NHLBI Evidence Table: RF14-OB

PMID	First Author	Title	Year	Study Type	Prospect./ Restrospect.	Study	CVD	RF by CQ	Country	Setting	Main Study Objective	N at Baseline (N at Follow-up)	Target Population	Eligibility Criteria	Patient Characteristics	Study Groups	n at Baseline (n at Follow-up) for Study Groups	Total Follow-up Duration	Outcomes Measured	Results	Main Reported Findings by Critical Question
8427537	Jiang X	Association of fasting insulin with blood pressure in young individuals. The Bogalusa Heart Study	1993	CrS	Retrospective	Bogalusa	None	Q5 (RF4,8,14) Q6 (RF4,8,14) Q7 (RF4,8,14)	USA	Community (other)	Evaluate the relationship btwn fasting insulin and BP in a biracial population of children & young adults	3518	Pediatric/ Young adults	All participants in the Bogalusa study for whom fasting insulin, glucose & BP data were available.	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. For this study, 4 age groups: 5-8, 9-12,13-17,& 18-26 yrs. were evaluated.	4 age groups: 5-8 yr: n=717 9-12 yr: n=939 13-17 yr: n=1846 18-26 yr: n=814	N/A	N/A	Ht Wt Ponderal index BMI SBP DBP Fasting glucose (FG) Triceps SF Subscapular SF Fasting insulin (IINS)	A marked & consistent increase in INS & SBP occurs at puberty in early adolescence, greatest in WMs & WFs. INS then declines until ~ 17 y when it plateaus across young adult yrs. Overall, INS levels were highest in BFs. INS was significantly and (+)ly asst'd with SBP & DBP for all age groups except 13-17 y olds, but correlation was highest in younger age groups and post puberty. Strongest simple correlation was 0.38 for INS and SBP in 9-12 y group. Strongest overall correlation with SBP& DBP was BMI. With MVA, INS remained independently correlated with BP after controlling for glucose, BMI and SFs in 5-8 y group (r=0.13), 9-12 y group (r=0.22) & young adult group (r=0.08) but not in adolescents.	Q6,7. Insulin, SBP & BMI cluster together throughout childhood and into young adult life . There is a (+) correlation between fasting insulin & SBP except in adolescence but the association is substantially weakened with inclusion of BMI.
10353925	Freedman DS	The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study	1999	CrS	Retrospective	Bogalusa	None	Q5 (RF 4,5,8,14) Q6 (RF 4,5,8,14)	USA	Community (other)	Examine the relationship btwn overweight & C-V RFs + RF clustering in childhood.	9167 (no loss to F/U by study design)	Pediatric/ Young adults	All child participants in 7 CrS surveys with fasting blood work. If a subject participated in more than 1 survey, only final data was included --> 9167 subjects	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. For this study, subjects were evaluated in 7 cross-sectional surveys btwn 1973 & 1994; 52% M; 36% B.	N/A	N/A	N/A	Ht Wt Quetelet index (Wt (kgs)/ Ht (meters squared) (QI) Rohrer index (Wt in kgs/ Ht in meters cubed) Subscapular & triceps skin fold (SFs) SBP DBP MAP = DBP + (SBP-DBP/3) TC (< 200 mg/dl = high) TG (≥130 mg/dl = high) HDL-C (<35 mg/dl = low) LDL-C (>130 mg/dl = high) Fasting insulin (INS) (> 95th %ile for age/race/sex = high) Results grouped by age: 5-10y & 11-17y. Overweight defined as QI > 95th%ile for age/sex.	Based on Quetelet Index(QI) > 95th%ile, 10.8% of children were overweight (OW). For QI from below the 25th%ile to the 84th%ile, there was little variation in the prevalence of C-V RFs. Above the 85th%ile for QI, the prevalence of C-V RFs increased substantially and progressively. For children with Quetelet Index (QI) > 95th%ile vs. < 75th%ile, OR was 2.4 for elevated TC (CI:2.0-3.0), 2.4 for high DBP(CI:1.8-3.0), 3.0 for elevated LDL-C(CI:2.4-3.6), 3.4 for low HDL-C(CI:2.8-4.2), 4.5 for high SBP(CI:3.6-5.8),7.1 for high TGs (CI:5.8-8.6)& 12.6 for high fasting insulin(CI:10-16). Among those with QI≥95th%ile, 58% of 11-17 y olds & 61% of 5-10 y olds had at least 1 C-V RF. Using QI≥95th%ile as a screening tool identified 50% of those with ≥ 2 RFs.	Q6. Overweight children & adolescents have increased levels of multiple C-V RFs. Overweight was most strongly associated with elevated levels of insulin, triglycerides and SBP. Overweight appeared in a cluster with multiple other RFs, with prevalence increasing as the degree of overweight increased. Screening for C-V RFs based on overweight should be considered since this identified 50% of those with ≥2 C-V RFs.
10385774	Urbina EM	Association of fasting blood sugar level, insulin level, and obesity with left ventricular mass in healthy children and adolescents: The Bogalusa Heart Study	1999	CrS	Retrospective	Bogalusa	LV mass	Q1 (RF4,8,14) Q2 (RF4,8,14) Q4 (RF4,8,14) Q6 (RF4,8,14)	USA	Community (other)	Correlate fasting glucose (FG) & insulin levels with echo estimate of LVM.	216	Pediatric/ Young adults	Subjects who had participated in previous Bogalusa screenings and in whom echo measurement of LVM was obtained.	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. For this study, subjects were: Age: 13-27 yrs;51%M;61%W.	N/A	N/A	N/A	Ht Wt Ponderal index (Wt/Ht cubed) Triceps & subscapular SFs LVM from 2D echo imaging LVMC = LVM/Ht to the 2.7 power	In univariate analysis, FG levels correlated with LVMI with all race/sex grps combined (r=.17,p=S). By MVA, there was no correlation btwn LVMI, FG and insulin levels when race/sex/age/BMI/BP included. When subjects were ranked by tertiles for fasting insulin & wt/ adiposity, increasing LVMI correlated with increasing insulin level in the grps with highest adiposity with the only significant difference seen btwn the high & low insulin grps (p=S). When grouped by increasing BP level, there was no difference in LVMI with increasing insulin level.	Q6. For adolescents & young adults of normal wt, there is no direct independent effect of insulin on LVM. Q1. For heavier and/or more obese subjects, increasing INS was associated with greater heart mass.
10421238	Srinivasan SR	Temporal association between obesity and hyperinsulinemia in children, adolescents, and young adults: the Bogalusa Heart Study	1999	Cohort	Prospective	Bogalusa	None	Q6 (RF8,14) Q7 (RF8,14) Q8 (RF8,14)	USA	Community (other)	Evaluate the temporal nature of the relationship btwn obesity & hyperinsulinemia in children, adolescents & young adults.	1,497	Pediatric/ Young adults	For this study, subjects examined between 1981 &1993 were eligible and 1,497 were selected: 427 children (5-7 y); 674 adolescents(12-14 y) 396 adults (20-24 yrs) were selected retrospectively with F/U periods of ~ 3 y.	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. Seven CrS surveys of school children & 4 surveys of previously examined young adults were performed between 1978 & 1993. For this study, subjects examined between 1981 &1993 were eligible. 427 children (5-7 y)/ 674 adolescents (12-14 y)/ 396 adults (20-24 y) were selected	427 children (5-7 y) 674 adolescents (12-14 y) 396 adults (20-24 y)	N/A	3 yrs	Ht Wt BMI (≥30=obese) Fasting insulin (INS)	Baseline BMI correlated with F/U insulin levels in all grps. Logistic regression analysis indicated that the proportion of subjects who developed BMI > 75th%ile at F/U increased significantly across baseline quintiles of insulin only among adolescents, irrespective of race/gender. This relationship disappeared after adjusting for baseline BMI. By contrast, a significant (+) trend btwn baseline top quintile of BMI & incidence of hyperinsulinemia (> 75th%ile) persisted after adjustment for race/ gender and baseline insulin: children, adolescents & adults in the top quintile for BMI were 3.7-8.4 X more likely to develop hyperinsulinemia on follow-up. In MVA, the best predictor of F/U insulin level was baseline BMI in children & adults / baseline insulin in adolescents. Baseline BMI was the best predictor of F/U BMI in all 3 age grps.	Q6. There is a significant (+) association between baseline obesity & incidence of hyperinsulinemia at subsequent F/U in children, adolescents & adults, independent of race, gender & baseline insulin level. Baseline BMI is the best predictor of insulin level at F/U in children, adolescents & adults.
10428311	Chen W	The association of cardiovascular risk factor clustering related to insulin resistance syndrome (Syndrome X) between young parents and their offspring: the Bogalusa Heart Study	1999	CrS	Retrospective	Bogalusa	None	Q4 (RF4,5,8,14) Q6 (RF4,5,8,14)	USA	Community (other)	Evaluate familial clustering of RF clustering pattern of Met S in children and their parents. RFs included were fasting insulin/ BMI/ TG/HDL ratio /mean BP. Children were 5-17 y at evaluation	599	Pediatric/ Young adults	Linked child-parent pairs were selected from CrS survey of 2,571 young adults aged 18-38y examined in 1988-1991 &1995-96, and of 3,262 children aged 5-17y performed in 1991-1993. Final sample was 599 children 53.9%W, including 282 sons & 317 daughters with 716 parents, 209 fathers & 507 mothers.	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B.	n= 599 children, 53.9%W, including 282 sons & 317 daughters with 716 parents, 209 fathers & 507 mothers.	N/A	N/A	Ht Wt BMI (≥30=obese) Subscapular skin fold (SSF) Waist circumference (WC) (>100cm=obese) SBP DBP Mean BP = DBP + (SBP-DBP/3) = MAP TC TG (>200 mg/dl=high) HDL-C (< 40 mg/dl = low) LDL-C (>160 mg/dl = high) Fasting glucose (FG) (>110 mg/dl = high) Fasting insulin (INS) (>18 uU/ml= high) HOMA-IR (= INS X FG/ 22.5) Abnormal values were defined based on the 75th%ile for the source population from which the study samople was derived for INS, BMI, TG/HDL & MAP.	Based on observed to expected ratios, there was a significant excess of parents and their offspring with clusters of any 3 or 4 MetS RFs (p=S-S**). By contrast, the O/E ratio for 2 MetS RFs was lower than expected by chance alone. Paternal, maternal obesity or hyperinsulinemia, and parental obesity & hyperinsulinemia were significantly associated with clustering of 3 or 4 MetS RFs in offspring. Based on paternal, maternal and parental Met S RFs, ORs for offspring having the same cluster were 7.2, 8.6 and 7.9. By MVA, adverse parental (mother,father, either or both) levels of insulin and BMI significantly increased the risk of offspring having 3 or 4 Met S RFs; effect of insulin was considerably reduced after adjustment for parental BMI but BMI effect was unchanged after adjustment for INS. Parental dyslipidemia and HBP were not associated with offspring Met S RFs.	Q6. RFs for MetS and the RF pattern show significant clustering in parents & children. MVA suggests that obesity and hyperinsulinemia are the most important mediators of MetS within families. Effect of BMI is much stronger than the effect of hyperinsulinemia.
10512420	Chen W	Cardiovascular risk factor clustering features of insulin resistance syndrome (Syndrome X) in a biracial (Black-White) population of children, adolescents, and young adults: the Bogalusa Heart Study	1999	CrS	Retrospective	Bogalusa	None	Q5 (RF4,5,8,14) Q6 (RF4,5,8,14)	USA	Community (other)	Evaluate clustering characteristics of RFs associated with Met S (Ponderal index/insulin levels/glucose/ TGS/ HDL/ BP) in children, adolescents and young adults in a longitudinal cohort study	4522 - no loss to F/U by study design	Pediatric/ Young adults	All subjects who participated in 1 or more of the 5 CrS surveys in the Bogalusa study conducted between 1981 & 1996. Subjects with missing study values, who were non-fasting, had HTN or were taking anti-hypertensive meds were excluded. Total n = 4,522	Community-based cohort of black(B) & white(W)W children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. For this study, subjects were divided into 3 age groups, 5-11y,12-17y & 18-38y; 63.7%W, 36.3%B.	5-11y: n=1,088 12-17y: n=1,427 18-38y: n= 2,007	N/A	N/A	Ht Wt Ponderal index (Wt (kg)/Ht(m) cubed) SBP DBP Mean BP = DBP + 1/3(SBP-DBP) = MBP TC TG HDL-C LDL-C Fasting glucose (FG) Fasting insulin (INS) IRI (= INS X FG/ 22.5; aka HOMA-IR) For subjects with multiple exams, the data from the most recent evaluation was used. Abnormal defined as > 75%ile for race/sex/age.	Prevalence of Syndrome X consisting of HTN, dyslipidemia (high TGs +/- low HDL), high INS and obesity ranged from 2.4 - 4.8%, 8 to 30X the expected prevalence by age group. Factor analysis yielded 2 uncorrelated factors (factor 1 = insulin/ITGs/HDL/glucose/ponderal index; factor 2 = insulin/BP). These 2 factors explained 54.6% of the total variance in the entire sample. Factor patterns were similar in Ws & Bs and in all 3 age groups.	Q6. Factor analysis suggests the presence of 2 distinct physiologic processes characterizing the clustering of RFs related to Syndrome X: a distinct metabolic entity characterized by hyperinsulinemia/insulin resistance, dyslipidemia & obesity linked to hypertension through hyperinsulinemia.

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10866058	Chen W	Age-related patterns of the clustering of cardiovascular risk variables of syndrome X from childhood to young adulthood in a population made up of black and white subjects: the Bogalusa Heart Study	2000	CrS	Retrospective	Bogalusa	None	Q5 (RF3, 4, 5, 8, 14) Q6 (RF3, 4, 5, 8, 14)	USA	Community (other)	Evaluate age-related clustering of RFs for Met S (insulin res index, BMI, TG/HDL, mean BP) in 3 age groups: 5-10 y,11-17 y, and 18-37 y in a longitudinal cohort.	8,875 (no loss to F/U by design)	Pediatric/ Young adults	All subjects who participated in 1 or more of the 5 CrS surveys in the Bogalusa study conducted between 1981 & 1996. Subjects with missing study values, who were non-fasting, had HTN or were taking anti-hypertensive meds were excluded. Total n = 8,875.	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. For this study, 3 different age groups (5-10y) (11-17 y) (18-37 y) were evaluated.	5-10y = 2,389; 50%M;37%B 11-17y =3,371;52%M;37%B 18-37y =2,115;43%B;33%B	N/A	N/A	Ht Wt BMI (≥30=obese) SBP DBP Mean BP = DBP + 1/3(SBP-DBP) = MBP TC TG HDL-C LDL-C Fasting glucose (FG) Fasting insulin (INS) Insulin resistance index (IRI= INS X FG/ 22.5; aka HOMA-IR) For subjects with multiple exams, the data from the most recent evaluation was used. Abnormal defined as > 75%ile for race/sex/age. MetS cluster = IRI; BMI; TG/HDL; MBP	Ratios of observed to expected were used to assess the degree of clustering of adverse levels of the 4 RFs by race & age group. RRs were significantly different than 1 for all race & sex groups (p=S*). RRs were higher in pre-pubertal & young adult age groups, lowest during puberty, regardless of race. Overall RR for clustering of adverse levels of all 4 variables was 9.8 for Ws and 7.4 for Bs (p=S). Intraclass correlations for 2,3 & 4 RF combinations for each race & sex group were calculated. For 2 & 3 RF combinations, correlation was strongest for combinations with IRI & BMI and lowest for those with TG/HDL & MBP. For 4-variable combinations with all the age-groups combined, Ws showed higher correlation(0.33 vs. 0.26 for B) with no overlap of CIs. Intraclass correlations were significant (p=S**) in all race and age groups, higher during pre-adolescence and young adult age than in adolescence. Intraclass correlations increased continuously with age during adulthood. When adjusted for BMI, intraclass correlations involving the other 3 variables were reduced by 50% and age-related pattern disappeared.	Q5. Clustering of RFs typical of the MetS was consistently stronger in Bs than Ws. Q6. RRs generated from observed to expected observation demonstrate strong evidence of clustering of BMI, IRI, TG/HDL & MBP at all ages but less during puberty. Q6. When adjusted for BMI, intraclass correlations for the other 3 variables decreased by 50% and age-related pattern disappeared suggesting that age-related changes in obesity may be the dominant factor accounting for RF clustering in MetS.
11756342	Srinivasan SR	Predictability of childhood adiposity and insulin for developing insulin resistance syndrome (syndrome X) in young adulthood: the Bogalusa Heart Study	2002	Cohort	Prospective	Bogalusa	None	Q6 (RF4,5,8,14) Q7 (RF4,5,8,14) Q8 (RF4,5,8,14)	USA	Community (other)	Examine the relative contribution of childhood adiposity & insulin to adult risk for development of syndrome X.	745 (No loss to F/U by study design)	Pediatric/ Young adults	For this study, subjects must have participated in at least 1 survey at age 8-17 yrs.and one at age>/= 19yrs and have no missing data among the variables of interest.	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. Five CrS surveys of school children & 5 surveys of previously examined young adults were performed were performed between 1978 & 1996. For this study, subjects must have participated in at least 1 survey at age 8-17 yrs.and one at age>/= 19yrs.	n=745 39% M, 67% W.	N/A	11.6 ±3.4 yr	Ht Wt BMI (≥30=obese) Subscapular skin fold (SSF) Waist circumference (WC) (>100cm=obese) SBP DBP TC TG (>150 mg/dl=high) HDL-C (<40 mg/dl in M,<50 mg/dl in F =low) LDL-C (>160 mg/dl = high) Fasting glucose (FG) (>110-125 mg/dl = impaired; ≥ 126 mg/dl = DM) Fasting insulin (INS) (>18 uU/ml= high) HOMA-IR (= INS X FG/ 22.5) To maximize F/U when subject participated in multiple screenings, earliest childhood and latest adult data used. Syndrome X cluster variables=Highest quartile for BMI, fasting insulin, SBP or mean BP, and TC/HDL or TG/HDL. Clustering = All 4 variables	6.4% of adults had Syndrome X cluster. In cluster(+) adults, BMI, INS, FG, SBP, DBP, TC, LDL, TGs, TC/HDL & TG/HDL were all significantly higher and HDL significantly lower than in cluster(-) group (all, p=S**). For the entire cohort, as the # of cluster variables present in adult life increased, childhood values increased significantly. Proportion of subjects who developed clustering as adults increased across childhood BMI & INS levels - children in the top quartile for BMI & INS were 11.7X (CI 3.4-39.7) (p=S**) & 3.6 X (CI 1.5-8.7) (p=S*) more likely to develop (+) clustering as adults. Relationship of clustering to childhood BMI persisted after correction for insulin (OR=10.0 ;CI 2.8-35.5, p=S**) but insulin was no longer predictive after BMI entered into the analysis. No difference by race or sex.	High childhood BMI is the strongest predictor of development of syndrome X in adult life. As BMI increases, number of cluster variables present increases.
11875319	Sinaiko AR	Relation of insulin resistance to blood pressure in childhood	2002	CrS	Retrospective	Minn	None	Q6 (RF4,5,8,14)	USA	Community (schools)	Determine the relationship between BP & insulin resistance in children.	357	Pediatric/ Young adults	Pts were selected from BP screening of 12,043 eighth graders from which a random selection of 2915 black(B) and white(W) children stratified as upper 25% and lower 75% of the BP distribution was made. This group were offered participation in a euglemic clamp study and 357 children ultimately participated	Age: 10-16y 174 subjects from the top 25% of the BP distribution - 54.5% male(M),19.5% B. 183 subjects from the lower 75% of the BP distribution - 43.7% female(F), 21.3% B.	N/A	N/A	N/A	Ht Wt BMI (Obesity=>95th%ile until yr-10, then ≥30) Waist circumference (WC) Triceps & sub-scapular SFs (SSFs) (% body fat= BF%) Tanner stage SBP DBP Fasting insulin (INS) Insulin euglycemic clamp(Mlbm = glucose utilization/ kg of lean body mass/min HOMA-IR TC TG HDL LDL	DBP was not correlated with any measure of body size or lab measurement. SBP was significantly correlated with all measures of body size except ht & waist/hip ratio in Ms & ht in Fs. INS & Mlbm were significantly correlated (r=-0.42,p=S**). There is no correlation between SBP & Mlbm for the entire cohort. SBP & INS were significantly but weakly correlated for all except BFs (r=0.16-0.33,p=S-S*) but this disappeared after adjustment for BMI. There was no difference in DBP between the HBP & LBP groups. All measures of fatness were significantly greater in the HBP group for Ms & Ws; body fat % & SSFs were greater in HBP WFs but not in BFs. There was no difference between BP groups for Mlbm, INS or lipids. There was a significant clustering effect for INS, BMI, TGs & HDL-C when above median SBP group compared to below median SBP group.	Q6. SBP & INS were significantly but weakly correlated in all except BFs but this association disappeared after adjustment for BMI. Q6. There was a significant clustering effect of BMI, BP, INS & TGs/HDL, the components of the MetS.
12355326	Schmitz KH	Association of physical activity with insulin sensitivity in children	2002	CrS	Retrospective	Minn	None	Q6 (RF4, 5, 8, 11, 14)	USA	Community (schools)	Evaluate insulin sensitivity by euglycemic hyperglycemic clamp relative to physical activity in children.	357	Pediatric/ Young adults	Pts were selected from BP screening of 12,043 eighth graders from which a random selection of 2915 black(B) and white(W) children stratified as upper 25% and lower 75% of the BP distribution was made. This group were offered participation in a euglemic clamp study and 357 children ultimately participated.	Age: 10-16 yrs 174 subjects were from the top 25% of the BP distribution - 54.5% male(M),19.5% B. 183 subjects were from the lower 75% of the BP distribution - 43.7% female(F), 21.3% B.	N/A	N/A	N/A	Ht Wt BMI (Obesity=>95th%ile until yr-10, then ≥30) Waist circumference (WC) Triceps & sub-scapular SFs (SSFs) (% body fat= BF%) Tanner stage SBP DBP Fasting insulin (INS) Insulin euglycemic clamp(Mfffm = glucose utilization/ kg of FFM/min HOMA-IR TC TG HDL LDL Physical activity by questionnaire (kcla/d)	Bs & Ms had higher activity levels. Wt & BMI did not change across activity levels but body fat % decreased & FFM increased as activity level increased. There were no differences in BP or lipids across activity quartiles. Physical activity (PA) correlated significantly but not strongly with INS and insulin sensitivity (r=.12, p=S; & r=.13,p=S*). There was no correlation between activity & body fat %, BMI, WC, BP or lipids. There was no modification of the association of activity and Mffm by introduction of gender, Tanner stage, BMI, HDL, TGs or DBP. Correlation was slightly stronger in children with above-median BP or above median body fat % (r=.17,p=S; & r=.35,p=S**). Adjustment for age/sex/ race/Tanner stage/BMI/% body fat/waist circumference or lipids did not affect these results.	Q6. There is a correlation between physical activity & both INS & Mffm; association is stronger in children with higher BP. Physical activity is associated with lower INS & higher insulin sensitivity.
12701056	Srinivasan SR	Longitudinal changes in risk variables of insulin resistance syndrome from childhood to young adulthood in offspring of parents with type 2 diabetes: the Bogalusa Heart Study	2003	Cohort	Prospective	Bogalusa	None	Q6 (RF4, 5, 6, 8, 14) Q7 (RF4, 5, 6, 8, 14) Q8 (RF4, 5, 6, 8, 14)	USA	Community (other)	Evaluate changes in the variables of the insulin resistance syndrome from childhood to young adulthood in offspring of parents with & without T2DM .	1,439 - no loss to F/U by study design	Pediatric/ Young adults	Study cohort selected from among 1,930 young adults who participated in the 1988-1991 survey and provided information on parental DM during this & the 1984-1986 surveys - n=1,439	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. For this study, 303 subjects with parental hx of T2DM, 1,136 subjects without parental T2DM, followed from evaluation at 4-17 yrs with repeated surveys into adulthood.	DM(+) = 303 DM(-) = 1,136 71% W, 29% B 61% F, 39% M	N/A	15 yrs.	Ht Wt BMI (≥30=obese) Subscapular skin fold (SSF) Waist circumference (WC) (>100cm=obese) SBP DBP TC TG (>150 mg/dl=high) HDL-C (< 40 mg/dl in M,< 50 mg/dl in F = low) LDL-C (>160 mg/dl = high) Fasting glucose (FG) (>110-125 mg/dl = impaired; ≥126 mg/dl = DM) Fasting insulin (INS) (>18 uU/ml= high) HOMA-IR (= INS X FG/ 22.5) Mean levels of RFs for preadolescence(4-11 y),adolescence (12-18 y) & adulthood (≥19 y) were combined for the analysis.	Offspring with parental T2DM had significantly greater BMI and subscapular SFs beginning in childhood, higher fasting insulin,/fasting glucose/ HOMA-IR from adolescence, and higher LDL-C/TGs/ lower HDL-C in adulthood. By univariate regression, rates of increase in BMI, SSFs,TGs,LDL & SBP were all significantly greater in DM(+) subjects vs DM(-) subjects. In MVA, DM(+) independently predicted adverse changes in adiposity/ glucose/ insulin/ HOMA-IR/ SBP/ DBP/ LDL-C in offspring regardless of race & gender. As young adults,T2DM offspring had higher prevalence of: BMI >30 (36% vs 16%,p=S**); WC >100 cms (15% vs 6%, p=S**); INS >18 microU/ml (11% vs 7%,p=S); FG ≥110mg/dl, 2% vs 0.5%, p=S); LDL-C ≥160 mg/dl (11% vs 7%,p=S); HDL-C <40 mg/dl in Ms,< 50 mg/dl in Fs (40% vs 31%, p=S*); TGs ≥150 mg/dl (23% vs 15%,p=S**); BP >140/90 (11% vs 6%, p=S*). FG >110 mg/dl (2% vs 0.5%,p=S); FG ≥ 126 mg/dl (0.7 vs0.1,p=S)	Offspring with parental T2DM had significantly greater BMI and subscapular SFs beginning in childhood, higher fasting insulin,/fasting glucose/ HOMA-IR from adolescence, and higher LDL-C/TGs/ lower HDL-C in adulthood. RFs for T2DM are found at a young age in children & adolescents with a positive parental hx DM. Development of obesity preceded the development of impaired glucose metabolism.
12912790	Cook S	Prevalence of a metabolic syndrome phenotype in adolescents: findings from the third National Health and Nutrition Examination Survey, 1988-1994	2003	CrS		NHANES	None	Q6 (RF2, RF6, RF14)	USA	Community (other)	Estimate the prevalence and distribution of a metabolic syndrome among adolescents in the United States	2,430	Pediatric/ Young adults	12-19 yr Exclusions: (1) had not fasted for 6 hours, (2) was currently pregnant, or (3) was taking medication classified as a blood glucose regulator, such as insulin, androgens or anabolic steroids, or adrenal corticosteroids.	Male: 1,150 Female: 1,280 White: 646 Black: 824 Mexican American: 846 Age 12-14 yr: 969 Age 15-19 yr: 1,462 Below poverty level: 804 At or above poverty level: 1,394 Has parental history of MI: 410	N/A	N/A	N/A	Prevalence and distribution of a metabolic syndrome using the NCEP (Adult Treatment Panel III) definition modified for age	The overall prevalence of the metabolic syndrome among adolescents was 4.2%; 6.1% of males and 2.1% of females were affected (P=0.01). The syndrome was present in 28.7% of overweight adolescents (BMI, ≥95th percentile) compared with 6.8% of at-risk adolescents (BMI, 85th to <95th percentile) and 0.1% of those with a BMI below the 85th percentile (P<0.001). Based on population-weighted estimates, approximately 910,000 US adolescents have metabolic syndrome. Metabolic syndrome was more frequent in Mexican Americans (5.6%) and whites (4.8%) than black subjects (2.0%). By region of the country, the rate was highest in the West and Midwest and lowest in the Northeast. Findings for age (12-14 years vs 15-19 years), Tanner stage by pubic hair, poverty level, and parental history of diabetes and myocardial infarction were not significant.	Q6: 4% of adolescents and nearly 30% of overweight adolescents in the United States meet these criteria for a metabolic syndrome

NHLBI Evidence Table: RF14-OB

PMID	First Author	Title	Year	Study Type	Prospect./ Restrospect.	Study	CVD	RF by CQ	Country	Setting	Main Study Objective	N at Baseline (N at Follow-up)	Target Population	Eligibility Criteria	Patient Characteristics	Study Groups	n at Baseline (n at Follow-up) for Study Groups	Total Follow-up Duration	Outcomes Measured	Results	Main Reported Findings by Critical Question
14574352	Frontini MG	Longitudinal changes in risk variables underlying metabolic Syndrome X from childhood to young adulthood in female subjects with a history of early menarche: the Bogalusa Heart Study	2003	CrS	Retrospective	Bogalusa	None	Q5 (RF4, 5, 6, 8,14) Q6 (RF4,5,6, 8,14) Q7 (RF4,5,6, 8,14) Q8 (RF4,5,6, 8,14)	USA	Community (other)	Examine longitudinal changes in adiposity and related risk variables of Syndrome X from childhood to young adulthood with respect to early menarche.	1479 - no loss to F/U by study design	Pediatric/ Young adults	Study cohort = all young adult Fs who participated in ≥ 2 surveys from childhood to adulthood and who supplied menarcheal age.	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. For this study, 437 women with menarche < 12 yrs & 1042 women with menarche > 12 yrs.; 65% W, 35% B. Evaluated in childhood (5-11 y), adolescence(12-18 y) & young adulthood(19-37 y); subjects were evaluated at least 2X.	EM = 437 women with menarche < 12 yrs LM = 1042 women with menarche > 12 yrs.; 65% W, 35% B.	N/A	N/A	Ht Wt BMI Triceps skin fold (TSF) SBP DBP MAP = DBP + (SBP-DBP/3) TC TG HDL-C LDL-C Fasting glucose (FG) Fasting insulin (INS) HOMA-IR (= INS X FG/ 22.5) Mean levels of RFs by age groups used for comparison: 5-7y;8-11i;12-18y;19-37y. MetS variables defined as highest quartile for age/race & study year of BMI,INS,SBP or MAP,TC/HDL or TG/HDL	Females with early menarche had higher BMI & triceps SFs from childhood through adulthood; higher stature in childhood & adolescence; higher fasting insulin & HOMA-IR in childhood & adulthood; & higher FG in adulthood. BP and lipoproteins showed no menarche related differences. Longitudinal rates of increase were (+) and faster for BMI (p=.002), triceps SFs (p=.05), insulin (p=.09) & HOMA-IR (p=.05) in early menarche grp. With MVA, body fatness & insulin related independently to early menarche. (p<.001); this association was stronger in WFs. In adulthood, the clustering of 3-4 RFs of syndrome X was higher among those with early menarche (10.7 vs. 6.2%,p=.002). OR for developing such a cluster among those with early menarche was 1.54 (CI:1.14-2.07)	Q6. In Fs with early menarche, higher BMI, increased triceps skin folds and higher levels of fasting insulin & HOMA-IR clustered together as early as 5-7 y of age. These RFs progressed adversely over time in this group. Early menarche was associated with enhanced clustering of the MetS RFs at adverse levels. The association between early menarche and greater adiposity was stronger among WFs.
14747217	Klein DJ	Obesity and the development of insulin resistance and impaired fasting glucose in black and white adolescent girls: a longitudinal study	2004	Cohort	Prospective	Growth	None	Q5 (RF6,8,14) Q6 (RF6,8,14) Q7 (RF6,8,14)	USA	Clinical	Examine the association between obesity and insulin resistance adjusted for race and pubertal stage.	955	Pediatric/ Young adults	From the total cohort of 1,491 girls, all those with BMI at baseline and yr-10 and fasting glucose at yr-10 were selected --> n=955.	1166 white(W) girls, 1213 black(B) girls enrolled in 3 geographic locations at age 9-10 y, evaluated annually X 10 yrs; 2/3 locations participated in this study. From the total cohort of 1,491 girls, all those with BMI at baseline and yr-10 and fasting glucose at yr-10 were selected --> n=955; 52% B.	B Fs - n=500 W Fs - n=455	N/A	10 y	Ht Wt BMI (Obesity=>95th%ile until yr-10, then ≥30) Tanner stage Fasting glucose (FG) (≥110 mg/dl=Impaired; ≥126 mg/dl=DM) Fasting insulin (INS) HOMA-IR	B girls had greater baseline BMI than W girls but not after adjusting for pubertal stage. B girls had a greater prevalence of obesity at baseline (17.6 vs 6.2%) and yr-10 (28.2 vs 11.2%) (both, p=S**). 10 yr incidence of obesity was 2.5 X greater in B vs W girls (13.2 vs 5.2%) BMI-INS correlations were (+) in both B & W girls at yr 1 (both, r=0.44 & p=S**) & yr 10 (r=0.48 & 0.55, both, p=S**) In B girls, INS and HOMA-IR were significantly higher in the prepubertal period, increased more during puberty and decreased less after puberty; FG levels were higher at yr-10. In MVA, BMI & race were significant independent predictors of INS as was pubertal stage at baseline. Baseline BMI predicted year 10 FG & the development of impaired FG in B girls; in W girls, rate of BMI increase predicted these outcomes. Obesity was more persistent in B than W girls; mean BMI was higher in B & W Fs when obesity was persistent. Across all participants, 10 yr changes in BMI correlated with changes in INS(r-0.26);HOMA-IR(r=0.24) & FG (r=0.16) (all,p=S**). 10-year incidence of DM in B girls was 1.4%; no W girls developed DM.	Q6. Obesity & insulin resistance are strongly associated in B & W girls. Q5. Incidence of obesity is greater among B girls and obesity is more likely to persist. Q5. Baseline BMI predicted year 10 FG & the development of impaired FG in B girls; in W girls, rate of BMI increase predicted these outcomes. Q5. B/W differences exist in insulin resistance beginning before puberty; in B girls, INS and HOMA-IR were significantly higher in the prepubertal period, increased more during puberty and decreased less after puberty; FG levels were higher at yr-10 and only B Fs developed DM during the 10 yr F/U.
15286257	Katzmarzyk PT	Body mass index, waist circumference, and clustering of cardiovascular disease risk factors in a biracial sample of children and adolescents	2004	CrS	Retrospective	Bogalusa	None	Q5 (RF4,5,8,14) Q6 (RF4,5,8,14)	USA	Community (other)	Predict C-V RF clustering from BMI & waist circumference (WC) thresholds in children & adolescents.	2597 - no loss to F/U by design	Pediatric/ Young adults	All 2,597 children in the Bogalusa study who were examined between 1992 &1994	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. For this study, data from all 2,597 children who were examined between 1992 &1994 were included. Subjects were 5 - 18 yrs, 48% M, 58% W.	N/A	N/A	N/A	Ht Wt BMI (>85th%ile=overweight;>95th%ile=obese)) Subscapular skin fold (SSF) Waist circumference (WC) (>100cm in adults=obese) SBP DBP TC TG (>200 mg/dl=high) HDL-C (< 40 mg/dl = low) LDL-C (>160 mg/dl = high) Fasting glucose (FG) (>110 mg/dl = high) Fasting insulin (INS) (>18 uU/ml= high) Global C-V RF cluster score defined by the # of the following age-adjusted RFs present: low HDL-C, high LDL-C, high TGs, high glucose, high insulin, high BP; ≥ 3 RFs = elevated RF score	Elevated C-V RF score (≥3 RFs) was present in 18.2% of WMs,17.3% of BMs, 16.5% of WFs and 16.6% of BFs. ROCs used to define optimum BMI and WC for prediction of elevated RF score --> generation of curves for age/ race/sex. The ROC curves for BMI & WC were similar with no advantage for either measure. Thresholds from these curves are lower than current reference criteria for overweight/ obesity. Optimal threshold for BMI was 53rd & 50th %iles for W & B male subjects, & 57th & 51st %iles for W & B female subjects. Optimal WC thresholds were at the 56th & 50th %iles for W & B male subjects and 57th & 52nd %iles for W & B female subjects. Sensitivity & specificity at the thresholds were similar for all gender/ race grps ranging from 67 - 75%.	Q5. There are racial differences in C-V risk profiles. In terms of predicting increased risk for C-VD, BMI & WC are equal & complimentary measures. Study defined population-based curves for BMI and WC, specific for age/race/sex, which can be used to predict the presence of increased risk for C-V disease in children.
15480365	Goodman E	Contrasting prevalence of and demographic disparities in the World Health Organization and National Cholesterol Education Program Adult Treatment Panel III definitions of Metabolic Syndrome among adolescents	2004	CrS	Retrospective	Princeton	None	Q6 (RF 4,5,8,14)	USA	Community (schools)	Determine the prevalence of metabolic syndrome among a cohort of adolescents by using definitions from the WHO and the NCEP Adult Treatment Panel III and to compare the populations identified by these definitions.	1513	Pediatric/ Young adults	All 2710 teens enrolled in the Princeton school district in Cincinnati in 200102 were eligible - 1513 participated.	1513 subjects from the Princeton School District . 49.5% non-Hispanic W/ 48.5% non-Hispanic B/ 2.0% Hispanic. 50% female. Age range = 12.2 - 19.4 y (mean = 15.2 +/- 1.6 y). BPs available for 2/3 's of the sample.	N/A	N/A	N/A	Ht Wt BMI (Obese >95th%ile; Overweight ≥85th%ile) Waist circumference (WC) Tanner stage SBP DBP Fasting glucose (FG) (≥110 mg/dl=Impaired; ≥126 mg/dl=DM) Fasting insulin (INS) HOMA-IR TC TG HDL LDL MetS: ATP definition: ≥3 of the following: WC >102 cm in Ms, 88 cm in Fs; HDL ≤40 mg/dl in Ms, 50 mg/dl in Fs; TG >150 mg/dl; BP ≥130/85; FG ≥110 mg/dl. WHO definition: Impaired FG or known DM or elevated INS + 2 additional parameters: BP>130/85; BMI >30; WC >102 cm in Ms, 88 cm in Fs; HDL ≤35 mg/dl in Ms, 39 mg/dl in Fs; TGs >150 mg/dl.	Prevalence of known C-V RFs was high in the group as a whole, with low HDL by ATPIII criteria as the most prevalent abnormality. Overall, the prevalence of MetS was 4.2% using ATPIII criteria and 8.4% using WHO criteria. Among obese teens, prevalence of ATPIII-defined MetS was 19.5% and WHO-defined MS was 38.9%. Prevalence of MetS was <1% in non-obese teens No race or sex differences were identified for MetS prevalence by ATPIII criteria. By WHO criteria, non-white teens were more likely to have MetS (RR=1.40;95% CI=1.04,1.87) and MetS was more common among girls (RR=1.26; 95% CI 1.08,1.88). Agreement between the MetS definitions was poor with k statistic of 0.41. One-third of ATPIII defined MetS subjects did not have hyperinsulinemia.	In this biracial adolescent cohort, the prevalence of MetS was 4.2% using ATPIII criteria and 8.4% using WHO criteria. There is poor agreement between these 2 definitions for MetS. Q6. While there is strong clustering of the component RFs in the MetS, the causative mechanism remains unclear.
15616245	Chen W	Metabolic syndrome variables at low levels in childhood are beneficially associated with adulthood cardiovascular risk: the Bogalusa Heart Study	2005	Cohort	Retrospective	Bogalusa	IMT	Q3 (RF4,5,8,14) Q6 (RF4,5,8,14) Q7 (RF4,5,8,14) Q8 (RF4,5,8,14) Q9 (RF4,5,8,14) Q14a (RF4, 5, 8, 14)	USA	Community (other)	(1)Compare adult prevalence of Met S RFs in a group with low levels of Met S RFs in childhood; (2)Compare CIMT in adulthood in a group with low level Met S RF status in childhood	1474 - no loss to F/U by design	Pediatric/ Young adults	All Bogalusa subjects who had data on the Met S RFs in childhood and had subsequent evaluation as adults	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. For this study, 1,474 subjects with evaluation at 4-17 y and 19-41 y; 41.9% B/ 62.6% W.	n=1,474 subjects; Sub-group of 138 subjects underwent cIMT measurement at 25-41 y of age	N/A	15.8 yr (range: 5-21.1 yr)	Ht Wt BMI (≥30=obese) SBP DBP TC TG (>200 mg/dl=high) HDL-C (< 40 mg/dl = low) LDL-C (>160 mg/dl = high) Fasting glucose (FG) (>110 mg/dl = high) Fasting insulin (INS) (>18 uU/ml = high) HOMA-IR (= INS X FG/ 22.5) Carotid IMT (cIMT) Metabolic syndrome variables=BMI; HOMA-IR; SBP; TC/HDL Low MetS clustering in childhood ≤25th%ile for 3 or 4 variables Adult dx of MetS ≥75th%ile for all 4 variables	In childhood, 9% of the cohort had 3 or 4 MetS RFs in the bottom quartile of BMI/ HOMA-IR/ SBP/ TC:HDL ratio(O/E, p=S*). Clustering was greatest for all 4 variables vs any combination of 3. With 3 (+) RFs, O/E was significantly greater when BMI & HOMA-IR were included. Overall prevalence of Met S in adulthood was 13.6%, higher in Ws than Bs (15.2% vs 11.1%, p=S). Using ATPIII definition of MetS,overall prevalence of MetS in adulthood for the cohort was 12.1%, higher in Ws than Bs (14.5% vs 8.2%,p=S**) As adults, low risk Met S group had lower prevalence of Met S compared with high risk group (3.8 vs 14.6%;p=S**). Using ATPIII definition of MetS, low risk MetS group had significantly lower prevalence of MetS (4.6 vs 12.9%,p=S*) In childhood, subjects with (-) fam hx of CHD & HTN had a significantly greater prevalence of low risk MetS cluster compared with high risk MetS cluster (9.4 vs 5%;p=S) and (10.5 vs. 6.6%; p=S). cIMT in adulthood decreased with increasing #s of RFs in the bottom quartile in childhood (p for trend=S).	Q6,7. Low levels of RFs for the MetS cluster together in childhood just as high levels do. The low risk MetS cluster is associated with negative fam hx of CAD & HTN. Q8. As adults, those with low MetS cluster in childhood have a significantly lower prevalence of MetS dx indicating tracking of the low risk pattern from childhood to adult life. Q14. Preservation of a low risk state is associated with decreased development of target organ damage.

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16264006	Morrison JA	Development of the metabolic syndrome in black and white adolescent girls: a longitudinal assessment.	2005	Cohort	Prospective	Growth	None	Q5 (RF 4,5,8,14) Q6 (RF 4,5,8,14) Q7 (RF 4,5,8,14) Q8 (RF 4,5,8,14)	USA	Clinical	Identify early predictors of the presence of the metabolic syndrome at 18 & 19 y in B and W girls.	1192/ 1078	Pediatric/ Young adults	624 black(B) girls & 773 white(W) girls evaluated at baseline for longitudinal cohort study at 3 sites and followed X 10 yrs. In 2 sites, insulin & glucose were measured along with other variables at baseline and F/U and these subjects constitute this study group.	624 B girls & 773 W girls evaluated at baseline at 9-10y for longitudinal cohort study at 3 sites & followed X 10y. In 2 sites, insulin & glucose were measured along with other variables at baseline and F/U and these subjects constitute this study group.	608 W Fs; 584 B Fs	W: 608/511 B: 584/567	10 yr	Ht Wt BMI (Obesity ≥95th%ile until yr-10, then ≥30) Waist circumference (WC) Tanner stage SBP DBP Fasting glucose (FG) (≥110 g/dl=Impaired; ≥126 mg/dl=DM) Fasting insulin (INS) HOMA-IR TC TG HDL LDL MetS = ATP definition: ≥3 of the following: WC >102 cm in Ms, 88 cm in Fs; HDL ≤40 mg/dl in Ms, 50 mg/dl in Fs; BP ≥130/85; FG ≥110 mg/dl. For baseline assessment. 10th & 90th %iles used to define abnormal except for BP & TGs.	At baseline, BFs had higher BMI, WC, INS, HOMA-IR, HDL FG & SBP but lower TGs. At baseline, only 1 B girl and 1 W girl had >/= 3 factors for MetS (0.2%). On F/U, BMI, WC & SBP increased significantly, more in Bs than in Ws; TGs increased only in Ws. At 18-19 y, Bs had significantly greater BMI, WC, INS, HOMA-IR, SBP & FG(all,p=S**) & HDL & DBP (p=S*) but lower TGs(p=S**). At 10 y, 20 B girls (3.5%) and 12 W girls (2.3%) had MetS; using the new definition of abnormal FG of 100 mg/dl, 31 BFs (3.6%) & 15 (3%) W Fs had MetS. Low HDL was prevalent throughout the period in B & W girls. In MVA, early measures of BMI, WC and TG level were significant predictors for development of metabolic syndrome. Tracking coefficient for WC was 0.83 from y-2 to y-10 indicating strong persistence of central obesity.	Q5. There are striking racial differences in the prevalence of the components of MetS with Bs having the greater prevalence for all factors except TGs. Q6,Q7,Q8. In this study, the MetS RFs cluster together beginning before puberty and persisting X 10 y. Q8. While the prevalence of MetS overall was 3%, it was 12.1% in girls with persistently increased WC. Components of the MetS become increasingly common during adolescence & the criteria for MetS are met in 3% of young adult Fs.
16769996	Srinivasan SR	Changes in metabolic syndrome variables since childhood in prehypertensive and hypertensive subjects: the Bogalusa Heart Study	2006	Cohort	Prospective	Bogalusa	None	Q6 (RF4,5,8,14) Q7 (RF4,5,8,14) Q8 (RF4,5,8,14)	USA	Community (other)	Evaluate serial changes in C-V RFs asst'd with Met S in a community-based cohort of normotensive, pre-hypertensive and hypertensive subjects as they age from childhood into adulthood.	3255 - no loss to F/U by design	Pediatric/ Young adults	Subjects from any of the 6 cross-sectional studies of children who had participated in at least 1 of 7 screenings in young adult life	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B. This study is a retrospective review of BP, adiposity, lipids and insulin resistance measured in childhood(4-11 yrs), adolescence (12-18 yrs) and adulthood (19-42 yrs) in 3 BP grps : normotensive (n=2206); pre-hypertensive (n=721); hypertensive (n=328).	BP at last evaluation --> 3 groups: Normotensive (NBP): 2206 Prehypertensive (PHTN): 721 Hypertensive (HTN): 328 Age at childhood study = 11.6 +/-3.9y Age at adult study= 27.0+/-6.5 81% of subjects were screened >/=3 times & 54%, 4-6 times.	3255 - by design	N/A	Ht Wt BMI (≥30=obese) Subscapular skin fold (SSF) Waist circumference (WC) (>100cm=obese) SBP DBP TC TG (>200 mg/dl=high) HDL-C (< 40 mg/dl = low) LDL-C (>160 mg/dl = high) Fasting glucose (FG) (>110 mg/dl = high) Fasting insulin (INS) (>18 uU/ml= high) HOMA-IR (= INS X FG/ 22.5) Mean levels of RFs fpr preadolescence(4-11 y),adolescence (12-18 y) & adulthood (≥19 y) were combined for the analysis.	Adult subjects with HTN vs NBP had higher adiposity, SBP & DBP, glucose and TGs beginning in childhood through into adulthood; higher insulin/ins resistance in childhood and adulthood; and lower HDL-C in adulthood. Adult subjects with dx of PreHTN vs NBP subjects had significantly higher BMI and SSFs, SBP & DBP; and TGs beginning in childhood through adulthood; higher glucose in adolescence; and higher LDL-C, insulin/ins resistance in adulthood. In MVA, PreHTN was independently asst'd with adverse changes in adiposity, SBP & DBP; HTN was independently asst'd adverse changes in adiposity, SBP & DBP, ins resistance index, LDL-C, HDL-C, and TGs with HTN. As young adults, PreHTN & HTN subjects showed significantly greater prevalence of obesity, hyperinsulinemia, hyperglycemia and dyslipidemia. Excess adiposity and higher BP beginning in childhood and accelerated adverse longitudinal changes in all Met S risk variables characterize the early natural hx of HTN.	Q6. Excess adiposity and higher BP beginning in childhood and accelerated adverse longitudinal changes in Met S risk variables characterize the early natural hx of HTN. Higher BMI, adiposity, SBP, DBP & FG cluster together beginning in adolescence; in adult life, they are joined by dyslipidemia, high INS & abnormal HOMA-IR. Adult subjects with HTN vs NBP had higher adiposity, SBP & DBP, glucose and TGs beginning in childhood; higher insulin/ins resistance in childhood and adulthood; and lower HDL-C in adulthood. Longitudinal changes with aging suggest a primary role for excess adiposity in the early natural history of hypertension.
17167128	Goodman E	Socioeconomic disparities in insulin resistance: results from the Princeton School District Study	2007	Cohort	Prospective	Princeton	None	Q5 (RF8, RF14)	USA	Don't know/NR	Determine whether lower SES is associated with changes in insulin resistance in adolescents over a 3-yr period and explore moderators of this effect	1,167 (NR)	Pediatric/ Young Adult	Participants in Princeton School District Study, a longitudinal study begun in 2001-2002. Subjects had baseline physical & metabolic examination and returned for reassessment 3 yr later. < 20 yr at follow-up 5th-12th graders Non-Hispanic Black - 58.2% of possible participants Non-Hispanic White - 60.3% of possible participants F = 62.7% of females participated vs 54.9% of males. Suburban Midwestern public school district	Black: 542 White: 625	Parental education high school or less Parental education > high school, < college Parental education college or higher	269 335 563	3 yr	SES status BMI z score Fasting insulin (INS) Fasting glucose (FG) HOMA (= FG X INS) TC TG HDL LDL	Blacks and lower SES youth had higher BMI z score and increased insulin resistance (p = S**). In multivariable models, lower parent education, but not household income, was associated with higher baseline insulin resistance (F = 7.84, p = S**) and worsening insulin resistance over time (F = 18.86, p=S**). Parent education effect on change in insulin resistance was more pronounced for obese youth compared with nonobese (F interaction = 10.12, p = S**) even with adjustment for multiple covariates.	Q5: Blacks and lower SES youth had higher BMI z score and increased insulin resistance; lower parent education appears to be related to increased insulin resistance. Q7. In multivariable models, lower parent education, but not household income, was associated with higher baseline insulin resistance (F = 7.84, p = S**) and worsening insulin resistance over time (F = 18.86, p=S**).
17283263	Lloyd-Jones DM	Consistently stable or decreased body mass index in young adulthood and longitudinal changes in metabolic syndrome components: the Coronary Artery Risk Development in Young Adults Study	2007	Cohort	Prospective	CARDIA	None	Q6 (RF5, RF8, RF14)	USA	Don't know/NR	Examine the association of stable BMI over the long term with metabolic syndrome components in young adults	NR (2,679)	Pediatric/ Young Adult	Population-based , prospective observational study with black(B) and white(W) participants recruited from 4 metropolitan areas (Birmingham, Ala; Chicago, Ill, Minneapolis, Minn; & Oakland, Calif) in 1985-1986 at 18-30 yrs of age (44.9% black, 53.9% female(F),46.1% male(M) & followed up 2,5,7,10 & 15 yrs later. 3672 subjects attended 15 y F/U; of these, 993 were excluded because of BMI < 20 or > 35, missing BMI at year 0 , pregnancy, dx of DM, at year 0 or missing FG at year 0.	M: 1,358 F: 1,321	Stratified by baseline BMI (20.0-24.9, 25.0-29.9, 30.0-34.9) and by change in BMI over time: BMI stable/decreased (within 2 kg of B/L) BMI increased (increased from B/L > 2 kg/m^2) BMI fluctuating	NR	15 yr	Changes in metabolic syndrome components: Increased WC Increased TGs Reduced HDL Increased BP Increased FG Incidence of metabolic syndrome	Only 16.3% of participants had stable or decreased BMI over 15 yrs vs 73.9% with increased BMI and 9.8% with fluctuating BMI; 94% of those with B/L BMI of 30-35 kg/m2 had an increased BMI on F/U. At higher B/L BMI, TGs, FG, INS and BP were higher and HDL lower. WC was highly correlated with BMI (0.84 - 0.91,p=S**) Over 15 years, participants with stable BMI had essentially unchanged levels of metabolic syndrome components, regardless of baseline BMI, whereas those with increased BMI had progressively worsening levels. Men with a baseline BMI of 20.0-24.9 kg/m^2 and stable BMI during follow-up had a mean increase of only 15 mg/dL in fasting TG over 15 years compared with 65 mg/dL (p<0.001) in those whose BMI increased. This trend was seen for all MetS components in sex-specific models. Incidence of metabolic syndrome at yr 15 was lower in the stable BMI group (2.2%) compared with 18.8% in the increased BMI group (p=S**). Incidence of impaired FG or DM was 3.5% in those with stable BMI vs 5.5% among those with fluctuating BMI(p=NS) and 8.2% in increased BMI(p=S**).	Q 5,7,8: Over 15 years, incidence of metabolic syndrome at yr 15 was significantly lower in the stable BMI group compared with the increased BMI group. Participants with stable BMI had essentially unchanged levels of metabolic syndrome components, regardless of baseline BMI, whereas those with increased BMI had progressively worsening levels.
17420347	Goodman E	Instability in the diagnosis of metabolic syndrome in adolescents	2007	Cohort	Prospective	Princeton	None	Q7 (RF14) Q8 (RF14)	USA	Community (schools)	Assess stability of factor patterns and clinical categorization of metabolic syndrome	NR (1,098)	Pediatric/ Young Adult	Participants in Princeton School District Study, a longitudinal study begun in 2001-2002. Subjects had a baseline physical examination and usable fasting morning sample and returned for reassessment 3 yr later	Age (SD): 15.0 yr (1.6) Female: 50.5% Non-Hispanic white: 51.6% Hispanic: 1.5% Overweight: 19.8% Obese: 20.4%	Met AHA definition for metabolic syndrome Met pediatric AHA definition for metabolic syndrome Met (International Diabetes Federation) IDF definition for metabolic syndrome	N/A	3 yr	Metabolic syndrome Risk factor constituents of metabolic syndrome using the 3 definitions.	Approximately half of adolescents with baseline metabolic syndrome lost the diagnosis at follow-up regardless of the definition used: pediatric AHA=56% (95% CI, 42% to 69%), AHA=49% (95% CI, 32% to 66%), IDF=53% (95% CI, 38% to 68%). In addition to loss of the MetS diagnosis, new cases were identified. Cumulative incidence rates for MetS were as follows: pediatric AHA=3.8% (95% CI, 2.8% to 5.2%); AHA=4.4% (95% CI, 3.3% to 5.9%); IDF=5.2% (95% CI, 4.0% to 6.8%). During adolescence, metabolic risk factor clustering is consistent; however, marked instability exists in the categorical diagnosis of metabolic syndrome.	Q6,7: During adolescence, metabolic risk factor clustering is consistent. Q8: Approximately half of adolescents with baseline metabolic syndrome lost the diagnosis at follow-up regardless of the definitions used

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PMID	First Author	Title	Year	Study Type	Prospect./ Restrospect.	Study	CVD	RF by CQ	Country	Setting	Main Study Objective	N at Baseline (N at Follow-up)	Target Population	Eligibility Criteria	Patient Characteristics	Study Groups	n at Baseline (n at Follow-up) for Study Groups	Total Follow-up Duration	Outcomes Measured	Results	Main Reported Findings by Critical Question
17573336	Chen W	Clustering of long-term trends in metabolic syndrome variables from childhood to adulthood in Blacks and Whites: the Bogalusa Heart Study	2007	Cohort	Prospective	Bogalusa	None	Q5 (RF5, RF8, RF14) Q6 (RF5, RF8, RF14)	USA	Community (other)	Evaluate long-term rates of change in metabolic syndrome variables from childhood to adulthood	1,020 (NR)	Pediatric/ Young Adult	Bogalusa subjects who had been examined at least once in childhood and at least once in adulthood - actual study group evaluated 3-6 times.	Community-based cohort of black(B) & white(W) children and young adults - originally examined at 5-17 yrs; 52% female(F),48% male(M); 44% B in 1982; serial cross-sectional studies performed from 1970 to present. For this study: Males: 40.9% Black: 389/ White: 631	N/A	N/A	Average of 16 yr	BMI HOMA-IR TG/HDL-C ratio Mean BP	Intraclass correlations, a measure of the degree of clustering among the variables were significant for childhood, adulthood, and incremental area values and were higher in adulthood than in childhood, more in Ms than Fs (p<S**for all 4 variables). Blacks showed a higher degree of clustering of long-term rates of change in risk variables than did Whites. Adjustment for body mass index reduced the degree of clustering by approximately 50%.	Results show that metabolic syndrome variables coexist in terms not only of their levels in childhood and adulthood but also the long-term rates of change. Q5: Blacks showed a higher degree of clustering of long-term rates of change in metabolic syndrome risk variables than did Whites. Q6: Intraclass correlations, a measure of the degree of clustering, among variables, were significant for childhood, adulthood, and incremental area values and were higher in adulthood than in childhood.
17986354	Kranz S	Diagnostic criteria patterns of U.S. children with Metabolic Syndrome: NHANES 1999-2002	2007	CrS	Retrospective	NHANES 1999-2002	None	Q6 (RF4, RF5, RF6, RF8)	USA	Clinical	Contribute to the understanding of MS risk factors during childhood by examining the diagnostic patterns of MS in nationally representative samples of 2-18 yr old children.	7,672	Pediatric/ Young adults	2-18 yr	Patient characteristics from NHANES 1999-2002	2-18 yr olds with data for ≥ 3 diagnostic criteria but did not provide fasting glucose levels 12-18 yr olds with data for ≥ 3 diagnostic criteria and provided fasting blood glucose data but were not overweight or obese 12-18 yr olds with data for ≥ 3 diagnostic criteria and provided fasting blood glucose data but were overweight or obese	3,467 1,064 641	NR	BMI classifications: Healthy weight - < 85th%ile At risk for overweight - 85th to 94th%iles Overweight - > 94th%ile MetS Criteria: TG ≥ 110 mg/dL HDL-C ≤ 40 mg/dL Fasting blood glucose (FBG) ≥ 110 mg/dL SBP &/or DBP≥ 90th%ile for age/sex/height Waist circumference: Abdominal obesity = WC ≥ 90th %ile for age/gender/ethnic group. MetS = Any 3 of the 5 possible diagnostic critera	Disease prevalence estimates were 2% in the group of 2-18 yr olds with data for ≥ 3 diagnostic criteria but no fasting glucose levels; 0.7% in the group of 12-18 yr olds with data for ≥ 3 diagnostic criteria and provided fasting blood glucose data but were not overweight or obese; and 23% in the group of 12-18 yr olds with data for ≥ 3 diagnostic criteria and provided fasting blood glucose data but were overweight or obese. More than 10% of the children providing fasting blood levels had hyperglycemia. 2% of the overweight or obese 12-18 year olds with fasting blood glucose data met all five diagnostic criteria for MS. In all groups, elevated total triglycerides and low high density lipoprotein (HDL) level affected a large proportion of the population.	Q6: Among overweight subjects, the MetS prevalence was high at 23% vs 0.7% in the healthy weight group. The prevalence of MetS RFs was high, especially high TGs and low HDL. More than 10% of the children providing fasting blood levels had hyperglycemia.