.9-20.8, > 20.8 <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3789 (469) G2: 3749 (565) <i>P</i> = 0.389 G3: 3643 (526) <i>P</i> = 0.032 G4: 3806 (578) <i>P</i> = 0.529</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Birthweight > 4500g</p> <p>Groups: Maternal weight gain categories:</p> <p>G1: < 11.5 kg G2: 11.5-16.0 kg G3: 16.1-20.0 kg G4: > 20.0 kg</p> <p>G5: 12.5-15.5kg G6: > 17.8-20.8 kg</p> <p>Results: Birth weight > 4500g, % G1: 4.3 G2: 4.1 (<i>P</i>< 0.05 between groups) G3: 9.1 (<i>P</i>< 0.05 between groups) G4: 10.2 (<i>P</i>< 0.05 between groups) <i>P</i> for trend< 0.015</p> <p>RR (95%CI) for > 4500g: G5: 1.00 (reference) G6: 3.54 (1.26-9.97)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Height <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Birth weight 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Fair</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bianco et al., 1998</p> <p>Country and setting: Mount Sinai Medical Center, New York City</p> <p>Enrollment period:</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy outcomes between morbidly obese and nonobese women and to determine effect of gestational weight gain on pregnancy outcome in morbidly obese women</p> <p>Time frame: NR</p> <p>Duration of the study: 1988 to 1995</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 613 morbidly obese 11,313 nonobese</p> <p>Group Description: G1: Obese G2: Controls</p> <p>Group N: G1: 613 G2: 11,313</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton pregnancy • Age 20 to 34 years <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiple gestations • Extremes of age • BMI between 27 and 34 • Missing height • Missing prepregnancy weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 104.7 (16.2) G2: 58.8 (7.1) (<i>P</i> < 0.05)</p> <p>Pregravid BMI:</p> <ul style="list-style-type: none"> • NR <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • NHANES II reference for women 20 to 29 <p>Age (mean, yrs): G1: 27.5 G2: 28.7 (<i>P</i> = NS)</p> <p>Parity: % multiparous: G1: 66.7% G2: 44.8% (<i>P</i> < 0.01)</p>	<p>Race, %: White G1: 17.7% G2: 57.3% (<i>P</i> < 0.01)</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: G1: 14.2% G2: 4.3% (<i>P</i> < 0.01)</p> <p>Hypertension, %: G1: 5.4% G2: 0.3% (<i>P</i> < 0.01)</p> <p>Additional characteristics: % college education: G1: 37.1% G2: 63.1% (<i>P</i> < 0.01)</p> <p>Preexisting diabetes: G1: 7.3% G2: 1.6% (<i>P</i> < 0.01)</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 613 G2: 11,313</p> <p>Total weight gain: G1: 20 (16.2) G2: 31.4 (11.5)</p> <p>Categorized: Only calculated for morbidly obese: 0 or weight loss, 1-15 lbs, 16-25 lbs, 26-35 lbs, >35 lbs</p> <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Not stated - from medical records 	<p>Birth weight: G1: 3352 (598) G2: 3269 (532) ($P < 0.05$)</p> <p>Gestational diabetes, %: G1: 14.2% G2: 4.3% ($P < 0.01$)</p> <p>Cesarean delivery, %: G1: 31.3% G2: 15.9%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> Preeclampsia Placental abruption Meconium Failure to progress Shoulder dystocia Postpartum hemorrhage Endomyometritis Wound infections <p>Other infant outcomes</p> <ul style="list-style-type: none"> Fetal growth restriction Preterm delivery Fetal demise Fetal distress 	<p>Outcomes Description: SGA (%)</p> <p>Groups G1: Weight loss or 0 lbs G2: 1-15 lbs G3: 16-25 lbs G4: 26-35 lbs G5: >35 lbs</p> <p>Results G1: 4 G2: 3.9 G3: 5.6 G4: 3.1 G5: 3.8</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Caulfield et al., 1998</p> <p>Country and setting: USA, hospital obstetric database</p> <p>Enrollment Period: 1987 to 1989</p> <p>Funding: NR</p> <p>Study Objective: To examine relation between gestational weight gain and risk of delivering a small for gestational age and large for gestational age infant by race</p> <p>Time frame: 1987-1989</p> <p>Duration of the study: Entry into pn care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 3,870</p> <p>Group Description:</p> <p>G1: BMI < 19.8 Black G2: BMI < 19.8 White G3: BMI 19.8 to 26.0 Black G4: BMI 19.8 to 26.0 White G5: BMI > 26.0 Black G6: BMI > 26.0 White</p> <p>Group N:</p> <p>G1: 523 G2: 267 G3: 1,479 G4: 796 G5: 615 G6: 190</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton pregnancies White or black ethnicity At least 28 weeks' gestation One delivery per woman (randomly chosen) Information on anthropometric data <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Improbable data Non-black or non-white ethnicity 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 13.3 (5.7) G2: 14.6 (5.1) G3: 13.6 (6.7) G4: 15.3 (5.4) G5: 12.4 (7.7) G6: 14.5 (7.3)</p> <p>Pregravid BMI:</p> <p>G1: 18.4 (1.0) G2: 18.5 (1.0) G3: 22.7 (1.8) G4: 22.1 (1.8)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: 21.7 (4.8) G2: 27.1 (6.6) G3: 22.7 (5.3) G4: 29.8 (5.8) G5: 24.9 (6.0) G6: 28.2 (5.5)</p> <p>Parity:</p> <p>G1: % primiparous: 52.4 G2: 55.4 G3: 50.1 G4: 48.0 G5: 36.9 G6: 46.9</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 32.8 G2: 20.6 G3: 35.4 G4: 20.0 G5: 28.8 G6: 25.4</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %:</p> <p>G1: 4.3 G2: 3.0 G3: 6.0 G4: 5.7 G5: 11.9 G6: 17.0</p> <p>Additional characteristics: NR</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: 13.3 (5.7) G2: 14.6 (5.1) G3: 13.6 (6.7) G4: 15.3 (5.4) G5: 12.4 (7.7) G6: 14.5 (7.3)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between selfreport prepregnancy weight and last recorded weight 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> AOR for SGA (95% CI) <p>Groups: G1: Underweight, BMI < 19.8 G2: Normal weight, BMI 19.8-26.0 G3: Overweight, BMI > 26.0</p> <p>Black women: G4: No weight gain < IOM G5: No weight gain > IOM</p> <p>White women: G6: No weight gain < IOM G7: No weight gain > IOM</p> <p>Results: AOR (95%CI) for SGA and Rate of weight gain (per 50 g/wk): G1: 0.87 (0.78-0.97) G2: 0.90 (0.84-0.96) G3: 0.93 (0.86-1.01)</p> <p>Expected Absolute Change (as % of baseline) in Incidence of SGA associated with modifiable risk factors (G4-G7): G4: -1.17 (-16) G5: +0.97 (+13) G6: -0.44 (-11)</p> <p>G7: +0.60 (+15) Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Height Hypertension Provider type Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Female infant</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 6 Good, 3 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
Author, year: Devader et al., 2007	Design: <ul style="list-style-type: none"> Cohort Retrospective 	Pregravid weight: <ul style="list-style-type: none"> Routine pre-natal care If missing, obtained from mother during postpartum hospital stay 	Race, %: White G1: 79.7 G2: 85.6 G3: 85.2
Country and setting: United States, birth certificate data	Total Study N: 94,696	Pregravid BMI: NR	Black G1: 15.7 G2: 10.8 G3: 12.1
Enrollment period: 1999 to 2001	Group Description: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs	Imputed: <ul style="list-style-type: none"> No 	Hispanic NR
Funding: NR	Group N: G1: 16,852 G2: 37,292 G3: 40,552	Categorized: NR	Asian/Pacific Islander NR
Study Objective: To investigate relationship between gestational weight gain and adverse pregnancy outcomes among women with normal prepregnancy BMI	Inclusion criteria: <ul style="list-style-type: none"> All mothers with normal prepregnancy BMI (19.8 –26.0 kg/m²) who were 18 to 35 years of age at time of delivery and who delivered full-term (37 weeks or more) singleton infant during period January 1, 1999, to December 31, 2001 	Age (mean, yrs): G1: Maternal age (y) 18 to 24*: 42.3% 25 to 30: 36.2% 31 to 35: 21.5% G2: Maternal age (y) 18 to 24*: 36.7% 25 to 30: 39.5% 31 to 35: 23.8% G3: Maternal age (y) 18 to 24*: 44.7% 25 to 30: 35.9% 31 to 35: 19.4%	Other G1: 4.6 G2: 3.5 G3: 2.7
Time frame: 1999 to 2001	Exclusion criteria: <ul style="list-style-type: none"> Women aged younger than 18 years and older than 35 years Non-Missouri residents Preterm deliveries Multiple gestations 	Parity: NR	Smoking, %: G1: 20.5 G2: 14.9 G3: 17.4
Duration of the study: Entry into prenatal care through delivery			Diabetes mellitus, %: NR Hypertension, %: NR Additional characteristics: NR

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: NR</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: NR</p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Figures 1 to 3 plot risk for each adverse pregnancy outcome by 10-lb increments in gestational weight gain. Women who gained 25 to 34 lbs during their pregnancy had lower risks for most outcomes when balancing risk for SGA status and other adverse pregnancy outcomes Women who gained 15 to 24 lbs had lowest risks for most outcomes, but increased their risk of having an SGA infant from 9.6% to 14.3% Women who gained more than 34 lbs had higher risks for all outcomes, although their risk of having an SGA infant decreased from 9.6% to 6.6% 	<p>Outcomes Description: AOR for SGA for Women With Normal Prepregnancy BMI (19.8 –26.0 kg/m²) by GWG Category, Missouri Birth Certificates, 1999–2001 (95%CI)</p> <p>Groups: G1: Gained less than 25 lbs G2: Gained 25 to 35 lbs G3: Gained more than 35 lbs</p> <p>Results: G1: 2.14 (2.01–2.27) G2: 1.0 G3: 0.48 (0.45–0.50)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Education Income Alcohol use Height Prior pregnancy Inadequate prenatal care use Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Child's gender Birth year 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Devader et al., 2007
(combined)

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	Other infant outcomes: NR		

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Edwards et al., 1996</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 1997-1993</p> <p>Funding: NR</p> <p>Study Objective: To compare pregnancy course and outcomes in obese and normal weight women and their associations with gestational weight change</p> <p>Time frame: 1997-1993</p> <p>Duration of the study: 1997-1993</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 1,443</p> <p>Group Description: G1: Obese G2: Normal Weight G3: total sample</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women and normal weight women identified from pregnancy and delivery summary records (normal weight matched to obese by race, age, parity) Singleton deliveries Live births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 103.5 G2: 61</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelinesobese (> 29) and normal weight (BMI 19.8-26.0) <p>Age (mean, yrs): G1: 27.1 G2: 25.4</p> <p>Parity: NR</p>	<p>Race, %: White G1: NR G2: NR G3: 69.0 (Total sample)</p> <p>Black G1: NR G2: NR G3: 21.0 (Total sample)</p> <p>Hispanic G1: NR G2: NR G3: 7.0 (Total sample)</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: NR G2: NR G3: 4.0 (Total sample)</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
Groups (N): G1: 683 G2: 660 Total weight gain: G1: 9.5 G2: 14.5 $P \leq 0.001$ Categorized: <ul style="list-style-type: none"> According to IOM Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	Birth weight: G1: 3420 G2: 3285 $P \leq 0.001$ Gestational diabetes, %: NR Cesarean delivery, %: G1: 25.6 G2: 9.1 $P < 0.001$ Instrumental delivery, %: Episiotomy, %: Other maternal outcomes: NA Other infant outcomes: NA	Outcomes Description: <ul style="list-style-type: none"> SGA Groups: Maternal weight gain categories (kg) Obese > 29: G1: Lost weight/no change G2: 0.5-6.5 G3: 7-11.5 G4: 12-16 G5: > 16 Normal BMI 19.8-26 G6: < 11.5kg G7: 11.5-16 G8: > 16kg Results: % SGA for Obese G1: 10.7% G2: 6.6% G3: 6.0% G4: 4.0% G5: 5.3% $P = 0.11$ For Normal weight G6: 15.9% G7: 7.5% G8: 5.7% $P = 0.001$ AOR (95%CI) Obese G1 vs G3 2.9 (1.1, 8.4) Normal weight G6 vs G7 1.7 (0.9,3.4) Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> Age Parity Pre-gravid BMI GDM Pregnancy induced hypertension Prenatal adequacy Alcohol use Drug use Smoking Infant and child confounders and effect modifiers accounted for in analysis: Gestational age	Background: Good Sample selection: Fair Definition of maternal weight gain: Fair Definition of outcomes: Fair Source of information on exposure, outcomes, and confounders: Fair Followup: Fair Analysis comparability: Good Analysis of outcomes: Fair Interpretation: Good Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor Final Quality Score: Fair

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hellerstedt et al., 1997</p> <p>Country and setting: United States, medical center</p> <p>Enrollment Period: 1977-1993</p> <p>Funding: NR</p> <p>Study Objective: To examine association between infant birth outcomes and maternal pregravid obesity, gestational weight gain, and prenatal smoking</p> <p>Time frame: 1977 to 1993</p> <p>Duration of the study: Entry into prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 1,343</p> <p>Group Description: G1: Obese G2: Normal weight</p> <p>Group N: G1: 683 G2: 660</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese and normal-weight women delivering singleton during study period <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing data Siblings Fetal deaths 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 103.5 kg (13.7) G2: 61.1kg (5.9)</p> <p>Pregravid BMI: G1: 38.3 (4.6) G2: 22.8 (1.6)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: NR</p> <ul style="list-style-type: none"> 16-34 years: 91% ≥ 35 years: 8.8% <p>G2: NR</p> <ul style="list-style-type: none"> 16-34 years: 93.5% ≥ 35 years: 5.8% <p>Parity: G1: NR</p> <ul style="list-style-type: none"> 0: 31.8% 1-3: 64.7% ≥ 4: 3.5% <p>G2: NR</p> <ul style="list-style-type: none"> 0: 33.3% 1-3: 64.9% ≥ 4: 1.8% 	<p>Race, %: White G1: 68.8 G2: 69.1</p> <p>Black G1: 20.4 G2: 20.6</p> <p>Hispanic G1: 6.6 G2: 6.5</p> <p>Asian/Pacific Islander G1: Native Am: 3.8 G2: Native Am: 3.2</p> <p>Other NR</p> <p>Smoking, %: G1: 26.4 G2: 26.2</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: SGA (%)</p> <p>Groups Maternal weight gain categories stratified by pregravid BMI and smoking status:</p> <p>Obese (BMI > 29.0): G1: Smokers, < IOM G2: Smokers, within IOM G3: Smokers, > IOM</p> <p>G4: Nonsmokers, < IOM G5: Nonsmokers, within IOM G6: Nonsmokers, > IOM</p> <p>Normal weight (BMI 19.8-26.0): G7: Smokers, < IOM G8: Smokers, within IOM G9: Smokers, > IOM</p> <p>G10: Nonsmokers, < IOM G11: Nonsmokers, within IOM G12: Nonsmokers, > IOM</p> <p>Obese: G13: Lost/no gain G14: 0.5-6.5 kg G15: 7-11.5 kg G16: 12-16 kg G17: > 16 kg</p> <p>Normal weight: G18: < 11.5kg G19: 11.5-16kg G20: > 16kg</p> <p>Results Frequencies of SGA, %: G1: 13.3 G2: 10.0 G3: 7.7 G4: 5.5 G5: 4.7 G6: 3.6 G7: 28.6 G8: 10.9 G9: 3.6 G10: 8.9 G11: 6.5 G12: 6.4</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Hellerstedt et al., 1997
(continued)

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		G13: 10.7 G14: 6.6 G15: 6.0 G16: 4.0 G17: 5.3 P = 0.115 for G13-G17	
		G18: 15.9 G19: 7.5 G20: 5.7 P = 0.001 for G18-G20	
		For obese women, compared to nonsmokers who gained 7-11.5kg, smokers who gained < 7kg were at significantly higher risk of SGA OR: 3.2 (95%CI: 1.1-10.1)	
		For normal weight women, compared to nonsmokers who gained	
		Maternal confounders and effect modifiers accounted for in analysis: Maternal age, pregravid BMI, infant sex, race, parity, prenatal alcohol use, prenatal illicit drug use, adequacy of prenatal care, gestational hypertension, GDM	
		Infant and child confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> • Gestational age 	

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Kiel et al., 2007</p> <p>Country and setting: United States, birth registry</p> <p>Enrollment period: 1990 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine effect of gestational weight change on pregnancy outcomes in obese women</p> <p>Time frame: 1990 to 2001</p> <p>Duration of the study: Entry into prenatal care through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 120,170</p> <p>Group Description:</p> <p>G1: Obese Class I (BMI 30–34.9) (n = 70,536)</p> <p>G2: Obese Class II (BMI 35–39.9) (n = 30,609)</p> <p>G3: Obese Class III (BMI 40 and More) (n = 19,025)</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Obese women residing in Missouri who delivered (at 37 or more weeks of gestation) liveborn, singleton infants during 1990–2001 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: Total: Class I obese: 59% Class II obese: 25% Class III obese: 16%</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> NIH guidelines <p>Age (mean, yrs):</p> <p>G1: <26: 46% 26-35: 47% Older than 35: 8%</p> <p>G2: <26: 44% 26-35: 48% Older than 35: 8%</p> <p>G3: <26: 40% 26-35: 52% Older than 35: 9%</p> <p>Parity: Nulliparous: G1: 34% G2: 33% G3: 32%</p>	<p>Race, %: White G1: 78 G2: 77 G3: 73</p> <p>Black G1: 22 G2: 23 G3: 27</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 22</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: GWG (lb) Less than 2: 3% 2 to 14: 15% 15 to 25: 26% More than 25: 56% G2: GWG (lb) Less than 2: 8% 2 to 14: 22% 15 to 25: 27% More than 25: 43% G3: GWG (lb) Less than 2: 15%</p> <p>Categorized:</p> <ul style="list-style-type: none"> 10-lb or less loss 2 to 9 lbs loss, no weight change, 2 to 9 lbs gain, 10 to 14 lbs gain, 15–25 lb gain, 26–35 lb gain, and greater than 35 lb gain <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: G1: SGA: 7% LGA: 13% (<i>P</i> < 0.05) G2: SGA: 7% LGA: 16% (<i>P</i> < 0.05) G3: SGA: 6% LGA: 18% (<i>P</i> < 0.05)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 28 G2: 34 G3: 41</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p>	<p>Outcomes Description: Absolute risk and OR (95% CI) of pregnancy outcomes for various classes of obese women (class I, II, III)</p> <p>Groups: Maternal weight gain categories stratified by prepregnancy obesity status, Obese Class I (BMI 30–34.9), Obese Class II (BMI 35–39.9), Obese Class III (> = BMI 40): G1: < = -10lbs G2: -2 to -9 lbs G3: No change G4: 2-9 lbs G5: 10-14 lbs G6: 15-25lbs G7: 26-35lbs G8: > 35 lbs</p> <p>Result: For Obese Class I: AOR (95% CI) for SGA were significantly greater (> 1.00, G6 was reference) for G1- G5 and significantly lower for G7-G8. For Obese Class II: AOR (95% CI) for SGA were significantly greater (> 1.00, G6 was reference) for G1- G5 and significantly lower for G7-G8 For Obese Class III: AOR (95% CI) for SGA were significantly greater (> 1.00, G6 was reference) for G1 and G3 and significantly lower for G7-G8</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Education Poverty (enrollment in Medicaid, WIC, food stamp programs) Tobacco use Chronic hypertension <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 6 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Nielsen et al., 2006</p> <p>Country and setting: USA, clinic</p> <p>Enrollment Period: 1990 to 2000</p> <p>Funding: NR</p> <p>Study Objective: To examine whether such weight gains improve birth outcomes in a cohort of disadvantaged African American adolescents</p> <p>Time frame: 1990 to 2000</p> <p>Duration of the study: First prenatal care visit to delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 815</p> <p>Group Description:</p> <p>G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI > 26.0</p> <p>Group N:</p> <p>G1: 193 G2: 431 G3: 191</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Adolescents ≤ 17 years at conception African American pregnancies <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: 18.3 (1.1) G2: 22.4 (1.6) G3: 30.9 (4.6)</p> <p>Imputed:</p> <ul style="list-style-type: none"> Yes <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: mean age at infant birth (SD): 16.9 (1.2) G2: 16.8 (1.1) G3: 17.0 (1.1)</p> <p>Parity:</p> <p>% primiparous:</p> <p>G1: 83.9 G2: 85.2 G3: 74.9</p>	<p>Race, %:</p> <p>White NR</p> <p>Black G1: 100 G2: 100 G3: 100</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 11.4 G2: 9.7 G3: 10.5</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 193 G2: 431 G3: 191</p> <p>Total weight gain: G1: < IOM: 30.3%; lower half of IOM: 18.1%; upper half of IOM: 21.9%; > IOM: 29.7% G2: < IOM: 31.3%; lower half of IOM: 16.1%; upper half of IOM: 17.6%; > IOM: 35.0% G3: < IOM: 16.5%; lower half of IOM: 9.4%; upper half of IOM: 10.6%; > IOM: 63.5</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine pre-natal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between final recorded weight within 4 weeks delivery and self-reported prepregnancy weight </p>	<p>Birth weight: G1: 2899 (595) G2: 3083 (645) <i>P</i> < 0.005 compared to BMI < 19.8 G3: 3181 (673) <i>P</i> < 0.005 compared to BMI < 19.8</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Size for gestational age (small, average, large) Birth weight category (suboptimal < 3000g, optimal 3000-4000g, above optimal > 4000g) 	<p>Outcomes Description:</p> <ul style="list-style-type: none"> SGA <p>Groups: G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI > 26.0</p> <p>G4: < IOM recommendation G5: Lower half of IOM recommendation G6: Upper half of IOM recommendation G7: > IOM recommendation</p> <p>Results: SGA, %: G1: 22.3 G2: 15.6 G3: 11.5 <i>P</i> < 0.01 for G1-G3</p> <p>AOR (95%CI) for SGA: G4: 2.31 (1.22-4.37) G5: 1.00 (reference) G6: 0.88 (0.41-1.89) G7: 0.68 (0.34-1.35) <i>P</i> < 0.01 for G4-G7</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Parity Pre-gravid BMI Pre-eclampsiatime between last weight measure and delivery Height Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: Infant sex</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Good</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 6 Good, 3 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Parker and Abrams, 1992</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: Sept 1980 to Dec 1988</p> <p>Funding: UC Committee on Research & MCH and Resources Development, Health Resources and Services Administration</p> <p>Study Objective: To test whether gains outside IOM reference ranges were associated with increased risks of suboptimal pregnancy outcome (SGA, LGA, cesarean delivery) and to determine whether locally developed ranges were more applicable to study population</p> <p>Time frame: Sept 1980 to Dec 1988</p> <p>Duration of the study: From entry into prenatal care until delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 6,690</p> <p>Group Description: G1: Overall G2: NR</p> <p>Group N: G1: 6,690 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Consecutive live singleton births at Moffitt Hospital between September 1980 and December 1988 with gestational ages of 37 to 42 weeks <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Maternal transfers or transports and deliveries complicated by fetal malformations, maternal diabetes, or maternal hypertension 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 56.8 kg(SD 11.0) G2: NR</p> <p>Pregravid BMI: G1: Underweight: 27.7%, Normal weight 61.8%, Overweight: 5.6%, Obese 4.9% G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 27.7 (5.5) G2: NR</p> <p>Parity: Primiparous: G1: 58.8% G2: NR</p>	<p>Race, %: White G1: 44.0 G2: NR</p> <p>Black G1: 8.3 G2: NR</p> <p>Hispanic G1: 9.4 G2: NR</p> <p>Asian/Pacific Islander G1: 21.4 G2: NR</p> <p>Other G1: 12.0 G2: NR</p> <p>Smoking, %: G1: 12.0 G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 6690 G2: NR</p> <p>Total weight gain: G1: 15.2kg (5.2) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM %: Weight gain ranges based on percentiles from previous study of UC population with good pregnancy outcomes: 25th - 75th, 10-90th percentiles. For 25-75th, weight gain range = 12-17kg for underweight women (BMI < 19.8); <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3408g (462) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> SGA <p>Groups: G1: < IOM range G2: Within IOM range G3: > IOM</p> <p>Results: AOR (95% CI) for SGA: G1: 1.78 (1.39-2.27) G2: 1.00 (reference)</p> <p>Incidence of SGA in nonobese women, %: G1: 3.25 G2: 6.14 G3: 13.11</p> <p>Incidence of SGA in obese women, %: G1: 11.76 G2: 3.09</p> <p>AOR of SGA and low weight gain UCSF 25-75 2.06 (1.62-2.63) UCSF 10-90 1.82 (1.35-2.47) IOM 1.78 (1.39-2.27)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Height Maternal high and low weight gain Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age <p>Birth weight</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stevens-Simon and McAnarney, 1992</p> <p>Country and setting: USA, adolescent maternity program</p> <p>Enrollment Period: 1986 to 1989</p> <p>Funding: Grant from Bureau of Maternal and Child Health</p> <p>Study Objective: To clarify advantages and disadvantages of large gestational weight gain among pregnant adolescents</p> <p>Time frame: 1986 to 1989</p> <p>Duration of the study: Entry into prenatal care through 6 weeks PP check up</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 141 (107 included in postpartum analyses)</p> <p>Group Description: G1: Slow gainers G2: Average gainers G3: Rapid gainers</p> <p>Group N: G1: 28 G2: 66 G3: 47</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Consecutively enrolled poor, black, 12-19 year olds Prenatal care prior to 2third week gestation No chronic disease No regular medications No known uterine anomalies Live birth Singletons <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 58.6 (11.1) G2: 160.9 (7.0) G3: 163.9 (5.5)</p> <p>Pregravid BMI: G1: 23.1 (3.5) G2: 23.5 (4.4) G3: 23.5 (4.2)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 16.9 G2: 16.6 G3: 16.2</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28 G2: 66 G3: 47</p> <p>Total weight gain: G1: 7.7 (average rate 0.2 kg/wk) G2: 12.4 (average rate 0.3 kg/wk) G3: 19.8 (average rate 0.5 kg/wk)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM slow gain: < 0.23kg/wk; average gain: 0.23-0.4kg/week; rapid gain: > 0.4kg/week <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 2745 (694) G2: 3097 (457) G3: 3351 (482) <i>P</i> < 0.0001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Distribution of SGA, %:</p> <p>Groups Maternal weight gain categories (kg/wk): G1: < 0.23 G2: 0.23-0.40 G3: > 0.40</p> <p>Results G1: 7.1 G2: 9.1 G3: 2.1 <i>P</i> = NS</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stotland et al., 2006</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: 1980 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine relationship between gestational weight gain and adverse neonatal outcomes among infants born at term (37 weeks or more)</p> <p>Time frame: 1980 to 2001</p> <p>Duration of the study: Entry into PN care up till delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 20465</p> <p>Group Description:</p> <p>G1: Gain below IOM recommendations</p> <p>G2: Gain within IOM recommendations</p> <p>G3: Gain above IOM recommendations</p> <p>Group N:</p> <p>G1: 4,114</p> <p>G2: 7,490</p> <p>G3: 8,861</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Pregnancies complicated by multiple gestations, congenital anomalies, chronic hypertension, gestational or pregestational diabetes Birth before 37 weeks Maternal transport Missing data on any of variables considered in multivariable analysis 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: < 19.8: 25.8%</p> <p>19.8-26.0: 19.4%</p> <p>26.1-29.0: 9.2%</p> <p>> 29.0: 20.6%</p> <p>G2: < 19.8: 49.1%</p> <p>19.8-26.0: 34.8%</p> <p>26.1-29.0: 23.3%</p> <p>> 29.0: 25.5%</p> <p>G3: < 19.8: 25.0%</p> <p>19.8-26.0: 45.8%</p> <p>26.1-29.0: 67.5%</p> <p>> 29.0: 53.9%</p> <p>$P < 0.001$</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: < 20 years: 23.4%</p> <p>20-29 years: 19.3%</p> <p>30-39 years: 19.9%</p> <p>> 40 years: 25.3%</p> <p>G2: < 20 years: 31.3%</p> <p>20-29 years: 36.6%</p> <p>30-39 years: 37.6%</p> <p>> 40 years: 36.3%</p> <p>G3: < 20 years: 45.4%</p> <p>20-29 years: 44.0%</p> <p>30-39 years: 42.5%</p> <p>> 40 years: 38.4%</p> <p>$P < 0.001$</p> <p>Parity:</p> <p>% Nulliparous:</p> <p>G1: 17.3</p> <p>G2: 36.2</p> <p>G3: 46.6</p> <p>$P < 0.001$</p>	<p>Race, %:</p> <p>White</p> <p>G1: 16.2</p> <p>G2: 35.8</p> <p>G3: 48.0</p> <p>Black</p> <p>G1: 25.5</p> <p>G2: 29.4</p> <p>G3: 45.1</p> <p>Hispanic</p> <p>G1: 19.2</p> <p>G2: 34.8</p> <p>G3: 46.0</p> <p>Asian/Pacific Islander</p> <p>G1: 24.3</p> <p>G2: 43.3</p> <p>G3: 32.4</p> <p>Other</p> <p>G1: 21.7</p> <p>G2: 37.9</p> <p>G3: 40.4</p> <p>P for all race categories < 0.001</p> <p>Smoking, %:</p> <p>G1: 23.5</p> <p>G2: 30.8</p> <p>G3: 45.8 $P < 0.001$</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 45. Gestational weight gain with reference to IOM recommendations and small-for-gestational age (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 4114 G2: 7490 G3: 8861</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM percentiles and dichotomous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: %SGA: 36.1; %AGA: 20.2; %LGA: 8.5 G2: %SGA: 39.4; %AGA: 37.5; %LGA: 26.5 G3: %SGA: 24.5; %AGA: 42.4; %LGA: 65.1 <i>P</i> < 0.001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 14.7 G2: 32.1 G3: 53.2</p> <p>Instrumental delivery, %: Operative vaginal delivery: G1: 18.0% G2: 37.5% G3: 44.5%</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Birth trauma 5 min Apgar score less than 7 , Assisted ventilation SGA LGA NICU admission SCN admission Neonatal infection Seizure Hypoglycemia Polycythemia MAS RDS Tachypnea Hospital stay > 5 days Hospital stay > 10 days 	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Risk of adverse neonatal outcomes by gestational weight gain by IOM guidelines, adjusted ORs compared to women with GWG within IOM guidelines and risk of adverse neonatal outcomes by extremes of GWG compared to women with weight gain 11.5-16.0kg <p>Groups: G1: < IOM G2: Within IOM G3: > IOM G4: < 7kg G5: > 18kg</p> <p>Results: Unadjusted Rates of SGA: G1: 11.74 <i>P</i> < 0.001 vs. G2 G2: 7.05 G3: 3.70 <i>P</i> < 0.001 vs. G2 G4: 13.99 <i>P</i> < 0.05 vs. G2 G5: 3.87 <i>P</i> < 0.05 vs. G2</p> <p>AOR (95% CI) for SGA: G1: 1.66 (1.44-1.92) G2: 1.00 (reference) G3: 0.51 (0.44-0.59) G4: 2.26 (1.76-2.90) G5: 0.50 (0.42-0.60)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Pregnancy induced hypertension Date of delivery Mode of delivery Length of first stage of labor Length of second stage of labor Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Birth weight 	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 46. Gestational weight gain with reference to IOM recommendations and Apgar scores

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Nixon et al., 1998</p> <p>Country and setting: USA, county nurse-midwifery services</p> <p>Enrollment Period: January 1991 to December 1994</p> <p>Funding: American College of Nurse Midwives</p> <p>Study Objective: To compare outcomes of term infants of average birth weight with outcomes of large infants using computer database</p> <p>Time frame: January 1991 to December 1994</p> <p>Duration of the study: First prenatal visit through birth collected retrospectively</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 2,228</p> <p>Group Description: G1: 2500 - 3999g G2: ≥ 4000g</p> <p>Group N: G1: 1906 G2: 322</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Gestational age ≥ 37 weeks Birth weight ≥ 2500g Live infant at onset of labor Birth occurred in hospital <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with gestational diabetes that required insulin therapy 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 138 (31) G2: 158 (36) ($P < 0.0001$)</p> <p>Pregravid BMI:</p> <p>G1: 24 (5) G2: 26 (5.8) ($P < 0.0001$)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous IOM guidelines <p>Age (mean, yrs): G1: 25 (6) G2: 27.5 (6) ($P < 0.0001$)</p> <p>Parity: % parous: G1: 56.3 G2: 69.9 ($P < 0.00001$)</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % shoulder dystocia: G1: 0.6 G2: 5.9 ($P < 0.001$)</p> <p>% NICU: G1: 4.3 G2: 6.6 ($P = ns$)</p>

Evidence Table 46. Gestational weight gain with reference to IOM recommendations and Apgar scores (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 1906 G2: 322</p> <p>Total weight gain: G1: 30.7+/-15 G2: 37.2+/-15 <i>(P < 0.0001)</i></p> <p>Categorized:</p> <ul style="list-style-type: none"> • <i>Continuous According to IOM</i> <p>Collected from:</p> <ul style="list-style-type: none"> • <i>Routine pre-natal care or maternity records</i> <p>Ascertained by:</p> <ul style="list-style-type: none"> • <i>Based on last clinically measured weight prior to delivery</i> 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> • Apgar scores 	<p>Outcomes Description: Apgar scores < 7</p> <p>Groups: NR</p> <p>Outcomes Set 2: Gestational weight gain not a predictor of Apgar scores < 7 (details NR)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 46. Gestational weight gain with reference to IOM recommendations and Apgar scores (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stevens-Simon and McAnarney, 1992</p> <p>Country and setting: USA, adolescent maternity program</p> <p>Enrollment Period: 1986 to 1989</p> <p>Funding: Grant from Bureau of Maternal and Child Health</p> <p>Study Objective: To clarify advantages and disadvantages of large gestational weight gain among pregnant adolescents</p> <p>Time frame: 1986 to 1989</p> <p>Duration of the study: Entry into prenatal care through 6 weeks PP check up</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 141 (107 included in postpartum analyses)</p> <p>Group Description: G1: Slow gainers G2: Average gainers G3: Rapid gainers</p> <p>Group N: G1: 28 G2: 66 G3: 47</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Consecutively enrolled poor, black, 12-19 year olds Prenatal care prior to 2third week gestation No chronic disease No regular medications No known uterine anomalies Live birth Singletons <p>Exclusion criteria:</p> <ul style="list-style-type: none"> NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 58.6 (11.1) G2: 160.9 (7.0) G3: 163.9 (5.5)</p> <p>Pregravid BMI: G1: 23.1 (3.5) G2: 23.5 (4.4) G3: 23.5 (4.2)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 16.9 G2: 16.6 G3: 16.2</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 46. Gestational weight gain with reference to IOM recommendations and Apgar scores (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28 G2: 66 G3: 47</p> <p>Total weight gain: G1: 7.7 (average rate 0.2 kg/wk) G2: 12.4 (average rate 0.3 kg/wk) G3: 19.8 (average rate 0.5 kg/wk)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM slow gain: < 0.23kg/wk; average gain: 0.23-0.4kg/week; rapid gain: > 0.4kg/week <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 2745 (694) G2: 3097 (457) G3: 3351 (482) <i>P</i> < 0.0001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Distribution of 1- and 5-minute Apgar scores, %:</p> <p>Groups Maternal weight gain categories (kg/wk): G1: < 0.23 G2: 0.23-0.40 G3: > 0.40</p> <p>Results Distribution of 1 minute Apgar score < = 4, %: G1: 25.0 G2: 4.5 G3: 14.9 <i>P</i> = 0.02 for G1 vs. G2 or G3</p> <p>Distribution of 5 minute Apgar score < = 4, %: G1: 3.5 G2: 0 G3: 0 <i>P</i> = NS</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 46. Gestational weight gain with reference to IOM recommendations and Apgar scores (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stotland et al., 2006</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: 1980 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine relationship between gestational weight gain and adverse neonatal outcomes among infants born at term (37 weeks or more)</p> <p>Time frame: 1980 to 2001</p> <p>Duration of the study: Entry into PN care up till delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 20465</p> <p>Group Description:</p> <p>G1: Gain below IOM recommendations</p> <p>G2: Gain within IOM recommendations</p> <p>G3: Gain above IOM recommendations</p> <p>Group N:</p> <p>G1: 4,114</p> <p>G2: 7,490</p> <p>G3: 8,861</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Pregnancies complicated by multiple gestations, congenital anomalies, chronic hypertension, gestational or pregestational diabetes Birth before 37 weeks Maternal transport Missing data on any of variables considered in multivariable analysis 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: < 19.8: 25.8%</p> <p>19.8-26.0: 19.4%</p> <p>26.1-29.0: 9.2%</p> <p>> 29.0: 20.6%</p> <p>G2: < 19.8: 49.1%</p> <p>19.8-26.0: 34.8%</p> <p>26.1-29.0: 23.3%</p> <p>> 29.0: 25.5%</p> <p>G3: < 19.8: 25.0%</p> <p>19.8-26.0: 45.8%</p> <p>26.1-29.0: 67.5%</p> <p>> 29.0: 53.9%</p> <p>$P < 0.001$</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: < 20 years: 23.4%</p> <p>20-29 years: 19.3%</p> <p>30-39 years: 19.9%</p> <p>> 40 years: 25.3%</p> <p>G2: < 20 years: 31.3%</p> <p>20-29 years: 36.6%</p> <p>30-39 years: 37.6%</p> <p>> 40 years: 36.3%</p> <p>G3: < 20 years: 45.4%</p> <p>20-29 years: 44.0%</p> <p>30-39 years: 42.5%</p> <p>> 40 years: 38.4%</p> <p>$P < 0.001$</p> <p>Parity:</p> <p>% Nulliparous:</p> <p>G1: 17.3</p> <p>G2: 36.2</p> <p>G3: 46.6</p> <p>$P < 0.001$</p>	<p>Race, %:</p> <p>White</p> <p>G1: 16.2</p> <p>G2: 35.8</p> <p>G3: 48.0</p> <p>Black</p> <p>G1: 25.5</p> <p>G2: 29.4</p> <p>G3: 45.1</p> <p>Hispanic</p> <p>G1: 19.2</p> <p>G2: 34.8</p> <p>G3: 46.0</p> <p>Asian/Pacific Islander</p> <p>G1: 24.3</p> <p>G2: 43.3</p> <p>G3: 32.4</p> <p>Other</p> <p>G1: 21.7</p> <p>G2: 37.9</p> <p>G3: 40.4</p> <p>P for all race categories < 0.001</p> <p>Smoking, %:</p> <p>G1: 23.5</p> <p>G2: 30.8</p> <p>G3: 45.8 $P < 0.001$</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 46. Gestational weight gain with reference to IOM recommendations and Apgar scores (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 4114 G2: 7490 G3: 8861</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM percentiles and dichotomous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: %SGA: 36.1; %AGA: 20.2; %LGA: 8.5 G2: %SGA: 39.4; %AGA: 37.5; %LGA: 26.5 G3: %SGA: 24.5; %AGA: 42.4; %LGA: 65.1 <i>P</i> < 0.001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 14.7 G2: 32.1 G3: 53.2</p> <p>Instrumental delivery, %: Operative vaginal delivery: G1: 18.0% G2: 37.5% G3: 44.5%</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Birth trauma 5 min Apgar score less than 7 , Assisted ventilation SGA LGA NICU admission SCN admission Neonatal infection Seizure Hypoglycemia Polycythemia MAS RDS Tachypnea Hospital stay > 5 days Hospital stay > 10 days 	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Risk of adverse neonatal outcomes by gestational weight gain by IOM guidelines, adjusted ORs compared to women with GWG within IOM guidelines and risk of adverse neonatal outcomes by extremes of GWG compared to women with weight gain 11.5-16.0kg <p>Groups: G1: < IOM G2: Within IOM G3: > IOM G4: < 7kg G5: > 18kg</p> <p>Results: Unadjusted Rates of 5 minute Apgar score < 7: G1: 1.94 G2: 1.58 G3: 2.14 (<i>P</i> < 0.05, G3 vs. G2) G4: 2.39 G5: 2.16 (<i>P</i> < 0.05, G5 vs. G2)</p> <p>AOR (95% CI) for 5 minute Apgar score < 7: G1: 1.18 (0.84-1.66) G2: 1.00 (reference) G3: 1.33 (1.01-1.76) G4: 1.29 (0.70-2.39) G5: 1.30 (0.95-1.77)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Pregnancy induced hypertension Date of delivery Mode of delivery Length of first stage of labor Length of second stage of labor Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age <p>Birth weight</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 47. Gestational weight gain with reference to IOM recommendations and perinatal mortality

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bracero and Byrne, 1997</p> <p>Country and setting: Hospital charts - Maimonides Medical Center, Brooklyn, NY</p> <p>Enrollment Period:</p> <p>Funding: NR</p> <p>Study Objective: To determine optimal weight gain in singleton pregnancy and evaluate current recommendations</p> <p>Time frame:</p> <p>Duration of the study: Jan 1, 1987 to Jan 1, 1993</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 20,971</p> <p>Group Description: G1: Total population G2: NR</p> <p>Group N: G1: 20,971 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Delivery at Maimonides Medical Center Singleton pregnancy No documentation of congenital anomaly, pregnancy was not terminated by abortion Documentation on chart of prepregnancy maternal weight, amount of maternal weight gain during pregnancy, and gender of infant <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Infants with any type of congenital anomaly (international classification of diseases (ICD-9-CM) codes 740.0-759.9 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: median BMI = 23.19 (range 14.46-40.07) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: % < 15 years: < 0.1; 15-19 yrs: 4.8; 20-24: 25.1; 25-29: 31.1; 30-34: 24.3; 35-39: 11.8; 40-44: 2.8; 45-49: 0.1; > 50: < 0.1 G2: NR</p> <p>Parity: % primigravida: G1: 25.1 G2: NR</p>	<p>Race, %: White G1: 92.1 G2: NR</p> <p>Black G1: 4.2 G2: NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander G1: 0.9 G2: NR</p> <p>Other G1: 2.1 G2: NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % married: G1: 12.4 G2: NR</p> <p>Additional characteristics: Type of service: G1: Ward, 22.5% Private: 77.5% G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 47. Gestational weight gain with reference to IOM recommendations and perinatal mortality (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: % weight gain: lost weight, 0.4; 1 to 5lbs, 0.9; 6 to 10, 2.3; 11 to 15, 5.4; 16 to 20, 12.0; 21 to 25, 17.2; 26 to 30, 21.1; 31 to 35, 14.8; 36 to 40, 11.5; 41 to 45, 6.1; ≥ 46, 8.3 G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM ordinal categories in 5 pound intervals <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: using last measurement obtained as an outpatient 	<p>Birth weight: G1: r = .210 correlation with maternal weight gain G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Optimal weight gain defined as 36 to 40 pounds for underweight women, 31 to 40 pounds for women of ideal prepregnancy weight, 26 to 30 pounds for overweight women</p> <p>Other infant outcomes: Adverse outcomes:</p> <ul style="list-style-type: none"> Still birth Neonatal death Preterm delivery/low birth weight Perinatal morbidity 	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Perinatal mortality and adverse perinatal outcome <p>Groups: Maternal weight gain in relation to IOM recommendations: G1: Under 17.6% G2: Within 56.9% G3: Over 25.5%</p> <p>Results: Adverse perinatal outcome % G1: 14.4 G2: 8.4 G3: 8.5 $P < 0.001$</p> <p>Birthweight < 2500 % G1: 10.1 G2: 3.3 G3: 2.5 $P < 0.001$</p> <p>Perinatal mortality % G1: 1.1 G2: 0.4 G3: 0.4 $P < 0.001$</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR G4: 0.7 $P = 0.298$ G5: 0.6 G6: 0.2 $P < 0.001$</p>	<p>Background: Fair</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 1 Good, 8 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 48. Gestational weight gain with reference to IOM recommendations and hypoglycemia

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hedderson et al., 2006</p> <p>Country and setting: USA, Kaiser Permanente Medical Care Program</p> <p>Enrollment Period: January 1, 1996 - June 31, 1998</p> <p>Funding: R01 DK 54834 from National Institute of Diabetes and Digestive and Kidney Diseases, grant from American Diabetes Association and Kaiser Community Benefit research support</p> <p>Study Objective: To examine whether pregnancy weight gains outside IOM recommendations and rates of maternal weight gain are associated with neonatal complications</p> <p>Time frame: January 1, 1996 to June 31, 1998</p> <p>Duration of the study: First prenatal care visit to 30 days post delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Case-control • Retrospective <p>Total Study N: 45,245</p> <p>Group Description: G1: Controls G2: Macrosomia G3: Hypoglycemia G4: Hyperbilirubinemia</p> <p>Group N: G1: 652 G2: 391 G3: 328 G4: 432</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton livebirth <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • No pregestational diabetes or history of gestational diabetes (screened at 24-28 weeks gestation - meeting National Diabetes Data Group criteria for GDM) 	<p>Pregavid weight:</p> <ul style="list-style-type: none"> • Self-reported in some cases used measured weight recorded in chart closes to woman's last menstrual period but no more than 12 months before her last menstrual period <p>Pregavid BMI: G1: < 19.8: 13.5% 19.8-24.9: 56.4% 25.0-29.0: 12.4% > 29.0: 17.6% G2: < 19.8: 5.1% 19.8-24.9: 51.2% 25.0-29.0: 16.6% > 29.0: 27.1% G3: < 19.8: 10.1% 19.8-24.9: 50.0% 25.0-29.0: 17.1% > 29.0: 22.9% G4: < 19.8: 13.9% 19.8-24.9: 57.9% 25.0-29.0: 13.2% > 29.0: 57.1%</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: < 25 years: 22.1% 25-29: 24.2% 30-34: 33.6% ≥ 35: 20.1% G2: < 25 years: 15.9% 25-29: 28.0% 30-34: 31.7% ≥ 35: 24.3% G3: < 25 years: 24.1% 25-29: 25.3% 30-34: 26.8% ≥ 35: 23.8% G4: < 25 years: 17.1% 25-29: 29.4% 30-34: 32.6% ≥ 35: 20.8%</p> <p>Parity: % primiparous: G1: 56.9 G2: 31.2 G3: 50.0 G4: 59.3</p>	<p>Race, %: White G1: 54.0 G2: 67.8 G3: 47.6 G4: 42.6</p> <p>Black G1: 10.0 G2: 5.1 G3: 11.3 G4: 4.4</p> <p>Hispanic G1: 17.2 G2: 15.1 G3: 20.4 G4: 15.5</p> <p>Asian/Pacific Islander G1: 8.1 G2: 3.6 G3: 6.7 G4: 20.1</p> <p>Other G1: 10.7 G2: 8.4 G3: 14.0 G4: 17.4</p> <p>Smoking, %: G1: %nonsmoking during pregnancy: 92.0; %smoked but quit: 4.2; %smoked 3.9 G2: %nonsmoking during pregnancy: 90.8; %smoked but quit: 5.3; %smoked 4.0 G3: %nonsmoking during pregnancy: 92.6; %smoked but quit: 1.5; %smoked 5.8 G4: %nonsmoking during pregnancy: 94.2; %smoked but quit: 4.9; %smoked 1.0</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Screening glucose value less than 140: G1: 85.0%: > 140: 15.0% G2: 81.6%: > 140: 18.4% G3: 81.4%: > 140: 18.6% G4: 83.3%: > 140: 16.7%</p>

Evidence Table 48. Gestational weight gain with reference to IOM recommendations and neonatal hypoglycemia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records rate of maternal weight gain was calculated as total pregnancy weight gain minus infant birth weight divided by weeks of gestation when last weight was measured; rate of maternal weight gain before the third trimester was calculated using the weight measured at or before the screening test for GDM (24-28 wks of gestation) minus prepregnancy weight divided by weeks of gestation <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between final recorded weight at last prenatal visit (within 2 weeks of delivery date) and prepregnancy weight 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> AOR for neonatal hypoglycemia (95% CI) <p>Groups:</p> <p>G1: Rate of maternal weight gain (kg/wk): -0.26-0.21</p> <p>G2: Rate of maternal weight gain (kg/wk): 0.22-0.31</p> <p>G3: Rate of maternal weight gain (kg/wk): 0.32-0.39</p> <p>G4: Rate of maternal weight gain (kg/wk): 0.40-1.03</p> <p>Results:</p> <p>G1: 0.87 (0.57-1.32)</p> <p>G2: 1.00</p> <p>G3: 0.74 (0.49-1.14)</p> <p>G4: 1.91 (1.33-2.82)</p> <p>Below IOM recommendations 0.91 (0.59-1.41)</p> <p>Within IOM recommendations 1.00</p> <p>Above IOM recommendations 1.39 (1.02-1.90)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Screening glucose value from 1 hour after 50g oral glucose challenge test Difference between age at delivery and gestational age at last weight measured <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 4 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 48. Gestational weight gain with reference to IOM recommendations and neonatal hypoglycemia (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stotland et al., 2006</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: 1980 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine relationship between gestational weight gain and adverse neonatal outcomes among infants born at term (37 weeks or more)</p> <p>Time frame: 1980 to 2001</p> <p>Duration of the study: Entry into PN care up till delivery</p> <p>Quality: Fair</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 20465</p> <p>Group Description:</p> <p>G1: Gain below IOM recommendations</p> <p>G2: Gain within IOM recommendations</p> <p>G3: Gain above IOM recommendations</p> <p>Group N:</p> <p>G1: 4,114</p> <p>G2: 7,490</p> <p>G3: 8,861</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Singleton <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Pregnancies complicated by multiple gestations, congenital anomalies, chronic hypertension, gestational or pregestational diabetes • Birth before 37 weeks • Maternal transport • Missing data on any of variables considered in multivariable analysis 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>G1: < 19.8: 25.8%</p> <p style="padding-left: 20px;">19.8-26.0: 19.4%</p> <p style="padding-left: 20px;">26.1-29.0: 9.2%</p> <p style="padding-left: 20px;">> 29.0: 20.6%</p> <p>G2: < 19.8: 49.1%</p> <p style="padding-left: 20px;">19.8-26.0: 34.8%</p> <p style="padding-left: 20px;">26.1-29.0: 23.3%</p> <p style="padding-left: 20px;">> 29.0: 25.5%</p> <p>G3: < 19.8: 25.0%</p> <p style="padding-left: 20px;">19.8-26.0: 45.8%</p> <p style="padding-left: 20px;">26.1-29.0: 67.5%</p> <p style="padding-left: 20px;">> 29.0: 53.9%</p> <p style="padding-left: 20px;"><i>P</i> < 0.001</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs):</p> <p>G1: < 20 years: 23.4%</p> <p style="padding-left: 20px;">20-29 years: 19.3%</p> <p style="padding-left: 20px;">30-39 years: 19.9%</p> <p style="padding-left: 20px;">> 40 years: 25.3%</p> <p>G2: < 20 years: 31.3%</p> <p style="padding-left: 20px;">20-29 years: 36.6%</p> <p style="padding-left: 20px;">30-39 years: 37.6%</p> <p style="padding-left: 20px;">> 40 years: 36.3%</p> <p>G3: < 20 years: 45.4%</p> <p style="padding-left: 20px;">20-29 years: 44.0%</p> <p style="padding-left: 20px;">30-39 years: 42.5%</p> <p style="padding-left: 20px;">> 40 years: 38.4%</p> <p style="padding-left: 20px;"><i>P</i> < 0.001</p> <p>Parity:</p> <p>% Nulliparous:</p> <p>G1: 17.3</p> <p>G2: 36.2</p> <p>G3: 46.6</p> <p style="padding-left: 20px;"><i>P</i> < 0.001</p>	<p>Race, %:</p> <p>White</p> <p>G1: 16.2</p> <p>G2: 35.8</p> <p>G3: 48.0</p> <p>Black</p> <p>G1: 25.5</p> <p>G2: 29.4</p> <p>G3: 45.1</p> <p>Hispanic</p> <p>G1: 19.2</p> <p>G2: 34.8</p> <p>G3: 46.0</p> <p>Asian/Pacific Islander</p> <p>G1: 24.3</p> <p>G2: 43.3</p> <p>G3: 32.4</p> <p>Other</p> <p>G1: 21.7</p> <p>G2: 37.9</p> <p>G3: 40.4</p> <p><i>P</i> for all race categories < 0.001</p> <p>Smoking, %:</p> <p>G1: 23.5</p> <p>G2: 30.8</p> <p>G3: 45.8 <i>P</i> < 0.001</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 48. Gestational weight gain with reference to IOM recommendations and neonatal hypoglycemia (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 4114 G2: 7490 G3: 8861</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM percentiles and dichotomous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: %SGA: 36.1; %AGA: 20.2; %LGA: 8.5 G2: %SGA: 39.4; %AGA: 37.5; %LGA: 26.5 G3: %SGA: 24.5; %AGA: 42.4; %LGA: 65.1 <i>P</i> < 0.001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 14.7 G2: 32.1 G3: 53.2</p> <p>Instrumental delivery, %: Operative vaginal delivery: G1: 18.0% G2: 37.5% G3: 44.5%</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Birth trauma 5 min Apgar score less than 7 Assisted ventilation SGA LGA NICU admission SCN admission Neonatal infection Seizure Hypoglycemia Polycythemia MAS RDS Tachypnea Hospital stay > 5 days Hospital stay > 10 days 	<p>Outcomes Description: AOR for neonatal hypoglycemia (95% CI)</p> <p>Groups: G1: Below IOM guidelines G2: Within IOM guidelines G3: Above IOM guidelines</p> <p>Results Hypoglycemia G1: 1.02 (0.64–1.62) G2: 1.0 G3: 1.52 (1.06–2.16)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Pregnancy induced hypertension Date of delivery Mode of delivery Length of first stage of labor Length of second stage of labor Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Birth weight 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 49. Gestational weight gain with reference to IOM recommendations and admission to neonatal intensive care

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stevens-Simon and McAnarney, 1992</p> <p>Country and setting: USA, adolescent maternity program</p> <p>Enrollment Period: 1986 to 1989</p> <p>Funding: Grant from Bureau of Maternal and Child Health</p> <p>Study Objective: To clarify advantages and disadvantages of large gestational weight gain among pregnant adolescents</p> <p>Time frame: 1986 to 1989</p> <p>Duration of the study: Entry into prenatal care through 6 weeks PP check up</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 141 (107 included in postpartum analyses)</p> <p>Group Description: G1: Slow gainers G2: Average gainers G3: Rapid gainers</p> <p>Group N: G1: 28 G2: 66 G3: 47</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Consecutively enrolled poor, black, 12-19 year olds • Prenatal care prior to 2third week gestation • No chronic disease • No regular medications • No known uterine anomalies • Live birth • Singletons <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 58.6 (11.1) G2: 160.9 (7.0) G3: 163.9 (5.5)</p> <p>Pregravid BMI: G1: 23.1 (3.5) G2: 23.5 (4.4) G3: 23.5 (4.2)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 16.9 G2: 16.6 G3: 16.2</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 49. Gestational weight gain with reference to IOM recommendations and admission to neonatal intensive care (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28 G2: 66 G3: 47</p> <p>Total weight gain: G1: 7.7 (average rate 0.2 kg/wk) G2: 12.4 (average rate 0.3 kg/wk) G3: 19.8 (average rate 0.5 kg/wk)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM slow gain: < 0.23kg/wk; average gain: 0.23-0.4kg/week; rapid gain: > 0.4kg/week <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 2745 (694) G2: 3097 (457) G3: 3351 (482) <i>P</i> < 0.0001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Admission to NICU (%) <p>Groups: Maternal weight gain categories (kg/wk): G1: < 0.23 (slow gainers) G2: 0.23-0.40 (average gainers) G3: > 0.40 (rapid gainers)</p> <p>Results: G1: 28.6 G2: 15.2 G3: 8.5 <i>P</i> = 0.1 for infants of slow gainers vs. all other infants</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NA</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 49. Gestational weight gain with reference to IOM recommendations and admission to neonatal intensive care (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stotland et al., 2006</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: 1980 to 2001</p> <p>Funding: NR</p> <p>Study Objective: To examine relationship between gestational weight gain and adverse neonatal outcomes among infants born at term (37 weeks or more)</p> <p>Time frame: 1980 to 2001</p> <p>Duration of the study: Entry into PN care up till delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 20465</p> <p>Group Description:</p> <p>G1: Gain below IOM recommendations</p> <p>G2: Gain within IOM recommendations</p> <p>G3: Gain above IOM recommendations</p> <p>Group N:</p> <p>G1: 4,114</p> <p>G2: 7,490</p> <p>G3: 8,861</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Singleton <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Pregnancies complicated by multiple gestations, congenital anomalies, chronic hypertension, gestational or pregestational diabetes Birth before 37 weeks Maternal transport Missing data on any of variables considered in multivariable analysis 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <p>G1: < 19.8: 25.8%</p> <p>19.8-26.0: 19.4%</p> <p>26.1-29.0: 9.2%</p> <p>> 29.0: 20.6%</p> <p>G2: < 19.8: 49.1%</p> <p>19.8-26.0: 34.8%</p> <p>26.1-29.0: 23.3%</p> <p>> 29.0: 25.5%</p> <p>G3: < 19.8: 25.0%</p> <p>19.8-26.0: 45.8%</p> <p>26.1-29.0: 67.5%</p> <p>> 29.0: 53.9%</p> <p>$P < 0.001$</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: < 20 years: 23.4%</p> <p>20-29 years: 19.3%</p> <p>30-39 years: 19.9%</p> <p>> 40 years: 25.3%</p> <p>G2: < 20 years: 31.3%</p> <p>20-29 years: 36.6%</p> <p>30-39 years: 37.6%</p> <p>> 40 years: 36.3%</p> <p>G3: < 20 years: 45.4%</p> <p>20-29 years: 44.0%</p> <p>30-39 years: 42.5%</p> <p>> 40 years: 38.4%</p> <p>$P < 0.001$</p> <p>Parity:</p> <p>% Nulliparous:</p> <p>G1: 17.3</p> <p>G2: 36.2</p> <p>G3: 46.6</p> <p>$P < 0.001$</p>	<p>Race, %:</p> <p>White</p> <p>G1: 16.2</p> <p>G2: 35.8</p> <p>G3: 48.0</p> <p>Black</p> <p>G1: 25.5</p> <p>G2: 29.4</p> <p>G3: 45.1</p> <p>Hispanic</p> <p>G1: 19.2</p> <p>G2: 34.8</p> <p>G3: 46.0</p> <p>Asian/Pacific Islander</p> <p>G1: 24.3</p> <p>G2: 43.3</p> <p>G3: 32.4</p> <p>Other</p> <p>G1: 21.7</p> <p>G2: 37.9</p> <p>G3: 40.4</p> <p>P for all race categories < 0.001</p> <p>Smoking, %:</p> <p>G1: 23.5</p> <p>G2: 30.8</p> <p>G3: 45.8 $P < 0.001$</p> <p>Diabetes mellitus, %:</p> <p>NR</p> <p>Hypertension, %:</p> <p>NR</p> <p>Additional characteristics:</p> <p>NR</p>

Evidence Table 49. Gestational weight gain with reference to IOM recommendations and admission to neonatal intensive care (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 4114 G2: 7490 G3: 8861</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM percentiles and dichotomous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: %SGA: 36.1; %AGA: 20.2; %LGA: 8.5 G2: %SGA: 39.4; %AGA: 37.5; %LGA: 26.5 G3: %SGA: 24.5; %AGA: 42.4; %LGA: 65.1 <i>P</i> < 0.001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 14.7 G2: 32.1 G3: 53.2</p> <p>Instrumental delivery, %: Operative vaginal delivery: G1: 18.0% G2: 37.5% G3: 44.5%</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Birth trauma 5 min Apgar score less than 7 , Aassisted ventilation SGA LGA NICU admission SCN admission Neonatal infection Seizure Hypoglycemia Polycythemia MAS RDS Tachypnea Hospital stay > 5 days Hospital stay > 10 days 	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Risk of adverse neonatal outcomes by gestational weight gain by IOM guidelines, adjusted ORs compared to women with GWG within IOM guidelines and risk of adverse neonatal outcomes by extremes of GWG compared to women with weight gain 11.5-16.0kg <p>Groups: G1: < IOM G2: Within IOM G3: > IOM G4: < 7kg G5: > 18kg</p> <p>Results: AOR (95% CI) for NICU admission: G1: 0.66 (0.46-0.96) G2: 1.03 (0.79-1.35) G3: 0.50 (0.23-1.12) G4: 0.66 (0.46-0.96) G5: 1.03 (0.79-1.35)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Pregnancy induced hypertension Date of delivery Mode of delivery Length of first stage of labor Length of second stage of labor Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age Birth weight 	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 50. Gestational weight gain with reference to IOM recommendations and childhood weight status

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Oken et al., 2007</i></p> <p>Country and setting: <i>Reported elsewhere</i></p> <p>Enrollment period: <i>NR</i></p> <p>Funding: <i>Supported by grants from US National Institutes of Health (HD 34568, HL 64925, HL68041, HD 44807), the Robert Wood Johnson Foundation, Harvard Medical School, and Harvard Pilgrim Health Care Foundation</i></p> <p>Study Objective: <i>Purpose of study to examine associations of gestational weight gain with child adiposity</i></p> <p>Time frame: <i>NR</i></p> <p>Duration of the study: <i>Entry to prenatal care thru delivery</i></p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 1,044</p> <p>Group Description: G1: Total</p> <p>Group N: G1: 1,044</p> <p>Inclusion criteria: Women delivering live singleton infant and enrolled for continuation of study beyond 6 months after delivery</p> <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Missing information on prepregnancy weight, parental BMI, or infant birthweight, or who did not have a weight recorded within 4 weeks preceding delivery 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 24.6 (SD 5.0)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 15-24: 6% 25-34: 62% 35-44: 32%</p> <p>Parity: G1: Nulliparous: 48% Parous: 52%</p>	<p>Race, %:</p> <p>White G1: 74%</p> <p>Black G1: 11%</p> <p>Hispanic G1: 6%</p> <p>Other G1: 10%</p> <p>Smoking, %: G1: Never: 67% Quit before pregnancy 20% Smoked in early pregnancy 10%</p> <p>Diabetes mellitus, %: G1: 4%</p>

Evidence Table 50. Gestational weight gain with reference to IOM recommendations and childhood weight status (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: 15.6 kg (5.4)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: G1: 4%</p> <p>Cesarean delivery, %: G1: 23% G2: 12% G3: 35% G4: 53%</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Association of MWG with child adiposity-related outcomes at age 3 years, before and after adjustment for potential confounding and pathway variables. Effect increments are for IOM weight gain categories <p>Groups: G1: Inadequate gestational weight gain G2: Adequate weight gain G3: Excessive weight gain</p> <p>Results:</p> <p>AOR of having overweight (< 95th percentile) child G1: 1.0 G2: 3.77 (1.38, 10.27) G3: 4.35 (1.69, 11.24)</p> <p>AOR of having child between 85-94th percentile G1: 1.0 G2: 2.09 (1.12, 3.92) G3: 2.03 (1.11, 3.72)</p> <p>AOR of having child between 50th-84th percentile G1: 1.0 G2: 1.85 (1.17, 2.92) G3: 1.84 (1.17, 2.88)</p> <p>Characteristic: Adjusted mean BMI z-score G1: 0.17 (95% CI, 0.01, 0.33) G2: (0.47 units, 95% CI, 0.37, 0.57) G3: (0.52 units, 95% CI, 0.44, 0.61)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Breastfeeding Education Time between last pregnancy weight and delivery Household income Marital status Paternal BMI Smoking 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 5 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 50. Gestational weight gain with reference to IOM recommendations and childhood weight status (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Oken et al., 2007
continued

Evidence Table 50. Gestational weight gain with reference to IOM recommendations and childhood weight status (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		Infant and child confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none">• Birth length• Sex• Child diet• Child television viewing	

Evidence Table 51. Gestational weight gain with reference to IOM recommendations and lactation performance

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Baker et al, 2007</p> <p>Country and setting: Denmark, birth registry</p> <p>Enrollment period: 4 years - 1999 to 2002</p> <p>Funding: Data analysis supported by Hatch grant NYC399405 (to KMR) and a grant from the Einaudi Center at Cornell University (to JLB). JLB was supported by National Institutes of Health training grant HD07331 (to KMR).</p> <p>Study Objective: To determine whether this association was stronger with increasing maternal obesity, was modified by gestational weight gain, and still existed when there was greater social support for breastfeeding</p> <p>Time frame: 4 years - 1999 to 2002</p> <p>Duration of the study: Entry into prenatal care through 18 months postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 37,459</p> <p>Group Description: NR</p> <p>Group N: G1: 37,459</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Delivered of liveborn, singleton infant <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Subjects who were aged 18 y or 45 y (n 40) Preexisting or gestational diabetes (n: 554) Chose to not breastfeed (n: 745) Used alternative breastfeeding method (e.g., breast pump only or feeding infant banked human milk; n: 14), whose infant was born preterm (gestation < 259 d; n: 1,316) or at a very low birth weight (2000 g; n: 29) Infant had birth defect, severe illness, or other condition that might preclude successful breastfeeding (as determined by KFM; n: 420) Excluded women (n 529) for whom duration of breastfeeding could not be determined; most of these women had extreme inconsistencies in answers to infant feeding questions 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI:</p> <ul style="list-style-type: none"> G1: 23.6 +/- 4.2 <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> WHO International Taskforce <p>Age (mean, yrs): G1: 30.5 (4.22)</p> <p>Parity: G1: 46.7 % primiparous (37,429)</p>	<p>Race, %: NR</p> <p>Smoking, %: G1: 18.0 (37,430)</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p>

Evidence Table 51. Gestational weight gain with reference to IOM recommendations and lactation performance (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 37 459</p> <p>Total weight gain: G1: 15.1kg +/- 6.0</p> <p>Categorized:</p> <ul style="list-style-type: none"> < 8 kg 8-15.9 kg ≥ 16 kg <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> Self-reported 	<p>Birth weight: G1: 3.64 +/- 0.49</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes</p> <ul style="list-style-type: none"> GWG increased odds of termination of breastfeeding inconsistently. Significant for termination of full breastfeeding at 1 (<i>P</i> 0.0001), 16 (<i>P</i> < 0.05), and 20 (<i>P</i> < 0.05) wk. Significant for termination of any breastfeeding only at 16 and 20 wk (<i>P</i> 0.0001 for both) <p>Other infant outcomes NR</p>	<p>Outcomes Description: Any breastfeeding or full breastfeeding</p> <p>Groups G1:<8 kg G2:8-15.9 kg G3:>=16 kg</p> <p>Results Overall higher risk of terminating full or any breastfeeding with higher pregravid BMI.</p> <p>Unadjusted RR full BF G1:1.13 (95%1.08, 1.18) G2: NR G3:1.05 (1.03, 1.08)</p> <p>Any BF G1:RR 1.16 (1.11, 1.22) G2: NR G3:1.05 (1.03, 1.08). GWG not a predictor of full or any when BMI was in the model.</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Pre-gravid BMI <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> NR 	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 7 Good, 1 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 51. Gestational weight gain with reference to IOM recommendations and lactation performance (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Li et al., 2003</p> <p>Country and setting: USA, WIC clinics</p> <p>Enrollment Period: 1996 to 1998</p> <p>Funding: Conducted by staff at CDC</p> <p>Study Objective: To test hypothesis that women who are obese before pregnancy or who gain excessive weight during pregnancy are less likely to initiate and maintain breast-feeding than are their normal-weight counterparts</p> <p>Time frame: 1996 to 1998</p> <p>Duration of the study: From entry into WIC for mom until 1 yr postpartum or she stops BF</p>	<p>Design:</p> <ul style="list-style-type: none"> WIC mother and child data sets that were linked Retrospective <p>Total Study N: 51,329</p> <p>Group Description: G1: Total Group (multiple logistic regression) G2: NR</p> <p>Group N: G1: 51329 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Low income US women and children participating in federally funded public health programs such as WIC <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple births Records with missing data for pregravid BMI, gestational weight gain, characteristics of children, characteristics of mother, breastfeeding initiation information Biologically implausible values for BW, gestational age, maternal BMI, maternal age, parity 	<p>Pregravid weight: Self-reported</p> <p>Pregravid BMI: G1: BMI before pregnancy (in kg/m²) Underweight (< 19.8) 7591 (14.8%) Normal (19.8-C26.0) 24417 (47.6%) Overweight (> 26.0-C29.0) 6836 (13.3%) Obese (> 29.0) 12485 (24.3%) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: Maternal age < 20 y 9631 (18.8%) 20-C24 y 18 256 (35.6%) 25-C29 y 13 251 (25.8%) ≥30 y 10 191 (19.9%) G2: NR</p> <p>Parity: G1: Multiparous 27897 (54.3%) Primiparous 23432 (45.7%) G2: NR</p>	<p>Race, %: White G1: 69.9% G2: NR</p> <p>Black G1: 17.9 G2: NR</p> <p>Hispanic G1: 9.7 G2: NR</p> <p>Asian/Pacific Islander NR</p> <p>Other G1: 2.5 G2: NR</p> <p>Smoking, %: G1: 27.1 G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 51. Gestational weight gain with reference to IOM recommendations and lactation performance (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 51329 G2: NR</p> <p>Total weight gain: G1: Gestational weight gain Below IOM 15888 (31.0%) Within IOM 13634 (26.6%) Above IOM 21 807 (42.5%) G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Self-reported/self-reported by subjects at the postpartum visit </p> <p>Ascertained by: <ul style="list-style-type: none"> Self-reported </p>	<p>Birth weight: G1: Low (< 2500 g) 3432 (6.7%) Normal (≥2500 g) 47897 (93.3%) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Adjusted OR for failure to initiate breast feeding by BMI</p> <p>Groups G1:<IOM G2: within IOM G3:>IOM BMI before pregnancy: Underweight < 19.8</p> <p>Results Under, normal and overweight G1 groups had a significant increased odds of failure to initiate BF compared to G2 within BMI strata. Obese women regardless of weight gain had increased odds of failure to initiate compared to normal wt G2.</p> <p>Adjusted mean duration of BF (p<0.01)* G1:12.9 wk* G2:13.6 wk (ref) G3:12.8wk*</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Race Parity Pre-gravid BMI Maternal education Marital status Prenatal care Poverty-income ratio Gestational weight gain Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age, Birth weight 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Poor</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 4 Good, 3 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 51. Gestational weight gain with reference to IOM recommendations and lactation performance (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Rasmussen et al., 2002</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: Jan 1988 to Dec 1997</p> <p>Funding: NR</p> <p>Study Objective: To examine how gestational weight gain might modify association between prepregnant bmi and lactational performance</p> <p>Time frame: Jan 1988 to Dec 1997</p> <p>Duration of the study: Entry into prenatal care through child's second year</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 2,494</p> <p>Group Description:</p> <p>Group N:</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • 19 to 40 year old women delivering singleton infants at Mary Imogene Bassett Hospital in Cooperstown, NY who attempted to BF at delivery and for whom complete data were available <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Contraindications for BF, gestational DM, underweight (BMI < 19.8) at conception or lost weight during pregnancy 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race,%: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking,%: NR</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 51. Gestational weight gain with reference to IOM recommendations and lactation performance (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: weight at delivery minus prepregnancy weight 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: OR unsuccessful initiation of BF (normal wt G2 ref)</p> <p>Groups G1:<IOM G2 within IOM G3:>IOM</p> <p>Results Underweight: no significant diff Normal wt: G3 1.66 (1.05,2.63) Overwt: no significant diff Obese: G3 2.89 (1.78, 4.69)</p> <p>Hazard OR discontinuing exclusive BF (normal wt G2 ref) Underwt G3 1.39 (1.01, 1.92) Normal wt-no signif differences Overwt G3 1.27 (1.03, 1.56) Obese G1:1.37 (1.01, 1.84), G2 1.50 (1.11, 2.03), G3:1.78 (1.48, 2.14)</p> <p>Hazard OR discontinuing any BF (normal wt G2 ref) Underwt-no sign difference Normal wt-no sign difference Overwt- no sign difference Obese G2 1.57 (1.14, 2.18), G3:1.99 (1.64, 2.43)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Participation in WIC/PCAP Type of delivery Mother attended college Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Poor</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 2 Good, 5 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 51. Gestational weight gain with reference to IOM recommendations and lactation performance (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hilson et al., 2006</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: Jan 1988 to Dec 1997</p> <p>Funding: NIH and USDA-Hatch</p> <p>Study Objective: To determine whether GWG was independently associated with initiation and continuation of BF and whether GWG modified previously observed association between high prepregnant BMI and these outcomes</p> <p>Time frame: Jan 1988 to Dec 1997</p> <p>Duration of the study: From entry into PNC through 1 year of life but all based on medical record info</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Retrospective <p>Total Study N: 2,783</p> <p>Group Description: G1: Underweight BMI < 19.8 G2: Normal BMI 19.8-26.0 G3: Overweight 26.1-29.0 G4: Obese > 29.0 G5: < IOM/ Within IOM G6: > IOM</p> <p>Group N: G1: 364 G2: 1522 G3: 354 G4: 543 G5: 520/ 877 G6: 1386</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Mother-infant dyads in which BF was ever attempted and to those thought to have a low potential for contraindications to BF Mothers also had to be 19–49 y old and free of gestational diabetes Singleton births Had information for all key variables analysed in present study <p>Exclusion criteria: See above</p>	<p>Pregravid weight: Self-reported G1: 51.2 +/-4.9 G2: 61.5 +/-6.8 G3: 73.9 +/- 6.5 G4: 90.4 +/-13.6 G5: 66.8(17.9)/ 63.2(13.1) G6: 70.2(14.7)</p> <p>Pregravid BMI: G1: 18.6 +/- 0.9 G2: 22.7 +/-1.7 G3: 27.4 +/- 0.9 G4: 33.7 +/- 4.1 G5: 24.9(6.4) / 23.4(4.5) G6: 25.8(5.2)</p> <p>Imputed: <ul style="list-style-type: none"> No </p> <p>Categorized: <ul style="list-style-type: none"> IOM guidelines </p> <p>Age (mean, yrs): G1: 27.3 +/- 5.1 G2: 28.5 +/- 5.1 G3: 28.0 +/-4.8 G4: 27.9 +/-4.9 G5: 27.8(5.0) / 28.9 (5.0) G6: 27.9 (5.0)</p> <p>Parity: G1: Nulliparous (%) 44.6 G2: Nulliparous (%) 37.6 G3: Nulliparous (%) 39.4 G4: Nulliparous (%) 34.1 G5: 29.1%/33.9% G6: 44.1%</p>	<p>Race,%: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking,%: Before pg: G1: 22.2% G2: 18.5 G3: 20.3 G4: 19.9 G5: 24.0/18.8 G6: 18.4</p> <p>Diabetes mellitus,%: NR</p> <p>Hypertension,%: NR</p> <p>Additional characteristics: Vaginal delivery: G1: 93.1% G2: 90.2% G3: 85.9% G4: 80.5% G5: 91.7/89.7 G6: 85.8</p> <p>Additional characteristics: NR</p>

Evidence Table 50. Gestational weight gain with reference to IOM recommendations and lactation performance (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 364 G2: 1,522 G3: 354 G4: 543 G5: 520/877 G6: 1,386</p> <p>Total weight gain: G1: 15.7 +/-4.7 G2: 15.8 +/- 3.4 G3: 15.0 +/- 6.1 G4: 11.6 +/-7.2 <i>P</i> < 0.01 from underweight group; <i>P</i> < 0.01 from normal; <i>P</i> < 0.01 from overweight group G5: 7.5 (4.1)/13.1 (2.6) <i>P</i> < 0.01) G6: 18.7 (5.0) <i>P</i> < 0.01</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records </p> <p>Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 3469 g (SD 462) G2: 3602 <i>P</i> < 0.01 from underweight group G3: 3662 <i>P</i> < 0.01 from underweight G4: 3703 <i>P</i> < 0.01 from underweight group; <i>P</i> < 0.01 from normal G5: 3413 g(462)/ 3571 g(455) <i>P</i> < 0.01 G6: 3713 (</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Initiated BF, %: Underweight 89, Normal 90.1, Overweight 88.4, Obese 82.58 (<i>P</i> < .05, <i>P</i> < 0.01 from normal weight group), < IOM 87.9, Within IOM 91.1, > IOM 86.7 <i>P</i> < 0.01 from women who gained within IOM <p>Other infant outcomes: Macrosomic, %:</p> <ul style="list-style-type: none"> Underweight 11.5 Normal 20.08 (<i>P</i> < 0.01 from underweight group) Overweight 23.48 (<i>P</i> < 0.01 from underweight group) 	<p>Outcomes Description:</p> <ul style="list-style-type: none"> The predicted duration of EBF was 1 wk shorter for underweight and overweight women whose GWG was above IOM recommendations and 3 wk shorter for obese women whose GWG was above IOM recommendation (Fig. 2) For obese women, predicted duration of ABF was 17 wk shorter among those who gained within IOM recommendation and 20 wk shorter among those who gained above IOM recommendation than among women in reference group (Fig. 2) <p>Groups: G1: Underweight BMI < 19.8 G2: Normal BMI 19.8-26.0 G3: Overweight 26.1-29.0 G4: Obese > 29.0 G5: < IOM/ Within IOM G6: > IOM</p> <p>Results:</p> <p>Underweight BMI G1: 1.21 (0.53, 2.76) G2: 1.59 (0.82, 3.07) G3: 1.88 (0.91, 3.92) G4: 1.31 (0.995, 1.71) G5: 1.04 (0.82, 1.31) G6: 1.39 (1.01, 1.92)</p> <p>Normal weight BMI G1: 1.69 (0.99, 2.88) G2: 1.0 G3: 1.66 (1.05, 2.63) <i>P</i> < 0.05) G4: 1.19 (0.981, 1.44) G5: 1.0 G6: 1.14 (0.969, 1.33)</p> <p>Overweight G1: 2.96 (0.90, 9.79) G2: 1.47 (0.61, 3.53) G3: 1.62 (0.90, 2.91) G4: 1.59 (0.94, 2.68) G5: 1.13 (0.81, 1.58) G6: 1.27 (1.03, 1.56) <i>P</i> < 0.05)</p> <p>Obese G1: 1.81 (0.86, 3.83) G2: 1.84 (0.83, 4.11) G3: 2.89 (1.78, 4.69) <i>P</i> < 0.01 G4: 1.37 (1.01, 1.84) <i>P</i> < 0.05) G5: 1.50 (1.11, 2.03) <i>P</i> < 0.01 G6: 1.78 (1.48, 2.14) <i>P</i> < 0.01</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 6 Good, 3 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 50. Gestational weight gain with reference to IOM recommendations and lactation performance (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Hilson et al., 2006
(continued)

Evidence Table 50. Gestational weight gain with reference to IOM recommendations and lactation performance (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
	<ul style="list-style-type: none"> Overweight 23.48 ($P < 0.01$ from underweight group) Obese 28.08 ($P < 0.01$ from underweight group, $P < 0.01$ from normal weight group, $< 10.0\%$ IOM) Within IOM 17.4 ($P < 0.01$), $> 10.0\%$ IOM 27.4% $P < 0.01$ 	<p>G1: Hazard ratio (HR) of discontinuing Any BF: $< 10.0\%$ IOM</p> <p>G2: Hazard ratio (HR) of discontinuing Any BF: Within IOM</p> <p>G3: Hazard ratio (HR) of discontinuing Any BF: $> 10.0\%$ IOM</p> <p>Underweight BMI</p> <p>G1: 1.21 (0.89, 1.64)</p> <p>G2: 0.95 (0.73, 1.24)</p> <p>G3: 1.34 (0.95, 1.88)</p> <p>Normal Weight</p> <p>G1: 1.09 (0.88, 1.35)</p> <p>G2: 1.0</p> <p>G3: 1.09 (0.92, 1.30)</p> <p>Overweight</p> <p>G1: 0.84 (0.43, 1.64)</p> <p>G2: 1.16 (0.82, 1.64)</p> <p>G3: 1.24 (0.989, 1.55)</p> <p>Obese</p> <p>G1: 1.33 (0.963, 1.85)</p> <p>G2: 1.57 (1.14, 2.18) $P < 0.01$</p> <p>G3: 1.99 (1.64, 2.43) $P < 0.01$</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Parity Participation in WIC/PCAP Type of delivery Mother attended college Smoking <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <p>NR</p>	

Evidence Table 52. Gestational weight gain with reference to IOM recommendations and fat retention

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Butte et al., 2003</i></p> <p>Country and setting: <i>USA, children's nutrition center</i></p> <p>Enrollment Period: <i>NR</i></p> <p>Funding: <i>US Department of Army and US Department of Agriculture/Agriculture Research Service</i></p> <p>Study Objective: <i>To evaluate how changes in gestational weight and body composition affect infant birth weight and maternal fat retention after delivery in underweight, normal weight and overweight women</i></p> <p>Time frame: <i>NR</i></p> <p>Duration of the study: <i>Prior to preg through pp</i></p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 63</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 63 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Nonsmokers • 18-40 years • parity ≤ 4 • Physically active (20 to 30 minutes of moderate exercise at least 3 times/week) • No long term medicine use • No alcohol/drug abuse <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiparous • Preterm deliveries • Miscarriage • Preeclampsia 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Measured by study investigators <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 31 (4) G2: NR</p> <p>Parity: NR</p>	<p>Race, %: White G1: 77 G2: NR</p> <p>Black G1: 10 G2: NR</p> <p>Hispanic G1: 10 G2: NR</p> <p>Asian/Pacific Islander G1: 3 G2: NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 52. Gestational weight gain with reference to IOM recommendations and fat retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: 15.0 (3.8) kg G2: 14.5 (4.5) kg G3: 17.9 (5.4) kg</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Birth weight 	<p>Outcomes Description: Fat retention</p> <p>Groups: BMI groups, low, normal, high</p> <p>Results:</p> <ul style="list-style-type: none"> After adjustment for gestational duration, gravidity, and ethnicity, gestational weight gain and net gestational weight gain (GWG-birth weight) were significantly lower in normal BMI group than in high BMI group ($P = 0.04$) - GWG and net GWG in low BMI group was not significantly different from women in normal and high BMI groups On average weight gain was 42% fat mass and 58% fat free mass Weight gain was linearly correlated with gains in TBW ($r = 0.39, P = 0.003$), TBK ($r = 0.49, P = 0.001$), protein ($r = 0.49, P = 0.001$), Fat free mass ($r = 0.50, P = 0.001$), and FM ($r = 0.76, P = 0.001$) Mean gestational weight gain (14.4kg) of women who gained within IOM recommendations was associated with gains of 7.1kg TBW, 5.0g TBK, 370g protein, 8.4 kg FFM, and 4.1 kg FM and a mean birth weight of 3.44kg Changes in body weight differed among BMI groups in first trimester (normal BMI < high BMI group, $P = 0.004$) and third trimester (low BMI < normal and high BMI group, $P < 0.01$) No effect of breast feeding on body weight and composition Birth weight correlated significantly with GWG ($r = 0.35, P = 0.006$), net GWG ($r = 0.26, P = 0.04$), and rate of weight gain ($r = 0.28, P = 0.03$), FFM ($r = 0.39, P = 0.003$) but not with FM Partitioning GWG into FFM and FM showed that FFM gain accounted for effect on birth weight (not FM) Maternal FFM gains in first ($P = 0.008$), second ($P = 0.005$), and third trimesters ($P = 0.005$) were shown to make independent contributions to birth weight Total gestational gains in maternal weight, TBW, TBK, FFM and FM were not shown to have an effect on infant FFM, FM, or percentage of FM at 2 weeks of age Postpartum weight retention was correlated positively with GWG ($r = 0.67, P = 0.001$), total FM gain ($r = 0.61, P = 0.001$) but not with FFM gain Postpartum fat retention was correlated positively with GWG ($r = 0.56, P = 0.001$) and total FM gain ($r = 0.57, P = 0.001$) Maternal fat retention at 27 weeks after delivery (5.3kg) was significantly higher in women who gained above IOM recommendations for weight gain compared to those women who gained within (2.3kg) or below (-0.5kg) recommendations 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

**Evidence Table 52. Gestational weight gain with reference to IOM recommendations and fat retention
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Butte et al., 2003
(continued)

**Evidence Table 52. Gestational weight gain with reference to IOM recommendations and fat retention
(continued)**

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
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Maternal confounders and effect modifiers accounted for in analysis:

- Race
- Pre-gravid BMI

Infant and child confounders and effect modifiers accounted for in analysis:

- Gestational age

Evidence Table 52. Gestational weight gain with reference to IOM recommendations and fat retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Lederman et al., 1997</i></p> <p>Country and setting: <i>USA, clinics</i></p> <p>Enrollment Period: <i>Jan 1991-Aug 1993</i></p> <p>Funding: <i>Grant from Maternal and Child Health Bureau and Department of Health and Human Services</i></p> <p>Study Objective: <i>To determine fat deposited during pregnancy in women according to recommendations of IOM and relationship of weight gain to fat gain in women of different starting weights classified by BMI</i></p> <p>Time frame: <i>Jan 1991 to Aug 1993</i></p> <p>Duration of the study: <i>From first visit through delivery</i></p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 196</p> <p>Group Description: G1: study cohort G2: NR</p> <p>Group N: G1: 196 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • 18 to 35 years of age • Non-smokers • Self-identified as Hispanic, black, or white • Expecting singleton birth • Able to schedule their first body composition laboratory visit before 16th week of gestation • Free of medical illnesses requiring regular medication • Not knowingly infected with HIV • Not a regular user of drugs or alcohol according to mother's report <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA they had to have a 37 week measurement and medical record available 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 63.4 (12.9) G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • NR <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 26.0 (4.8) G2: NR</p> <p>Parity: G1: 0.8 (1.0) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 52. Gestational weight gain with reference to IOM recommendations and fat retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 196 G2: NR</p> <p>Total weight gain: G1: 13.6 (6.1) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM %: <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between measurement at week 37+ and prepregnancy 	<p>Birth weight: G1: 3,449 (433) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Study investigators measured body weight, body density by hydrodensitometry, and deuterium dilution volume twice during pregnancy (at weeks 12-16 and at 37+ weeks)</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Fat gain between pregnancy weeks 14-37 <p>Groups: < IOM, within IOM, > IOM, for BMI groups for three outcomes: G1: Body weight gain G2: Body water gain G3: Fat gain</p> <p>Results:</p> <p>BMI < 19.8: all women (n = 21) G1: 12.6 (4.4) G2: 6.1 (2.4) G3: 4.8 (3.8)</p> <p>BMI < 19.8: less than recommended; recommended; more than recommended G1: 7.9 (1.6); 12.6 (2.4); 16.1 (3.9) G2: 6.4 (3.7); 5.9 (1.6); 6.1 (2.2) G3: 0.6 (1.9); 6.0 (2.6); 6.9 (3.5)</p> <p>BMI 19.8-26.0: all women (n = 118) G1: 12.2 (4.0) G2: 7.0 (2.7) G3: 3.9 (3.7)</p> <p>BMI 19.8-26.0: less than recommended; recommended; more than recommended G1: 8.6 (1.9); 12.1 (3.4); 15.2 (3.4) G2: 6.2 (2.1); 6.9 (2.7); 7.6 (3.0) G3: 1.3 (3.0); 3.8 (3.5); 6.0 (3.1)</p> <p>BMI > 26.0-29.0: all women (n = 29) G1: 11.0 (4.6) G2: 7.8 (3.5) G3: 2.8 (5.4)</p>	<p>Background: Good</p> <p>Sample selection: Good</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Poor</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

**Evidence Table 52. Gestational weight gain with reference to IOM recommendations and fat retention
(continued)**

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Lederman et al., 1997
(continued)

**Evidence Table 52. Gestational weight gain with reference to IOM recommendations and fat retention
(continued)**

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
		<p>BMI > 26.0-29.0: less than recommended; recommended; more than recommended G1: 8.5 (3.2); 9.1 (3.1); 13.6 (5.1) G2: 6.9 (3.0); 5.7 (3.0); 9.7 (3.2) G3: 0.3 (2.5); 2.8 (4.1); 4.2 (6.9)</p> <p>BMI > 29.0: all women (n = 28) G1: 8.7 (5.6) G2: 7.3 (2.9) G3: 0.2 (5.0)</p> <p>BMI > 29.0: less than recommended; recommended; more than recommended G1: 3.2 (2.7); 6.9 (4.4); 12.0 (4.6) G2: 7.8 (3.5); 6.0 (2.9); 7.6 (2.7) G3: -5.2 (1.5); -0.6 (4.6); 3.1 (3.9)</p> <p>Results for BMI and IOM recommendations over time: G1: BMI < 19.8 and gained within IOM recommendations G2: BMI 19.8-26.0 and gained within IOM recommendations G3: BMI > 26.0-29.0 and gained within IOM recommendations G4: BMI > 29.0 and gained within IOM recommendations G1: 7 G2: 46 G3: 9 G4: 6</p> <p>Total body fat at week 14 G1: 12.2 (2.3) G2: 18.2 (2.8)</p> <p>Total body fat at week 37+ G1: 17.9 (5.4) G2: 21.7 (5.8)</p> <p>Characteristics: G1: 25.1 (4.5) G2: 28.0 (3.8)</p> <p>Group G1: 33.1 (8.3) G2: 32.5 (5.7)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	

Evidence Table 53. Gestational weight gain with reference to IOM recommendations and short-term weight retention

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Luke et al., 1996</p> <p>Country and setting: USA, clinic</p> <p>Enrollment Period: March 1, 1974 to June 15, 1979</p> <p>Funding: NR</p> <p>Study Objective: Reanalysis of original data to examine contribution of maternal weight gain to infant birth weight and retained maternal weight in immediate postpartum period, and effect of weight gains below, at, and above IOM guidelines on both infant birth</p> <p>Time frame: March 1, 1974 to June 15, 1979</p> <p>Duration of the study: Prenatal visit through 2 days postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 487</p> <p>Group Description:</p> <p>G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI > 26.0</p> <p>Group N:</p> <p>G1: 104 G2: 268 G3: 115</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Referred for nutrition counseling > 37- < 43 weeks gestation Singleton pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women with history of or concurrent metabolic disease, such as diabetes, seizure disorder, hypertension, cardiac disease, asthma, or drug dependence Women developing antepartum complications such as preeclampsia, GDM, or multiple gestation 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 47.9 (5.1) G2: 58.7 (6.3) G3: 83.9 (16.9)</p> <p>Pregravid BMI:</p> <p>G1: 18.3 (1.0) G2: 22.6 (1.7) G3: 31.7 (5.3)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: 23.1 (5.5) G2: 23.8 (5.5) G3: 27.4 (6.2)</p> <p>Parity: % primipara:</p> <p>G1: 60.6 G2: 48.1 G3: 27.0</p>	<p>Race, %:</p> <p>White NR</p> <p>Black G1: 48.1 G2: 48.8 G3: 63.5</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 17.3 G2: 15.3 G3: 13.0</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 53. Gestational weight gain with reference to IOM recommendations and short-term weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 104 G2: 268 G3: 115</p> <p>Total weight gain: G1: 12.6 (0.7) G2: 13.2 (0.4) G3: 11.7 (0.7) <i>Significantly different from mean for normal BMI group at $P < 0.05$</i></p> <p><i>Categorized:</i></p> <ul style="list-style-type: none"> According to IOM <p><i>Collected from:</i></p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: total weight gain: difference between last measurement and pregravid weight; net weight gain: difference between pregravid weight and last measured weight minus infant birth weight 	<p>Birth weight: G1: 3,067 (44) $P < 0.05$ significantly different from mean for normal BMI</p> <p>G2: 3308 (27) G3: 3300 (43)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Net gain (kg): 9.5 (0.6), 9.9 (0.4), 7.8 (0.6) significantly different from mean for normal BMI group at $P < 0.05$ Retained weight (kg): 6.6 (0.6), 6.6 (0.4), 4.2 (0.6) significantly different from mean for normal BMI group at $P < 0.05$ Percent retained weight (%): 11.4 (0.9), 9.4 (0.5), 4.4 (0.8) significantly different from mean for normal BMI group at $P < 0.05$ <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Mean retained weight</p> <p>Groups Maternal weight gain < IOM recommendations: G1: BMI < 19.8 G2: BMI 19.8-26.0 G3: BMI > 26.0</p> <p>Maternal weight gain within IOM recommendations: G4: BMI < 19.8 G5: BMI 19.8-26.0 G6: BMI > 26.0</p> <p>Maternal weight gain > IOM recommendations: G7: BMI < 19.8 G8: BMI 19.8-26.0 G9: BMI > 26.0</p> <p>Results Mean (SEM) retained weight (defined as 2-day postpartum weight minus pregravid weight, kg): G1: 3.2 (0.5) $P < 0.05$ compared to G4 G2: 0.8 (0.4) $P < 0.05$ compared to G5 G3: -5.0 (0.7) $P < 0.05$ compared to G6 G4: 8.2 (0.7) G5: 7.0 (0.4) G6: 1.4 (0.8) G7: 15.5 (0.9) $P < 0.05$ compared to G4 G8: 12.9 (0.4) $P < 0.05$ compared to G5 G9: 9.5 (0.5) $P < 0.05$ compared to G6</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Age, parity, race, smoking, gestation duration, fetal sex</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 5 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 53. Gestational weight gain with reference to IOM recommendations and short-term weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Scholl et al., 1995</p> <p>Country and setting: USA, Camden Study</p> <p>Enrollment Period: September 1985 to May 1990</p> <p>Funding: NIH</p> <p>Study Objective: To determine whether risk of maternal overweight associated with an excessive rate of gestational weight gain needs to be balanced against risk of impaired fetal growth associated with low rate of gain</p> <p>Time frame: September 1985 to May 1990</p> <p>Duration of the study: During pregnancy through 6 months postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 274</p> <p>Group Description: G1: Low rate of GWG G2: Moderate rate of GWG G3: Excessive rate of GWG</p> <p>Group N: G1: 59 G2: 138 G3: 77</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women with pregravid BMI 19.8-26.0 • Enrolled before January 1988 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing information from delivery to 6 months postpartum • Pregravid under or over weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White G1: 8.5 G2: 10.9 G3: 10.4 Black G1: 61.0 G2: 59.4 G3: 62.3 Hispanic G1: 30.5 G2: 29.7 G3: 27.3 Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 30.5 G2: 26.8 G3: 26.9</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 53. Gestational weight gain with reference to IOM recommendations and short-term weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 59 G2: 138 G3: 77</p> <p>Total weight gain: G1: Gestation duration (wk)38.5 (0.28) <i>P</i> < 0.05, low vs. moderate plus excessive weight gain G2: 39.2 (0.17) G3: 39.4 (0.24)</p> <p><i>Categorized:</i></p> <ul style="list-style-type: none"> According to IOM rate of gestational weight gain measured between 20 to 36 weeks: low GWG = < 0.34kg/wk; moderate GWG = 0.34-0.68 kg/wk; excessive GWG = > 0.68 kg/wk <p><i>Collected from:</i></p> <ul style="list-style-type: none"> Collected by study investigators <p><i>Ascertained by:</i></p> <ul style="list-style-type: none"> NR 	<p>Birth weight: G1: 3,049 (56.94) <i>P</i> < 0.05, low vs. moderate plus excessive weight gain G2: 3,208 (36.33) G3: 39.4 (0.24)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Mean change in weight</p> <p>Groups Maternal weight gain categories (kg/wk): G1: ≤ 0.34 G2: > 0.34-0.68 G3: > 0.68</p> <p>Results Mean (SEM) change in weight (kg) from pregravid to 6 weeks postpartum: G1: 3.1 (0.80) G2: 3.9 (0.51) G3: 9.4 (0.70) <i>P</i> < 0.001, G3 vs. G1,G2</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Age, parity, race, height, lactation status, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 53. Gestational weight gain with reference to IOM recommendations and short-term weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Stevens-Simon and McAnarney, 1992</p> <p>Country and setting: USA, adolescent maternity program</p> <p>Enrollment Period: 1986 to 1989</p> <p>Funding: Grant from Bureau of Maternal and Child Health</p> <p>Study Objective: To clarify advantages and disadvantages of large gestational weight gain among pregnant adolescents</p> <p>Time frame: 1986 to 1989</p> <p>Duration of the study: Entry into prenatal care through 6 weeks PP check up</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 141 (107 included in postpartum analyses)</p> <p>Group Description: G1: Slow gainers G2: Average gainers G3: Rapid gainers</p> <p>Group N: G1: 28 G2: 66 G3: 47</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Consecutively enrolled poor, black, 12-19 year olds • Prenatal care prior to 2third week gestation • No chronic disease • No regular medications • No known uterine anomalies • Live birth • Singletons <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 58.6 (11.1) G2: 160.9 (7.0) G3: 163.9 (5.5)</p> <p>Pregravid BMI: G1: 23.1 (3.5) G2: 23.5 (4.4) G3: 23.5 (4.2)</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 16.9 G2: 16.6 G3: 16.2</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 53. Gestational weight gain with reference to IOM recommendations and short-term weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 28 G2: 66 G3: 47</p> <p>Total weight gain: G1: 7.7 (average rate 0.2 kg/wk) G2: 12.4 (average rate 0.3 kg/wk) G3: 19.8 (average rate 0.5 kg/wk)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM slow gain: < 0.23kg/wk; average gain: 0.23-0.4kg/week; rapid gain: > 0.4kg/week <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 2745 (694) G2: 3097 (457) G3: 3351 (482) <i>P</i> < 0.0001</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Short-term weight retention; adjusted odds ratio for subsequent maternal obesity</p> <p>Groups Maternal weight gain categories (kg/wk): G1: < 0.23 G2: 0.23-0.40 G3: > 0.40</p> <p>Results Short term weight retention (2-11 weeks postpartum), total kg: G1: -1.7 (SD 2.9) G2: 2.9 (SD 2.9) G3: 9.6 (SD 5.6) <i>P</i> < 0.0001</p> <p>AOR (95% CI) for subsequent maternal obesity (> 120% ideal weight for height): G3: 190.94 (7.55-4,779.02)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Age Pregravid BMI Level of physical activity Timing of first prenatal and postpartum visits Substance use Body habitus <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: 3 Good, 4 Fair, 2 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 53. Gestational weight gain with reference to IOM recommendations and short-term weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Walker et al., 2004</i></p> <p>Country and setting: <i>USA, Austin New Mothers Study</i></p> <p>Enrollment Period: <i>1999-2001</i></p> <p>Funding: <i>National Institute of Nursing Research grant</i></p> <p>Study Objective: <i>To assess proportion of women attaining prepregnant weight and to ascertain predictors of amount of retained weight at 6 weeks postpartum in a tri-ethnic low income population</i></p> <p>Time frame: <i>1999 to 2001</i></p> <p>Duration of the study: <i>Delivery to 6 weeks was prospective nature-retrospectively they obtained info from medical record</i></p>	<p>Design:</p> <ul style="list-style-type: none"> • Cross-sectional • Combination: recruited at delivery- they filled out questionnaires and then got some info from medical records <p>Total Study N: 419</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 419 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Low income women • Term infants • Singletons • Low-risk pregnancies • At least 18 years • Perinatal care funded by Medicaid <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Women who reported weighing less at end of pregnancy than before (n = 4) • Missing weight data (n = 137) 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 66.9 (15.1) G2: NR</p> <p>Pregravid BMI:</p> <p>G1: 25.6 (6.0) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines since few underweight and overweight women 2 groups were made: underweight/normal and overweight/obese <p>Age (mean, yrs): G1: 22.2 (3.8) G2: NR</p> <p>Parity: G1: 1.0 (0.0) G2: NR</p>	<p>Race, %: White G1: 30.3 G2: NR</p> <p>Black G1: 24.1 G2: NR</p> <p>Hispanic G1: 45.6 G2: NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 53. Gestational weight gain with reference to IOM recommendations and short-term weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 419 G2: NR</p> <p>Total weight gain: G1: 15.8 (7.1) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Self-reported <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: G1: 3377 (424) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 14.3 G2: NR</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Mean weight retention; percentage of women with retained weight, correlation and multiple regression analysis</p> <p>Groups Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM</p> <p>Mean (SD) weight (kg) retained at 6 weeks postpartum: G1: -0.34 (3.44) G2: 3.86 (3.45) G3: 10.55 (6.14) <i>P</i> = 0.000</p> <p>% Women who attained pregravid weight at 6 weeks postpartum: G1: 48.8 G2: 14.3 G3: 2.3</p> <p>Correlation of gestational weight gain, excluding infant weight, (continuous variable) and weight retained at 6 weeks postpartum: <i>r</i> = 0.90 <i>P</i> = 0.000</p> <p>Multiple regression analysis predicted a mean increase in retained weight of 0.88 kg for each 1 kg increase in maternal weight gain (<i>B</i> = 0.88, <i>SE</i> = 0.02, <i>P</i> = 0.000)</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Race Parity Pregravid BMI Gestational weight gain <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> Gestational age 	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 3 Good, 6 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Amorim et al., 2007</p> <p>Country and setting: Sweden, hospital</p> <p>Enrollment period: Study comprised follow-up period from delivery (1984 to 1985) to 15 years postpartum (1999 to 2000).</p> <p>Funding: Study supported by Brazilian Foundation for training of researchers in Doctoral Exchange Programme (CAPES) (to A.R.A.) and by Arbeitsmarknadens Forsakrings-och Aktiebolag(AFA) (to M.N.)</p> <p>Study Objective: Explore effect of GWG according to IOM recommendations on long-term BMI, accounting for several potentially confounding factors, including postpartum weight changes and pre-pregnancy BMI</p> <p>Time frame: Study comprised follow-up period from delivery (1984 to 1985) to 15 years postpartum (1999 to 2000).</p> <p>Duration of the study: Entry into prenatal care through 15 years after childbirth</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: In maternity unit, staff invited women to take part in study at first control visit after delivery. Up to that point, study was retrospective in that information about weight development during pregnancy was collected from obstetrics records. Women were then prospectively monitored up to 1 year postpartum and 15 years later <p>Total Study N: 483</p> <p>Group Description: G1: Total</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women who delivered children in 1984 to 1985 in 14 maternity units in Stockholm, Sweden <p>Exclusion criteria: NR</p>	<p>Pregravid weight: Self-reported</p> <p>Pregravid BMI: G1: 21.5 (2.4)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 30.0 (4.6)</p> <p>Parity: G1: Primiparous 52%</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: 14.2 (4.1) kg</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: G1: 3506 (470) g</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Time and weight gain interaction</p> <p>Groups Maternal weight gain categories: < IOM Within IOM >IOM</p> <p>Results A mixed ANOVA with one repeated measures factor (weight before pregnancy, 6 months, 1, and 15 years) and one between-subjects factor (< IOM, within IOM, > IOM) showed a main effect of time [F (9.024) = 113.7, P = 0.000] and a significant time group interaction [F(6,12) = 77.23, P = 0.000]</p> <p>The weight of women who gained excessive during pregnancy was significantly greater at each time-point [main effect of group: F (10.55) = 870.0, P = 0.000]</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Pre-gravid BMI</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Keppel and Taffel, 1993</p> <p>Country and setting: USA, 1988 National Maternal and Infant Health Survey</p> <p>Enrollment Period: 1988</p> <p>Funding: National Center for Health Statistics</p> <p>Study Objective: To examine implications of compliance with IOM guidelines for postpartum weight retention</p> <p>Time frame: 1988</p> <p>Duration of the study: NA, cross-sectional</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cross-sectional • Retrospective <p>Total Study N: 2,944</p> <p>Group Description: NR</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Live births • Singletons • Women interviewed 10-18 months following delivery • Births at ≥ 37 weeks gestation • White or black women • ≥ 15 years of age <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Obese women, BMI > 29.0 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): Total weight gain: Categorized: <ul style="list-style-type: none"> According to IOM Collected from: <ul style="list-style-type: none"> Self-reported Ascertained by: <ul style="list-style-type: none"> Self-reported </p>	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Weight retention by postpartum time</p> <p>Groups Categories of amount of weight retained (lbs) at 10-18 months postpartum: G1: Lost weight G2: 0-3 G3: 4-8 G4: 9-13 G5: ≥ 14</p> <p>Results The percent distribution of women in G1-G5 stratified by maternal weight gain categories showed that both black and white women who gained < IOM or within the IOM guidelines retained less weight (10-18 months postpartum) than women who gained > IOM recommendations. Irrespective of maternal weight gain, black women retained more weight than white women</p> <p>Maternal confounders and effect modifiers accounted for in analysis: None</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: None</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Poor</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Poor</p> <p>Sum of Good/Fair/Poor: : 3 Good, 3 Fair, 3 Poor</p> <p>Final Quality Score: Poor</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued) (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Olson et al., 2003</p> <p>Country and setting: USA, hospital and primary care clinic system</p> <p>Enrollment Period: Mid 1990s</p> <p>Funding: NIH grants</p> <p>Study Objective: To describe importance of GWG, postpartum exercise, food intake and breastfeeding to weight change from early pregnancy to 1 year post partum and to identify subgroups of women at greatest risk for major weight gain surrounding child bearing</p> <p>Time frame: Mid 1990s</p> <p>Duration of the study: Women were followed from early pregnancy to one year postpartum (specific dates are not mentioned)</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 540</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 540 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> ≥ 18 years Singleton infants <p>Exclusion criteria:</p> <ul style="list-style-type: none"> No 1 year weight available Invalid 1 year weight Pregnant at 1 year Serious postpartum illness affecting body weight Last prenatal weight taken more than 6 weeks prior to delivery 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured at first prenatal visit <p>Pregravid BMI: G1: < 19.8: 8.9%; 19.8-26.0: 50.6%; > 29.0: 25.2% G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> Yes <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: < 20y: 3.9% 20-40y: 93.5% > 40y: 2.6% G2: NR</p> <p>Parity: G1: Nulliparous: 41.2% G2: NR</p>	<p>Race, %: White G1: 96 G2: NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % married: G1: 92.8% G2: NR</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 540 G2: NR</p> <p>Total weight gain: G1: Less than recommended: 20.4%; recommended: 37.8%; more than recommended: 41.9% G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between first trimesters weight and last weight measured (usually within 1 week of delivery) 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> At 1 year postpartum, women were on average 1.51 (5.95) kg heavier than they were in early pregnancy <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Pregnancy weight versus postpartum weight</p> <p>Groups Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM G4: Interaction for > IOM and income ≤ 185% federal poverty line</p> <p>Results Regression coefficient (SE) for weight change from early pregnancy to 1 year postpartum (kg): G1: -1.50 (0.62) <i>P</i> = 0.016 G2: reference G3: 0.32 (0.65) <i>P</i> = 0.621 G4: 3.41 (0.91) <i>P</i> < 0.001</p> <p>AOR (95% CI) for major weight gain (≥ 10 lbs) at 1 year postpartum: G1: 0.33 (0.13-0.83) G2: 1.00 (reference) G3: 1.47 (0.73-2.94) G4: 3.23 (1.25-9.08)</p> <p>Compared to normal-weight women (BMI 19.8-26.0) in G2, normal weight, overweight (BMI 26.1-29.0) and obese (BMI > 29.0) women in G3 retained significantly more weight at 1 year postpartum (all <i>P</i> < 0.01)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Exercise, food intake, breastfeeding, pregravid BMI, age, marital status, income, postpartum month that weight was measured</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Rooney et al., 2002</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 10 year followup of study from Apr 1989 to March 1990</p> <p>Funding: Gundersen Lutheran Medical Center</p> <p>Study Objective: To estimate impact of excess pregnancy weight gain and failure to lose weight by 6 months postpartum on excess weight 8 to 10 years later</p> <p>Time frame: 10 year followup of study from Apr 1989 to March 1990</p> <p>Duration of the study: April 1, 1989 to 1999 (10 years) Entry into prenatal care up to 10 years postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 540</p> <p>Group Description: G1: Group Studied (Continued Care) G2: NR</p> <p>Group N: G1: 540 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Convenience sample of women with uncomplicated pregnancies receiving care at Gundersen Clinic from April first 1989 to March 30 1990 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women who discontinued care at clinic or did not have a weight available 5-10 years after their study pregnancy 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> weight at first pn visit <p>Pregravid BMI: G1: 25.0 G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 28.6 G2: NR</p> <p>Parity: NR</p>	<p>Race, %: White G1: 97% G2: NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 540 G2: NR</p> <p>Total weight gain: G1: 13.1 kg (mean) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: Study investigators measured weight at delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Mean retained maternal weight (kg) was 1.7kg 66% retained pregnancy weight at 6 months follow up 26% gained less than recommended (IOM) amount of weight during pregnancy, 50% gained recommended amount, and 24% gained more than recommended <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Weight change</p> <p>Groups Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM</p> <p>BMI IOM</p> <p>Results Average weight change between prepregnancy and 6 months postpartum (kg): G1: -0.61 G2: 1.8 G3: 4.2 <i>P</i> = 0.01</p> <p>Regression coefficient (95% CI) for weight at 6 months postpartum: G1: -1.53 (-3.36–0.30) G2: Reference G3: 1.24 (-0.63–3.11)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Duration of breastfeeding, postpartum aerobic exercise, weight loss by 6 months</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 4 Good, 4 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Scholl et al., 1995</p> <p>Country and setting: USA, Camden Study</p> <p>Enrollment Period: September 1985 to May 1990</p> <p>Funding: NIH</p> <p>Study Objective: To determine whether risk of maternal overweight associated with an excessive rate of gestational weight gain needs to be balanced against risk of impaired fetal growth associated with low rate of gain</p> <p>Time frame: September 1985 to May 1990</p> <p>Duration of the study: During pregnancy through 6 months postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 274</p> <p>Group Description: G1: Low rate of GWG G2: Moderate rate of GWG G3: Excessive rate of GWG</p> <p>Group N: G1: 59 G2: 138 G3: 77</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women with pregravid BMI 19.8-26.0 • Enrolled before January 1988 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Missing information from delivery to 6 months postpartum • Pregravid under or over weight 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): NR</p> <p>Parity: NR</p>	<p>Race, %: White G1: 8.5 G2: 10.9 G3: 10.4 Black G1: 61.0 G2: 59.4 G3: 62.3 Hispanic G1: 30.5 G2: 29.7 G3: 27.3 Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: G1: 30.5 G2: 26.8 G3: 26.9</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 59 G2: 138 G3: 77</p> <p>Total weight gain: G1: Gestation duration (wk)38.5 (0.28) $P < 0.05$, low vs. moderate plus excessive weight gain G2: 39.2 (0.17) G3: 39.4 (0.24)</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM rate of gestational weight gain measured between 20 to 36 weeks: low GWG = < 0.34kg/wk; moderate GWG = 0.34-0.68 kg/wk; excessive GWG = > 0.68 kg/wk <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: G1: 3,049 (56.94) $P < 0.05$, low vs. moderate plus excessive weight gain G2: 3,208 (36.33) G3: 39.4 (0.24)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Change in weight, risk for becoming overweight</p> <p>Groups Maternal weight gain categories (kg/wk): G1: ≤ 0.34 G2: > 0.34-0.68 G3: > 0.68</p> <p>Results Mean (SEM) change in weight (kg) from pregravid to 6 months postpartum: G1: 3.2 (0.95) G2: 3.8 (0.61) G3: 7.9 (0.83) $P < 0.001$, G3 vs. G1, G2</p> <p>Mean (SEM) change in weight (kg) from 6 weeks to 6 months postpartum: G1: 0.13 (0.64) G2: -0.05 (0.41) G3: -1.48 (0.56) $P < 0.05$, G3 vs. G1, G2</p> <p>AOR (95% CI) for becoming overweight (BMI > 26.0) at 6 months postpartum: G1, G2: 1.0 (reference) G3: 2.89 (1.36-6.00)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Age, race, parity, pregravid BMI, lactation, height, smoking</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Fair</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 2 Good, 7 Fair, 0 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Walker, 1996</p> <p>Country and setting: USA, multicounty community</p> <p>Enrollment Period: NR</p> <p>Funding: Biomedical Research Support Grant; Luci B. Johnson Centennial Professorship in Nursing</p> <p>Study Objective: To test contributions of life-style and stress to postpartum weight gain after controlling for sociodemographic and reproductive influences</p> <p>Time frame: NR</p> <p>Duration of the study: Pregravid (retrospective) through 18 months postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Combination: Prospective on outcomes, retrospective on pregravid weight <p>Total Study N: 88</p> <p>Group Description: G1: Total G2: NR</p> <p>Group N: G1: 88 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women identified through newspaper birth announcements were sent questionnaires in mail <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Hypertensive or bleeding complications during pregnancy • Illnesses between delivery and 6 months • Pregnant or may be pregnant at time of survey • Missing prenatal or postpartum weight data • Extensive missing predictor data for 6-month follow-up • Obese women 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 26.4 G2: NR</p> <p>Parity: G1: 41% primiparae G2: NR</p>	<p>Race, %: White G1: 98% G2: NR</p> <p>Black G1: NR G2: NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 54. Gestational weight gain with reference to IOM recommendations and weight retention during the first year postpartum (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 88 G2: NR</p> <p>Total weight gain: G1: 16.4 kg (SD 7.2) G2: NR</p> <p>Categorized: <ul style="list-style-type: none"> According to IOM </p> <p>Collected from: <ul style="list-style-type: none"> Self-reported </p> <p>Ascertained by: <ul style="list-style-type: none"> Self-reported </p>	<p>Birth weight: G1: 3544 G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 81% vaginal births G2: NR</p> <p>Instrumental delivery, %:</p> <p>Episiotomy, %:</p> <p>Other maternal outcomes: GWG was significantly related to weight gain at 6 months ($r[86] = 0.60, P < 0.001$) and 18 months ($r[73] = 0.49, P < 0.001$)</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Maternal weight gain and postpartum weight</p> <p>Groups Maternal weight gain categories: G1: < IOM G2: Within IOM G3: > IOM</p> <p>Results Mean weight retention at 6 months postpartum, lbs: G1: 0.4 G2: 3.7 G3: 13.5 $P < 0.001$</p> <p>Maternal weight gain was significantly related to weight at 6 months postpartum: $r = 0.60, P < 0.001$ Mean weight retention at 18 months postpartum, lbs: G1, G2: 0.7 G3: 11.0 $P < 0.01$</p> <p>Maternal weight gain was significantly related to weight at 18 months postpartum: $r = 0.49, P < 0.001$</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Mode of delivery, infant sex, breastfeeding, infant birth weight, pregravid BMI</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 4 Good, 4 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 55. Gestational weight gain with reference to IOM recommendations and long-term weight retention

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Amorim et al., 2007</p> <p>Country and setting: Sweden, hospital</p> <p>Enrollment period: Study comprised follow-up period from delivery (1984 to 1985) to 15 years postpartum (1999 to 2000).</p> <p>Funding: Study supported by Brazilian Foundation for training of researchers in Doctoral Exchange Programme (CAPES) (to A.R.A.) and by Arbeitsmarknadens Forsakrings-och Aktiebolag(AFA) (to M.N.)</p> <p>Study Objective: Explore effect of GWG according to IOM recommendations on long-term BMI, accounting for several potentially confounding factors, including postpartum weight changes and pre-pregnancy BMI</p> <p>Time frame: Study comprised follow-up period from delivery (1984 to 1985) to 15 years postpartum (1999 to 2000).</p> <p>Duration of the study: Entry into prenatal care through 15 years after childbirth</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Combination: In maternity unit, staff invited women to take part in study at first control visit after delivery. Up to that point, study was retrospective in that information about weight development during pregnancy was collected from obstetrics records. Women were then prospectively monitored up to 1 year postpartum and 15 years later <p>Total Study N: 483</p> <p>Group Description: G1: Total</p> <p>Group N: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women who delivered children in 1984 to 1985 in 14 maternity units in Stockholm, Sweden <p>Exclusion criteria: NR</p>	<p>Pregravid weight: Self-reported</p> <p>Pregravid BMI: G1: 21.5 (2.4)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs): G1: 30.0 (4.6)</p> <p>Parity: G1: Primiparous 52%</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 55. Gestational weight gain with reference to IOM recommendations and long-term weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): NR</p> <p>Total weight gain: G1: 14.2 (4.1) kg</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine prenatal care or maternity records <p>Ascertained by: NR</p>	<p>Birth weight: G1: 3506 (470) g</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Weight change across postpartum years</p> <p>Groups G1: < IOM G2: Within IOM G3: > IOM</p> <p>Results Mean (SD) change in weight at 15 years postpartum, kg: G1: 6.2 (6.8) G2: 6.7 (6.8) G3: 10.3 (8.5) <i>P</i> = 0.000</p> <p>Mean (SD) BMI at 15 years postpartum: G1: 23.5 (3.7) G2: 23.6 (3.0) G3: 25.9 (3.9) <i>P</i> = 0.000</p> <p>Multiple regression coefficient, B (95% CI) for 15 year BMI status: G1: 0.01 (-0.56-0.59) G2: Reference G3: 0.72 (0.15-1.30) <i>P</i> = 0.033</p> <p>Multiple regression coefficient (95% CI) for change in BMI status between pregravid and 15 years postpartum: G1: 0.02 (-0.56-0.59) G2: Reference G3: 0.68 (0.11-1.24) <i>P</i> = 0.042</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Education, lactation, weight retention at 6 months postpartum, weight gain between 6 months and 1 year postpartum, pregravid BMI</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Poor</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: 5 Good, 3 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 55. Gestational weight gain with reference to IOM recommendations and long-term weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Gunderson et al., 2000</p> <p>Country and setting: USA, university hospital</p> <p>Enrollment Period: 1980-1990</p> <p>Funding: Grants from California Dietetic Association, Zellmer Grant, Dowdle Endowment and Grossman Medical Research Funds, NIH, University at California, Berkeley</p> <p>Study Objective: To assess relationships between gestational weight gain, race/ethnicity, reproductive history, age, education, and risk of becoming overweight after pregnancy</p> <p>Time frame: 1980 to 1990</p> <p>Duration of the study: 2 pregnancies; weight gain in first up to second pregnancy</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Retrospective <p>Total Study N: 1,300</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 1300 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • White, black, Hispanic, and Asian adult women who delivered two consecutive singleton births <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • < 18 years • Adoptions • Pregnancy complications • Medical conditions which could modify gestational weight gain or retention 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI: G1: < 19.8: 28.3% 19.8-26.0: 59.5% > 26-29.0: 6.6% > 29.0: 5.6% G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 27 (5) G2: NR</p> <p>Parity: G1: % nulliparous: 72.4 G2: NR</p>	<p>Race, %: White G1: 53.3 G2: NR</p> <p>Black G1: 10.5 G2: NR</p> <p>Hispanic G1: 12.4 G2: NR</p> <p>Asian/Pacific Islander G1: 23.8 G2: NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: G1: % married: 77% G2: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 55. Gestational weight gain with reference to IOM recommendations and long-term weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N):</p> <p>Total weight gain: G1: 16.1kg G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between self reported weight and weight at last prenatal visit (average of 0.9 weeks prior to delivery) 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> 6.4% (n = 72) of women became overweight by second pregnancy (all perviously normal weight except for 1 underweight woman) Mean weight increase from baseline (pregravid weight at index pregnancy) until start of second pregnancy = 10.4 (5.2) kg among women who became overweight compared with 1.6 (3.6) kg among women who did not become overweight ($P < 0.001$) <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Adjusted odds ratio (95% CI) for becoming overweight between baseline (pregravid weight at start of index pregnancy) and start of second study pregnancy (median interval time = 1.5 years):</p> <p>Groups G1: < IOM/ within IOM G2: > IOM</p> <p>Results G1: Reference G2: 2.95 (1.67-5.24)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Smoking, PIH, education, parity, marital status, age at menarche, interval to first birth</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Fair</p> <p>Followup: Good</p> <p>Analysis comparability: Good</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Good</p> <p>Sum of Good/Fair/Poor: : 6 Good, 3 Fair, 0 Poor</p> <p>Final Quality Score: Good</p>

Evidence Table 55. Gestational weight gain with reference to IOM recommendations and long-term weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Rooney et al., 2002</p> <p>Country and setting: USA, hospital</p> <p>Enrollment Period: 10 year followup of study from Apr 1989 to March 1990</p> <p>Funding: Gundersen Lutheran Medical Center</p> <p>Study Objective: To estimate impact of excess pregnancy weight gain and failure to lose weight by 6 months postpartum on excess weight 8 to 10 years later</p> <p>Time frame: 10 year followup of study from Apr 1989 to March 1990</p> <p>Duration of the study: April 1, 1989 to 1999 (10 years) Entry into prenatal care up to 10 years postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 540</p> <p>Group Description: G1: Group Studied (Continued Care) G2: NR</p> <p>Group N: G1: 540 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Convenience sample of women with uncomplicated pregnancies receiving care at Gundersen Clinic from April first 1989 to March 30 1990 <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women who discontinued care at clinic or did not have a weight available 5-10 years after their study pregnancy 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> weight at first pn visit <p>Pregravid BMI: G1: 25.0 G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 28.6 G2: NR</p> <p>Parity: NR</p>	<p>Race, %: White G1: 97% G2: NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 55. Gestational weight gain with reference to IOM recommendations and long-term weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 540 G2: NR</p> <p>Total weight gain: G1: 13.1 kg (mean) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM NR <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: Study investigators measured weight at delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Mean retained maternal weight (kg) was 1.7kg 66% retained pregnancy weight at 6 months follow up 26% gained less than recommended (IOM) amount of weight during pregnancy, 50% gained recommended amount, and 24% gained more than recommended <p>Other infant outcomes: NR</p>	<p>Outcomes Description: Change in weight or BMI across postpartum time</p> <p>Groups G1: < IOM G2: within IOM G3: > IOM</p> <p>Results Average weight change between prepregnancy and ~8.5 years postpartum (kg): G1: 4.1 G2: 6.5 G3: 8.4 P = 0.01</p> <p>Regression coefficients (95% CI) for BMI at ~8.5 years postpartum: G1: -3.86 (-5.56 - -2.16) G2: Reference G3: -0.70 (-2.13-0.74)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Duration of breastfeeding, postpartum aerobic exercise, weight loss by 6 months</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Fair</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Poor</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Good</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 4 Good, 4 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 55. Gestational weight gain with reference to IOM recommendations and long-term weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Rooney et al., 2005</p> <p>Country and setting: USA, medical center</p> <p>Enrollment Period: 1988 to 2004</p> <p>Funding: Gundersen Luterhan Medical Foundation</p> <p>Study Objective: To estimate impact of perinatal weight change on obesity, weight gain, and development of obesity related illnesses 15 years after pregnancy</p> <p>Time frame: 1988 to 2004</p> <p>Duration of the study: Original study conducted April 12, 1988 to October 12, 1990 followed up until 15 years later (2004)</p> <p>Quality: Fair</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 484</p> <p>Group Description: G1: Cohort (at beginning of study) G2: NR</p> <p>Group N: G1: 484 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> NA <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Multiple births Missing weight measurements Deceased 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured at first prenatal visit (average of 10.3 weeks gestation) <p>Pregravid BMI: G1: 24.2 G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 28.6 G2: NR</p> <p>Parity: % primiparous: G1: 39% G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: Retained weight at 6 months postpartum: G1: 1.7kg G2: NR</p> <p>% married: G1: 90 G2: NR</p>

Evidence Table 55. Gestational weight gain with reference to IOM recommendations and long-term weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis	Quality Rating
<p>Groups (N): G1: 484 G2: NR</p> <p>Total weight gain: Categorized: <ul style="list-style-type: none"> According to IOM Collected from: <ul style="list-style-type: none"> Routine prenatal care or maternity records Ascertained by: <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery </p>	<p>Birth weight: G1: 13.0 kg G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description: Change in weight or BMI</p> <p>Groups G1: < IOM G2: within IOM G3: > IOM</p> <p>Results Multivariable regression coefficient (95% CI) for BMI at 15 years postpartum: G1: -0.57 (-0.57-1.21) G2: reference G3: 1.69 (0.79-2.58)</p> <p>Multivariable regression coefficient (95% CI) for change in weight between baseline and 15 years postpartum: G1: 0.43 (-1.87-2.73) G2: reference G3: 4.19 (1.88-6.51)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: Marital status at delivery, change in marital status, current parity, insurance status at delivery, current insurance status, baseline BMI, weight gain at index pregnancy, retained weight at 6 months postpartum, participation in postpartum aerobic exercise, duration of breastfeeding</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>	<p>Background: Good</p> <p>Sample selection: Poor</p> <p>Definition of maternal weight gain: Fair</p> <p>Definition of outcomes: Good</p> <p>Source of information on exposure, outcomes, and confounders: Good</p> <p>Followup: Good</p> <p>Analysis comparability: Fair</p> <p>Analysis of outcomes: Fair</p> <p>Interpretation: Fair</p> <p>Sum of Good/Fair/Poor: 4 Good, 4 Fair, 1 Poor</p> <p>Final Quality Score: Fair</p>

Evidence Table 56. Anthropometrics of maternal weight retention

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bartha, 2007</p> <p>Country and setting: Spain, tertiary referral university center</p> <p>Enrollment Period: NR</p> <p>Funding: Consejería de Salud</p> <p>Study Objective: <i>to study the relationships between ultrasound estimated visceral fat and metabolic risk factors during early pregnancy.</i></p> <p>Time frame: NA</p> <p>Duration of the study: NR</p> <p>Quality:</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 30</p> <p>Group Description: NA</p> <p>Group N: 30</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • 11-14 weeks of gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • 64.01 kg <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • Yes 24.4 <p>Categorized:</p> <p>10 women were overweight BMI > 25</p> <p>Age (mean, yrs): 29.07 years</p> <p>Parity: NR</p>	<p>Race, %: NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NA</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
<p>Groups (N):</p> <p>Total weight gain:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight:</p> <p>Gestational diabetes, %:</p> <p>Cesarean delivery, %:</p> <p>NR</p> <p>Instrumental delivery, %:</p> <p>NR</p> <p>Episiotomy, %:</p> <p>NR</p> <p>Other maternal outcomes:</p> <p>NR</p> <p>Other infant outcomes:</p> <p>NR</p>	<p>Outcomes Descriptions</p> <p>Metabolic risk factors as a function of visceral fat thickness (VFT) versus subcutaneous fat thickness (SFT)</p> <p>Groups</p> <p>NA</p> <p>Results</p> <p>VFT significantly correlated with</p> <ul style="list-style-type: none"> Diastolic blood pressure (r= 0.37, p= 0.04) Glycemia (r= 0.37, p =0.04) Insulinemia (r= 0.59, p = 0.001) Insulin sensitivity (HOMA; r = 0.59, p= 0.001), Triglycerides (r = 0.58, p =0.03) HDL-C (r=0.39, p = 0.03) Total cholesterol/HDL-C ratio (p = 0.002) <p>SFT significantly correlated with</p> <ul style="list-style-type: none"> Diastolic blood pressure (p _ 0.03). <p>VFT better significantly correlated with the metabolic risk factors than pre-gestational BMI</p> <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <p>NA</p> <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <p>NA</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Bo et al., 2003</p> <p>Country and setting: Italy, university clinic</p> <p>Enrollment Period: April 1999 to February 2001</p> <p>Funding: NR</p> <p>Study Objective: To evaluate pregnancy outcomes in cohort of caucasian pregnant women in relation to BMI and glucose toleranc status; role of central fat distribution, as indicated by waist to hip circumference ratio also considered</p> <p>Time frame: April 1999 to February 2001</p> <p>Duration of the study: Screened during pregnancy at 24 to 28 weeks, recall data on pregravid weight</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 700</p> <p>Group Description: G1: Normal wieight, normal OGTT G2: Overweight/Obese, normal OGTT G3: Normal Weight, IGT/GDM G4: Overweight/Obese, IGT/GDM</p> <p>Group N: G1: 333 G2: 117 G3: 133 G4: 117</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Caucasian pregnant women attending Gynecological and Obstetrical Department of University of Torino screened with 50g oral glucose test at 24 to 28 weeks gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Women known to have preexistent diabetes mellitus, a disease affecting glucose metabolism, or hypertension 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>Pregravid BMI: G1: 21.2 G2: 29.9 G3: 21.5 G4: 29.9</p> <p>Imputed: <ul style="list-style-type: none"> No </p> <p>Categorized: NR</p> <p>Age (mean, yrs): G1: 31.7 G2: 31.1 G3: 32.9 G4: 32.6</p> <p>Parity: G1: Nulliparous (%): 63.7 G2: 53.0 G3: 62.4 G4: 51.3</p>	<p>Race, %: White G1: 100 G2: 100 G3: 100 G4: 100</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: G1: 11.4 G2: 15.4 G3: 15.0 G4: 18.8</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: G1: 1.2 G2: 10.3 G3: 4.5 G4: 11.1</p> <p>Additional characteristics: Waist-to-hip ratio: G1: 0.86 G2: 0.87 G3: 0.89 G4: 0.90</p> <p>Additional characteristics: Preterm delivery (%): G1: 6.9 G2: 6.7 G3: 9.2 G4: 8.5</p> <p>Additional characteristics: LGA (%): G1: 13.1 G2: 27.6 G3: 13.3 G4: 27.4</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
<p>Groups (N): G1: 333 G2: 117 G3: 133 G4: 117</p> <p>Total weight gain: G1: 13.2+/-4.1 <i>(P < 0.01 vs. G2)</i> G2: 10.5+/-6.1 G3: 11.8+/-5.7 <i>(P < 0.05 vs. G2, P < 0.05 vs. G4)</i> G4: 9.5+/-6.8 <i>(P < 0.01 vs. G1)</i> <i>(overall P < 0.0001)</i></p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Gains during pregnancy not collected <p>Ascertained by:</p> <ul style="list-style-type: none"> Not explained by researchers, may be difference between prepregnancy weight and weight measured at 24 to 28 weeks gestation 	<p>Birth weight: G1: 3271+/-446 <i>(P < 0.05 vs. G2)</i> G2: 3413+/-589 <i>(P < 0.01 vs. G3)</i> G3: 3186+/-578 <i>(P < 0.01 vs. G4)</i> G4: 3389+/-447 <i>(P < 0.05 vs. G1)</i> <i>(overall P = 0.001)</i></p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: G1: 30.5 G2: 38.1 G3: 39.2 G4: 44.3 <i>(P < 0.01 vs. G1)</i> <i>(overall P = 0.044)</i></p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Height Parental diabetes Waist Systolic bp Diastolic bp Hypertension Triglycerides HDL <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Weeks of delivery SGA Neonatal pathologies 	<p>Outcomes Description: Explanation of multivariate models:</p> <ul style="list-style-type: none"> OR for hypertension in pregnancy and obesity - adjusted for age, gestational age, weight gain, and gestational hyperglycemia OR for cesarean sections included gestational hyperglycemia, gestational weight gain, age, obesity OR for LGA included obesity (BMI ≥ 30), gestational weight gain, age, gestational hyperglycemia, and smoking OR for LGA/cesarean sections and WHR adjusted for age, gestational age, weight gain, gestational hyperglycemia, obesity, smoking habits Prepregnancy weight was not associated with adverse outcomes, also height and parity not significantly associated with any pregnancy outcomes <p>Groups: G1: Normal weight, normal OGTT G2: Overweight/Obese, normal OGTT G3: Normal Weight, IGT/GDM G4: Overweight/Obese, IGT/GDM</p> <p>Results: Per kg increase in gestational weight gain G1: 1.06 (1.02 - 1.10) G2: 1.08 (1.03 - 1.12)</p> <p>Gestational hyperglycemia G1: 1.78 (1.21 - 2.62) G2: ns</p> <p>Age G1: NS G2: NS</p> <p>Obesity G1: NS G2: 4.48 (2.30 - 8.71)</p> <p>Smoking G1: NR G2: NS</p> <p>Waist to hip ratio > .90 G1: 1.51 (1.02 - 2.24) G2: 1.81 (1.12- 2.93)</p> <p>Height G1: ns G2: ns</p> <p>Parity G1: ns G2: ns</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Bo et al., 2003
(continued)

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
		Prepregnancy overweight G1: ns G2: ns Maternal confounders and effect modifiers accounted for in analysis: NR Infant and child confounders and effect modifiers accounted for in analysis: NR

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Butte et al., 2003</p> <p>Country and setting: USA, children's nutrition center</p> <p>Enrollment Period: NR</p> <p>Funding: US Department of Army and US Department of Agriculture/Agriculture Research Service</p> <p>Study Objective: To evaluate how changes in gestational weight and body composition affect infant birth weight and maternal fat retention after delivery in underweight, normal weight and overweight women</p> <p>Time frame: NR</p> <p>Duration of the study: Prior to preg through pp</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 63</p> <p>Group Description: G1: Total cohort G2: NR</p> <p>Group N: G1: 63 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Nonsmokers • 18-40 years • parity ≤ 4 • Physically active (20 to 30 minutes of moderate exercise at least 3 times/week) • No long term medicine use • No alcohol/drug abuse <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Multiparous • Preterm deliveries • Miscarriage • Preeclampsia 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Measured by study investigators <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 31 (4) G2: NR</p> <p>Parity: NR</p>	<p>Race, %: White G1: 77 G2: NR</p> <p>Black G1: 10 G2: NR</p> <p>Hispanic G1: 10 G2: NR</p> <p>Asian/Pacific Islander G1: 3 G2: NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
<p>Groups (N):</p> <p>Total weight gain: G1: 15.0 (3.8) kg G2: 14.5 (4.5) kg G3: 17.9 (5.4) kg</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NA</p> <p>Other infant outcomes:</p> <ul style="list-style-type: none"> Birth weight 	<p>Outcomes Description: Fat retention</p> <p>Groups: BMI groups, low, normal, high</p> <p>Results:</p> <ul style="list-style-type: none"> After adjustment for gestational duration, gravidity, and ethnicity, gestational weight gain and net gestational weight gain (GWG-birth weight) were significantly lower in normal BMI group than in high BMI group ($P = 0.04$) - GWG and net GWG in low BMI group was not significantly different from women in normal and high BMI groups On average weight gain was 42% fat mass and 58% fat free mass Weight gain was linearly correlated with gains in TBW ($r = 0.39, P = 0.003$), TBK ($r = 0.49, P = 0.001$), protein ($r = 0.49, P = 0.001$), Fat free mass ($r = 0.50, P = 0.001$), and FM ($r = 0.76, P = 0.001$) Mean gestational weight gain (14.4kg) of women who gained within IOM recommendations was associated with gains of 7.1kg TBW, 5.0g TBK, 370g protein, 8.4 kg FFM, and 4.1 kg FM and a mean birth weight of 3.44kg Changes in body weight differed among BMI groups in first trimester (normal BMI < high BMI group, $P = 0.004$) and third trimester (low BMI < normal and high BMI group, $P < 0.01$) No effect of breast feeding on body weight and composition Birth weight correlated significantly with GWG ($r = 0.35, P = 0.006$), net GWG ($r = 0.26, P = 0.04$), and rate of weight gain ($r = 0.28, P = 0.03$), FFM ($r = 0.39, P = 0.003$) but not with FM Partitioning GWG into FFM and FM showed that FFM gain accounted for effect on birth weight (not FM) Maternal FFM gains in first ($P = 0.008$), second ($P = 0.005$), and third trimesters ($P = 0.005$) were shown to make independent contributions to birth weight Total gestational gains in maternal weight, TBW, TBK, FFM and FM were not shown to have an effect on infant FFM, FM, or percentage of FM at 2 weeks of age Postpartum weight retention was correlated positively with GWG ($r = 0.67, P = 0.001$), total FM gain ($r = 0.61, P = 0.001$) but not with FFM gain Postpartum fat retention was correlated positively with GWG ($r = 0.56, P = 0.001$) and total FM gain ($r = 0.57, P = 0.001$) Maternal fat retention at 27 weeks after delivery (5.3kg) was significantly higher in women who gained above IOM recommendations for weight gain compared to those women who gained within (2.3kg) or below (-0.5kg) recommendations

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Butte et al., 2003
(continued)

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
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Maternal confounders and effect modifiers accounted for in analysis:

- Race
- Pre-gravid BMI

Infant and child confounders and effect modifiers accounted for in analysis:

- Gestational age

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Hediger et al., 1994</p> <p>Country and setting: USA, setting NR</p> <p>Enrollment Period: 1985</p> <p>Funding: NICHD grant</p> <p>Study Objective: To study relationship between changes in maternal subcutaneous fat and infant birth weight</p> <p>Time frame: 1985</p> <p>Duration of the study: Initiation of prenatal care to 4 to 6 weeks postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 608</p> <p>Group Description: G1: Teenagers 13-15 years G2: Teenagers 16-18 years G3: Adults 19-29</p> <p>Group N: G1: 197 G2: 207 G3: 204</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Primigravid and multigravid teenagers (< 19 years) with first pregnancy at < 16 y Older women ages 18 to 29 years at first pregnancy <p>Exclusion criteria:</p> <ul style="list-style-type: none"> History of serious nonobstetric problems (seizure disorders, leukemia or drug or alcohol abuse) Fetal demise Multiple pregnancy Missing data on study variables Women who breast fed after delivery or who were still breastfeeding at 4 to 6 weeks postpartum 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 56.00 (0.84) kg G2: 59.95 (0.82) G3: 60.91 (0.82)</p> <p>Pregravid BMI:</p> <p>G1: 21.81 (0.30) G2: 23.02 (0.29) G3: 23.18 (0.29)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Age (mean, yrs):</p> <p>G1: 14.49 (0.14) G2: 17.41 (0.13) G3: 22.63 (0.14)</p> <p>Parity: % primiparous: G1: 93.9 G2: 37.2 G3: 36.3</p>	<p>Race, %:</p> <p>White G1: 7.6 G2: 9.2 G3: 8.8</p> <p>Black G1: 69.5 G2: 57.5 G3: 61.8</p> <p>Hispanic G1: 22.8 G2: 33.3 G3: 29.4</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: G1: 20.8 G2: 34.8 G3: 40.2</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics:</p> <p>Mean change in arm muscle area, cm²: G1: 2.19 (0.44) G2: 1.78 (0.38) G3: 2.00 (0.39)</p> <p>Change in arm fat area, cm²: G1: -0.46 (0.48) G2: -1.18 (0.43) G3: -1.26 (0.44)</p> <p>Change in triceps skinfold, mm Change in subscapular skinfold, mm: G1: -0.85 (0.38) -1.13 (0.38) G2: 1.22 (0.33) -0.87 (0.33) G3: -1.25 (0.34) -1.53 (0.34)</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
<p>Groups (N): G1: 197 G2: 207 G3: 204</p> <p>Total weight gain: G1: 14.85 (0.54) kg G2: 13.82 (0.47) G3: 14.12 (0.48)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Routine pre-natal care or maternity records <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery 	<p>Birth weight: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Anthropometric measurements taken were: mid-upper arm circumference, triceps, and subscapular skinfold thickness from left side of body - upper arm muscle and fat area <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> $r = 0.21, P < 0.001$ for infant birth weight and arm fat area at 28 wk gestation $r = 0.16, P < 0.001$ for infant birth weight and arm muscle area at 28 wk gestation Question 54: Shows multiple linear regression analysis of infant birth weight (g) - model included: gestation (wk), maternal age (y), low pregravid weight, maternal height, prior poor outcome, primiparity, infant sex, race, smoking Question 67: Shows pattern of pregnancy weight gain, birth weight, and weight retention by arm fat area changes (28 weeks to the postpartum period) * designates model was adjusted for maternal age, parity, ethnicity, low pregravid weight, height, smoking, length of gestation or interval (wk) to the 4-6 wk postpartum visit ** designates model was adjusted for length of gestation, maternal age, parity, ethnicity, low pregravid weight, height, smoking, total weight gain, prior poor outcome, infant sex *** designates model was adjusted for length of gestation, maternal age, parity, ethnicity, low pregravid weight, height, smoking, total weight gain, prior poor outcome, infant sex - but not significantly different from zero <p>Groups: G1: Teenagers 13 to 15 years G2: Teenagers 16 to 18 years G3: Adults 19-29</p> <p>Results: Total weight gain (kg) G1: 16.7 (2.5) $P = 0.001$ G2: NR</p> <p>Fat loss > 6.4 cm² G1: 144.3 (51.9) $P = 0.006$ G2: NR</p> <p>Fat loss and low weight (< 25th percentile for chronological age) G1: -339.5 (130.9) $P = 0.010$ G2: NR</p> <p>Fat accretion > 5 cm² G1: -123.3 (49.5) $P = 0.013$ G2: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Hediger et al., 1994
(continued)

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
		<p>Confounders and effect modifiers G1: < 1fifth percentile arm fat area loss G2: 1fifth-50th percentile arm fat area loss G3: 50th-8fifth percentile arm fat area loss G4: > 8fifth percentile arm fat area loss</p> <p>G1: 89 G2: 214 G3: 223 G4: 82</p> <p>Weight gain at 28 wk, kg G1: 9.77 (0.60) G2: 9.02 (0.38) G3: 8.74 (0.37) G4: 10.63 (0.62) *<i>P</i> < 0.05 significantly different from means for other arm fat area change percentile groups by analysis of covariance</p> <p>Weight gain in third trimester, kg G1: 4.44 (0.36) G2: 4.74 (0.23) G3: 5.01 (0.23) G4: 6.33 (0.38) *<i>P</i> < 0.05 significantly different from means for other arm fat area change percentile groups by analysis of covariance</p> <p>Total gain, kg G1: 14.06 (0.70) G2: 13.73 (0.44) G3: 13.90 (0.44) G4: 16.81 (0.72) *<i>P</i> < 0.05 significantly different from means for other arm fat area change percentile groups by analysis of covariance</p> <p>Change in arm muscle area, cm² G1: 6.71 (0.52) **<i>P</i> < 0.05 significantly different from means for other arm fat area change percentile groups by analysis of covariance G2: 2.24 (0.33) G3: 0.92 (0.33) G4: -0.89 (0.54) ***<i>P</i> < 0.05 si</p> <p>infant birth weight, g G1: 3247.2 (43.5) **<i>P</i> < 0.05 significantly different from means for other arm fat area change percentile groups by analysis of covariance G2: 3146.4 (27.7) G3: 3163.1 (27.2) G4: 3026.7 (45.3) **<i>P</i> < 0.05 sign</p> <p>Gestation, wk G1: 39.2 (0.2) G2: 39.0 (0.1) G3: 38.7 (0.1) G4: 39.1 (0.2)</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<i>Author, year:</i> <i>Hediger et al., 1994</i> <i>(continued)</i>			

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
		Interval 28 wk to 4 to 6 wk postpartum, wk G1: 16.4 (0.4) G2: 15.8 (0.2) G3: 15.8 (0.2) G4: 16.7 (0.4)
		Retained weight, kg G1: 3.72 (0.38) G2: 4.40 (0.25) G3: 5.25 (0.24) * <i>P</i> < 0.05 significantly different from means for other arm fat area change percentile groups by analysis of covariance G4: 7.08 (0.40) * <i>P</i> < 0.05 significantly dif
		Small for gestational age, % G1: 7.9% G2: 6.1% G3: 9.4% G4: 11.0%
		Maternal confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> • Age • Race • Parity • Pregravid weight • Height • Length of gestation/interval to delivery • Total weight gain prior poor outcome • Fat loss • Fat loss & low weight • Fat accretion • Smoking
		Infant and child confounders and effect modifiers accounted for in analysis: <ul style="list-style-type: none"> • Infant sex

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Javanovic-Peterson 1993</p> <p>Country and setting: USA, hospitals affiliated with medical schools</p> <p>Enrollment Period: 1959 to 1966</p> <p>Funding: NR</p> <p>Study Objective: <i>to investigate with MRI the relationship between maternal weight, fat distribution, and glucose levels and neonatal birthweight ratio, percent fat, and infant outcome in pregnancies complicated by gestational diabetes.</i></p> <p>Time frame: NR</p> <p>Duration of the study: NA</p>	<p>Design:</p> <ul style="list-style-type: none"> • Observational • Prospective <p>Total Study N: 20</p> <p>Group Description: NA</p> <p>Group N: 20</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women with GDM at 36 to 38 weeks' gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NR 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • No <p>Age (mean, yrs): 28.8 years</p> <p>Parity: NR</p>	<p>Race, %: NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: 100%</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
<p>Groups (N):</p> <p>Total weight gain:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight:</p> <p>Gestational diabetes, %:</p> <p>0%</p> <p>Cesarean delivery, %:</p> <p>NR</p> <p>Instrumental delivery, %:</p> <p>NR</p> <p>Episiotomy, %:</p> <p>NR</p> <p>Other maternal outcomes:</p> <p>NR</p> <p>Other infant outcomes:</p> <p>NR</p>	<p>Outcomes Description:</p> <p>Maternal body composition measures, infant birthweight and neonatal morbidity</p> <p>Groups:</p> <p>NA</p> <p>Results:</p> <ul style="list-style-type: none"> Maternal body composition was related to maternal weight (p=0.012, r=0.54) Maternal arm fat was related to maternal weight (p=0.05, r=0.60) Maternal arm fat correlated with trunk fat Maternal trunk fat not correlated with weight (NS) Maternal hemoglobin correlated with maternal weight (p=0.05, r=0.43) Maternal hemoglobin not correlated with infant birth weight Infant birth weight ratio predicted by MRI (p<0.001, r=0.88) Mother's arm > 50mm² risk or fetus more than 4.0 mm mean thickness of maximal abdominal fat, risk of macrosomia and neonatal glycemia increased <p>Maternal confounders and effect modifiers accounted for in analysis:</p> <ul style="list-style-type: none"> NA <p>Infant and child confounders and effect modifiers accounted for in analysis:</p> <p>NA</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: <i>Larciprete et al., 2003</i></p> <p>Country and setting: <i>Italy, obstetrics ambulatory clinic</i></p> <p>Enrollment period: NR</p> <p>Funding: NR</p> <p>Study Objective: <i>To evaluate changes in maternal body composition and normal ranges of maternal body components during various periods of pregnancy</i></p> <p>Time frame: NR</p> <p>Duration of the study: <i>First prenatal visit to delivery</i></p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 170</p> <p>Group Description: G1: Total sample G2: NR</p> <p>Group N: G1: 170 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Women with singleton healthy pregnancy were consecutively recruited for a longitudinal study at early gestation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Did not complete study program • Premature rupture of membranes at 24 to 26 weeks gestation • Spontaneous miscarriage • Incomplete prenatal data • Gestational diabetes that required insulin • Gestational hypertension treated with nifedipine 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Routine pre-natal care <p>G1: 66.73 (1.39) kg G2: NR</p> <p>Pregravid BMI: G1: 24.15 (0.48) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 32.06 (0.50) G2: NR</p> <p>Parity:</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
<p>Groups (N): G1: 170 G2: NR</p> <p>Total weight gain:</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: G1: 3472.75 (42.35) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> analysis of correlations TBW and ECW significantly increase during second and third trimester of gestation - progressive decrease in resistance provides indirect proof of TBW and ECW expansion at mid-gestation and term gestation, since inverse relationship between first and last 2 parameters is well known Reactance undergoes a progressive rise during entire gestation, following maternal weight gain - this result demonstrates that even fat mass deposition and not only fluid retention is responsible for GWG, since reactance is an indirect parameter in estimating fat mass amount Intracellular water slightly enhances during course of gestation with a peak in late third trimester - this observation may be explained by water filling need of some tissues, occurring at term gestation to guarantee correct development of labor, delivery, and puerperium <p>Groups: G1: Total sample G2: NR</p> <p>Results:</p> <p>Extracellular water G1: 0.146 <i>P</i> = 0.116 G2: NR</p> <p>Intracellular water G1: 0.151 <i>P</i> = 0.108 G2: 0.398 <i>P</i> = 0.000</p> <p>Total body water G1: 0.147 <i>P</i> = 0.116 G2: 1.00 <i>P</i> = 0.000 G3: 0.998 <i>P</i> = 0.000</p> <p>Reactance G1: 0.105 <i>P</i> = 0.251 G2: 0.315 <i>P</i> = 0.001 G3: 0.302 <i>P</i> = 0.002 G4: 0.313 <i>P</i> = 0.002</p> <p>Resistance G1: -0.538 <i>P</i> = 0.000 G2: -0.135 <i>P</i> = 0.144 G3: -0.146 <i>P</i> = 0.118 G4: -0.135 <i>P</i> = 0.149</p> <p>Outcomes Set 2: NR</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Lederman et al., 1997</p> <p>Country and setting: USA, clinics</p> <p>Enrollment Period: Jan 1991-Aug 1993</p> <p>Funding: Grant from Maternal and Child Health Bureau and Department of Health and Human Services</p> <p>Study Objective: To determine fat deposited during pregnancy in women according to recommendations of IOM and relationship of weight gain to fat gain in women of different starting weights classified by BMI</p> <p>Time frame: Jan 1991 to Aug 1993</p> <p>Duration of the study: From first visit through delivery</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 196</p> <p>Group Description: G1: study cohort G2: NR</p> <p>Group N: G1: 196 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • 18 to 35 years of age • Non-smokers • Self-identified as Hispanic, black, or white • Expecting singleton birth • Able to schedule their first body composition laboratory visit before 16th week of gestation • Free of medical illnesses requiring regular medication • Not knowingly infected with HIV • Not a regular user of drugs or alcohol according to mother's report <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • NA they had to have a 37 week measurement and medical record available 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • Self-reported <p>G1: 63.4 (12.9) G2: NR</p> <p>Pregravid BMI:</p> <p>Imputed:</p> <ul style="list-style-type: none"> • NR <p>Categorized:</p> <ul style="list-style-type: none"> • IOM guidelines <p>Age (mean, yrs): G1: 26.0 (4.8) G2: NR</p> <p>Parity: G1: 0.8 (1.0) G2: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
<p>Groups (N): G1: 196 G2: NR</p> <p>Total weight gain: G1: 13.6 (6.1) G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> According to IOM <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> Based on last clinically measured weight prior to delivery: difference between measurement at week 37+ and prepregnancy 	<p>Birth weight: G1: 3,449 (433) G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: Study investigators measured body weight, body density by hydrodensitometry, and deuterium dilution volume twice during pregnancy (at weeks 12-16 and at 37+ weeks)</p> <p>Other infant outcomes: NA</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Fat gain between pregnancy weeks 14-37 <p>Groups: < IOM, within IOM, > IOM, for BMI groups for three outcomes: G1: Body weight gain G2: Body water gain G3: Fat gain</p> <p>Results:</p> <p>BMI < 19.8: all women (n = 21) G1: 12.6 (4.4) G2: 6.1 (2.4) G3: 4.8 (3.8)</p> <p>BMI < 19.8: less than recommended; recommended; more than recommended G1: 7.9 (1.6); 12.6 (2.4); 16.1 (3.9) G2: 6.4 (3.7); 5.9 (1.6); 6.1 (2.2) G3: 0.6 (1.9); 6.0 (2.6); 6.9 (3.5)</p> <p>BMI 19.8-26.0: all women (n = 118) G1: 12.2 (4.0) G2: 7.0 (2.7) G3: 3.9 (3.7)</p> <p>BMI 19.8-26.0: less than recommended; recommended; more than recommended G1: 8.6 (1.9); 12.1 (3.4); 15.2 (3.4) G2: 6.2 (2.1); 6.9 (2.7); 7.6 (3.0) G3: 1.3 (3.0); 3.8 (3.5); 6.0 (3.1)</p> <p>BMI > 26.0-29.0: all women (n = 29) G1: 11.0 (4.6) G2: 7.8 (3.5) G3: 2.8 (5.4)</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Lederman et al., 1997
(continued)

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
		<p>BMI > 26.0-29.0: less than recommended; recommended; more than recommended G1: 8.5 (3.2); 9.1 (3.1); 13.6 (5.1) G2: 6.9 (3.0); 5.7 (3.0); 9.7 (3.2) G3: 0.3 (2.5); 2.8 (4.1); 4.2 (6.9)</p> <p>BMI > 29.0: all women (n = 28) G1: 8.7 (5.6) G2: 7.3 (2.9) G3: 0.2 (5.0)</p> <p>BMI > 29.0: less than recommended; recommended; more than recommended G1: 3.2 (2.7); 6.9 (4.4); 12.0 (4.6) G2: 7.8 (3.5); 6.0 (2.9); 7.6 (2.7) G3: -5.2 (1.5); -0.6 (4.6); 3.1 (3.9)</p> <p>Results for BMI and IOM recommendations over time: G1: BMI < 19.8 and gained within IOM recommendations G2: BMI 19.8-26.0 and gained within IOM recommendations G3: BMI > 26.0-29.0 and gained within IOM recommendations G4: BMI > 29.0 and gained within IOM recommendations G1: 7 G2: 46 G3: 9 G4: 6</p> <p>Total body fat at week 14 G1: 12.2 (2.3) G2: 18.2 (2.8)</p> <p>Total body fat at week 37+ G1: 17.9 (5.4) G2: 21.7 (5.8)</p> <p>Characteristics: G1: 25.1 (4.5) G2: 28.0 (3.8)</p> <p>Group G1: 33.1 (8.3) G2: 32.5 (5.7)</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Paxton et al., 1998</p> <p>Country and setting: USA, prenatal clinics</p> <p>Enrollment Period: Jan 1991 to Jan 1994</p> <p>Funding: Supported by grant MCJ-360601 from Maternal and Child Health Bureau (Title V, SSA), HRSA, DHHS</p> <p>Study Objective: To accurately estimate fat without making extensive assumptions regarding composition of lean tissue in pregnant women, authors developed a 4-compartment model (weight, water, bone mineral mass, and body density) as standard, tested 4 exist</p> <p>Time frame: Jan 1991 to Jan 1994</p> <p>Duration of the study: From week 14 to week 37 of pregnancy</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 200</p> <p>Group Description: G1: All G2: NR</p> <p>Group N: G1: 200 G2: NR</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Black, Hispanic, and white women 18-35 years of age with singleton pregnancy, free of major illness <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Smoker during pregnancy Regular drug or alcohol use during pregnancy Delivered before second measurement visit 	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Self-reported <p>G1: 63.2 ± 12.8 G2: NR</p> <p>Pregravid BMI: G1: Maternal prepregnancy weight classification: Underweight (BMI < 19.8) 10.5% Normal weight (BMI 19.8–26.0) 61.5% Overweight (BMI > 26 to 29.0) 14.5% Obese (BMI > 29) 13.5%</p> <p>G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs): G1: 26 ± 4.8 G2: NR</p> <p>Parity: G1: 0.8 ± 1.0 G2: NR</p>	<p>Race, %: White G1: 21% G2: NR</p> <p>Black G1: 25% G2: NR</p> <p>Hispanic G1: 55% G2: NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
<p>Groups (N): G1: 200 G2: NR</p> <p>Total weight gain: G1: 13.6 kg ± 4.5 G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> (classified as < 5, %: 5 to < 10, 10 to < 15, and ³ 15 kg), <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: G1: 3451 ± 439g G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes:</p> <ul style="list-style-type: none"> Existing anthropometric measures varied from each other, with 4-compartment model providing lowest estimate of weight gain Change in fat and fat mass estimate from weeks 14 to 37 or at week 37 from new anthropometric model was not significantly different from estimate from 4-compartment model (weight, water, bone mineral mass, and body density) <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Traditional anthropometric measures Comparisons between new anthropometric model and 4-compartment model <p>Groups: G1: Anthropometric equation for fat at 37 weeks G2: Four compartment model for fat at 37 weeks G3: Anthropometric equation for change in fat mass from 14- 37 weeks G4: Four-compartment model for change in fat mass from 14- 37 weeks</p> <p>G5: Weight and body-composition changes during gestation</p> <p>Results: GWG (wks 14 to 37) < 5 kg G1: 27.83 ± 13.51 G2: 23.55 ± 13.00 G3: - 4.17 ± 1.99 G4: - 5.66 ± 4.01 (no significant differences based on repeated-measures)</p> <p>GWG (wks 14 to 37) 5 to < 10 kg G1: 22.00 ± 6.96 G2: 21.46 ± 7.69 G3: 0.24 ± 1.16 G4: 0.96 ± 2.36 (no significant differences based on repeated-measures)</p> <p>GWG (wks 14 to 37) 10 to < 15 kg G1: 23.14 ± 6.09 G2: 22.90 ± 6.91 G3: 3.87 ± 1.38 G4: 4.36 ± 2.80 (no significant differences based on repeated-measures)</p> <p>GWG (wks 14 to 37) ≥ 15 kg G1: 30.93 ± 10.08 G2: 31.55 ± 10.33 G3: 9.73 ± 2.17 G4: 8.70 ± 2.73 (no significant differences based on repeated-measures)</p> <p>Change in weight (prepregnancy to week 14) Prepregnancy to week 14) G5: 2.1 ± 4.5 (-9.5, 26.9)</p> <p>Change in weight (week 14 to 37) G5: 11.5 ± 4.5 (-0.9, 23.8)</p> <p>Change in total body water (week 14 to 37) G5: 7.0 ± 2.9 (-2.5, 16.1)</p> <p>Change in fat (week 14 to 37) G5: 3.3 ± 4.3 (-9.2, 14.1)</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Paxton et al., 1998
(continued)

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
		Hydration of fat-free mass (%) at week 14 G5: 73.84 ± 3.43 (64.88, 82.37)
		Hydration of fat-free mass (%) at week 37 G5: 75.66 ± 3.58 (60.81, 87.87)
		Density of fat-free mass (g/L) at week 14 G5: 1100 ± 12 (1074, 1128)
		Density of fat-free mass (g/L) at week 37 G5: 1091 ± 12 (1054, 1135)
		Maternal confounders and effect modifiers accounted for in analysis: NR
		Infant and child confounders and effect modifiers accounted for in analysis: NR

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Sohlstrom et al., 1993</p> <p>Country and setting: Sweden, setting NR</p> <p>Enrollment Period: not stated</p> <p>Funding: NR</p> <p>Study Objective: To validate and assess precision of MRI method; to estimate changes in amount of TBF and FF body weight during pregnancy and throughout first year post partum in a group of healthy Swedish women; to study how distribution of TBF is affected during pregnancy and throughout the first year post partum</p> <p>Time frame: Not stated</p> <p>Duration of the study: First visit during pregnancy to 1 year postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> • Cohort • Prospective <p>Total Study N: 10</p> <p>Group Description: G1: Total sample G2: NR</p> <p>Group N: G1: 10 G2: NR</p> <p>Inclusion criteria: NR</p> <p>Exclusion criteria: NR</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> • NR <p>G1: 62.6 (9.7) kg G2: NR</p> <p>Pregravid BMI: G1: 22.4 (2.7) G2: NR</p> <p>Imputed:</p> <ul style="list-style-type: none"> • No <p>Categorized:</p> <ul style="list-style-type: none"> • Continuous <p>Age (mean, yrs): G1: 28 (5) G2: NR</p> <p>Parity: NR</p>	<p>Race, %: White NR Black NR Hispanic NR Asian/Pacific Islander NR Other NR</p> <p>Smoking, %: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics: % total body fat prepregnancy: G1: 25.7 (4.8) G2: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
<p>Groups (N): G1: 10 G2: NR</p> <p>Total weight gain: G1: 19.0 (7.9) kg G2: NR</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: G1: 3700 (620) g G2: NR</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: net weight gain during pregnancy: 9.8 (6.3)kg - 5.5 (3.2)kg was TBF and 4.3 (3.7)kg was fat free body weight</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> During first 6 and 12 months postpartum women mobilized 2.6 (3.6) and 3.2 (3.2)kg body fat, respectively Correlations - indicates that women who retained more fat during pregnancy also were those who mobilized more fat post partum On average, 84% of fat retained during pregnancy was placed subcutaneously - amount of subcutaneous fat decreased during whole year post partum while non subcutaneous fat did not change or even tended to increase during this period of time 44% of fat retained during pregnancy was placed in lower trunk, 30% in upper trunk, 1% in thighs, 4% in upper arms, 2% in calves, and 1% in forearms During first 2 months postpartum fat was mainly mobilized from lower trunk, most of fat retained in thighs was mobilized during first year post partum while fat which still remained after 1 year mainly was found in upper and lower trunk <p>Groups: G1: Total sample</p> <p>Results: Fat mobilized at 6 months postpartum G1: $r = -0.66$ $P < 0.05$</p> <p>Fat mobilized at 12 months postpartum G1: $r = -0.83$ $P < 0.01$</p> <p>Maternal confounders and effect modifiers accounted for in analysis: NR</p> <p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
<p>Author, year: Soltani and Fraser, 2000</p> <p>Country and setting: UK, hospital</p> <p>Enrollment Period: NR</p> <p>Funding: NR</p> <p>Study Objective: To investigate pattern of changes in weight gain and fat distribution during pregnancy and postpartum and whether this differed by maternal BMI measured in first trimester</p> <p>Time frame: NR</p> <p>Duration of the study: First prenatal visit to 6 months postpartum</p>	<p>Design:</p> <ul style="list-style-type: none"> Cohort Prospective <p>Total Study N: 77</p> <p>Group Description: G1: Total sample G2: Normal weight G3: Overweight G4: Obese</p> <p>Group N: G1: 77 G2: 29 G3: 23 G4: 25</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> Women attending first prenatal visit at Northern General Hospital <p>Exclusion criteria: NR</p>	<p>Pregravid weight:</p> <ul style="list-style-type: none"> Measured during first prenatal visit <p>G1: 73.0 (16.8) G2: 60.8 (5.6) G3: 72.0 (5.9) G4: 93.0 (10.6)</p> <p>Pregravid BMI:</p> <p>G1: 27.4 (5.9) G2: 22.7 (1.3) G3: 27.7 (1.4) G4: 34.5 (3.54)</p> <p>Imputed:</p> <ul style="list-style-type: none"> No <p>Categorized:</p> <ul style="list-style-type: none"> IOM guidelines <p>Age (mean, yrs):</p> <p>G1: 26.71 (4.77) G2: 26.44 (5.32) G3: 26.91 (4.50) G4: 27.68 (3.83)</p> <p>Parity:</p> <p>G1: 0.78 (0.86) G2: 0.55 (0.87) G3: 0.81 (0.75) G4: 1.00 (0.96)</p>	<p>Race, %:</p> <p>White NR</p> <p>Black NR</p> <p>Hispanic NR</p> <p>Asian/Pacific Islander NR</p> <p>Other NR</p> <p>Smoking, %:</p> <p>G1: 24% G2: NR</p> <p>Diabetes mellitus, %: NR</p> <p>Hypertension, %: NR</p> <p>Additional characteristics:</p> <p>Fat mass (kg) at first visit:</p> <p>G1: 24.5 (9.9) G2: 16.5 (3.6) G3: 24.6 (3.9) G4: 36.1 (5.9)</p> <p>Waist:hip ratio:</p> <p>G1: 0.92 (0.08) G2: 0.88 (0.06) G3: 0.92 (0.08) G4: 0.96 (0.08)</p> <p>Total Skinfold Thickness (mm):</p> <p>G1: 117.09 (40.19) G2: 84.3 (25.31) G3: 125.02 (22.76) G4: 158.74 (21.52)</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
<p>Groups (N): G1: 77 G2: 29 G3: 25</p> <p>Total weight gain: G1: 13-36 weeks: 10.8 (4.7) G2: 11.0 (3.2) G3: 11.9 (6.4) G4: 9.7 (4.3)</p> <p>Categorized:</p> <ul style="list-style-type: none"> Continuous <p>Collected from:</p> <ul style="list-style-type: none"> Collected by study investigators <p>Ascertained by:</p> <ul style="list-style-type: none"> NR 	<p>Birth weight: G1: 3443.0 (589.60) G2: 3331.5 (481.7) G3: 3423.7 (543.2) G4: 3670.4 (489.5)</p> <p>Gestational diabetes, %: NR</p> <p>Cesarean delivery, %: NR</p> <p>Instrumental delivery, %: NR</p> <p>Episiotomy, %: NR</p> <p>Other maternal outcomes: NR</p> <p>Other infant outcomes: NR</p>	<p>Outcomes Description:</p> <ul style="list-style-type: none"> Pattern of weight changes during pregnancy and up to 6 months postpartum follow a monotonous trend in normal weight women, all seem to increase weight during pregnancy and a considerable weight loss is observed at 6 weeks post partum - from then until 6 months postpartum, they either tend to reduce slightly or stay at the same level Normal weight women follow a comparatively monotonous pattern of changes in fat mass Overweight women show a divergent pattern - women with maximum weight gain and also maximum weight loss are seen in this - overweight women show a very scattered pattern of changes in fat mass Majority of obese women seem to be considerably heavier at 6 months postpartum in comparison with 13 weeks gestation Obese women mostly have higher values of fat mass at 6 months postpartum than early pregnancy Underweight women showed a similar trend of change as normal weight women <p>Groups: G1: Total sample G2: Normal weight G3: Overweight G4: Obese</p> <p>G1: 29 G2: 23 G3: 25 G4: 77</p> <p>Results: Change in fat mass 13 weeks gestation - 36 weeks gestation G1: 4.9 (2.7) G2: 5.3 (4.5) G3: 3.7 (2.8) G4: 4.6 (3.4)</p> <p>Change in fat mass: 13 weeks gestation - 6 months postpartum (n = 47; normal wt n = 18; overwt n = 12; obese n = 17) G1: 1.1 (2.7) G2: 3.9 (6.5) G3: 3.2 (4.1) G4: 2.6 (4.5)</p> <p>Change in fat mass: 36 weeks gestation - 6 months postpartum (n = 47; normal wt n = 18; overwt n = 12; obese n = 17) G1: -4.1 (2.1) G2: -1.1 (4.3) G3: -0.9 (3.9) <i>P</i> < 0.05 G4: -2.4 (3.8)</p>

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Study Description	Study Design, Patient Population, Inclusion/ Exclusion Criteria	Baseline Characteristics	Baseline Characteristics (continued)
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Author, year:
Soltani and Fraser, 2000
(continued)

Evidence Table 56. Anthropometrics of maternal weight retention (continued)

Maternal Weight Gain	Outcomes from Bivariate Analysis	Outcomes from Multivariate Analysis
		<p>Change in body weight 13 weeks gestation - 36 weeks gestation G1: 11.0 (3.2) G2: 11.9 (6.4) G3: 9.7 (4.3) G4: 10.8 (4.7)</p>
		<p>Change in body weight: 13 weeks gestation - 6 months postpartum (n = 47; normal wt n = 18; overwt n = 12; obese n = 17) G1: 0.4 (3.2) G2: 2.8 (8.4) G3: 0.6 (6.4) G4: 1.1 (6.0)</p>
		<p>Change in body weight: 13 weeks gestation - 6 months postpartum (n = 47; normal wt n = 18; overwt n = 12; obese n = 17) G1: -10.7 (2.5) G2: -8.8 (5.0) G3: -9.7 (5.4) G4: -9.9 (4.4)</p>
		<p>Change in TSF(mm): 13-36 weeks gestation G1: 30.26 (18.61) G2: 28.82 (24.97) G3: 22.20 (17.86)</p>
		<p>Change in TSF (mm): 13 weeks gestation - 6 months postpartum (n = 47; normal wt n = 18; overwt n = 12; obese n = 17) G1: 8.74 (15.77) G2: 24.10 (38.68) G3: 28.04 (19.18)</p>
		<p>Change in TSF (mm): 36 weeks gestation - 6 months postpartum (n = 47; normal wt n = 18; overwt n = 12; obese n = 17) G1: -23.96 (14.85) G2: -9.48 (28.49) G3: 3.93 (22.05) <i>P</i> < 0.05</p>
		<p>Change in waist to hip ratio 6 weeks to 6 months postpartum G1: -0.02 (0.05) G2: 0.01 (0.03) G3: 0.02 (0.03) <i>P</i> < 0.05</p>
		<p>Maternal confounders and effect modifiers accounted for in analysis: NR</p>
		<p>Infant and child confounders and effect modifiers accounted for in analysis: NR</p>

Appendix D. List of Excluded Studies

Exclusion Codes

Code	Criteria	N
X-1	Article is not concerned with topics relevant to maternal weight gain or the measurement of body fat	80
X-2	Wrong publication type (e.g. letter, commentary or editorial)	32
X-4	n < 40 for comparisons including cohort studies	10
X-5	n < 100 for case-series	2
X-6	Not published in english	0
X-7	Wrong publication type (e.g. letter, commentary or editorial)	2
X-8	Wrong design - please explain	23
X-9	Includes only a population w/ a pre-existing condition - please list condition	18
X-10	100% multi-fetal	2
X-12	Study not conducted in a developed nation?	21
X-14	Not related to key questions	74
X-17	Pre-pregnancy weight or BMI is not in article	36

1. From the Centers for Disease Control. Pregnancy risks determined from birth certificate data-- United States, 1989. *J Am Med Assoc* 1992;268(14):1831-2. X2
2. Pregnancy risks determined from birth certificate data--United States, 1989. *MMWR Morb Mortal Wkly Rep* 1992;41(30):556-63. X1
3. From the Centers for Disease Control and Prevention. Pregnancy-related behaviors among migrant farm workers--four states, 1989-1993. *J Am Med Assoc* 1997;277(19):1512. X2
4. Midwifery and childbirth news. *Midwifery Today* 2006(79):60-60. X1
5. Recommended gestational weight gain linked to childhood obesity. *Contemp OB/GYN* 2007;52(5):19-19. X2
6. New in review. Periodicals. *J Am Diet Assoc* 2007;107(3):512-517. X1
7. Abrams B. Prenatal weight gain and postpartum weight retention: a delicate balance. *Am J Pub Health* 1993;83(8):1082-1084. X2, B
8. Abrams B, Carmichael S, Selvin S. Factors associated with the pattern of maternal weight gain during pregnancy. *Obstet Gynecol* 1995;86(2):170-6. X8
9. Abrams B, Parker JD. Maternal weight gain in women with good pregnancy outcome. *Obstet Gynecol* 1990;76(1):1-7. X17
10. Achadi EL, Hansell MJ, Sloan NL, Anderson MA. Women's nutritional status, iron consumption and weight gain during pregnancy in relation to neonatal weight and length in West Java, Indonesia. *Int J Gynaecol Obstet* 1995;48 Suppl:S103-19. X12
11. Akbay E, Tiras MB, Yetkin I, Toruner F, Ersoy R, Uysal S, Ayvaz G. Insulin secretion and insulin sensitivity in normal pregnancy and gestational diabetes mellitus. *Gynecol Endocrinol* 2003;17(2):137-42. X1
12. Albers LL. Clues to positive birth outcomes in New Mexico. *J Nurse Midwifery* 1994;39(4):273-7. X14
13. Albers LL, Greulich B, Peralta P. Body mass index, midwifery intrapartum care, and childbirth lacerations. *J Midwifery Womens Health* 2006;51(4):249-53. X14
14. Althuisen E, van Poppel MN, Seidell JC, van der Wijden C, van Mechelen W. Design of the New Life(style) study: a randomised controlled trial to optimise maternal weight development during pregnancy. [ISRCTN85313483]. *BMC Public Health* 2006;6:168. X8
15. Anderson NE, Smiley DV, Flick LH, Lewis CY. Missouri Rural Adolescent Pregnancy Project (MORAPP). *Public Health Nurs* 2000;17(5):355-362. X14
16. Artal R, Catanzaro RB, Gavard JA, Mostello DJ, Friganza JC. A lifestyle intervention of weight-gain restriction: diet and exercise in obese women with gestational diabetes mellitus. *Appl Physiol Nutr Metab* 2007;32(3):596-601. X2
17. Ayustawati, Matsubara S, Minakami H, Ohkuchi A, Izumi A, Sato I. Symphysis-fundus height and weight gain pattern in Japanese women with twin pregnancies. *J Reprod Med* 2003;48(4):277-82. X10
18. Babinszki A, Kerenyi T, Torok O, Grazi V, Lapinski RH, Berkowitz RL. Perinatal outcome in grand and great-grand multiparity: effects of parity on obstetric risk factors. *Am J Obstet Gynecol* 1999;181(3):669-74. X14
19. Bainbridge J. Lingering pregnancy fat puts women in danger. *Br J Midwifery* 2006;14(11):644-644. X2
20. Barker DJ. Fetal programming of coronary heart disease. *Trends Endocrinol Metab* 2002;13(9):364-8. X2
21. Barnett E. Race differences in the proportion of low birth weight attributable to maternal cigarette smoking in a low-income population. *Am J Health Promot* 1995;10(2):105-110. X1
22. Barry H. Does abnormal weight gain in pregnancy predict poor outcome? *Evidence-Based Pract* 1998;1(4):9-10, insert 2p. X2
23. Bar-Zohar D, Azem F, Klausner J, Abu-Abeid S. Pregnancy after laparoscopic adjustable gastric banding: perinatal outcome is favorable also for

- women with relatively high gestational weight gain. *Surg Endosc* 2006;20(10):1580-3. X9
24. Behrman CA, Hediger ML, Scholl TO, Arkangel CM. Nausea and vomiting during teenage pregnancy: effects on birth weight. *J Adolesc Health Care* 1990;11(5):418-22. X14
 25. Berenson AB, Wiemann CM, Rowe TF, Rickert VI. Inadequate weight gain among pregnant adolescents: risk factors and relationship to infant birth weight. *Am J Obstet Gynecol* 1997;176(6):1220-4; discussion 1224-7. X17
 26. Bergmann MM, Flagg EW, Miracle-McMahill HL, Boeing H. Energy intake and net weight gain in pregnant women according to body mass index (BMI) status. *Int J Obes Relat Metab Disord* 1997;21(11):1010-7. X14
 27. Bergsjö P, Bakketeig LS, Lindmark G. Maternal smoking does not affect fetal size as measured in the mid-second trimester. *Acta Obstet Gynecol Scand* 2007;86(2):156-60. X1
 28. Black J. Re: Urinalysis and weighing at all antenatal visits. *Aust N Z J Obstet Gynaecol* 2005;45(6):541. X2
 29. Bo S, Marchisio B, Volpiano M, Menato G, Pagano G. Maternal low birth weight and gestational hyperglycemia. *Gynecol Endocrinol* 2003;17(2):133-6. X14
 30. Bodnar LM, Ness RB, Markovic N, Roberts JM. The risk of preeclampsia rises with increasing prepregnancy body mass index. *Ann Epidemiol* 2005;15(7):475-482. X1
 31. Bodnar LM, Siega-Riz AM, Cogswell ME. High prepregnancy BMI increases the risk of postpartum anemia. *Obes Res* 2004;12(6):941-8. X1
 32. Boney CM, Verma A, Tucker R, Vohr BR. Metabolic syndrome in childhood: association with birth weight, maternal obesity, and gestational diabetes mellitus. *Pediatrics* 2005;115(3):e290-6. X14
 33. Brawarsky P, Stotland NE, Jackson RA, Fuentes-Afflick E, Escobar GJ, Rubashkin N, Haas JS. Pre-pregnancy and pregnancy-related factors and the risk of excessive or inadequate gestational weight gain. *Int J Gynaecol Obstet* 2005;91(2):125-31. X14, B
 34. Bronsky J, Karpisek M, Bronska E, Pechova M, Jancikova B, Kotolova H, Stejskal D, Prusa R, Nevoral J. Adiponectin, adipocyte fatty acid binding protein, and epidermal fatty acid binding protein: proteins newly identified in human breast milk. *Clin Chem* 2006;52(9):1763-70. X12
 35. Brost BC, Goldenberg RL, Mercer BM, Iams JD, Meis PJ, Moawad AH, Newman RB, Miodovnik M, Caritis SN, Thurnau GR, Bottoms SF, Das A, McNellis D. The Preterm Prediction Study: association of cesarean delivery with increases in maternal weight and body mass index. *Am J Obstet Gynecol* 1997;177(2):333-7; discussion 337-41. X1
 36. Brown JE, Kaye SA, Folsom AR. Parity-related weight change in women. *Int J Obes Relat Metab Disord* 1992;16(9):627-31. X1
 37. Brown JE, Mahan CS. Weight gain and pregnancy outcome. *Am J Obstet Gynecol* 1996;175(5):1396-7. X2
 38. Buchanan TA, Xiang A, Kjos SL, Lee WP, Trigo E, Nader I, Bergner EA, Palmer JP, Peters RK. Gestational diabetes: antepartum characteristics that predict postpartum glucose intolerance and type 2 diabetes in Latino women. *Diabetes* 1998;47(8):1302-10. X9
 39. Burrowes JD. Nutrition for a lifetime. *Nutr Today* 2006;41(6):267-273. X8
 40. Buschman NA, Foster G, Vickers P. Adolescent girls and their babies: achieving optimal birthweight. Gestational weight gain and pregnancy outcome in terms of gestation at delivery and infant birth weight: a comparison between adolescents under 16 and adult women. *Child Care Health Dev* 2001;27(2):163-71. X14
 41. Butte NF. Energy requirements during pregnancy and consequences of deviations from requirement on fetal outcome. *Nestle Nutr Workshop Ser Pediatr Program* 2005(55):49-67; discussion 67-71. X8
 42. Butte NF, Wong WW, Treuth MS, Ellis KJ, O'Brien Smith E. Energy requirements during pregnancy based on total energy expenditure and energy deposition. *Am J Clin Nutr* 2004;79(6):1078-87. X1

43. Calfee EF, Rust OA, Bofill JA, Ross EL, Morrison JC. Maternal hypoglycemia: is it associated with adverse perinatal outcome? *J Perinatol* 1999;19(5):379-82. X14
44. Carmichael S, Abrams B, Selvin S. The pattern of maternal weight gain in women with good pregnancy outcomes. *Am J Public Health* 1997;87(12):1984-8. B, X14
45. Carpenter MW, Sady SP, Sady MA, Haydon B, Coustan DR, Thompson PD. Effect of maternal weight gain during pregnancy on exercise performance. *J Appl Physiol* 1990;68(3):1173-6. X1
46. Casanueva E, Rosello-Soberon ME, De-Regil LM, Arguelles Mdel C, Cespedes MI. Adolescents with adequate birth weight newborns diminish energy expenditure and cease growth. *J Nutr* 2006;136(10):2498-501. X14
47. Catalano PM. Management of obesity in pregnancy. *Obstet Gynecol* 2007;109(2 Part 1):419-433. X8
48. Caulfield LE, Witter FR, Stoltzfus RJ. Determinants of gestational weight gain outside the recommended ranges among black and white women. *Obstet Gynecol* 1996;87(5 Pt 1):760-6. B, X8
49. Cazano C, Russell BK, Brion LP. Size at birth in an inner-city population. *Am J Perinatol* 1999;16(10):543-8. X14
50. Chez RA. Weight gain during pregnancy. *Am J Pub Health*;76(12):1390-1391. X7
51. Clapp JF, 3rd, Kim H, Burciu B, Schmidt S, Petry K, Lopez B. Continuing regular exercise during pregnancy: effect of exercise volume on fetoplacental growth. *Am J Obstet Gynecol* 2002;186(1):142-7. X14
52. Cliver SP, Goldenberg RL, Cutter GR, Hoffman HJ, Copper RL, Gotlieb SJ, Davis RO. The relationships among psychosocial profile, maternal size, and smoking in predicting fetal growth retardation. *Obstet Gynecol* 1992;80(2):262-7. X14
53. Cogswell ME, Scanlon KS, Fein SB, Schieve LA. Medically advised, mother's personal target, and actual weight gain during pregnancy. *Obstet Gynecol* 1999;94(4):616-22. X14, B
54. Colletto GM, Segre CA. Lack of effect of maternal body mass index on anthropometric characteristics of newborns in twin gestations. *Genet Mol Res* 2005;4(1):47-54. X1
55. Conti J, Abraham S, Taylor A. Eating behavior and pregnancy outcome. *J Psychosom Res* 1998;44(3-4):465-77. X17
56. Copper RL, DuBard MB, Goldenberg RL, Oweis AI. The relationship of maternal attitude toward weight gain to weight gain during pregnancy and low birth weight. *Obstet Gynecol* 1995;85(4):590-5. X14
57. Cordero L, Hines S, Shibley KA, Landon MB. Perinatal outcome for women in prison. *J Perinatol* 1992;12(3):205-9. X9
58. Covington DL, Peoples-Sheps MD, Buescher PA, Bennett TA, Paul MV. An evaluation of an adolescent prenatal education program. *Am J Health Behav* 1998;22(5):323-333. X14
59. Cox S. Weight gain during pregnancy. *J Midwifery Womens Health* 2003;48(3):229-30. X7
60. Cundy T, Gamble G, Manuel A, Townend K, Roberts A. Determinants of birth-weight in women with established and gestational diabetes. *Aust N Z J Obstet Gynaecol* 1993;33(3):249-54. X9
61. Czeizel AE, Dudas I, Dobo M, Pal M. Maternal weight gain and birth weight. *Acta Paediatr Hung* 1992;32(2):91-100. X12
62. Dabbs WN. Got milk? *J Miss State Med Assoc* 2004;45(4):102-5. X1
63. D'Alfonso A, Iovenitti P, Carta G. Urinary disorders during pregnancy and postpartum: our experience. *Clin Exp Obstet Gynecol* 2006;33(1):23-5. X17
64. Davies K, Wardle J. Body image and dieting in pregnancy. *J Psychosom Res* 1994;38(8):787-99. X14
65. Dawes MG, Green J, Ashurst H. Routine weighing in pregnancy. *Br Med J* 1992;304(6825):487-9. X1

66. Dawes MG, Grudzinskas JG. Patterns of maternal weight gain in pregnancy. *Br J Obstet Gynaecol* 1991;98(2):195-201. X14
67. de Groot LC. High maternal body weight and pregnancy outcome. *Nutr Rev* 1999;57(2):62-4. X2
68. de Jong CL, Gardosi J, Baldwin C, Francis A, Dekker GA, van Geijn HP. Fetal weight gain in a serially scanned high-risk population. *Ultrasound Obstet Gynecol* 1998;11(1):39-43. X1
69. Di Cianni G, Benzi L, Bottone P, Volpe L, Orsini P, Murru S, Casadidio I, Clemente F, Navalesi R. Neonatal outcome and obstetric complications in women with gestational diabetes: effects of maternal body mass index. *Int J Obes Relat Metab Disord* 1996;20(5):445-9. X17
70. Di Cianni G, Volpe L, Ghio A, Lencioni C, Cuccuru I, Benzi L, Del Prato S. Maternal metabolic control and perinatal outcome in women with gestational diabetes mellitus treated with Lispro or Aspart Insulin: comparison with regular insulin. *Diabet Care* 2007;30(4):e11-e11. X1
71. Di Cianni G, Volpe L, Lencioni C, Miccoli R, Cuccuru I, Ghio A, Chatzianagnostou K, Bottone P, Teti G, Del Prato S, Benzi L. Prevalence and risk factors for gestational diabetes assessed by universal screening. *Diabet Res Clin Pract* 2003;62(2):131-7. X14
72. DiPietro JA, Millet S, Costigan KA, Gurewitsch E, Caulfield LE. Psychosocial influences on weight gain attitudes and behaviors during pregnancy. *J Am Diet Assoc* 2003;103(10):1314-1319. X1
73. Dixon JB, Dixon ME, O'Brien PE. Birth outcomes in obese women after laparoscopic adjustable gastric banding. *Obstet Gynecol* 2005;106(5 Pt 1):965-72. X9
74. Dubois L, Girard M. Early determinants of overweight at 4.5 years in a population-based longitudinal study. *Int J Obes (Lond)* 2006;30(4):610-7. X1
75. Durnwald CP, Ehrenberg HM, Mercer BM. The impact of maternal obesity and weight gain on vaginal birth after cesarean section success. *Am J Obstet Gynecol* 2004;191(3):954-7. X14
76. Ehrenberg HM, Dierker L, Milluzzi C, Mercer BM. Low maternal weight, failure to thrive in pregnancy, and adverse pregnancy outcomes. *Am J Obstet Gynecol* 2003;189(6):1726-30. X17
77. Ehrenberg HM, Durnwald CP, Catalano P, Mercer BM. The influence of obesity and diabetes on the risk of cesarean delivery. *Am J Obstet Gynecol* 2004;191(3):969-74. X1
78. Ellard GA, Johnstone FD, Prescott RJ, Ji-Xian W, Jian-Hua M. Smoking during pregnancy: the dose dependence of birthweight deficits. *Br J Obstet Gynaecol* 1996;103(8):806-13. X1
79. Ellison GT, Holliday M. The use of maternal weight measurements during antenatal care. A national survey of midwifery practice throughout the United Kingdom. *J Eval Clin Pract* 1997;3(4):303-17. X1
80. Erez-Weiss I, Erez O, Shoham-Vardi I, Holcberg G, Mazor M. The association between maternal obesity, glucose intolerance and hypertensive disorders of pregnancy in nondiabetic pregnant women. *Hypertens Pregnancy* 2005;24(2):125-36. X12
81. Eriksson JG. Early growth and adult health outcomes--lessons learned from the Helsinki Birth Cohort Study. *Matern Child Nutr* 2005;1(3):149-54. X1
82. Evans KC, Evans RG, Royal R, Esterman AJ, James SL. Effect of caesarean section on breast milk transfer to the normal term newborn over the first week of life. *Arch Dis Child Fetal Neonatal Ed* 2003;88(5):F380-2. X1
83. Farr SL, Jamieson DJ, Rivera HV, Ahmed Y, Heilig CM. Risk factors for cesarean delivery among Puerto Rican women. *Obstet Gynecol* 2007;109(6):1351-1357. X14
84. Fell DB, Joseph KS, Dodds L, Allen AC, Jangaard K, Van den Hof M. Changes in maternal characteristics in Nova Scotia, Canada from 1988 to 2001. *Can J Public Health* 2005;96(3):234-8. X8
85. Forsum E. Energy requirements during pregnancy: old questions and new findings. *Am J Clin Nutr* 2004;79(6):933-4. X2

86. Fowles ER. Comparing pregnant women's nutritional knowledge to their actual dietary intake. *Am J Matern Child Nurs* 2002;27(3):171-177. X1
87. Fowles ER, Walker LO. Correlates of dietary quality and weight retention in postpartum women. *J Comm Health Nurs* 2006;23(3):183-197. X17
88. Frederick IO, Rudra CB, Miller RS, Foster JC, Williams MA. Adult weight change, weight cycling, and prepregnancy obesity in relation to risk of preeclampsia. *Epidemiology* 2006;17(4):428-34. X1
89. Galvez M, Myles TD. Teenage pregnancy in the Texas Panhandle. *J Rural Health* 2005;21(3):259-62. X14
90. Gillman MW. Developmental origins of health and disease. *N Engl J Med* 2005;353(17):1848-50. X1
91. Gillman MW, Rich-Edwards JW, Huh S, Majzoub JA, Oken E, Taveras EM, Rifas-Shiman SL. Maternal corticotropin-releasing hormone levels during pregnancy and offspring adiposity. *Obesity (Silver Spring)* 2006;14(9):1647-53. X14
92. Giovannini M, Radaelli G, Banderali G, Riva E. Low prepregnant body mass index and breastfeeding practices. *J Hum Lact* 2007;23(1):44-51. X1
93. Giuliani A, Tamussino K, Basver A, Haas J, Petru E. The impact of body mass index and weight gain during pregnancy on puerperal complications after spontaneous vaginal delivery. *Wien Klin Wochenschr* 2002;114(10-11):383-6. X17
94. Goldenberg RL, Iams JD, Mercer BM, Meis P, Moawad A, Das A, Copper R, Johnson F. What we have learned about the predictors of preterm birth. *Semin Perinatol* 2003;27(3):185-93. X1
95. Gonen O, Rosen DJ, Dolfin Z, Tepper R, Markov S, Fejgin MD. Induction of labor versus expectant management in macrosomia: a randomized study. *Obstet Gynecol* 1997;89(6):913-7. X1
96. Goodman MM, Clarke JA, Jehne C. A case for revising the 'weight gain during pregnancy' guidelines for Australian women. *Aust N Z J Obstet Gynaecol* 1992;32(2):129-32. X1
97. Gray-Donald K, Robinson E, Collier A, David K, Renaud L, Rodrigues S. Intervening to reduce weight gain in pregnancy and gestational diabetes mellitus in Cree communities: an evaluation. *Can Med Assoc J* 2000;163(10):1247-51. X14
98. Grisaru-Granovsky S, Eitan R, Algur N, Schimmel MS, Diamant YZ, Samueloff A. Maternal and umbilical cord serum leptin concentrations in small-for-gestational-age and in appropriate-for-gestational-age neonates: a maternal, fetal, or placental contribution? *Biol Neonate* 2003;84(1):67-72. X4
99. Groth S. Are the Institute of Medicine recommendations for gestational weight gain appropriate for adolescents? *J Obstet Gynecol Neonatal Nurs* 2007;36(1):21-7. X17
100. Gunderson EP. Nutrition during pregnancy for the physically active woman. *Clin Obstet Gynecol* 2003;46(2):390-402. X14
101. Gunderson EP, Murtaugh MA, Lewis CE, Quesenberry CP, West DS, Sidney S. Excess gains in weight and waist circumference associated with childbearing: The Coronary Artery Risk Development in Young Adults Study (CARDIA). *Int J Obes Relat Metab Disord* 2004;28(4):525-35. X14
102. Gunes T, Koklu E, Ozturk MA. Maternal and cord serum lipid profiles of preterm infants with respiratory distress syndrome. *J Perinatol* 2007;27(7):415-21. X12
103. Gutbrod T, Wolke D, Soehne B, Ohrt B, Riegel K. Effects of gestation and birth weight on the growth and development of very low birthweight small for gestational age infants: a matched group comparison. *Arch Dis Child Fetal Neonatal Ed* 2000;82(3):F208-14. X1
104. Gutierrez YM. Cultural factors affecting diet and pregnancy outcome of Mexican American adolescents. *J Adolesc Health* 1999;25(3):227-37. X8
105. Haakstad LA, Voldner N, Henriksen T, Bo K. Physical activity level and weight gain in a cohort of pregnant Norwegian women. *Acta Obstet Gynecol Scand* 2007;86(5):559-64. X14

106. Haas AV. Preventing complications with nutrition. *Midwifery Today Int Midwife* 2003(67):40-1. X2
107. Harris H. Is fat a pregnancy issue? *Pract Midwife* 1998;1(6):20-2. X8
108. Harris HE, Ellison GT. Practical approaches for estimating prepregnant body weight. *J Nurse Midwifery* 1998;43(2):97-101. X14
109. Harris HE, Ellison GTH, Richter LM, De Wet T, Levin J. Are overweight women at increased risk of obesity following pregnancy? *Br J Nutr* 1998;79(6):489-494. X14
110. Heilemann MV, Lee KA, Stinson J, Koshar JH, Goss G. Acculturation and perinatal health outcomes among rural women of Mexican descent. *Res Nurs Health* 2000;23(2):118-25. X17
111. Helms E, Coulson CC, Galvin SL. Trends in weight gain during pregnancy: a population study across 16 years in North Carolina. *Am J Obstet Gynecol* 2006;194(5):e32-4. X17
112. Herman AA, Yu KF. Adolescent age at first pregnancy and subsequent obesity. *Paediatr Perinat Epidemiol* 1997;11 Suppl 1:130-41. X14
113. Herrera-Perdigon J, Hopkins E, Marcalle M, Brooten D, Youngblut JM, Lizardo ML. Weight gain in high-risk pregnant women: comparison by primary diagnosis and type of care. *Clin Excell Nurse Pract* 2005;9(4):195-201. X9
114. Hickey CA, Cliver SP, Goldenberg RL, Blankson ML. Maternal weight status and term birth weight in first and second adolescent pregnancies. *J Adolesc Health* 1992;13(7):561-9. X17
115. Hickey CA, Cliver SP, Goldenberg RL, McNeal SF, Hoffman HJ. Relationship of psychosocial status to low prenatal weight gain among nonobese black and white women delivering at term. *Obstet Gynecol* 1995;86(2):177-83. B, X8
116. Hickey CA, Cliver SP, Goldenberg RL, McNeal SF, Hoffman HJ. Low prenatal weight gain among low-income women: what are the risk factors? *Birth* 1997;24(2):102-8. X9
117. Hickey CA, Cliver SP, McNeal SF, Goldenberg RL. Low pregravid body mass index as a risk factor for preterm birth: variation by ethnic group. *Obstet Gynecol* 1997;89(2):206-12. X14
118. Hirose K, Tajima K, Hamajima N, Kuroishi T, Kuzuya K, Miura S, Tokudome S. Comparative case-referent study of risk factors among hormone-related female cancers in Japan. *Jpn J Cancer Res* 1999;90(3):255-61. X1
119. Homko CJ, Sivan E, Nyirjesy P, Reece EA. The interrelationship between ethnicity and gestational diabetes in fetal macrosomia. *Diabetes Care* 1995;18(11):1442-5. X9
120. Howie LD, Parker JD, Schoendorf KC. Excessive maternal weight gain patterns in adolescents. *J Am Diet Assoc* 2003;103(12):1653-7. X14
121. Hun DJ, Stoecker BJ, Hermann JR, Kopel BL, Williams GS, Claypool PL. Effects of nutrition education programs on anthropometric measurements and pregnancy outcomes of adolescents. *J Am Diet Assoc* 2002;102(3 Suppl):S100-2. X4
122. Hutcheon JA, Platt RW, Meltzer SJ, Egeland GM. Is birth weight modified during pregnancy? Using sibling differences to understand the impact of blood glucose, obesity, and maternal weight gain in gestational diabetes. *Am J Obstet Gynecol* 2006;195(2):488-94. X9
123. Ijuin H, Douchi T, Nakamura S, Oki T, Yamamoto S, Nagata Y. Possible association of body-fat distribution with preeclampsia. *J Obstet Gynaecol Res* 1997;23(1):45-9. X1
124. Jackson EA, Francke L, Vasilenko P. Management of gestational diabetes by family physicians and obstetricians. *J Fam Pract* 1996;43(4):383-8. X1
125. Jaksic J, Mikulandra F, Perisa M, Miletic T, Dubovecak Z, Skugor D, Tadin I. Effect of insulin and insulin-like growth factor I on fetal macrosomia in healthy women. *Coll Antropol* 2001;25(2):535-43. X12
126. Janney CA, Zhang D, Sowers M. Lactation and weight retention. *Am J Clin Nutr* 1997;66(5):1116-1124. X14

127. Jeffery AN, Voss LD, Metcalf BS, Wilkin TJ. The impact of pregnancy weight and glucose on the metabolic health of mother and child in the south west of the UK. *Midwifery* 2004;20(3):281-9. X1
128. Jensen DM, Damm P, Sorensen B, Molsted-Pedersen L, Westergaard JG, Ovesen P, Beck-Nielsen H. Pregnancy outcome and prepregnancy body mass index in 2459 glucose-tolerant Danish women. *Am J Obstet Gynecol* 2003;189(1):239-44. X1
129. Johnson PJ, Hellerstedt WL, Pirie PL. Abuse history and nonoptimal prenatal weight gain. *Public Health Rep* 2002;117(2):148-56. X14
130. Johnston CS, Christopher FS, Kandell LA. Pregnancy weight gain in adolescents and young adults. *J Am Coll Nutr* 1991;10(3):185-9. X17
131. Johnston CS, Kandell LA. Prepregnancy weight and rate of maternal weight gain in adolescents and young adults. *J Am Diet Assoc* 1992;92(12):1515-7. X14
132. Jonquil SG. Weight gain and pregnancy. *Midwifery Today Childbirth Educ* 1997(42):40-1. X2
133. Kahn HS, Tatham LM, Heath CW, Jr. Contrasting factors associated with abdominal and peripheral weight gain among adult women. *Int J Obes Relat Metab Disord* 1997;21(10):903-11. X1
134. Kaijser M, Jacobsen G, Granath F, Cnattingius S, Ekblom A. Maternal age, anthropometrics and pregnancy oestriol. *Paediatr Perinat Epidemiol* 2002;16(2):149-53. X1
135. Kearney MH, Munro BH, Kelly U, Hawkins JW. Health behaviors as mediators for the effect of partner abuse on infant birth weight. *Nurs Res* 2004;53(1):36-45. X1
136. Kearney MH, Simonelli MC. Intervention fidelity: lessons learned from an unsuccessful pilot study. *App Nurs Res* 2006;19(3):163-166. X4
137. Kim I, Hungerford DW, Yip R, Kuester SA, Zyrkowski C, Trowbridge FL. Pregnancy nutrition surveillance system--United States, 1979-1990. *MMWR CDC Surveill Summ* 1992;41(7):25-41. X2
138. King JC. New National Academy of Sciences guidelines for nutrition during pregnancy. *Diabetes* 1991;40 Suppl 2:151. X2
139. Kinnunen TI, Luoto R, Gissler M, Hemminki E. Pregnancy weight gain from 1960s to 2000 in Finland. *Int J Obes Relat Metab Disord* 2003;27(12):1572-7. X8
140. Kinnunen TI, Pasanen M, Aittasalo M, Fogelholm M, Hilakivi-Clarke L, Weiderpass E, Luoto R. Preventing excessive weight gain during pregnancy - a controlled trial in primary health care. *Eur J Clin Nutr* 2007;61(7):884-91. X14
141. Kirchengast S, Gruber D, Sator M, Huber J. Postmenopausal weight status, body composition and body fat distribution in relation to parameters of menstrual and reproductive history. *Maturitas* 1999;33(2):117-26. X17
142. Konje JC, Palmer A, Watson A, Hay DM, Imrie A, Ewings P. Early teenage pregnancies in Hull. *Br J Obstet Gynaecol* 1992;99(12):969-73. X14
143. Kramer MS, Morin I, Yang H, Platt RW, Usher R, McNamara H, Joseph KS, Wen SW. Why are babies getting bigger? Temporal trends in fetal growth and its determinants. *J Pediatr* 2002;141(4):538-42. B, X14
144. Krueger PM, Scholl TO. Adequacy of prenatal care and pregnancy outcome. *J Am Osteopath Assoc* 2000;100(8):485-92. X14
145. Krummel DA. Postpartum weight control: a vicious cycle. *J Am Diet Assoc* 2007;107(1):37-40. X2
146. Lagiou P, Hsieh CC, Trichopoulos D, Xu B, Wu J, Mucci L, Tamimi R, Adami HO, Cnattingius S. Birthweight differences between USA and China and their relevance to breast cancer aetiology. *Int J Epidemiol* 2003;32(2):193-8. X12
147. Lagiou P, Lagiou A, Samoli E, Hsieh CC, Adami HO, Trichopoulos D. Diet during pregnancy and levels of maternal pregnancy hormones in relation to the risk of breast cancer in the offspring. *Eur J Cancer Prev* 2006;15(1):20-6. X1

148. Lagiou P, Tamimi RM, Mucci LA, Adami HO, Hsieh CC, Trichopoulos D. Diet during pregnancy in relation to maternal weight gain and birth size. *Eur J Clin Nutr* 2004;58(2):231-7. X1
149. Lahmann PH, Lissner L, Gullberg B, Olsson H, Berglund G. A prospective study of adiposity and postmenopausal breast cancer risk: the Malmo Diet and Cancer Study. *Int J Cancer* 2003;103(2):246-52. X1
150. Landon MB, Thom E, Spong CY, Carpenter M, Mele L, Johnson F, Tillinghast J, Anderson G. The National Institute of Child Health and Human Development Maternal-Fetal Medicine Unit Network randomized clinical trial in progress: standard therapy versus no therapy for mild gestational diabetes. *Diabet Care* 2007;30 Suppl 2:S194-9. X1
151. Lao TT, Ho LF. Impact of iron deficiency anemia on prevalence of gestational diabetes mellitus. *Diabetes Care* 2004;27(3):650-6. X1
152. Lao TT, Wong KY. Perinatal outcome in large-for-gestational-age infants. Is it influenced by gestational impaired glucose tolerance? *J Reprod Med* 2002;47(6):497-502. X1
153. Lauszus FF, Paludan J, Klebe JG. Birthweight in women with potential gestational diabetes mellitus--an effect of obesity rather than glucose intolerance? *Acta Obstet Gynecol Scand* 1999;78(6):520-5. X17
154. Lawoyin TO. A prospective study on some factors which influence the delivery of large babies. *J Trop Med Hyg* 1993;96(6):352-6. X12
155. Lederman SA, Alfasi G, Deckelbaum RJ. Pregnancy-associated obesity in black women in New York City. *Matern Child Health J* 2002;6(1):37-42. X14
156. Lepercq J, Hauguel-De Mouzon S, Timsit J, Catalano PM. Fetal macrosomia and maternal weight gain during pregnancy. *Diabet Metab* 2002;28(4 Pt 1):323-8. X14
157. Levine RJ, Ewell MG, Hauth JC, Curet LB, Catalano PM, Morris CD, Choudhary G, Sibai BM. Should the definition of preeclampsia include a rise in diastolic blood pressure of ≥ 15 mm Hg to a level < 90 mm Hg in association with proteinuria? *Am J Obstet Gynecol* 2000;183(4):787-92. X17
158. Linne Y, Rossner S. Interrelationships between weight development and weight retention in subsequent pregnancies: the SPAWN study. *Acta Obstet Gynecol Scand* 2003;82(4):318-25. X17
159. Little RE. Weight gain and relation to maternal smoking. *J Epidemiol Community Health* 1999;53(4):256. X2
160. Lo T, Candido G, Janssen P. Diastasis of the Recti abdominis in pregnancy: risk factors and treatment. *Physiotherapy Canada* 1999;51(1):32. X14
161. Lucas A, Fewtrell MS, Davies PS, Bishop NJ, Clough H, Cole TJ. Breastfeeding and catch-up growth in infants born small for gestational age. *Acta Paediatr* 1997;86(6):564-9. X1
162. Luciano A, Bolognani M, Biondani P, Ghizzi C, Zoppi G, Signori E. The influence of maternal passive and light active smoking on intrauterine growth and body composition of the newborn. *Eur J Clin Nutr* 1998;52(10):760-3. X8
163. Luke B. Maternal weight, body mass index, and cesarean delivery. *Am J Obstet Gynecol* 1998;179(2):564. X2
164. Magann EF, Winchester MI, Carter DP, Martin JN, Jr., Bass JD, Morrison JC. Factors adversely affecting pregnancy outcome in the military. *Am J Perinatol* 1995;12(6):462-6. X8
165. Maloni JA, Alexander GR, Schluchter MD, Shah DM, Park S. Antepartum bed rest: maternal weight change and infant birth weight. *Biol Res Nurs* 2004;5(3):177-86. X9
166. Marceau P, Kaufman D, Biron S, Hould FS, Lebel S, Marceau S, Kral JG. Outcome of pregnancies after biliopancreatic diversion. *Obes Surg* 2004;14(3):318-24. X9
167. Marsoosi V, Jamal A, Eslamian L. Pre-pregnancy weight, low pregnancy weight gain, and preterm delivery. *Int J Gynaecol Obstet* 2004;87(1):36-7. X12
168. Martinez H, Allen LH, Lung'aho M, Chavez A, Peltó GH. Maternal fatness in Mexican women predicts body composition changes in pregnancy

- and lactation. *Adv Exp Med Biol* 1994;352:99-107. X12
169. McAnarney ER, Stevens-Simon C. First, do no harm. Low birth weight and adolescent obesity. *Am J Dis Child* 1993;147(9):983-5. X2
170. McFarland MB, Trylovich CG, Langer O. Anthropometric differences in macrosomic infants of diabetic and nondiabetic mothers. *J Matern Fetal Med* 1998;7(6):292-5. X14
171. Meyers-Seifer CH, Vohr BR. Lipid levels in former gestational diabetic mothers. *Diabetes Care* 1996;19(12):1351-6. X1
172. Mikode MS, White AA. Dietary assessment of middle-income pregnant women during the first, second, and third trimesters. *J Am Diet Assoc* 1994;94(2):196-9. X4
173. Millard GL, Beerman KA, Massey L, Shulz T, Heiss C. Pregnancy and birth outcomes of high-risk women participating in a multidisciplinary intervention program. *Topics Clin Nutr*;14(4):64-75. X14
174. Miser WF. Outcome of infants born with nuchal cords. *J Fam Pract* 1992;34(4):441-5. X1
175. Misra DP, Kiely JL. The effect of smoking on the risk of gestational hypertension. *Early Hum Dev* 1995;40(2):95-107. X1
176. Mohamed N, Dooley J. Gestational diabetes and subsequent development of NIDDM in aboriginal women of northwestern Ontario. *Int J Circumpolar Health* 1998;57 Suppl 1:355-8. X12
177. Mongoven M, Dolan-Mullen P, Groff JY, Nicol L, Burau K. Weight gain associated with prenatal smoking cessation in white, non-Hispanic women. *Am J Obstet Gynecol* 1996;174(1 Pt 1):72-7. X14
178. Montgomery KS. Improving nutrition in pregnant adolescents: recommendations for clinical practitioners. *J Perinat Educ* 2003;12(2):22-30. X2
179. Moreira P, Padez C, Mourao-Carvalho I, Rosado V. Maternal weight gain during pregnancy and overweight in Portuguese children. *Int J Obes (Lond)* 2007;31(4):608-14. X17
180. Morin K, Gennaro S, Fehder W. Nutrition and exercise in overweight and obese postpartum women. *App Nurs Res* 1999;12(1):13-21. X14
181. Moses RG, Luebcke M, Davis WS, Coleman KJ, Tapsell LC, Petocz P, Brand-Miller JC. Effect of a low-glycemic-index diet during pregnancy on obstetric outcomes. *Am J Clin Nutr* 2006;84(4):807-12. X14
182. Mottola MF, Campbell MK. Activity patterns during pregnancy. *Can J Appl Physiol* 2003;28(4):642-53. X14
183. Nafstad P, Jaakkola JJ, Hagen JA, Pedersen BS, Qvigstad E, Botten G, Kongerud J. Weight gain during the first year of life in relation to maternal smoking and breast feeding in Norway. *J Epidemiol Community Health* 1997;51(3):261-5. X1
184. Napoli A, Sabbatini A, Di Biase N, Marceca M, Colatrella A, Fallucca F. Twenty-four-hour blood pressure monitoring in normoalbuminuric normotensive type 1 diabetic women during pregnancy. *J Diabet Complic* 2003;17(5):292-6. X1
185. Neggers YH, Goldenberg RL, Ramey SL, Cliver SP. Maternal prepregnancy body mass index and psychomotor development in children. *Acta Obstet Gynecol Scand* 2003;82(3):235-40. X17
186. Neher JO. Transforming practice. New evidence challenges IOM gestational weight gain goals. *Evidence-Based Practice* 2007;10(8):1-3, 2p. X2
187. Ng SC, Gomez JM, Rajadurai VS, Saw SM, Quak SH. Establishing enteral feeding in preterm infants with feeding intolerance: a randomized controlled study of low-dose erythromycin. *J Pediatr Gastroenterol Nutr* 2003;37(5):554-8. X1
188. Nielsen GL, Dethlefsen C, Moller M, Sorensen HT. Maternal glycated haemoglobin, pre-gestational weight, pregnancy weight gain and risk of large-for-gestational-age babies: a Danish cohort study of 209 singleton Type 1 diabetic pregnancies. *Diabet Med* 2007;24(4):384-7. X9
189. Nohira T, Kim S, Nakai H, Okabe K, Nohira T, Yoneyama K. Recurrence of gestational diabetes mellitus: rates and risk factors from initial GDM

- and one abnormal GTT value. *Diabetes Res Clin Pract* 2006;71(1):75-81. X1
190. Ohlin A, Rossner S. Trends in eating patterns, physical activity and socio-demographic factors in relation to postpartum body weight development. *Br J Nutr* 1994;71(4):457-70. X14
 191. Ohlin A, Rossner S. Factors related to body weight changes during and after pregnancy: the Stockholm Pregnancy and Weight Development Study. *Obes Res* 1996;4(3):271-6. X17
 192. Olausson PM, Cnattingius S, Goldenberg RL. Determinants of poor pregnancy outcomes among teenagers in Sweden. *Obstet Gynecol* 1997;89(3):451-7. X17
 193. Olsen J. Cigarette smoking in pregnancy and fetal growth. Does the type of tobacco play a role? *Int J Epidemiol* 1992;21(2):279-84. X17
 194. Olson CM, Strawderman MS. Modifiable behavioral factors in a biopsychosocial model predict inadequate and excessive gestational weight gain. *J Am Diet Assoc* 2003;103(1):48-54. B, X8
 195. Olson CM, Strawderman MS, Reed RG. Efficacy of an intervention to prevent excessive gestational weight gain. *Am J Obstet Gynecol* 2004;191(2):530-6. X14
 196. O'Neill ME, Cooper KA, Hunyor SN, Boyce GS. Maternal heart rate response to low-intensity weight-bearing exercise. *J Appl Physiol* 1991;70(3):1407-9. X1
 197. Ouzilleau C, Roy MA, Leblanc L, Carpentier A, Maheux P. An observational study comparing 2-hour 75-g oral glucose tolerance with fasting plasma glucose in pregnant women: both poorly predictive of birth weight. *Can Med Assoc J* 2003;168(4):403-9. X17
 198. Parker JD, Abrams B. Differences in postpartum weight retention between black and white mothers. *Obstet Gynecol* 1993;81(5 (Pt 1)):768-74. X17
 199. Patterson RJ, Ellerbee S, Powell MJ, Thompson PJ, Jackson E. Evaluation of a clinic for pregnant adolescents. *J Ark Med Soc* 1994;91(3):131-4. X14
 200. Perez R, Patience T, Pulous E, Brown G, McEwen A, Asato A, Hume R, Calhoun BC. Use of a focussed teen prenatal clinic at a military teaching hospital: model for improved outcomes of unmarried mothers. *Aust N Z J Obstet Gynaecol* 1998;38(3):280-3. X1
 201. Perry RL, Mannino B, Hediger ML, Scholl TO. Pregnancy in early adolescence: are there obstetric risks? *J Matern Fetal Med* 1996;5(6):333-9. X1
 202. Peters RK, Kjos SL, Xiang A, Buchanan TA. Long-term diabetogenic effect of single pregnancy in women with previous gestational diabetes mellitus. *Lancet* 1996;347(8996):227-30. X1
 203. Piers LS, Diggavi SN, Thangam S, van Raaij JMA, Shetty PS, Hautvast JGA. Changes in energy expenditure, anthropometry, and energy intake during the course of pregnancy and lactation in well-nourished Indian women. *Am J Clin Nutr* 1995;61(3):501-513. X12
 204. Pole JD, Dodds LA. Maternal outcomes associated with weight change between pregnancies. *Can J Public Health* 1999;90(4):233-6. X1
 205. Polley BA, Wing RR, Sims CJ. Randomized controlled trial to prevent excessive weight gain in pregnant women. *Int J Obes Relat Metab Disord* 2002;26(11):1494-502. X14
 206. Poppitt SD, Prentice AM, Goldberg GR, Whitehead RG. Energy-sparing strategies to protect human fetal growth. *Am J Obstet Gynecol* 1994;171(1):118-25. X8
 207. Poppitt SD, Prentice AM, Jequier E, Schutz Y, Whitehead RG. Evidence of energy sparing in Gambian women during pregnancy: a longitudinal study using whole-body calorimetry. *Am J Clin Nutr* 1993;57(3):353-64. X12
 208. Prozialeck LL, Pesole L. Performing a program evaluation in a family case management program: determining outcomes for low birthweight deliveries. *Public Health Nurs* 2000;17(3):195-201. X4
 209. Prysak M, Lorenz RP, Kisly A. Pregnancy outcome in nulliparous women 35 years and older. *Obstet Gynecol* 1995;85(1):65-70. X14

210. Qureshi IA, Xi XR, Limbu YR, Bin HY, Chen MI. Hyperlipidaemia during normal pregnancy, parturition and lactation. *Ann Acad Med Singapore* 1999;28(2):217-21. X12
211. Rasmussen KM, Adams B. Annotation: cigarette smoking, nutrition, and birthweight... The effects of cigarette smoking and gestational weight change on birth outcomes in obese and normal-weight women. *Am J Public Health* 1997;87:591-596. *Am J Pub Health* 1997;87(4):543-544. X2
212. Ratner RE, Hamner LH, 3rd, Isada NB. Effects of gestational weight gain in morbidly obese women: II: Fetal morbidity. *Am J Perinatol* 1990;7(4):295-9. X10
213. Ray JG, Vermeulen MJ, Shapiro JL, Kenshole AB. Maternal and neonatal outcomes in pregestational and gestational diabetes mellitus, and the influence of maternal obesity and weight gain: the DEPOSIT study. *Diabetes Endocrine Pregnancy Outcome Study in Toronto. Q J Med* 2001;94(7):347-56. X9
214. Reece EA, Lequizamón G, Silva J, Whiteman V, Smith D. Intensive interventional maternity care reduces infant morbidity and hospital costs. *J Matern Fetal Neonatal Med* 2002;11(3):204-10. X14
215. Retnakaran R, Hanley AJ, Raif N, Connelly PW, Sermer M, Zinman B. Hypoadiponectinaemia in South Asian women during pregnancy: evidence of ethnic variation in adiponectin concentration. *Diabet Med* 2004;21(4):388-92. X1
216. Rhodes JC, Schoendorf KC, Parker JD. Contribution of excess weight gain during pregnancy and macrosomia to the cesarean delivery rate, 1990-2000. *Pediatrics* 2003;111(5):1181-1185. X17
217. Richardson P. Women's experiences of body change during normal pregnancy. *Maternal-Child Nurs J* 1990;19(2):93-111. X14
218. Roberts LA. Cesarean section. *Am J Obstet Gynecol* 1998;179(2):564-5. X2
219. Rooks JP, Weatherby NL, Ernst EKM. The National Birth Center Study -- methodology and prenatal care and referrals... part 1. *J Nurse-Midwifery* 1992;37(4):222-253. X14
220. Rosenberg L, Palmer JR, Wise LA, Horton NJ, Kumanyika SK, Adams-Campbell LL. A prospective study of the effect of childbearing on weight gain in African-American women. *Obes Res* 2003;11(12):1526-35. X17
221. Rossner S. Pregnancy, weight cycling and weight gain in obesity. *Int J Obes Relat Metab Disord* 1992;16(2):145-7. X8
222. Rota S, Yildirim B, Kaleli B, Aybek H, Duman K, Kaptanoglu B. C-reactive protein levels in non-obese pregnant women with gestational diabetes. *Tohoku J Exp Med* 2005;206(4):341-5. X12
223. Rudolph CM, Al-Fares S, Vaughan-Jones SA, Mullegger RR, Kerl H, Black MM. Polymorphic eruption of pregnancy: clinicopathology and potential trigger factors in 181 patients. *Br J Dermatol* 2006;154(1):54-60. X9
224. Rydhstrom H, Tyden T, Herbst A, Ljungblad U, Walles B. No relation between maternal weight gain and stillbirth. *Acta Obstet Gynecol Scand* 1994;73(10):779-81. X17
225. Salsberry PJ, Reagan PB. Taking the long view: the prenatal environment and early adolescent overweight. *Res Nurs Health* 2007;30(3):297-307. X1
226. Sanderson M, Gonzalez JF. 1988 National Maternal and Infant Health Survey: methods and response characteristics. *Vital Health Stat 2* 1998(125):1-39. X1
227. Sanin Aguirre LH, Reza-Lopez S, Levario-Carrillo M. Relation between maternal body composition and birth weight. *Biol Neonate* 2004;86(1):55-62. X12
228. Savitz DA, Whelan EA, Rowland AS, Kleckner RC. Maternal employment and reproductive risk factors. *Am J Epidemiol* 1990;132(5):933-45. X17
229. Schauberger CW, Rooney BL, Brimer LM. Factors that influence weight loss in the puerperium. *Obstet Gynecol* 1992;79(3):424-9. X17

230. Schieve LA, Perry GS, Cogswell ME, Scanion KS, Rosenberg D, Carmichael S, Ferre C. Validity of self-reported pregnancy delivery weight: an analysis of the 1988 National Maternal and Infant Health Survey. NMIHS Collaborative Working Group. *Am J Epidemiol* 1999;150(9):947-56. X1
231. Schmitt K. Chlamydial infection in pregnancy: An association with low birth weight [Ph.D.]: University of Florida; 1999.
232. Scholl TO, Chen X. Insulin and the "thrifty" woman: the influence of insulin during pregnancy on gestational weight gain and postpartum weight retention. *Matern Child Health J* 2002;6(4):255-61. X8
233. Scholl TO, Hediger ML. Weight gain, nutrition, and pregnancy outcome: findings from the Camden study of teenage and minority gravidas. *Semin Perinatol* 1995;19(3):171-81. X2
234. Scholl TO, Hediger ML, Fischer RL, Shearer JW. Anemia vs iron deficiency: increased risk of preterm delivery in a prospective study. *Am J Clin Nutr* 1992;55(5):985-8. X14
235. Scholl TO, Hediger ML, Vasilenko P, III, Healy MF. Growth and nutrition during adolescent pregnancy Growth and nutrition during adolescent pregnancy. In: *Malnourished children in the United States: caught in the cycle of poverty*. New York: Springer Publishing; 1993. p. 156-167.
236. Sebire NJ, Jolly M, Harris JP, Wadsworth J, Joffe M, Beard RW, Regan L, Robinson S. Maternal obesity and pregnancy outcome: a study of 287,213 pregnancies in London. *Int J Obes Relat Metab Disord* 2001;25(8):1175-82. X1
237. Segal MR, Wight S, Hanrahan JP, Tager IB. Maternal smoking during pregnancy and birth outcomes with weight gain adjustments via varying-coefficient models. *Stat Med* 1997;16(14):1603-16. X1
238. Selvin S, Abrams B. Analysing the relationship between maternal weight gain and birthweight: exploration of four statistical issues. *Paediatr Perinat Epidemiol* 1996;10(2):220-34. X14
239. Shaarawy M, el-Mallah SY. Leptin and gestational weight gain: relation of maternal and cord blood leptin to birth weight. *J Soc Gynecol Investig* 1999;6(2):70-3. X12
240. Sharma R, Synkewecz C, Raggio T, Mattison DR. Intermediate variables as determinants of adverse pregnancy outcome in high-risk inner-city populations. *J Natl Med Assoc* 1994;86(11):857-60. X17
241. Shrewsbury VA, Garnett SP, Cowell CT, Crawford D, Baur LA. Change in women's body mass index and waist circumference, 1997 to 2002: the Nepean Study. *Aust N Z J Public Health* 2005;29(2):183-6. X14
242. Siega-Riz AM, Hobel CJ. Predictors of poor maternal weight gain from baseline anthropometric, psychosocial, and demographic information in a Hispanic population. *J Am Diet Assoc* 1997;97(11):1264-8. X14, B
243. Skull AJ, Slater GH, Duncombe JE, Fielding GA. Laparoscopic adjustable banding in pregnancy: safety, patient tolerance and effect on obesity-related pregnancy outcomes. *Obes Surg* 2004;14(2):230-5. X9
244. Smith DE, Lewis CE, Caveny JL, Perkins LL, Burke GL, Bild DE. Longitudinal changes in adiposity associated with pregnancy. The CARDIA Study. Coronary Artery Risk Development in Young Adults Study. *J Am Med Assoc* 1994;271(22):1747-51. X14
245. Sohlstrom A, Forsum E. Changes in adipose tissue volume and distribution during reproduction in Swedish women as assessed by magnetic resonance imaging. *Am J Clin Nutr* 1995;61(2):287-295. X4
246. Solomon CG, Willett WC, Carey VJ, Rich-Edwards J, Hunter DJ, Colditz GA, Stampfer MJ, Speizer FE, Spiegelman D, Manson JE. A prospective study of pregravid determinants of gestational diabetes mellitus. *J Am Med Assoc* 1997;278(13):1078-83. X1
247. Sowers M, Zhang D, Janney CA. Interpregnancy weight retention patterning in women who breastfed. *J Matern Fetal Med* 1998;7(2):89-94. X14
248. Stage E, Ronneby H, Damm P. Lifestyle change after gestational diabetes. *Diabetes Res Clin Pract* 2004;63(1):67-72. X1

249. Steegers EA, Van Lakwijk HP, Jongsma HW, Fast JH, De Boo T, Eskes TK, Hein PR. (Patho)physiological implications of chronic dietary sodium restriction during pregnancy; a longitudinal prospective randomized study. *Br J Obstet Gynaecol* 1991;98(10):980-7. X4
250. Stein AD, Ravelli AC, Lumey LH. Famine, third-trimester pregnancy weight gain, and intrauterine growth: the Dutch Famine Birth Cohort Study. *Hum Biol* 1995;67(1):135-50. X17
251. Stein TP, Scholl TO, Schluter MD, Schroeder CM. Plasma leptin influences gestational weight gain and postpartum weight retention. *Am J Clin Nutr* 1998;68(6):1236-40. X14
252. Stephansson O, Dickman PW, Johansson A, Cnattingius S. Maternal weight, pregnancy weight gain, and the risk of antepartum stillbirth. *Am J Obstet Gynecol* 2001;184(3):463-9. X17
253. Sternfeld B, Quesenberry CP, Jr., Eskenazi B, Newman LA. Exercise during pregnancy and pregnancy outcome. *Med Sci Sports Exerc* 1995;27(5):634-40. X8
254. Stevens-Simon C, Fullar S, McAnarney ER. Tangible differences between adolescent-oriented and adult-oriented prenatal care. *J Adolesc Health Care* 1992;13(4):298-302. X14
255. Stevens-Simon C, McAnarney ER. Skeletal maturity and growth of adolescent mothers: relationship to pregnancy outcome. *J Adolesc Health* 1993;14(6):428-32. X14
256. Stevens-Simon C, McAnarney ER. Childhood victimization: relationship to adolescent pregnancy outcome. *Child Abuse Negl* 1994;18(7):569-75. X1
257. Stevens-Simon C, Roghmann KJ, McAnarney ER. Relationship of self-reported prepregnant weight and weight gain during pregnancy to maternal body habitus and age. *J Am Diet Assoc* 1992;92(1):85-7. X5
258. Stevens-Simon C, Thureen P, Barrett J, Stamm E. Regional body fat distribution and insulin resistance during adolescent pregnancy. *J Am Diet Assoc* 2002;102(4):563-5. X4
259. Stevens-Simon C, Thureen P, Barrett J, Stamm E. Research and professional briefs. Regional body fat distribution and insulin resistance during adolescent pregnancy. *J Am Diet Assoc* 2002;102(4):563-565. X4
260. Stone SE. Factors associated with a high rate of cesarean section in a small rural hospital [D.N.Sc.]: University of Tennessee Center for the Health Sciences; 2001.
261. Stotland NE, Haas JS, Brawarsky P, Jackson RA, Fuentes-Afflick E, Escobar GJ. Body mass index, provider advice, and target gestational weight gain. *Obstet Gynecol* 2005;105(3):633-8. X14, B
262. Strychar IM, Chabot C, Champagne F, Ghadirian P, Leduc L, Lemonnier MC, Raynauld P. Psychosocial and lifestyle factors associated with insufficient and excessive maternal weight gain during pregnancy. *J Am Diet Assoc* 2000;100(3):353-6. X14
263. Sutton L, Sayer GP, Bajuk B, Richardson V, Berry G, Henderson-Smart DJ. Do very sick neonates born at term have antenatal risks? 2. Infants ventilated primarily for lung disease. *Acta Obstet Gynecol Scand* 2001;80(10):917-25. X1
264. Taffel SM. Cesarean delivery in the United States, 1990. *Vital Health Stat* 21 1994(51):1-24. X8
265. Taffel SM, Keppel KG, Jones GK. Medical advice on maternal weight gain and actual weight gain. Results from the 1988 National Maternal and Infant Health Survey. *Ann N Y Acad Sci* 1993;678:293-305. B, X8
266. Tavares M, Rodrigues T, Cardoso F, Barros H, Leite LP. Independent effect of maternal birth weight on infant birth weight. *J Perinat Med* 1996;24(4):391-6. X17
267. Theron GB, Thompson ML. The usefulness of weight gain in predicting pregnancy complications. *J Trop Pediatr* 1993;39(5):269-72. X12
268. Trujillo K, Harvey-Banchik L. Hyperemesis gravidarum: feed the mother, feed the child. *J Parenter Enteral Nutr* 2005;29(2):134-5. X2
269. Turhan NO, Seckin NC, Aybar F, Inegol I. Assessment of glucose tolerance and pregnancy

- outcome of polycystic ovary patients. *Int J Gynaecol Obstet* 2003;81(2):163-8. X9
270. Turner RE, Langkamp-Henken B, Littell R. Update on adequacy of protein and energy intake during pregnancy. *J Am Diet Assoc* 2003;103(5):563. X2
271. Turner RE, Langkamp-Henken B, Littell RC, Lukowski MJ, Suarez MF. Comparing nutrient intake from food to the estimated average requirements shows middle- to upper-income pregnant women lack iron and possibly magnesium. *J Am Diet Assoc* 2003;103(4):461-466. X14
272. Vahratian A, Siega-Riz AM, Savitz DA, Zhang J. Maternal pre-pregnancy overweight and obesity and the risk of cesarean delivery in nulliparous women. *Ann Epidemiol* 2005;15(7):467-474. X1
273. Vallianatos H, Brennand EA, Raine K, Stephen Q, Petawabano B, Dannenbaum D, Willows ND. Beliefs and practices of First Nation women about weight gain during pregnancy and lactation: implications for women's health. *Can J Nurs Res* 2006;38(1):102-19. X5
274. van Bogaert LJ. Maternal end-pregnancy ponderal index and birth weight. *J Obstet Gynaecol* 2005;25(4):353-4. X12
275. van der Maten GD. Low sodium diet in pregnancy: effects on maternal nutritional status. *Eur J Obstet Gynecol Reprod Biol* 1995;61(1):63-4. X14
276. van der Maten GD, van Raaij JM, Visman L, van der Heijden LJ, Oosterbaan HP, de Boer R, Eskes TK, Hautvast JG. Low-sodium diet in pregnancy: effects on blood pressure and maternal nutritional status. *Br J Nutr* 1997;77(5):703-20. X1
277. Van Wootten W, Turner RE. Macrosomia in neonates of mothers with gestational diabetes is associated with body mass index and previous gestational diabetes. *J Am Diet Assoc* 2002;102(2):241-3. X17
278. Ventura SJ, Martin JA, Curtin SC, Mathews TJ. Births: final data for 1997. *Natl Vital Stat Rep* 1999;47(18):1-96. X8
279. Vik T, Jacobsen G, Vatten L, Bakketeig LS. Pre- and post-natal growth in children of women who smoked in pregnancy. *Early Hum Dev* 1996;45(3):245-55. X1
280. Villamor E, Cnattingius S. Interpregnancy weight change and risk of adverse pregnancy outcomes: a population-based study. *Lancet* 2006;368(9542):1164-70. X1
281. Walker LO. Weight-related distress in the early months after childbirth. *West J Nurs Res* 1998;20(1):30-44. X17
282. Walker LO, Freeland-Graves JH, Milani T, Hanss-Nuss H, George G, Sterling BS, Kim M, Timmerman GM, Wilkinson S, Arheart KL, Stuijbergen A. Weight and behavioral and psychosocial factors among ethnically diverse, low-income women after childbirth: I. Methods and context. *Women Health* 2004;40(2):1-17. X18
283. Walker LO, Kim M. Psychosocial thriving during late pregnancy: relationship to ethnicity, gestational weight gain, and birth weight. *J Obstet Gynecol Neonatal Nurs* 2002;31(3):263-74. X8 (wrong outcome)
284. Walker LO, Timmerman GM, Sterling BS, Kim M, Dickson P. Keeping pregnancy-related weight may result in long-term weight problems for women. *Ethn Dis* 2004;14(1):161-2. X2
285. Wen SW, Kramer MS. Etiologic fraction analysis for continuously distributed outcome variables and empirical analogy with dichotomized outcome variables. *Int J Epidemiol* 1995;24(2):457-61. X1
286. Wiles R. The views of women of above average weight about appropriate weight gain in pregnancy. *Midwifery* 1998;14(4):254-260. X4
287. Williamson DF, Madans J, Pamuk E, Flegal KM, Kendrick JS, Serdula MK. A prospective study of childbearing and 10-year weight gain in US white women 25 to 45 years of age. *Int J Obes Relat Metab Disord* 1994;18(8):561-9. X1
288. Witter FR. Epidemiology, antenatal screening, nutrition, and therapeutics in pregnancy. *Curr Opin Obstet Gynecol* 1990;2(1):36-9. X2
289. Wolfe HM, Gross TL. Obesity in pregnancy. *Clin Obstet Gynecol* 1994;37(3):596-604. X8

290. Wolfe WS, Sobal J, Olson CM, Frongillo EA, Jr. Parity-associated body weight: modification by sociodemographic and behavioral factors. *Obes Res* 1997;5(2):131-41. X14
291. Wolfe WS, Sobal J, Olson CM, Frongillo EA, Jr., Williamson DF. Parity-associated weight gain and its modification by sociodemographic and behavioral factors: a prospective analysis in US women. *Int J Obes Relat Metab Disord* 1997;21(9):802-10. X1
292. Wong W, Tang NLS, Lau TK, Wong TW. Research. A new recommendation for maternal weight gain in Chinese women. *J Am Diet Assoc* 2000;100(7):791-796. X12
293. Woolbright LA. Postneonatal mortality in Alabama: why no progress in the 90s? *Ann Epidemiol* 2001;11(3):208-212. X17
294. Xiao R, Sorensen TK, Williams MA, Luthy DA. Influence of pre-eclampsia on fetal growth. *J Matern Fetal Neonatal Med* 2003;13(3):157-62. X1
295. Xu B, Jarvelin MR, Pekkanen J. Prenatal factors and occurrence of rhinitis and eczema among offspring. *Allergy* 1999;54(8):829-36. X1
296. Yamamoto S, Douchi T, Yoshimitsu N, Nakae M, Nagata Y. Waist to hip circumference ratio as a significant predictor of preeclampsia, irrespective of overall adiposity. *J Obstet Gynaecol Res* 2001;27(1):27-31. X14
297. Yanagisawa K, Iwasaki N, Sanaka M, Minei S, Kanamori M, Omori Y, Iwamoto Y. Polymorphism of the beta3-adrenergic receptor gene and weight gain in pregnant diabetic women. *Diabetes Res Clin Pract* 1999;44(1):41-7. X9
298. Yekta Z, Porali R, Aiatollahi H. The effect of pre-pregnancy body mass index, gestational weight gain on pregnancy outcomes. *Internet J Health* 2005;4(2):9p. X12
299. Yogev Y, Langer O. Recurrence of gestational diabetes: pregnancy outcome and birth weight diversity. *J Matern Fetal Neonatal Med* 2004;15(1):56-60. X9
300. Zeanah M, Schlosser SP. Adherence to ACOG guidelines on exercise during pregnancy: effect on pregnancy outcome. *J Obstet Gynecol Neonatal Nurs* 1993;22(4):329-35. X1
301. Zimmer-Gembeck MJ, Helfand M. Low birthweight in a public prenatal care program: behavioral and psychosocial risk factors and psychosocial intervention. *Soc Sci Med* 1996;43(2):187-97. X17

Appendix E. Acknowledgments

Appendix E. Acknowledgments

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Technical Expert Panel

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