Resource 1: Children's dietary intakes

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Recommendations for a Healthy Diet in Childhood and Adolescence

Ideally, children and adolescents should consume a diet that provides an adequate intake of all essential nutrients needed for normal growth and development, metabolism, immunity and cognitive function; and an intake of total energy (caloric) that is balanced with energy expenditure in order to maintain body weight within a healthy range. In addition to consuming a variety of nutrient-rich foods and beverages from all of the major food groups, the total diet should not only promote health in childhood, but also reduce risk for future chronic disease, e.g. cardiovascular disease, certain types of cancer, type 2 diabetes, and obesity. At the present time, however, there is concern that the majority of US children are not consuming a diet that meets these goals. This is especially true with respect to maintaining energy balance and preventing obesity.

Energy Balance in Childhood: Key to a Healthy Weight

The most significant adverse health trend among US children in the past 40 years has been the dramatic increase in overweight and obesity. Since the early 1970s, the prevalence of overweight and obesity has approximately doubled among 2-5 and 6-11 year-olds, and tripled among 12-19 year old adolescents. Among children surveyed in NHANES 2003-2006, 16.3 % of 2-19 year old children and teens were obese[2], with BMI levels at or above the age- and gender-specific 95th percentile, and almost one-third, (31.9%) were overweight or obese, with BMI levels ≥ 85th percentile (Ogden, 2008). This is a serious public health concern since obesity is associated with adverse health effects during childhood, and increases risk of future chronic disease in adult life.

There is general agreement that childhood obesity results from long term, poorly regulated energy balance, with gradual increases in body fat, as stored energy, resulting from energy intake that exceeds energy expenditure. In other words, many children have increasingly been consuming more energy (calories) than they expend in physical activity, or need for metabolism and growth. On

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[1] This document was prepared as supplemental information related to the *Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010,* which can be found at www.dietaryguidelines.gov.

[2] In this document, obesity in children, 2-18 years of age, is defined as a BMI level equal to or above the age- and gender-specific 95th percentile, and overweight is defined as a BMI level between the 85th and 94th percentile relative to gender and age on the Centers for Disease Control and Prevention (CDC) growth charts (http://www.cdc.gov/growthcharts/).

average, the youth of America currently have energy intakes that fall on the high end of their respective energy ranges.

Evidence Linking Dietary Intake with Childhood Obesity

The 2010 Dietary Guidelines Advisory Committee (DGAC) examined evidence linking specific dietary and dietary behaviors with adiposity and risk of obesity in childhood. Conclusions based on the evidence reviews on energy balance are summarized below, since they provide a framework for dietary changes that may improve energy balance in childhood. Evidence supporting these associations is discussed in detail in the 2010 DGAC Report in ***Part D. Section 1: Energy Balance and Weight Management***.

The dietary intake and diet-related behaviors associated with *increased* adiposity in children include: increased total energy intake; higher energy density of the diet; higher total fat intake; higher intake of sugar-sweetened beverages; low intake of fruits and vegetables; large amounts of fruit juice, especially for overweight children; large portions of food and beverages; frequent consumption of "fast foods"; less frequent consumption of breakfast; and more hours of "screen-time" (television, computer, video games, etc). Alternately, the dietary intake and diet-related behaviors associated with *decreased* adiposity in children include: lower total energy intake; lower energy density of the diet; lower total fat intake; lower intake of sugar-sweetened beverages; higher intakes of fruits and vegetables; smaller amounts of fruit juice; smaller portions of food and beverages; less frequent consumption of "fast foods"; frequent consumption of breakfast; and fewer hours of "screen-time".

In addition to the items listed above for which evidence reviews led to conclusions that to some degree they played a role in either promoting or protecting against increased body weight, evidence for several other dietary intakes was inconclusive, either because little research had been conducted, as in the case of dietary fiber and childhood adiposity; or because results were inconclusive, as in the case of dairy (milk and milk products). It is important to emphasize, however, that despite the lack of evidence linking dietary fiber and dairy with adiposity in childhood; they are both important components of a healthy diet in childhood and currently are under-consumed by US children.

What are Children Eating in America? Highlights of Current Intake, Trends and Food Sources

Similar to adults, the "total diet" of children and adolescents consists of the combined intake of foods, energy, and nutrients that constitute their complete dietary intake, on average, over time.

This includes the foods and beverages, amounts, groupings, and resulting eating pattern that characterize the total dietary intake of American children.

Since evidence suggests that increased energy intake and dietary energy density, as well as higher intakes of dietary fat and sugar-sweetened beverages are associated with adiposity in children, it is of interest to compare current patterns of consumption with respect to recommended levels of intake. Increased energy intake from all caloric sources, without compensatory increased energy expenditure, could be responsible for increasing rates of childhood obesity; however national surveys of dietary intake in US children have only been able to demonstrate such an increase in recent years. Data comparing total energy intake for children surveyed in the Nationwide Food Consumption Surveys (NFCS) over a 20 year period of time, suggested that total energy intake had increased among children 2-18 years of age from 1,840 kcal/d in 1977-78 to 1,958 kcal/d in 1994-96 (Kennedy, 1996). In contrast, total energy intakes for children in the nationally representative cross-sectional National Health and Nutrition Examination Surveys (NHANES) have shown little change in reported total energy intakes in children and adolescents. As summarized in several reviews, however, the methodological challenges inherent in accurately measuring dietary intake in children are significant, especially with respect to assessing the independent effects of specific dietary components and characteristics, while adequately controlling for confounding by other factors (Newby, 2007; Must, 2009). As discussed in ***Part D. Section 1: Energy Balance and Weight Management*** in the 2010 DGAC Report, the greatest methodological challenge in accurately assessing energy intake in children, however, is due to bias from implausible reporting of energy intake. Under-reporting of energy intake is common, with heavier children more likely to under-report energy intake compared with normal weight children (Livingstone, 2000). When implausible energy intakes are identified, a growing number of studies have found a positive association between energy intake and adiposity in children, an association that is often masked when implausible energy intake reports are not excluded.

The top sources of energy among US children and adolescents in the NHANES 2005-2006 survey were grain desserts (138 kcal/day), pizza (136 kcal/day), and soda (118 kcal/day) (NCI, 2010a). Looking across beverage categories, 2-18 year olds consumed 171 kcal/day from sugar-sweetened beverages (soda and fruit drinks combined) (NCI, 2010b). Major contributors varied somewhat by age, sex, race/ethnicity, and family income. Consumption of solid fats (NCI, 2010c) and added sugars (NCI, 2010d) far exceeded the discretionary calorie allowance for all sex-age groups.

- **Mean Intake of Energy and Mean Contribution (kcal) of Various Foods Among US Children and Adolescents, by Race/Ethnicity and Family Incomes, NHANES 2005–06:**

  http://riskfactor.cancer.gov/diet/foodsources/energy/table5b.html

- **Distribution of Intake (calories) across Beverage Types, US children & adolescents (2-18 years), 2005–06:**

  http://riskfactor.cancer.gov/diet/foodsources/beverages/table1.html

Total energy needs in childhood and adolescence vary significantly with age, gender, and physical activity level (see Table B2.1 in ***Part B. Section 2: The Total Diet: Combining Nutrients, Consuming Food***). The recommendations are for healthy children and adolescents, 2-18 years of age, and regardless of weight status. However, most children over age 2 years, and especially those who are gaining weight at a disproportionately greater rate than height, or who are already overweight or obese, would benefit from moving toward consuming a total diet that is nutrient-rich but lower in energy density. For children, as for adults, reducing the current high consumption of solid fats and added sugars (SoFAS) may be the most critically needed change for better energy balance in childhood.

Survey data from NHANES 2003-04 shows that nearly 40% of total calories consumed (798 kcal/day of 2027 kcal) by 2-18 year olds in the US are in the form of empty calories (433 kcal from solid fat and 365 kcal from added sugars) with empty calories representing the sum of calories from solid fat and added sugars. This contrasts markedly with discretionary calorie allowances, which range from 8% to 20% of total calories (Reedy, 2010). Currently, intake of empty calories far exceeds the discretionary calorie allowance for all sex-age groups.

Among 2-18 year olds, about half of all empty calories come from six specific foods and beverages: soda, fruit drinks, dairy desserts, grain desserts, pizza, and whole milk (Reedy, 2010). Sugar-sweetened beverages are the largest contributor, providing 22% of empty calories. In fact, among both males and females 9-13 and 14-18 years old, the empty calories consumed from soda and fruit drinks alone effectively "use up" or exceed the discretionary calorie allowance.

Dietary Intake of Solid Fats: US Children, NHANES 2003-04

Among US children and adolescents, 2-18 years of age, the average daily intake of energy from solid fat is 433 kcal (NCI, 2010c). The top sources of solid fat are pizza (50 kcal/day from solid fat), grain desserts (43 kcal), whole milk (35 kcal), regular cheese (34 kcal), and fatty meats (29 kcal). This list varies by age, with younger children obtaining a greater share of their solid fat from both whole and reduced-fat milk and 14-18 year olds getting more from fried potatoes. Major contributors of solid fat also include fried potatoes among non-Hispanic Black children and youth; reduced-fat milk among non-Hispanic Whites; and Mexican dishes among Mexican-Americans.

- **Mean Intake of Solid Fats & Mean Contribution (kcal) of Various Foods Among US Children & Adolescents, by Race/Ethnicity & Family Income, NHANES 2005–06:**

  http://riskfactor.cancer.gov/diet/foodsources/solid_fats/table4b.html

Dietary Intake of Added Sugars: US Children, NHANES 2005-06

Among 2-18 year old children and adolescents in the US, the average daily intake of energy from added sugars is 365 kcal (NCI, 2010d). The major sources of added sugars are soda (116 kcal/day from added sugars), fruit drinks (55 kcal), grain desserts (40 kcal), dairy desserts (29 kcal), and candy (25 kcal). There is some variation with respect to age and demographic groups, for example, cold cereals are among the top sources of added sugars for 2-8 year old children, Non-Hispanic Whites, and low-income groups.

Sugar-sweetened beverages (soda, energy and sports drinks and fruit drinks) are the top two sources of calories from added sugars among nearly all age and demographic groups. Adolescents, 14-18 years of age, consume on average 260 kcal/day of added sugars from sugar-sweetened beverages; 9-13 year olds consume 168 kcal/day; 4-8 year olds consume 121 kcal/day; and for 2-3 year olds, 60 kcal/day. Among all racial/ethnic and income groups, sugar-sweetened beverages contributed almost half (45-50%) of the daily energy intake from added sugars. For non-Hispanic Blacks, more added sugars are consumed from fruit drinks than soda, however, a notable difference from other groups.

- **Mean Intake of Added Sugar & Mean Contribution (kcal) of Various Foods Among US Children & Adolescents, by Race/Ethnicity & Family Income, NHANES 2005–06:**

  http://riskfactor.cancer.gov/diet/foodsources/added_sugars/table4b.html

- **Mean Intake of Added Sugar & Mean Contribution (kcal) of Various Foods Among US Children & Adolescents, by Age, NHANES 2003–04:**

  http://riskfactor.cancer.gov/diet/foodsources/added_sugars/table1b.html

Dietary Intake of Beverages: US Children, NHANES 2005-06

Data from the 2005-06 NHANES describes the distribution of intake across beverage types, by fluid weight (in grams) and by energy (calories) for US children and adolescents (2 - 18 years) (NCI, 2010c). Results show that soda is the top beverage for US children and adolescents, supplying more of both fluid weight (grams) and energy (calories) than any other beverage. Regular soda contributes 33% of the gram weight of beverages consumed by children. Other sources of beverage fluid weight include reduced fat milk (17%), fruit drink, (13%), 100% fruit juice (12%), whole milk (9%), tea (5%), skim milk (3%) and low calorie soda (3%) contribute to the fluid weight of beverages consumed by children and adolescents. When considering the distribution of beverage calories by source of beverage, again, the largest proportion of beverage calories consumed by US children and adolescents comes from regular soda (29%). Other sources of beverage calories include reduced fat milk (22%), whole milk (15%), fruit drink (14%), 100% fruit juice (13%), and skim milk (3%).

- **Distribution of Intake (grams) across Beverage Types, US children & adolescents (2-18 years):**

  http://riskfactor.cancer.gov/diet/foodsources/beverages/figure3.html

- **Distribution of Intake (calories) across Beverage Types, US children & adolescents (2-18 years):**

  http://riskfactor.cancer.gov/diet/foodsources/beverages/figure6.html

Major shifts in the types and amounts of beverages consumed by US children have occurred over recent decades. In a review of time trends in food choices made by children 6-19 years since the late 1970s, Sebastian et al. (2006) analyzed data from two nationally representative surveys: the 1977-78 Nationwide Food Consumption Survey (NFCS) and the 2001-02 What We Eat in America, NHANES (WWEIA-NHANES). In both surveys, multiple days of dietary intake data were collected from participants of all ages; however, only the first day of dietary data, collected using the 24-hour recall method, was utilized in this study. Data from 4,107 children 6-11 years and 5,890 teenagers 12-19 years in the NFCS 1977-78 and 1,136 children and 2,297 teenagers in the 2001-02 WWEIA-NHANES who provided complete Day 1 dietary recalls were analyzed. Differences in mean intake of milk, soda, fruit drinks and 100% fruit juice were significant ($p<0.001$) for both children and teens between the 1977-78 and 2001-02 surveys. As a percentage of total beverage intake, intake of soda by children 6-11 years increased from 15% to 33% during this 25 year time period. At the same time, milk decreased from 61% of total beverage intake to 33%. Among teens, soda replaced milk as the beverage of choice. In 1977-78, soda accounted for 29% and milk 51% of all beverages consumed by teens on a per gram basis. In 2001-02, these percentages were virtually reversed with soda making up 50% and milk 23% of this total. Ninety-five percent of soda consumed by both age groups was regular (sugar-sweetened) soda. Consumption of fruit drinks and fruitades changed slightly, increasing as a percentage of total beverages from 14% to 20% for children and 11% to 17% for teens. Intake of 100% fruit juice as a percentage of total beverages increased from 10% to 14% for children and remained relatively constant for teens (9% in 1977-78, 10% in 2001-02). In addition to changes in the type of beverage consumed, significant changes also occurred in the amount of various beverages consumed by children. Children and teens who consumed fruit juice, fruit drinks and fruitades, and soda in 1977-78 were drinking more per day of these products in 2001-02, while amounts of milk consumed by milk drinkers declined. For the 6-11 year olds, significant differences ($p<0.001$) were observed in consumption of milk, soda, and 100% fruit juice. For adolescents, significant differences in intake were found for all beverages examined except milk. In 2001-02, soda was consumed in the largest amount of any beverage. To translate into common measures, mean soda intake by children who drank soda was about 15 ounces per day for 6-11 year olds and 25 ounces for teenagers.

Dietary Intake of Fruits, Vegetables and 100% Fruit Juice: US Children, NHANES 2001-04

Although evidence suggests that increased consumption of fruits and vegetables confers some protection against increased adiposity in children, at present, current intake by US children does not meet recommendations, either with respect to numbers of daily servings or variety of types consumed. Recently, the National Cancer Institute (NCI) used data from NHANES 2003-04 to determine the distribution of intake (cup equivalents) of vegetables, whole fruit and fruit juice within the MyPyramid Vegetable and Fruit Groups, for US Children and Adolescents (2-18 years). In this analysis, the weighted population contribution of each subgroup to its MyPyramid food group and the contribution of specific foods to intakes of whole fruit, fruit juice, dark green vegetables, orange vegetables, legumes, starchy vegetables, other and vegetables were determined.

Vegetables: US children and adolescents do not consume vegetables in the proportions that are recommended. Rather they eat more starchy vegetables, and other vegetables, and less dark green and orange vegetables and legumes than recommended. Mean intake of total vegetables in NHANES 2001-04 among 1-8 yr old children was only 0.8 to 1.0 servings/day, and for older children, 1.2 to 1.5 servings/day (NCI, 2010e). For older children however, especially teens, a significant proportion of total vegetable intake is from white potatoes, often consumed as french fries. On the other hand, children consume too few servings of dark green and orange vegetables. In 2003-04, consumption of these nutrient-rich vegetables represented only 7% of total vegetable consumption by children and adolescents, 2-19 years, compared with 31% for potatoes (NHANES 2003-04).

Within the MyPyramid Vegetable Group, starchy vegetables contributed 36% of daily vegetable intake (cup equivalents), legumes contributed 7%, while dark green and orange vegetables each contributed 3%. The largest source was from "other vegetables," a category that includes vegetable components of pizza, pasta and pasta dishes, condiments, lettuce, tomatoes, vegetable medleys, burgers, rice and mixed rice dishes, string beans, soups, Mexican mixed dishes, chicken and chicken mixed dishes, and tomato sauces.

Fried white potatoes accounted for one-third (33%) of intake from starchy vegetables, followed by potato/corn/other chips (26%); other white potatoes (23%); and corn (7%). Carrots were the top vegetable consumed in the orange vegetable subgroup, comprising 62% of children's intake, with sweet potatoes accounting for only 5%. For dark green vegetables, broccoli accounted for 43% of intake, followed by spinach (19%), and lettuce (14%). Almost two-thirds (65%) of legumes consumed were beans, followed by legumes contained in Mexican mixed dishes (20%), rice and rice mixed dishes (7%), chili (4%), and soup (3%).

- **Usual Intake of Total Vegetables, Including Cooked Dry Beans & Peas, NHANES 2001-2004:**

  http://riskfactor.cancer.gov/diet/usualintakes/pop/t14.html

- **Distribution of Intake (cup equivalents) among Subgroups within the MyPyramid Vegetable Group, US Children and Adolescents (2–18 years), NHANES 2003-2004:**

  http://riskfactor.cancer.gov/diet/foodsources/food_groups/figure3.html

Fruit and Fruit Juice: US children and adolescents consume more fruit juice and less whole fruit than recommended. Mean intake of total fruit for US children in NHANES 2001-04 was only 0.8 to 1.2 servings/day for ages 4-18 years, and 1.5 servings/day for ages 1-3 years (NCI, 2010f). In addition, more than half of the fruit intake (cup equivalents) within the MyPyramid fruit group, is from juice (57%) while whole fruit accounts for just 43%. For whole fruit intake, apples and pears were the top whole fruit choice of children (38%), followed by bananas (16%), other fruit and fruit salads (8%), citrus fruits (8%), melon (8%), and grapes (7%). The leading source of juice intake, contributing 44% of cups consumed, was 100% fruit juice (not orange or grapefruit). This was followed by 100% orange/grapefruit juice (41%), fruit drinks (10%) and other (5%). It should be noted, that although 100% fruit juice can be part of a healthful, nutrient-rich diet in childhood, consumption of very large amounts have been associated with adverse health effects (AAP, 2001). For this reason, current recommendations are to limit the amount consumed by children on a daily basis. In addition, the MyPyramid worksheet for school-age children provides this tip "Make most choices fruit, not juice," and on the "Tips for Families" page, includes this advice: "Focus on Fruits: Eat them at meals, and at snack time, too. Choose fresh, frozen, canned or dried, and go easy on the fruit juice."

- **Usual Intake of Total Fruit: US Children, NHANES 2001-2004:** http://riskfactor.cancer.gov/diet/usualintakes/pop/t3.html

- **Distribution of Intake (cup equivalents) between Juice & Whole Fruit within the MyPyramid Fruit Group, US Children & Adolescents (2–18 years):**

  http://riskfactor.cancer.gov/diet/foodsources/food_groups/figure2.html

- **Food sources of Whole Fruit, Fruit Juice, Dark Green Vegetables, Orange Vegetables, Legumes, Starchy Vegetables, Other Vegetables, Whole Grains, Non-Whole Grains, Meat, Poultry, Fish, Eggs, Soy, Nuts and Seeds, Milk, Cheese, Oils, Solid Fats, & Added Sugars, among US Children & Adolescents (ages 2–18), 2003–2004 NHANES:**

  http://riskfactor.cancer.gov/diet/foodsources/food_groups/table2.html

National surveys show that the food choices of US children and adolescents have changed considerably since 1977-78. Overall, foods which typically have a high caloric content relative to the nutrients they provide also showed large gains in popularity. Children are consuming fewer total vegetables than they were several decades earlier. Enns et al. (2002) examined time trends in intake of vegetables and fruits for US children between 1977-78, and 1994-96, 1998 and found that 6-11 year olds consumed more total vegetables in the 1970s than children in the 1990s. Total vegetable intake also decreased over this 25 year period of time for 12-17 year old adolescents, as well.

In 1994-96, 1998, only 18% of adolescent girls and 14% of adolescent boys consumed the recommended number of Food Pyramid recommended fruit servings (Enns, 2003). With respect to total fruit servings, in 1994-96, 1998, only 24% of girls and 23% of boys consumed the number of Food Pyramid recommended fruit servings. Consumption of 100% fruit juice increased between the 1977-78 and 2001-02, however (Sebastian, 2006). Intake as a percentage of total beverages increased from 10% to 14% for 6-11 year-old children, but remained relatively constant for 12-19 year-old teens (9% to 10%). In addition, children and teens who consumed fruit juice in 1977-78 were drinking more per day of these products in 2001-02. Between the 1977-78 and 2001-02, the amount of 100% fruit juice consumed each day increased from 212 to 327 grams/day for 6-11 year-old children, and increased from 238 to 423 grams/day for 12 – 19 year-old adolescents (Sebastian, 2006).

Current Intake of Dietary Fiber: US Children, NHANES 2005-06

Currently, dietary fiber is under-consumed by US children, whose intake is far less than the recommended adequate intake (AI) of 14 grams of per 1000 kcal (see ***Part D. Section 2: Nutrient Adequacy*** in the 2010 DGAC Report for more information on current dietary intake of fiber). Thus, public health strategies to increase consumption of dietary fiber are vitally important to promote the health of US children. Among 2-18 year olds surveyed in NHANES 2005-06 (NCI, 2010g), top food sources of dietary fiber intake, contributing at least 5% are yeast breads, Mexican mixed dishes, pasta and pasta dishes, pizza, ready-to-eat cereals, grain-based desserts, fried white potatoes, and potato/corn/other chips, with some variation by age, gender, race/ethnicity, and income. For example, apples and pears (6%) and bananas (5%) are major contributors for 2-3 year olds, and beans (8%) and apples and pears (5%) are major contributors for all Mexican-American children and adolescents.

- **Distribution of Fiber Intake (grams) across Food Sources, US Children & Adolescents (2–18 years):**

  http://riskfactor.cancer.gov/diet/foodsources/fiber/figure2.html

- **Mean Intake of Dietary Fiber & Percentage Contribution of Various Foods among US Children & Adolescents, by Age, NHANES 2005–06:**

  http://riskfactor.cancer.gov/diet/foodsources/fiber/table1a.html

- **Mean Intake of Dietary Fiber & Percentage Contribution of Various Foods among US Children & Adolescents, by Race/Ethnicity & Family Income, NHANES 2005–06:**

  http://riskfactor.cancer.gov/diet/foodsources/fiber/table4a.html

Total Fat Intake in US Children: Current Intake, Trends, and Food Sources

Trends in dietary fat intake among children are of interest with respect to increasing childhood obesity since fat is the most energy dense nutrient. Based on data from cross-sectional surveys of US children over the past several decades, percent of energy from total fat has decreased. Between 1965 and 1996, the proportion of energy from total fat consumed by US children decreased from 39% to 32%, and saturated fat from 15 to 12%. Both children, age 6 -11 years, and adolescents, age 12-19 years, in 1994-96, 1998 consumed 25-26% of calories from discretionary fat (Enns, 2002). Data from the 2001-2004 NHANES survey shows that among children, mean intake of total fat has remained at about 32-33 % of energy intake. Although mean intake falls with the Acceptable Macronutrient Distribution Range (AMDR), fully one-fourth of 2-18 yr olds consume more than 35% of energy as fat, exceeding the recommended range (available at: http://www.cnpp.usda.gov/Publications/DietaryGuidelines/2010/Meeting6/AdditionalResources/NutrientsByTotalFatQuartiles-AllAges.pdf).

In contrast, comparing dietary intake in 1977-78 with intake in 2001-02 shows that higher fat food choices among US children have increased (Sebastian, 2006). Consumption of pizza, tacos, and snack foods increased dramatically among children and teens over this 25 year period. The following food groups showed large increases in mean intake: savory grain snacks including corn chips, tortilla chips, popcorn, pretzels, and non-sweet crackers (+320% in both groups); pizza (+413% for children, +208% for teens); Mexican dishes (+367% for children, +567% for teens); and candy (+180%, +220%). Overall, vegetables not consumed as part of a mixed dish exhibited a decrease in consumption despite a sizable increase in fried potatoes intake. All reported differences in food group intake were significant ($p<0.001$).

Further analysis of data from NHANES 2001-2004 reveals that as total fat intake increases, so also does intake of saturated fat, cholesterol and sodium (available at: http://www.cnpp.usda.gov/Publications/DietaryGuidelines/2010/Meeting6/AdditionalResources/NutrientsByTotalFatQuartiles-AllAges.pdf). Thus from the perspective of promoting cardiovascular health in children and adolescents, keeping total fat, saturated fat and cholesterol intakes within recommended intake levels is very important. Although it is theoretically possible for children with high total fat intakes to maintain energy balance with careful attention to calorie intake and expenditure; and to substitute monounsaturated fat for saturated fat to promote healthy a healthy lipid profile, the reality of achieving this, in view of the top sources of energy among US children and adolescents, is unlikely without drastic changes in the foods and beverages currently consumed.

Current recommended levels of fat intake for children were proposed by the National Academy of Sciences (NAS) in their 2005 Macronutrient Report (IOM, 2005). Acceptable

Macronutrient Distribution Ranges (AMDR) for total fat by age of child are as follows: age 1-3 yrs: 30-40 % energy; age 4-8 yrs: 25-35 % energy; and for ages 9-13 and 14-18 yrs: 25-35% energy. The rationale for the Upper Limit of the AMDR's was based on consideration of reducing risk for chronic disease, as well as providing adequate intake of other nutrients, while the Lower Limit of the AMDR was based on concerns related to the increase in plasma triglycerides (TG) and lower HDL-cholesterol seen with very low fat (and thus higher carbohydrate) diets. The NAS report also stated that studies conducted to ascertain whether a certain amount of dietary fat is needed to ensure normal growth in children, had generally concluded that there is no effect of fat intake on growth when consumed at levels as low as 21% of energy, provided that total energy intake is adequate (Boulton, 1995; Lagström, 1999; Lapinleimu, 1995; Niinikoski, 1997a, 1997b; Obarzanek, 1997; Shea, 1993). Thus, without sufficient evidence to identify a defined intake level of fat to prevent obesity or chronic diseases, and the lack of an effect of fat intake on growth, the NAS declined to set either an Adequate Intake (AI) or an Estimated Average Requirement (EAR) and Recommended Dietary Allowance (RDA) for children and adolescents."

The 2005 Dietary Guidelines Advisory Committee (HHS/USDA, 2008) mirrored the NAS guidelines, however they applied to children 2 years of age and older, rather than 1 year of age and older in the NAS guideline. Thus for the 2005 DGAC, the NAS guideline for fat intake for 1-3 year olds of 30-40 % energy was modified to 35-40 % energy for 2-3 yr olds, in line with a transition toward the lower fat range (25-35% energy) for children 4 years of age and older.

Although mean intake of total fat among US children is within the NAS recommended range, a significant proportion of children and adolescents have intakes of total fat that exceed the AMDR. Based on data from NHANES 2005-06, fully one-fourth of 2-18 yr olds consume more than 35% of energy as fat. In addition to the evidence linking higher fat intake with adiposity in children, other prospective studies, such as the DISC and STRIP studies, suggest that cardiovascular risk factors in children are significantly reduced on diets characterized by 30% energy or less from total fat and less than 10% energy from saturated fat (Obarzanek, 2001; Niinikoski, 2007).

Dietary Patterns in Childhood Associated With Specific Health Benefits: Evidence From the Scientific Literature

A growing number of important research studies have identified specific health benefits that result when children consume energy-balanced dietary patterns where most calories come from a variety of nutrient-rich foods and beverages, especially fruits and vegetables, dietary fiber and whole grains, lean protein, low-fat dairy, and low sodium; and where intake of added sugar, refined carbohydrates, and total and saturated fat, are low. Key findings from several of these studies are summarized here:

<u>The Special TURKU Risk Factor Intervention Project (STRIP):</u> In this unique randomized controlled dietary intervention trial in Finland, children have now been followed prospectively for more than 15 years, beginning in infancy. To date, more than 100 scientific reports from the STRIP study have been published on methodology, as well as outcomes. Overall, findings from the STRIP study suggest that a dietary pattern begun early in life, characterized by low saturated fat and low cholesterol, with total fat intake at about 30% of energy intake, may translate into significant long-term reductions in risk factors for cardiovascular disease, including healthier lipid profiles, lower blood pressure levels, less metabolic syndrome, and in some children, less obesity.

In the STRIP trial, a low-saturated-fat, low-cholesterol diet was introduced to intervention infants (n=540) at 7 months of age, and control children (n=522) received an unrestricted diet. Children's dietary intake, serum cholesterol values, somatic growth, and development were subsequently monitored through childhood and adolescence. Breastfeeding was encouraged until weaning. At 12 months of age, dietary counseling included skim milk for intervention children versus reduced fat milk (2% fat by weight) for the usual care group. Intervention children were also encouraged to consume 2 tsp (10g) soft margarine or vegetable oil daily during the second year of life to maintain adequate fat intake and increase the ratio of unsaturated to saturated fatty acids. No advice to lower sodium given until age 8 yrs, and even then – not strongly emphasized. An extensive list of outcome measures were obtained on subjects, parents and siblings during from childhood through adolescence; however key outcomes variables included measures of dietary intake, blood lipids, blood pressure, growth and development, and cognitive and psychosocial status.

Improved Lipid Profiles: Niinikoski et al. (2007) evaluated the effect of the STRIP intervention on fat intakes, growth, serum cholesterol values, and pubertal development in participating children. Results showed that saturated fat intakes, serum total cholesterol, and low-density lipoprotein cholesterol values were lower ($p<0.001$) in the intervention than in control children during the 14 years of follow-up, whereas HDL-cholesterol values in the 2 study groups showed no difference. Boys had lower total and low-density lipoprotein cholesterol concentrations than girls throughout childhood ($p<0.001$), and the intervention effect on serum cholesterol concentration was larger in boys than girls. The 2 study groups showed no difference in growth, body mass index, pubertal development, or age at menarche (median, 13.0 and 12.8 years in the intervention and control girls, respectively; $p=0.52$). The cholesterol values decreased as puberty progressed. Mean concentrations of total and HDL-cholesterol decreased from ≈ 4.5 and ≈1.4 mmol/L, respectively, in Tanner stage 1 (prepubertal) boys to ≈3.9 and ≈1.1 mmol/L in Tanner stage 4 (late pubertal) boys. The authors concluded that repeated dietary counseling remains effective in decreasing saturated fat and cholesterol intake and serum cholesterol values at least until 14 years of age. Puberty markedly influences serum cholesterol concentrations.

Lower Blood Pressure: Niinikoski et al. (2009) measured blood pressure annually among the 1,062 children followed in the STRIP study from 7 months to 15 years of age. At age 15 years, systolic and diastolic blood pressures were 1.0 mm Hg lower (95% CI for SBP: -1.7 to – 0.2 mm Hg; 95% CI for DBP: -1.5 to – 0.4 mm Hg) in children receiving low-saturated fat counseling through childhood than in control children. Intakes of saturated fat were lower; and intakes of polyunsaturated fat were higher in the intervention versus control group. Dietary intakes of sodium (p=0.76) and calcium (p=0.08) did not differ between the study groups, but intakes of potassium (p=0.002) and magnesium (p<0.0001) were significantly higher in children in the intervention group compared with controls.

***Reduced Prevalence of Metabolic Syndrome**:* Hakanen et al. (2010) evaluated the impact of the STRIP dietary and lifestyle intervention on the clustering of overweight-related metabolic syndrome risk factors among subjects in the trial. A cluster was defined as having high BMI and ≥ 2 other risk factors. Results showed that at age 15 years, 13.0% of girls and 10.8% of boys in the intervention group, and 17.5% of girls and 18.8% of boys in the control group had the risk factor cluster (p=0.046 for main effect of the study group). Having even one risk factor at the age of 5 years predicted the clustering of risk factors at the age of 15 years (OR: 3.8, p < 0.001). They concluded that repeated, individualized dietary and lifestyle counseling may reduce the clustering of cardiometabolic risk factors in adolescents even if the counseling is not intense enough to prevent overweight.

Lower Indices of Insulin Resistance: Kaitosaari et al. (2006) assessed insulin resistance (HOMA-IR) index, serum lipids, blood pressure, and weight for height in a random subgroup of 78 STRIP intervention children and 89 control children at 9 years of age. Intervention children consumed less total and saturated fat than the control children (p=0.002 and 0.0001, respectively). Results showed that the HOMA-IR index was lower in intervention children than in control children (p=0.020). There was a significant association between saturated fat intake and HOMA-IR. In multivariate analyses including saturated fat intake, study group, and other determinants of HOMA-IR (serum triglyceride concentration, weight for height, and systolic blood pressure), study group was, whereas saturated fat intake was not, significantly associated with HOMA-IR. This suggests that the beneficial effect of intervention on insulin sensitivity was largely, but not fully, explained by the decrease in saturated fat intake. The authors concluded that long-term biannual dietary intervention decreases the intake of total and saturated fat and has a positive effect on insulin resistance index in 9-year-old children.

Less Overweight and Obesity in Girls at Age 10 years; but not at Age 13 in Males or Females: Hakanen et al. (2006) evaluated the impact of individualized dietary and lifestyle counseling on the prevalence of overweight during the first 10 years of life in children participating in the STRIP intervention trial, with children classified as overweight or obese if their weight for height was 120% or 140% above the mean weight for height of healthy Finnish children, respectively. Results showed that after the age of 2 years, there were continuously fewer overweight girls in the intervention group than in the control group. At the age of 10 years, 10.2% of the intervention girls and 18.8% of the control girls were overweight ($p=0.0439$), whereas 11.6% of the intervention boys and 12.1% of the control boys were overweight ($P \approx 1.00$). Only three children in the intervention group were obese at some age point, whereas 14 control children were classified as obese at some age point. The authors concluded that individualized dietary and lifestyle counseling given twice a year since infancy decreased the prevalence of overweight among 10-year-old girls, even without any primary energy restrictions. Subsequently, Lagstrom et al. (2008), reported on the growth patterns and development of overweight in 541 STRIP participants at 13 years of age. Children were classified as overweight (n = 84) if his or her BMI exceeded the international age- and gender-specific overweight criteria. Children who were overweight at 13 years of age had gained more weight than their normal-weight peers by the age of 2 or 3 years onward. The girls became overweight by the age of 5 years, whereas the boys only after 8 years of age. Parental BMI and steep weight gain in early childhood markedly increased risk for becoming overweight. At this age 13 year follow-up, the STRIP intervention had no effect on the examined growth parameters of the children.

In summary, results from the STRIP study suggest that a healthy dietary pattern begun early in life may translate into significant long-term reductions in risk factors for cardiovascular disease, including healthier lipid profiles, lower blood pressure levels, less metabolic syndrome, and in some children, less obesity.

Other Programs and Trials: In another prospective cohort study of preschool children, Moore et al. (2005) found that overall dietary patterns, especially those rich in fruits, vegetables, and low-fat dairy, were associated with lower blood pressure levels in childhood and adolescence. In this **Framingham Children's Study**, blood pressure and other CVD risk factor levels were assessed prospectively in a cohort of 95 healthy 3-5 year old children. After 8 years, children who consumed more fruits and vegetables (≥ 4 servings/day) or more dairy products (≥ 2 servings/day) during the preschool years had significantly smaller yearly gains in systolic blood pressure throughout childhood. Dietary intake of magnesium (negative association) and sodium (positive association) were independent predictors of systolic blood pressure; however, adjusting for mean intake of these minerals in multivariate analysis did not explain the reduction in systolic blood pressure associated with greater fruit, vegetable, and dairy intakes.

Similarly, in a randomized controlled clinical trial of the **DASH (Dietary Approaches to Stopping Hypertension)** diet pattern in 57 adolescents with elevated blood pressure, Couch et al.

(2008) found that subjects assigned to the DASH diet pattern for 3 months had a significantly greater decrease in systolic blood pressure and diastolic blood pressure z-scores compared with subjects in the usual care group. In this study, the DASH group had a greater increase in intake of fruits ($p<0.001$), low-fat dairy products ($p<0.001$), potassium and magnesium (both ($p<0.001$), and decreased intake of total fat ($p<0.05$) compared with controls. Sodium intake did not differ significantly between treatment groups.

Thus in summary, there is a small but growing body of scientific literature that links health benefits in childhood, especially lower blood pressure and reduced risk of cardiovascular disease, with specific dietary patterns in well-designed cohort studies and clinical trials. Evidence from these studies suggest that children and adolescents are likely to accrue health benefits from diets that emphasize plant-based foods, especially vegetables and fruits, and an intake of total fat that is in the lower range of the AMDR (<30% energy) and is low in saturated fat (<10% energy). In addition, health benefits are linked to carbohydrate intake that is primarily from complex carbohydrates, especially from high fiber and whole grain products; low-fat and non-fat dairy; and lean sources of high quality protein. These findings are of public health importance, since cardiovascular diseases are the leading cause of death in the US and atherosclerosis begins in childhood.

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Resource 2: Implications of food allergens and a safe food supply

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Introduction

Food allergy is a serious public and personal health concern that affects approximately 10-12 million individuals. The serious nature of food allergies is amplified by about 30,000 anaphylactic episodes annually, and their contribution to 150 anaphylactic-related deaths per year. Recent survey data indicate nearly 4% of children under the age of 18 years reported an allergy to at least one food item. This statistic increases to 6-8% of children less than six years of age, and is comparable to that of adults.

Six common foods account for nearly 90% of the food allergy reactions. Those foods are milk, eggs, peanuts, tree nuts (Almond, Cashew, Brazil nut, Pistachio, Macadamia, Walnut, Pecan, Hazelnut, Pine nut), fish, and crustacean shellfish. According to the Food Allergen Labeling and Consumer Protection Act of 2004, these foods plus two others, namely soybeans and wheat, are now required to be declared on food labels, if the product contains or was produced in a facility that may contain any of these basic eight foods.

The serious nature of food allergy reactions and the increasing prevalence of food allergies across the population spectrum provided a public health foundation for the current Dietary Guidelines Advisory Committee to assess the food safety implications of food allergens, to recommend to the government that they take further action to educate the general consumer on the topic, as well as providing guidance to sensitive individuals on reducing exposure to food allergens.

Background

Before addressing some essential and often complex food allergy-related questions, it is important to facilitate a basic understanding of food allergies. Fundamentally, there are two types of food sensitivities or adverse reactions associated with exposures to food allergens. Those types involve the consumption of the triggering component(s) or inhalation of the causative agent(s). Sensitive individuals may present overt food allergy symptoms, or present symptoms associated with

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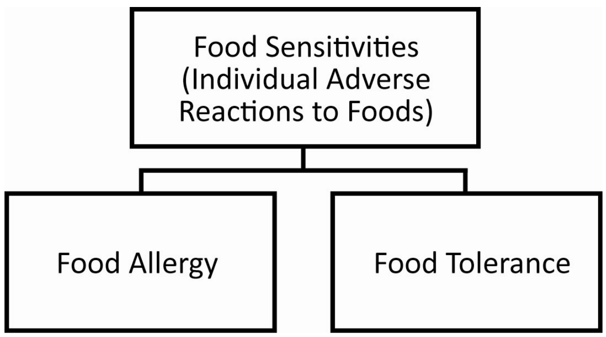
food intolerance. A diagram depicting this adverse food reaction divergence among these individuals is shown below in Figure 1.

Figure 1. Food Sensitivities



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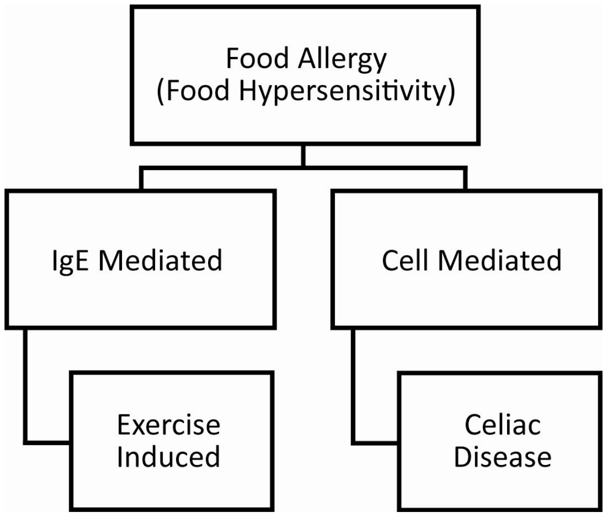
According to the National Institute of Allergy and Infectious Diseases, the human body's adverse response to food can be caused by several by two fundamental mechanisms. Those mechanisms either involve the immune system or numerous systems outside of the immune system, typically the digestive system. The latter is often referred to as food intolerance. A classic example of food intolerance is lactose, a natural sugar found in breast milk and other mammalian milk products, including cheese, yogurt, and kefir. Other possible food intolerances perceived by consumers and may be clinically identified include strawberries, mushrooms, chocolate and raspberries. Yet, many individuals can present food allergy symptoms with these same foods.

Food allergens, usually proteins, occur naturally in all foods whether raw, semi-processed or processed. In sensitive individuals, exposure to these food proteins stimulates certain kinds of cells that result in specific immunologic reactions.

As suggested in Figure 2, there are many components involved in frank food allergy. A food allergy reaction may be mediated by IgE antibodies, a specific type of immunoglobulin made in response to offending proteins, or not mediated by IgE but rather through specific kinds of cells.

Food-dependent allergic symptoms and even anaphylaxis may also present during or immediately following exercise (Beaudouin, 2006). While this occurs infrequently, several of the common allergenic foods are considered the offending culprits. The most notable of these foods are wheat flour, crustaceans and soybeans (Adachi, 2009). Once again, avoidance of known and potentially offending foods is essential if individuals are to reduce the risk of exercise-induced food allergy reactions.

Figure 2. Food Allergy



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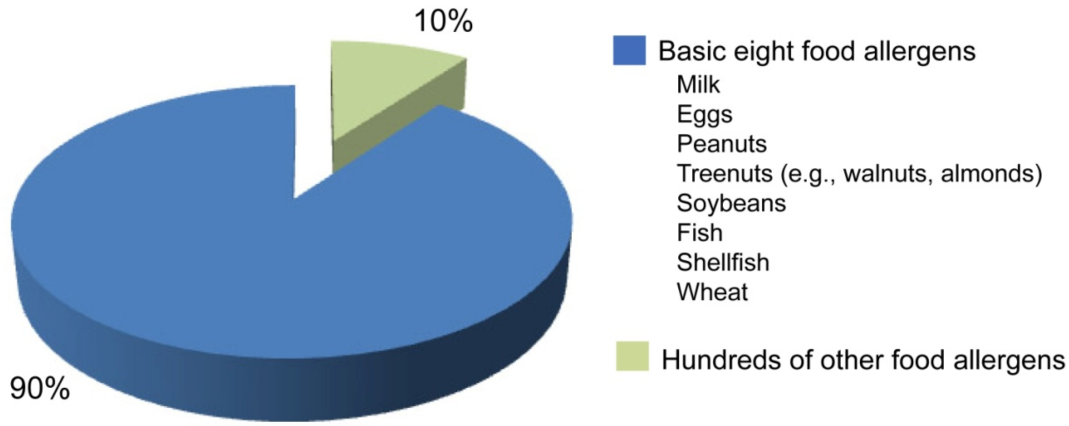
In addition to the basic eight allergenic foods, estimates suggest that the wide variation in food allergenicity also includes 0.1% to 4.3% for fruits and tree nuts, 0.1% to 1.4% for vegetables, and less than 1% for wheat, soy, and sesame (see Figure 3). Allergenic reactions to these foods are more common among adults than children. Allergy to food additives and preservatives, such as Yellow #5 (tartrazine), monosodium glutamate and sulfites is quite uncommon. Similar reactions to natural food substances, including colorants and spices like annatto, carmine, and saffron, are rare. However, the serious medical management of adverse events associated the exposure to and consumption of these food ingredients cannot be underestimated (Chapman, 2006).

There are many factors that contribute to IgE-mediated food allergy. Those factors include individual genetics, exposure to allergenic food, an individual's age at initial exposure, the dose, frequency, and duration of exposure, and the immunogenicity of the food. Recent IgE antibody survey data indicate individuals (> 18 years of age) classified as non-Hispanic black and Hispanic are at greater risk of adverse reaction from peanuts, eggs, milk, and shrimp, than their non-Hispanic white counterparts (Branum, 2009). Regardless of these factors, the associated broad-range of symptoms of IgE-mediated reactions to foods affecting the gastrointestinal tract, skin (cutaneous), and respiratory tract can contribute to a life-threatening reaction known as anaphylactic shock. This generalized, systemic reaction can produce multiple organ failure, a significant loss in blood pressure and heart beat irregularities. Anaphylactic reactions in response to food allergen exposure account for 33-52% of emergency room visits. The majority of these visits is among teens, who often consume offending foods with peer groups despite the inherent adverse reactions.

Figure 3. Food Allergies Prevalence



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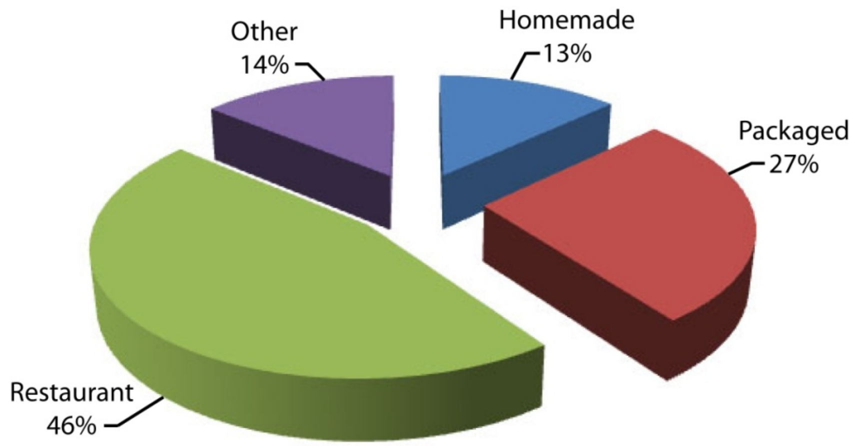
Implications:

Restaurants: Allergenic foods are most frequently associated with restaurant menu items prepared without adequate separation from known allergenic foods and without appropriate product labeling (see Figure 4) (Ahuja, 2007). Therefore, it is incumbent upon sensitive individuals to adhere to strict avoidance of offending foods, relentlessly ask questions concerning food preparation and composition, and read product labels. Ultimately, these individuals must be prepared to manage an adverse reaction, especially in the potential of food-induced anaphylaxis.

Figure 4. Source of Food Fatalities



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There are two other critical and necessary actions that can reduce the exposure of allergenic foods in restaurant settings. Those two actions for restaurants include a written plan in the event of a food allergic reaction by a patron, and a plan to assure "allergen" safe meals. Each of these action items requires additional training of all kitchen and wait staff, and additional precautionary efforts by consumers. These important changes in restaurant settings are currently voluntary. Under current nutrition labeling regulations, restaurants are exempt unless a health claim, such as low fat or low sodium is stated. However, many cities across the country have advocated a federal nutrition labeling requirement, a position also supported by the restaurant industry if the requirement were uniform.

Packaged Foods: Effective January 2006, all commercially produced foods must include an allergy statement if the product contains one of the basic eight sources of food allergens or the product was produced in a facility that may contain or have contained one of these food allergen sources. There are several food ingredients that are exempt of food allergen labeling. Those ingredients include refined oils, even if they are derived from one of the basic eight food allergen source, and commodities, such as fruits and vegetables. While these oils may contain virtually negligible traces of allergenic proteins, a recent report suggests that these trace amounts may be sufficient to trigger an allergic response in some individuals with a very low threshold of a reactive dose of allergenic protein (Ramazzotti, 2008). In addition, some cold-pressed oils, while providing more flavor, may actually contain allergenic proteins (Hoffman, 1994).

In addition, there is a regulatory process whereby a food supplier can petition the FDA for an exemption if the company provides sufficient evidence that the food or ingredient is free of known allergens. An inventory of those ingredients is available at the following websites: http://www.fda.gov/Food/LabelingNutrition/FoodAllergensLabeling/ExemptionsfromFoodAllergenLabelingPetitionNotificationProcess/ucm076656.htm and http://www.fda.gov/Food/LabelingNutrition/FoodAllergensLabeling/ExemptionsfromFoodAllergenLabelingPetitionNotificationProcess/ucm076631.htm

Schools, Day Cares and Camps: School lunchroom, day care centers and summer camps represent venues of unexpected exposure to food allergens and new challenges for parents of young children and program administrators. Among those challenges are indoor allergens.

Interestingly, some allergen exposures in school and day care environments are greater than those in the home. Many of aeroallergen exposures include cat and dog allergens, even in the absence of these companion animals, dust mite allergens, cockroach and rodent allergens, and fungal allergens (Salo, 2009). These risk factors may augment adverse respiratory reactions among susceptible individuals, including those where asthma and food allergy are chronic conditions. As a result, many schools and centers with a high density of children have discouraged pet contact before attendance, and have modified facilities, including shelving and ventilation, in order to improve control of allergens in the classroom.

Although the U.S. now has mandatory food allergen labeling and declaration, the risk remains high for accidental exposure to food allergens in a co-mingled atmosphere of young children (Sheth, 2010). This issue, heightened by the 2007 Newsweek (November 5, 2007) article on allergies in the lunchroom, appears to lack adequate studies that assess the risks of food allergen exposure in environments dominated by young children. Nearly a decade ago, several medical organizations and health care professions, in collaboration with parents and schools developed guidelines to assist schools to reduce the risk of accidental food allergen exposure and establish response strategies to manage unintended exposures (Sheetz, 2004; Young, 2009). Collaborative efforts by the National Association of School Nurses, The Food Allergy & Anaphylaxis Network, the National Association of Secondary School Principals, National School Boards Association, and the American School Food Service Association lead to the development of an important document that outlined school guidelines for managing students with food allergies (http://www.foodallergy.org/school/guidelines/SchoolGuidelines.pdf).Members of these organizations presented specific areas of responsibility for families, schools, and students in an effort to minimize food allergen exposure risks and to provide a safe educational environment for food-allergic students. Central to these guidelines is educating children on the management of their food allergy, working with school administration and teachers on policies and prevention plans that address food allergy management, and providing a proactive "no trading food" stance among students.

In addition to these excellent guidelines, several communities and states have established regulations and laws requiring implementation of plans to educate students about food allergies and development of plans that provide medical management, risk reduction, and communication and implementation that are uniform among schools across the country. For example, in 2004 the New Jersey Legislature passed a resolution which urges school districts to acquaint personnel with the dangers of peanut allergy and to establish peanut-free cafeteria areas. Subsequently, New Jersey launched a "Ask Before You Eat" campaign designed to inform the public about food allergies and anaphylaxis (http://www.state.nj.us/health/chs/monthlyfactsheets/foodallergy.pdf). Similar initiatives were adopted in Michigan, Connecticut, Massachusetts, Tennessee, Vermont and California. An in-service training program for school staff, camps, and daycare centers regarding food allergy safety is now available through Safe@School™ Partners Inc. (www.foodallergysmart.org). In addition, the USDA has numerous educational materials and resources available that inform the public regarding food allergies and food intolerances (http://www.nal.usda.gov/fnic/pubs/bibs/gen/allergy.pdf).

Home Environment: Some of the variables that impact the potential of food allergies in the home are genetic background, local environment, and time of exposure. Since the immune system in infants and children is not fully developed, these populations have a greater risk of developing food allergic disease than adults (Rona, 2007). Thus, one would expect children of parents with at least one food allergy are at greater risk of developing a food allergy. However, the American Academic of Pediatrics recently noted the absence of conclusive evidence that even among women with food allergies that dietary restrictions during pregnancy may reduce the risk or delay the onset of food allergy in their infants (Thygarajan, 2008).

The home and its environment typically represent children's first exposure to common allergenic foods (Vlieg-Boestra, 2008). Thus, the fundamental principle of reducing the risk of food allergy begins in the home. The American Academy of Pediatrics has an informative brochure on managing food allergies among children (www.aap.org). The principle goal in the food allergy home of growing children is to eliminate exposure to the offending foods while providing adequate nutrition for optimal growth and development. Even among adults, avoidance of food allergens can contribute to dietary insufficiencies and possibly excessive weight loss (Kershaw, 2009). In general, avoidance advice should include several principles as shown in Table 1 (Venter, 2010).

Table 1. Food Avoidance Principles

- Prevent cross-contamination: thoroughly wash food contact surfaces, (cutting boards, utensils) and hands
- Ask preparation questions, especially if eating away from home
- Read and understand food labels
- Contact food manufacturers, if uncertain; undeclared processing aids and "may contain" statements could require greater clarification

Source: Venter, 2010

Child or adult, it is critical to assess the level of food allergen avoidance as well as the type of food hypersensitivity (see Figure 2). This assessment should be determined in collaboration with a professional allergist.

Oral Tolerance: The concept of oral tolerance has gained attention in the medical and scientific community. Recent evidence suggests the onset of food allergy may reflect intolerance to dietary or foreign proteins. An important barrier to foreign proteins is the gastrointestinal (GI) tract. The GI tract not only represents a large surface area through which we absorb nutrients provided through foods, it is a significant component of the immune system. If this immune system is compromised or immature, there is an increased risk for food allergy development. For example, while about 2% of ingested food allergens are absorbed and transported without modification in the mature gut, the GI tract among susceptible individuals may have an increased permeability or leakiness and altered intestinal bacteria profile. These changes may occur following the administration of some antibiotics, thereby increasing their risk of food sensitization and enhanced severity of food-induced allergic reactions (Groschwitz, 2009).

A novel approach in treating food allergy is through the induction of oral tolerance. Limited research suggests early introduction of allergenic proteins, such as those in peanuts, may actually reduce the risk of allergy (Du Toit, 2008). In this case, it appears that in some susceptible individuals, high level of exposure to peanuts, such as through peanut butter in the home, may promote sensitization, whereas low level exposure may be protective (Fox, 2009). These kinds of observations relative to the development of food allergy and the timing of complementary foods are inconsistent and controversial. On the side of caution, the American Academy of Pediatrics' consensus statement is that there is insufficient evidence to support early intervention (4-6 mo. of age) with complementary foods as protective against the onset of food allergy (Greer, 2008).

Other Food Allergens: Approximately 10% of food allergens are not limited to cow's milk, egg, crustaceans, fish, peanut, soybean, tree nuts, and wheat. Many sensitive individuals experience cross-reactivity among multiple foods. For example, an individual allergic to birch tree pollen may experience allergy symptoms when exposed to peach, apple, celery, carrots or cherries and related fruits (Asero, 2004; Matthes, 2009; Bollen, 2007; Marković-Housley, 2009; Fuchs, 2006). Some of the claimed immunomodulatory effects of garlic, a member of the same family of onions, shallots and leeks, contains alliin lyase, which appears to be cross reactive and sufficiently allergenic to trigger allergic reactions among those sensitive to members of the Allium family (Kao, 2004).

Food Processing: The impact of food processing, such as the use of food enzymes and heat to hydrolyze or breakdown allergenic proteins requires additional research. There is limited evidence that food grade enzymes may reduce the allergenicity of some milk proteins, such as β-lactoglobulin in the whey fraction, and may reduce the phytate content of grains. In addition, some heat treatments, intended to assure food safety, may denature allergenic proteins, such as those in some vegetables (Mills, 2008). A recent evaluation of food processing on the impact on allergenic properties of food allergens indicates there is a dearth of scientific research on this topic, which, in part, reflects the complex nature of a food matrix and the individuality of allergenic response to these food components (Mills, 2009). This issue is further complicated by our naive understanding of cross reactivity of allergenic proteins, and that many of these proteins are naturally found in an array of foods. For example, some proteins found in egg whites are abundant and distributed in edible nuts and seeds, such as soya beans. Another complication is that while some proteins are partially denatured during various processing environments, other proteins are resistant to structural modifications and potential reduction in allergenicity. Again, some of the soybean-derived protein fractions are slow to change allergenic properties during exposure to an elevated heat environment and even during an extensive mixing or shear process (Mills, 2003). It is important to note that several plant-derived proteins present similar structural characteristics and possibility of allergenicity as those found in some animal proteins. Some of these proteins are also thermally stable and resistant to hydrolysis (Breiteneder, 2005; Sathe, 2009).

Some methods of food processing may increase the allergenicity of foods (Sathe, 2009) although evidence is mixed. For example, whereas some research suggests that peanut roasting may not alter the allergenicity of peanut proteins (Mondoulet, 2005), other studies indicate that the roasting and possibly the maturity of the peanut may increase the presence of antibody binding epitopes, or those protein segments responsible for an allergic reaction (Pomés, 2006).

The National Institute of Allergy and Infectious Disease will publish an update for "Guidelines for the Diagnosis and Management of Food Allergy" in 2010. While this publication is directed to health care professionals, the concepts of identifying and managing food intolerance and food allergy are well-presented and should be useful for those interested in these important areas (http://www3.niaid.nih.gov/topics/foodAllergy/clinical/).

Consumers should continue to carefully read food product labels which provides information on the basic eight food allergens. Individuals diagnosed with food allergies beyond these basic eight are urged to read food product label ingredient declaration statements that should include all product components, including those that may contain potential allergens. At this time, the food ingredient declaration statements are not required to include processing aids. These are similar to excipients included in some medications, yet are not bioactive or included in the ingredient statement. Thus, it is critical that consumers with diagnosed food allergens contact food producers for additional information. This information should be readily available through the customer service contact information.

Additional Resources:

For further information on food allergens, the reader is encouraged to access the Allergy Resource List from USDA's Food and Nutrition Information Center (Beltsville, MD) via http://www.nal.usda.gov/fnic/pubs/bibs/gen/allergy.pdf.

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Resource 3: Conventional and organically produced foods

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The United States has two major regulations that define and stipulate the criteria for producing, processing, handling, and marketing organic foods. Those regulations, initiated in the 1990s as part of the US Farm Bill, resulted in an Organic Rule according to the National Organic Standard Board and implementation of the National Organic Program (NOP) in 2002 under the jurisdiction of the USDA. According to this program, all but the smallest organic farmers and processors must be certified by a State or private agency accredited under national standards.

According to the Organic Rule, organic foods are those produced without use of genetic engineering, ionizing radiation, and sewage sludge, and only by using tillage, cultivation practices such as crop rotation, cover crop, and fertilization with properly treated crop and animal wastes.

Organic foods are labeled using three fundamental categories. Foods in the first two categories are permitted to display the USDA Organic seal (see Figure 1):

- Organic foods with a "100% Organic" declaration contain all organic produced ingredients.
- Food products labeled "organic" must contain at least 95 percent organic ingredients (see Table 1). The other 5 percent of ingredients may be from the approved list of substances for organic foods stipulated in the Code of Federal Regulations (7CFR 205.605, 7CFR 205.606).
- The third category is "made with Organic," which refers to food products that contain at least 70 percent organic ingredients.

Figure 1. USDA Organic Seal

[1] This document was prepared as supplemental information related to the *Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010,* which can be found at www.dietaryguidelines.gov.

Organic refers to a food production management process. Organic labeling does not imply that the food products are healthier or safer than those provided through conventional means. Four major review articles on this topic (Woese, 1997; Worthington, 2001; Bourn 2002; Dangour, 2009) provided inconsistent findings. The apparent inconsistencies may reflect cultivar choices, innate nutritional qualities, application of fertilizer types, post-harvest handling practices, climate and soil plant stresses. The traditional nutritional contributions of organic foods may not be significantly different from non-organic foods typically consumed. Several small recent studies compared non-traditional composition of organic and conventional produced wheat, strawberries, carrots, peaches, tomatoes, lettuce and apples. These studies, summarized in Table 1 assessed the concentration of organic acids and polyphenolics, many of which may present potential health effects (Winter, 2006). Findings from these limited studies were inconsistent relative to nutritional quantitative and qualitative differences between organic and conventionally produced food products. This evidence suggests that it is premature to conclude that the nutritional value and purported health benefits of organic foods are better than those produced through conventional agricultural practices.

Table 1. Summary of Select Studies on Nutrient Content of Organic Compared to Non-organic Produce

Foods	Substances Studied	Results	Reference
Wheat	Polyphenols	Climate greater influence than production method	Stracke BA et al., J Agric Food Chem 2009;57:10116-21
Apples	Polyphenols	No significant differences in bioavailability of polyphenols	Stracke BA et al., Eur J Nutr 2009; Dec 22 Epub
	Phenolics	Phenolics higher in organic apple pulp than in conventional apple pulp; no differences in phenolic content of apple peals	Veberic R et al., J Sci Food Agric 2005;85:1687-94
Tomatoes	Vitamin C, carotenoids, polyphenols	Fresh organic tomatoes had higher levels of vitamin C, carotenoids, and polyphenols than fresh conventional tomatoes	Caris-Veyrat C et al., J Agric Food Chem 2004;52:6503-9
Carrots	Carotenoids	No differences in carotenoid bioavailability or carotenoid content	Stracke BA et al., Br J Nutr 2009;101:1664-72
Peach, Pear	Total phenolics	Organic fruit had higher phenolic content	Carbonaro M et al., J Agric Food Chem 2002;50:5458-62
Lettuce	Total phenolics	No differences	Young JE et al., Mol Nutr Food Res 2005;49:1136-42

Implications

Our current understanding of conventionally and organically produced foods indicate that their nutritional values and contributions to human health are similar. Agricultural practices and conditions have markedly changed over the past decade. Thus, the consumer's exposure to PCBs and POPs has decreased to levels well below those advised by the EPA, and levels that are consistent with safe food standards. The emerging consumer interests in and investigational efforts on possible healthful substances in the food supply, such as the array of phytochemicals (carotenoids, phenolics, alkaloids, and organosulfur compounds) were not evaluated. Several research studies suggest that increased consumption of some of these substances may not be consistent with improved health, regardless if the food were produced consistent with conventional or organic practices.

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