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Impact of the Home Food Environment on Dietary Intake, Obesity and Cardiovascular Health of U.S. Children and Adolescents, Aged 6-19

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by

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Youth obesity is an ongoing problem in the United States. Obese children and adolescents are likely to be obese as adults and have an increased risk of developing chronic diseases, including coronary heart disease, earlier in life. The multifactorial nature of obesity continues to challenge researchers and health professionals to determine methods for preventing and reducing childhood obesity. Research has suggested that obesity is a normal response to an "obesigenic" environment. Emerging as one of the most influential environments in obesity and behavior development is the home food environment. However, little is understood about the role of the home food environment in obesity and disease development in youth. The purpose of this research was to examine factors that influence the home food environment as well as the relationship between the home food environment and dietary intake, obesity, and disease development in a nationally representative sample of U.S. youth aged 6-19 years from the National Health and Nutrition Examination Survey (NHANES). Race-ethnicity and poverty income ratio (PIR) were found to influence home food availability, family meal patterns, and family food expenditures, three aspects of the home food environment. Race-ethnicity, PIR, and home food availability appeared to influence dietary consumption in youth. However, home food availability did not appear to be related to overweight or obesity in youth. Overweight and obesity in children and adolescents was associated with adverse lipid concentrations. The home food environment is complex but may serve as a modifiable area for nutrition educators to influence dietary intake in youth. Racial and socioeconomic disparities in home food environments should be addressed in the development of effective public policy and nutrition education development. Although the home food environment was not found to be related to obesity in youth, research should continue assessing environmental factors of obesity development as obesity is related to disease development earlier in life.

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Introduction

Youth obesity is an ongoing problem in the United States. Obesity in children aged 6-11 has increased from 7 to 20% and from 5-18% in adolescents aged 12-19 in the past 30 years (1). Obese children and adolescents are likely to be obese as adults and have an increased risk of developing chronic diseases, including type 2 diabetes and cardiovascular disease, earlier in life (2).

The multifactorial nature of obesity continues to challenge researchers and health professionals to determine major causes of development and methods for preventing and reducing obesity. Research has suggested that obesity is a normal response to an "obesigenic" environment (3). Emerging as one of the most influential environments in obesity and behavior development is the home food environment. The home food environment is complex and is suggested to be composed of influences from built and natural, political and economic, and micro-level and macro-level environments (4).

Several factors have the ability to influence the home food environment including socioeconomic status, race-ethnicity, and parent knowledge/motivation for healthy behaviors. The home food environment and the availability of certain foods in the home can positively or negatively influence dietary intake in youth. Dietary intake can influence obesity and disease development or prevention.

Therefore, the home food environment, which is largely controlled by parents, may influence the long term health of youth. The relationship of the home food environment and childhood obesity and/or disease development is outlined in Figure 1, a Model of the Home Food Environment. This model is based on current evidence about the home food environment as well as predicted relationships that were developed from personal knowledge of health behaviors, family structures, and disease development.

The purpose of this research was to examine relationships depicted in Figure 1 in a nationally representative sample of U.S. youth aged 6-19 years from the National Health and Nutrition Examination Survey (NHANES). This study had four primary objectives.

The ***primary objectives*** were the following:

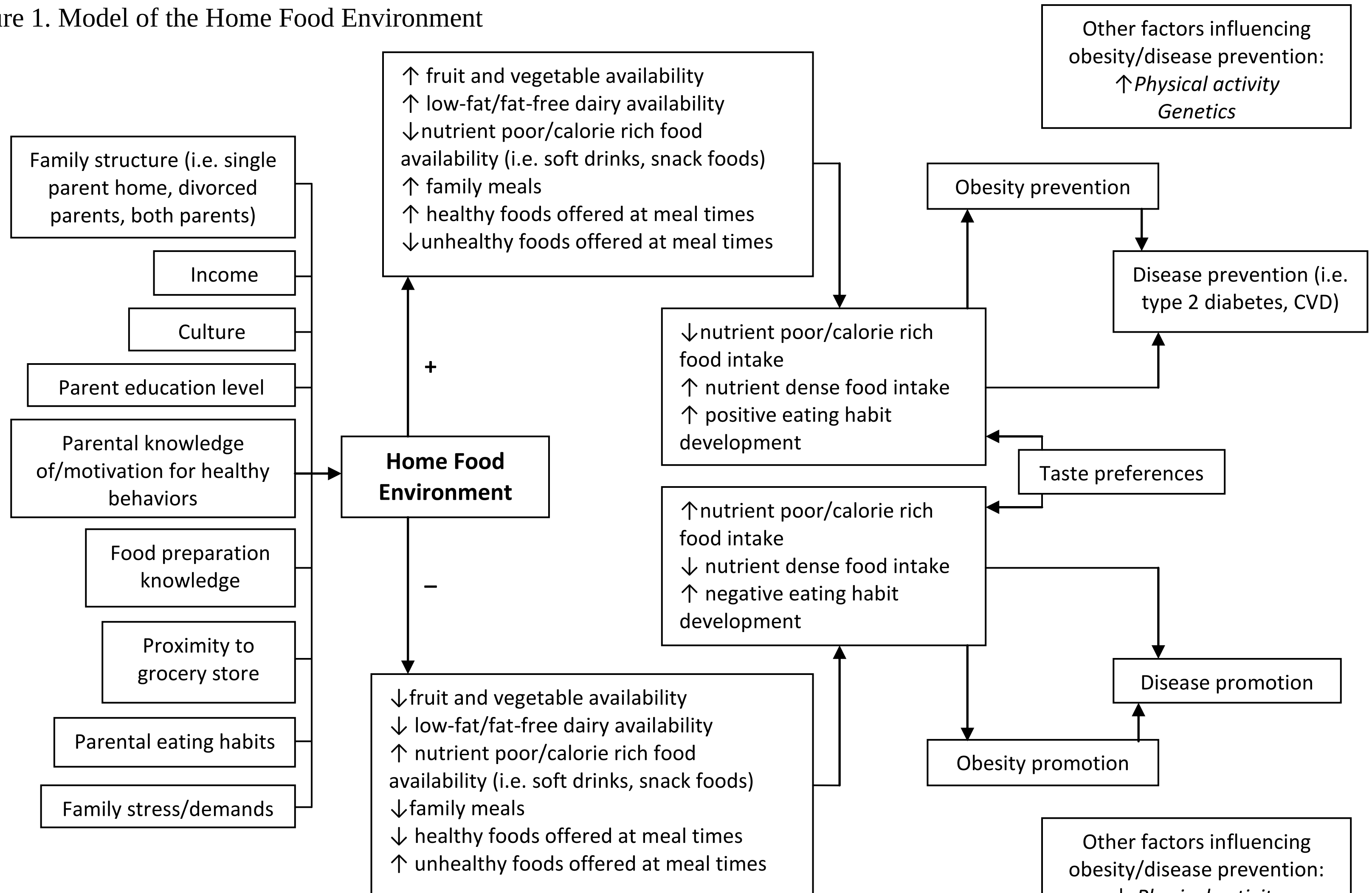
1. To determine what factors influence the home food environment.

2. To explore the influence of home food availability on food consumption and obesity.

3. To explore the relationship between obesity and cardiovascular disease risk factors.

The ***long-term goals*** of this study were to yield guidance for reducing childhood obesity and improving cardiovascular health through understanding the role of the home food environment in the development of dietary habits and to guide actions and policies that improve the health of young Americans.

Figure 1. Model of the Home Food Environment



Source: Masters, M. 2012

Review of Literature

I. Factors influencing the home food environment

Parents largely control the home food environment and influence food availability in the home (4). Children and adolescents are rarely responsible for food shopping and therefore, have a more limited influence on food availability. Foods not available in the home are unable to be consumed by youth while at home (5). This simple fact indicates that the availability of healthy foods likely increases consumption of a healthful diet in youth. Home availability of fruits and vegetables is one of the strongest correlates of fruit and vegetable intake in adolescents (6). Therefore, understanding what factors influence the home food environment and availability of foods in the home is essential for the development of effective nutrition education programs.

Influence of socioeconomic status on the home food environment

Socioeconomic status is one factor that influences the home food environment. Adolescents of lower socioeconomic status tend to consume lower amounts of fruits, vegetables, fiber rich foods, and dairy products (7). One possible explanation for lower consumption of healthful foods in low socioeconomic status youths is reduced availability of these foods at home and a decrease in the number of family meals. Several studies have examined the relationship between socioeconomic status and dietary intake; however, few have examined the relationship with factors that may precede dietary intake such as home food availability and family meals (7-9).

Socioeconomic status of a family is often defined by the highest level of education of a parent. Campbell et al. (10) assessed the influence of socioeconomic status, defined by maternal education, on family meal patterns; one variable of the home food environment. Parents of Australian children 5-6 years of age completed a questionnaire addressing various measures of the family food environment, including family meal patterns. Results indicated that families with middle or low maternal education levels ate more family meals together than those with high maternal education levels; however, these families were also more likely to watch television during family meals. In addition, mothers with the lowest education were more likely to report purchasing take-out foods for family meals. Limitations of this study include the fact that the majority of mothers (43.7%) had a high level of education and those that chose to participate in the study, were parents that found childhood nutrition to be of importance.

Food availability, another variable of the home food environment, also differs based on maternal education. MacFarlane et al. (11) examined the relationship of food availability and socioeconomic status, also based on maternal education, in older youth. Adolescents aged 12-15 years from Melbourne, Australia were asked questions regarding the home food availability. Responses were self-reported by the adolescents and parents who were sent surveys to assess demographics and socioeconomic status. Results indicated that a higher proportion of adolescents living in low socioeconomic households reported that soft drinks, salty snacks, sports drinks, and confectionaries were always or usually available at home compared to high or middle socioeconomic households. Additionally, a larger proportion of high socioeconomic households reported that fruit was always or usually available. One limitation of this study was that adolescents reported on food availability, not parents whom may have a better understanding of food available due to the parent role in food purchasing for the family.

Socioeconomic status of a family is not always determined solely by maternal education, but often from the highest education level of either parent. Neumark-Sztainer et al. (12) assessed the relationship of socioeconomic status, defined by highest education level of either parent, and food availability. Middle and high school Minnesotan adolescents from Project EAT answered questions regarding the family food environment and family sociodemographic information. Similar to MacFarlane et al. (11), high socioeconomic status was associated with more fruit availability in the home. High socioeconomic status was also associated with higher vegetable availability and more frequent family meals. However, inaccuracies in the data may exist due to adolescent reported family socioeconomic status.

Results from these studies indicate that socioeconomic status, based on parent education level, influences food availability in homes. Low socioeconomic homes may have less accommodating environments for healthy eating as evidenced by an increased availability of energy-dense foods and decreased availability of fruits and vegetables (11,12).Evidence examining the relationship of socioeconomic status (based on parent education) and family meal frequency is conflicting. Campbell et al. (10) found that families of low or middle socioeconomic status ate more family meals together; however, Neumark-Sztainer et al. (12) found that high socioeconomic families ate more meals together.

Income is a second commonly used measure of socioeconomic status that may influence food availability and consumption in homes of children and adolescents. Kit et al. (13) with the National Center for Health Statistics analyzed low-fat milk consumption based on family income. Data for children and adolescents 2-19 years of age from the 2007-2008 NHANES survey were utilized for analyses. Youth living in homes with a poverty income ratio (PIR) at or above 350% (high income) had significantly higher levels of low-fat milk consumption compared to youth living in homes with a PIR of 130-349% (middle income) or less than 130% (low income). No explanation as to why high income youth consumed more low-fat milk was reported and the influence of home availability on consumption was not assessed. Youth living in high income homes may possibly consume more low-fat milk due to an increased availability in the home.

Ding et al. (14) conducted a cross-sectional study to assess the relationship between income level and home food availability. Adolescents aged 12-18 and their parents as well as children aged 5-11 and their parents were recruited and answered questions regarding the home food environment and family income level. High income was significantly related to an increased availability of healthful foods in the home. Income level may directly influence food availability in the home due to cost differences in energy-dense and nutrient-dense foods. In addition, high income families often have higher educated parents, indicating that knowledge and application of healthy behaviors may influence food availability in these homes.

Limited studies exist examining the influence of socioeconomic status on food availability and family food characteristics in homes of youth. Only one study has examined income and the home food environment. The question of why youth of low socioeconomic status tend to consume less healthy foods has yet to be answered. Researchers have indicated that food availability is strongly correlated with food intake.

Therefore, studies examining the role of socioeconomic status on home food availability are needed and may provide insight into why youth of low socioeconomic status consume less healthy diets.

Influence of race-ethnicity on the home food environment

Cultural differences exist for food purchasing and preparation (4). Race-ethnicity is often the determinant of culture and has been shown to influence the home food environment. Cullen et al. (15) reported that Hispanic families purchased larger quantities of fruits and vegetables compared to African Americans, non-Hispanic whites purchased more mixed dishes than Hispanics, and African Americans purchased more protein foods than non-Hispanic whites. Food purchasing may influence home food availability and therefore, food consumption patterns in youth.

Differences in dietary consumption between race-ethnicities have been found. Kit et al. (13) assessed consumption of low-fat milk between non-Hispanic white, non-Hispanic black, and Hispanic youth aged 2-19 years participating in the 2007-2008 NHANES. A significantly larger percentage of non-Hispanic white youth consumed low-fat milk compared to non-Hispanic black and Hispanic youth. The reason for this difference was not discussed and home availability of low-fat milk was not assessed. This study indicates that consumption of foods differs based on race-ethnicity, a difference that may be attributed to food availability in the home. Home food availability possibly differs by race-ethnicity due to cultural differences affecting the purchasing of foods as well as neighborhood availability of foods.

Skala et al. (16) reported that home food availability in preschool aged children did differ based on race-ethnicity. In a cross-sectional study utilizing data from preschoolers enrolled in Head Start, researchers analyzed the home food environment for Hispanic and African-American participants using surveys self-administered to parents. Hispanic homes were more likely to have fresh vegetables and soft-drinks available, indicating that race-ethnicity may influence home food availability.

However, Cullen et al. (17) found that home availability of foods did not differ between race-ethnicities. Children aged 9-12 years and their parents were asked questions regarding race-ethnicity and the availability of fruits, juices, and vegetables in the home. Availability did not differ between African-Americans, Euro-Americans, and Mexican-Americans. Results were similar to previous work done by Cullen et al. (18). Adolescent Boy Scouts and their parents attended focus groups conducted to indentify factors which influence food availability. Researchers reported that fruit and vegetable availability did not differ between African-American and European American homes of adolescent boys.

Studies examining the relationship of race-ethnicity and home food availability in youth are contradictory and limited. More research is needed to understand how the home food environment is influencing the health of youth of different race-ethnicities.

II. The influence of the home food environment on dietary intake

Food availability and food consumption

Consumption of foods in the home is limited to the foods available within the home. If healthy foods are not available, healthy foods cannot be consumed while children and adolescents are at home. Although away-from-home food consumption has increased over the past 30 years, roughly 60% of meals and snacks are still consumed at home in children and adolescents aged 6-19 (19). Exploring and understanding what factors within the home environment influence food consumption will help nutrition educators increase healthy dietary intake in youth.

Researchers examining the relationship of food availability and dietary intake in adolescent youth report that home availability is related to consumption. Ding et al. (14) assessed the availability of more-healthful foods (i.e. fruits, vegetables, 100% fruit juice, baked chips, sugar-free soda, fat-free/low-fat milk, unsweetened breakfast cereals), less-healthful foods (i.e. chocolates, candies, cakes, regular chips, juice drinks, sugared soda, sports drinks, 2% or whole milk, sweetened breakfast cereals), fruits, and vegetables, in the home environment of adolescents aged 12-18. The availability of healthful foods, fruits, and vegetables in the home environment was significantly related to consumption of fruits and vegetables.

Likewise, Neumark-Sztainer et al. (6) assessed the availability/consumption relationship of fruits and vegetables in homes of adolescents and found that home availability and taste preferences were the strongest correlates of fruit and vegetable intake. Granner et al. (20) also assessed home food availability and consumption for adolescents aged 11-15 who completed questionnaires that included measures of demographic information, fruit and vegetable intake, and fruit and vegetable availability. Fruit and vegetable consumption was strongly correlated with availability and the highest intake was found in homes where fruits and vegetables were more available.

However, researchers stratifying the home food availability/consumption relationship by gender report mixed results. Cullen et al. (21) assessed home food availability and consumption in Houston, Texas fourth- through sixth-grade children. Children completed six days of food records with the assistance of trained data collectors to assess food consumption. Parents completed telephone questionnaires analyzing fruit, juice, and vegetable availability and accessibility in the home. Questionnaires were completed at the end of the week that children completed food records. Children also completed home food availability/accessibility questionnaires. Parent reported availability of fruits, juices, and vegetables was a strong predictor of child consumption. In addition, child reported availability of these foods was also related to consumption. When assessing for gender differences, 35% of the variance in girls' consumption of fruits, juices, and vegetables was accounted for by availability and accessibility of these foods. However, no significant relationship existed between food availability/accessibility and consumption for boys.

Similar differences for boys and girls in the home availability/consumption relationship were found in older youth. Hanson et al. (22) analyzed food availability based on both parent and adolescent reporting by utilizing the Project EAT survey. Minnesotan adolescents completed the Project EAT survey along with the Youth Adolescent Food Frequency Questionnaire (YAQ) which measures usual dietary intake.

Additionally, a modified version of the Project EAT survey was administered to parents willing to participate. In adolescent girls, the availability of fruits and vegetables in the home was significantly correlated with intake, and the availability of soft drinks in the home was inversely related to consumption of dairy. Adolescent girls living in homes with fruits and/or vegetables always available consumed on average 1.3 servings more per day compared to girls in homes where fruits and/or vegetables were sometimes or never available. No significant relationship was found for boys.

Beyond gender, another factor that may influence the availability/consumption relationship is race-ethnicity. Granner et al. (20) analyzed food availability and consumption stratified by race-ethnicity in 11-15 year old adolescents. Self-reported questionnaires were administered to youth participants who answered questions regarding home food availability and consumption. No reporting from parents was utilized. Non-Hispanic white adolescents reported that the family environment, including fruit and vegetable availability in the home, had a greater influence on consumption than non-Hispanic black adolescents. Non-Hispanic black adolescents reported a greater influence from the social environment including influences from peers.

Befort et al. (23) also assessed the availability/consumption relationship for non-Hispanic black and non-Hispanic white adolescents ages 10-19. Adolescent participants completed food consumption questionnaires and home food availability was reported by parents. Home availability of fruits was significantly related to consumption in non-Hispanic white adolescents. No relationship between fruit availability and consumption was reported for non-Hispanic black adolescents and no availability/consumption relationship for vegetables or fat was found for either non-Hispanic black or non-Hispanic white adolescents.

The availability of fruits and vegetables appears to strongly influence the consumption of these foods as indicated in the previous studies. However, gender and race-ethnicity differences in the home food availability/consumption relationship for fruits and vegetables exist. The availability/consumption relationship for fruits and vegetables has been addressed by several researchers; however this relationship in dairy, snack foods, and soft drinks has not been extensively studied.

Dairy intake is a critical component of osteoporosis prevention; a disease that transpires in later adulthood (24). Intake of calcium rich dairy tends to decline for adolescents. Therefore, it is important to understand factors that encourage decreased consumption. One factor appears to be availability of dairy foods in the home. Larson et al. (25) utilized data from the Project EAT survey to assess dairy availability at meals with calcium and dairy intake in adolescents aged 11-18. In both male and female adolescents, the availability of milk at meals was positively related to calcium intake. Hanson et al. (22) also examined the availability of milk at meals with dairy intake in adolescents and found that the availability of milk at meals was positively associated with dairy intake levels in adolescent boys only.

Snack foods and soft drinks tend to be energy-dense and may contribute to the development of excess weight in children and adolescence. Campbell et al. (26) examined the relationship of the availability of energy-dense snacks in the home with consumption in adolescents. Australian youth 12-13 years of age and their parents completed questionnaires regarding the home food environment including one focused on food availability. Youth also completed a food frequency questionnaire to assess dietary intake. Researchers reported that the availability of unhealthy snack foods was positively related to savory snack consumption for both male and female adolescents and positively related to sweet snack consumption in females. Soft drink availability was also related to consumption in youth ages 8-13 years who completed and mailed in a magazine survey that included questions regarding soft drink availability in the home and soft drink consumption (27).

The relationship between energy-dense food availability and consumption has been reported in children as young as preschool age. Spurrier et al. (28) assessed the availability of sweetened beverages and snack foods and consumption in a sample of Australian preschoolers. Trained research interviewers collected data by visiting the homes of families with preschool aged children. Food availability data was collected along with a children's dietary questionnaire completed by parents. Increased availability of sweetened-beverages and high-fat/high-sugar snack foods was found to be significantly related to an increased consumption of these foods in preschoolers. These results indicate that the availability/consumption relationship extends from older adolescents to young children, and that age does not influence this relationship.

Strong evidence exists for the relationship of food availability and food consumption in youth. Researchers examining this relationship for fruits and vegetables report conflicting evidence for children and adolescents. The influence of gender and race-ethnicity on the availability/consumption relationship of fruits and vegetables has not been readily addressed and no studies exist examining the availability/consumption relationship in Hispanic youth. Research examining the relationship of fruit and vegetable availability and consumption in a nationally representative sample accounting for differences in gender and race-ethnicity is needed.

Data examining the availability/consumption relationship of dairy and energy-dense snacks is limited for a youth population. The importance of dairy consumption for bone health in childhood and adolescent years and the possible contribution of energy-dense foods to the development of obesity, indicate the need to study factors that influence intake of these foods. Studies examining the role of availability in the consumption of dairy and energy-dense snacks are needed and the influence of race-ethnicity and gender on this relationship should be analyzed.

Family meal patterns and dietary intake

Researchers have found that eating family meals is related to an increased consumption of healthful foods. Gillman et al. (29) assessed the relationship of family meals with dietary intake in male and female 9-14 year old youth that were sons or daughters of registered nurses participating in the Nurses' Health Study II. The frequency of family meals was positively correlated with fruit and vegetable intake and intake of several beneficial nutrients including fiber, calcium, iron, and vitamin C. Family meals were also related to a reduced intake of soft drinks in these youth.

Similar results were found when analyzing the influence of family meals on food consumption in middle and high school adolescents. Neumark-Sztainer et al. (12) utilized data from the Project EAT survey. An increase in family meal frequency was found to be related to an increased consumption of fruits, vegetables, grains, and calcium rich foods and a decreased consumption of soft drinks. A longitudinal study conducted by Larson et al. (25) also assessed family meal frequency and dietary intake in high school students. Data was taken from the Project EAT-II study, a longitudinal study assessing aspects of the home food environment and dietary intake. Results indicate that family meal frequency in high school students was related to increased intake of fruits and vegetables, and decreased intake of soft drinks.

Several factors may influence the frequency of family meals and diet quality in youth. Families that eat meals together may have a better understanding of or stronger motivation for health behaviors. Therefore, it may be possible that families with a higher frequency of family meals also have an increased availability of healthful foods in the home.

Utter et al. (30) assessed the relationship of family meal frequency and food availability in New Zealand families with adolescents. Family meal frequency and food availability questions were answered by adolescents using a handheld computer and self-reporting. An increase in family meals was found to be related to an increased availability of fruits in the home, indicating that families that eat meals together may also have more healthful foods available in the home.

An increased frequency of family meals appears to influence consumption of healthful foods in children and adolescents. Family meal frequency may be influenced by factors including race-ethnicity and socioeconomic status. Asian American families, families with a non-working mother, and families of high socioeconomic status have been found to have a higher frequency of family meals (12). Few studies have examined the influence of these factors of family meal frequency. Additionally, families that eat more meals together may have overall healthier food environments and an increased availability of healthful foods. However, limited data exists examining this relationship. Research examining the factors influencing family meal frequency, the relationship between family meal frequency and food availability, and the impact of family meal frequency on food consumption is warranted.

III. The role of the home food environment in childhood and adolescent obesity and disease development

The role of the home food environment in obesity

Obesity in children and adolescents in the United States has significantly increased in the past 30 years. Being overweight or obese as an adolescent increases the likelihood of being overweight or obese as an adult (31). The tracking of obesity into adulthood increases the risk of development of chronic diseases like cardiovascular disease (2). Diet is likely a strong influence in the development of obesity and chronic diseases. Food availability and family meals are two factors of the home food environment that strongly influence dietary intake in children and adolescents, indicating that the home food environment may also influence obesity and disease development.

While the role of the home food environment in childhood obesity has been studied, most available data regarding the home food environment are derived from homogenous populations or are based on small-scale studies (32). Few cross-sectional epidemiological studies have examined the relationship of the home food environment directly with indicators of body fat, including BMI. Studies examining this relationship directly have focused on the prevalence of family meals, excluding food availability data, in relation to BMI (30,33,34).

Utter et al. (30) examined the relationship of family meals to BMI in New Zealand adolescents using a cross-sectional study design and found that BMI was modestly negatively correlated with family meal frequency. However, after accounting for demographic characteristics, the significance of this relationship disappeared.

Longitudinal analyses have found that overweight status and family meal frequency are related. Taveras et al. (33) assessed this relationship in male and female youth aged 9-14 years over a one year period. Data were collected from 1996-1999 through a yearly mailed self-administered questionnaires. BMI was calculated from self-reported height and weight measurements which were suggested to be conducted with assistance from an adult. Children self-reported family meal frequency by answering the question, “How often do you sit down with other members of your family to eat dinner or supper?” Response categories were never, some days, most days, and every day. Assessment of the relationship of family meal frequency and overweight status at baseline in 1996 yielded a significant inverse relationship. In longitudinal analyses over the four year period, family meal frequency did not increase the likelihood of the youth to become overweight.

Sen (34) also examined the relationship of family dinner frequency and overweight during a three year time period in adolescents 12-15 years of age and stratified the relationship based on race-ethnicity. Participants were interviewed once a year from 1997-2000 and asked questions regarding family meal frequency as well as height and weight for BMI calculations. For white adolescents, an increase in family dinner frequency was associated with reduced odds of being overweight at baseline and becoming overweight over the three year study period. In addition, family dinner frequency at the end of the study was associated with increased odds of ceasing to be overweight. However, these relationships were not found for black or Hispanic youth participating in the study.

The relationship between family meal frequency and overweight/obesity in youth may be due to an increased availability of healthful foods in homes of families that eat more meals together. Research examining the relationship of food availability in the home and body mass index does not exist. Several studies have found that food availability influences consumption, so it is likely that food availability influences obesity development or prevention in youth. Furthermore, examination of the relationship of the home food environment and childhood/adolescent obesity in a nationally representative sample is limited. The NHANES 2007-2008 is the first and most recent dataset that includes home food environment variables. To date limited published studies utilize these NHANES variables, which indicate that this dataset has not been widely examined in relation to childhood obesity.

Research examining the relationship of the home food environment and obesity in youth is needed to develop a better understanding of environmental contributors of obesity development and prevention.

The role of the home food environment in cardiovascular disease development

Cardiovascular diseases are collectively the leading cause of death in the United States accounting for 34.3% of all deaths in 2006 (35, 36). Atherosclerotic heart disease, otherwise known as coronary heart disease or coronary artery disease, is most often caused by atherosclerosis that occurs due to the deposition of cholesterol in the arterial wall. This deposition causes plaque accumulation resulting in the narrowing of arteries and increasing the risk of myocardial infarction and ischemic stroke (33, 34). Adult cardiovascular disease develops silently during childhood and adolescence. Autopsy studies in children and adolescents have reported that early atherosclerotic lesions present starting at a young age (39, 40).

The relationship of the home food environment with cardiovascular health in children and adolescents has not been examined. Several studies have reported a relationship between fruit and vegetable availability and consumption in youth. Fruit and vegetable intake are indicators of a healthy diet because of their preventative relationship with diseases, including cardiovascular disease (41). Adults consuming a healthy diet have been shown to have more favorable anthropometric measurements, blood pressure, and blood lipid values compared to dietary patterns higher in energy and fat in a Swedish population (42).

In adolescents, consumption of fruits and vegetables had beneficial effects on markers of inflammation and oxidative stress; important factors in the development and progression of coronary heart disease (43). C-reactive protein, a well known inflammatory marker involved in the development of atherosclerosis, was found to be significantly inversely associated with intakes of fruit, vitamin C, and folate (43, 44).

Food availability influences food consumption and therefore, the lack of healthful foods in the home could contribute to the development of cardiovascular disease. Examination of the relationship of the home food environment with cardiovascular health in children and adolescents is necessary due to the lack of information and due to the need to understand environmental contributors to cardiovascular disease development.

IV. The role of obesity in cardiovascular disease development

Obesity is independently associated with cardiovascular disease and increased morbidity and mortality (45). It is widely accepted that atherosclerosis begins in childhood and progresses slowly into adulthood and is influenced by excess weight (46, 47). Obese children have an increased carotid itima-media thickness, a measure of atherosclerosis, compared to non-obese children (48). The American Academy for Pediatrics states that overweight children belong to a special risk category of children and are in need of cholesterol screening regardless of family history or other risk factors (49). Several studies provide information regarding cardiovascular disease risk in children indicating that body fatness is correlated with an increase in the prevalence of blood lipid levels and an increased risk of developing cardiovascular disease (47, 50-59). However, few studies have been conducted in U.S. children and adolescents.

Markers of cardiovascular disease include total cholesterol, HDL cholesterol, LDL cholesterol, triglyceride levels, and C-reactive protein levels. Brazilian children and adolescents assessed for BMI, blood pressure and blood lipid levels had significant associations between BMI and increased blood pressure, decreased HDL cholesterol, and increased triglyceride levels (47).Similar results were found in a sample of 780 Greek children (50). In a large study of 26,008 overweight and obese European children, the degree of overweight classified by BMI was inversely associated with HDL-cholesterol levels and related to an increase in blood pressure and triglyceride levels (51). BMI was also associated with increased triglyceride levels and decreased HDL-cholesterol levels in Iranian adolescents aged 10-19 years (52).

Researchers in India examined a small sample of 49 overweight and obese children aged 6-11. Obese children had a significantly higher rate of high triglyceride and low HDL-cholesterol levels (53). In addition to blood lipid levels, C-reactive protein levels, a marker of inflammation associated with cardiovascular disease, were found to be higher in overweight and obese children compared to their normal weight counterparts (53, 54).

Researchers examining the relationship between excess body fat, defined by BMI, in samples of non-U.S. children and adolescents reported significant positive correlations between BMI and markers of cardiovascular disease. Children and adolescents with an increased BMI had an increase in triglyceride, C-reactive protein, and blood pressure levels as well as a decrease in HDL-cholesterol levels. Studies examining these relationships in U.S. children and adolescents are limited to a few studies.

Chen et al. (55) examined the relationship of BMI to blood pressure in a sample of U.S. children aged 8-10, limited to only Chinese Americans. BMI was positively associated with systolic blood pressure. Williams and Strobino (56) assessed associations between body mass index and lipid levels in young children with a mean age of 3.9. Lipid levels and BMI were assessed at baseline and four years later in 519 children. Increasing BMI levels over the four year period were significantly inversely associated with HDL-cholesterol levels and children at higher BMI levels had higher total cholesterol and triglyceride levels.

Similar results were found in a study utilizing data from a nationally representative sample. Masters (57) analyzed lipid concentrations in relation to body fat indicators in U.S. children aged 6-11. Data came from the 2001-2004 NHANES and multiple linear regression analyses adjusted for age, gender, survey period, and race-ethnicity were conducted. HDL cholesterol levels were significantly inversely associated with BMI, subscapular skinfold measures, and triceps skinfold measures. In addition, total cholesterol levels were positively associated with subscapular skinfold and triceps skinfold measures.

The correlation between body fat and lipid levels in adolescents also exists. Lamb et al. (58) analyzed associations between body fat percentage and lipid concentrations in both children and adolescents from the NHANES 1999-2004. Body fat percentage measured by dual-energy X-ray absorptiometry was utilized and triglycerides, total, HDL, and LDL cholesterol were assessed for youth with or without high adiposity. A significantly higher prevalence of adverse triglyceride, total, HDL, and LDL cholesterol levels was found in youth with high adiposity compared to those without high adiposity. Body fat percentage explained 2-20% of the variance in lipid values.

Camhi et al. (59) assessed body fat and blood lipid levels in adolescents 12-18 years of age using data from the 2001-2008 NHANES. BMI was used as the marker of overweight/obese and markers of cardiovascular disease were clustered. Prevalence of risk factor clustering was defined as having two or more of the following: high triglycerides, low HDL-cholesterol, high blood pressure, and high fasting glucose. Adolescents with risk factor clustering were more likely to have a higher BMI.

No published studies have utilized the most recent 2009-2010 NHANES data and only one study has examined the relationship between body fat and blood lipid levels in children 6-11 years of age (57). It is important to examine these relationships using the most recent data and for both children and adolescents due to the fact that overweight/obese youth with unfavorable blood lipids have an increased risk of carrying these risk factors into adulthood. Juhola et al. (60) tracked childhood lipid levels, blood pressure, and body mass over a 27 year period. Participants were ages 3-18 when the study started in 1980 and 30-45 year old adults at the time of the 27-year follow-up in 2007. Unfavorable blood lipid, blood pressure, and BMI levels correlated strongly with unfavorable levels in middle age suggesting that obese children are setting the stage for disease development earlier in adulthood. Research examining the associations between body fat and adverse lipid concentrations in a recent sample of U.S. children and adolescents is warranted.

V. Research Direction

Several questions have yet to be answered regarding the home food environment and the influence it has on dietary intake, the development of obesity, and cardiovascular disease. Additional questions remain about the relationship between childhood and adolescent obesity and cardiovascular disease development. Based on the current review of literature, the following research hypotheses and questions have been developed and will be addressed further in this study:

Hypothesis #1:

Researchers have indicated that socioeconomic status, race-ethnicity, and family meal patterns influence food availability in the home. Based on this information, it is hypothesized that income, race-ethnicity, as well as other family food characteristics, including family meal patterns, will influence the home food environment in a nationally representative sample of U.S. youth.

Research Question #1:

What factors influence the home food environment in U.S. youth and do these factors work together synergistically to influence the home food environment?

Hypothesis #2:

Several researchers have reported that food availability is the strongest predictor of food consumption and that other factors like family meal frequency also influence consumption. Therefore, it is hypothesized that in a nationally representative sample of U.S. youth, home food availability will be related to food consumption and sociodemographic factors (i.e. gender, race-ethnicity, age) will affect the availability-consumption relationship.

Research Question #2:

Does the home food environment influence food consumption in children and adolescents?

Hypothesis #3:

Food availability and family meals, two factors of the home food environment, influence food consumption in youth. Energy-dense food availability leads to consumption, which could contribute to the development of obesity. Based on this relationship, it is hypothesized that the home food environment would be related to childhood obesity, defined by BMI, in a nationally representative sample of U.S. youth.

Research Question #3:

Is the home food environment related to childhood obesity in youth?

Hypothesis #4:

Rates of obesity in U.S. youth have significantly increased in the past 30 years. Excess body fat in youth was found to be associated with an increase in the presence of unfavorable blood lipids. Therefore, it is hypothesized that obesity in children and adolescents would be associated with unfavorable levels in markers of cardiovascular disease.

Research Question #4:

Is obesity associated with cardiovascular disease risk factors in youth?

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Overview of NHANES Study Methodology

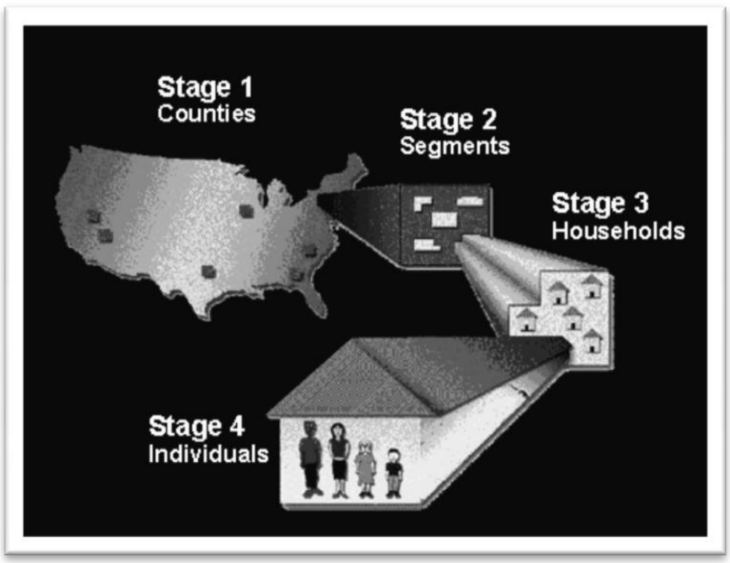
NHANES data collection was conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention and provides cross-sectional, nationally representative health examination data on non-institutionalized civilians of the United States. The survey samples were selected using a stratified multistage probability design with random sampling of the civilian non-institutionalized population, with over-sampling of certain subgroups. NHANES uses oversampling to increase the reliability and precision of estimates of health status indicators for certain subgroups in the U.S. population. The oversampled subgroups in the 2007-2010 NHANES are African Americans, Hispanics (Mexican American and other Hispanic), low-income White Americans, and individuals over the age of 60. Persons residing in a nursing home, members of the armed forces, institutionalized persons, or U.S. nationals living abroad were not included in the NHANES sample. The NHANES sampling procedure consists of four stages as outlined and pictured below:

Stage 1: Selection of primary sampling units (PSUs) occurs. PSUs are mostly single counties or groups of adjacent counties with probability proportional to a measure of size (PPS).

Stage 2: Division of the PSUs into sections that are generally city blocks. Sample sections are selected with PPS.

Stage 3: Listing of households within each section and random drawing of a sample from these households.

Stage 4: Individuals are selected to participate in NHANES from a list of all persons residing in selected households. Individuals are drawn at random. An average of 1.6 persons are selected per household.



Study I:

Factors influencing the home food environment of US youth, aged 6-19

Factors influencing the home food environment of US youth, aged 6-19

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Abstract

Background: The home food environment is complex and has the potential to influence dietary habit development in youth. Several factors may influence the home food environment including family income and race-ethnicity.

Objective: The purpose of this analysis was to examine how various factors, including family income and race-ethnicity, influence the home food environment (food availability, family meal patterns, and family food expenditures) using data from the National Health and Nutrition Examination Survey among youth ages 6-19 years in 2007-2008 (n=2500).

Methods: Prevalence of food availability in homes of youth was assessed for the entire sample. Differences in the prevalence of food availability were estimated by race-ethnicity, poverty income ratio (PIR), and race-ethnicity by PIR. Significant associations between family food characteristics and race-ethnicity, PIR, and food availability were examined.

Results: High income homes had the highest prevalence of fruits (79.7 ± 3.4%), dark green vegetables (57.1 ± 4.1%), salty snacks (55.8 ± 3.6%), and fat-free/low-fat milk (48.1 ± 4.1%) always available. Middle and low income homes had the highest prevalence of soft drinks always available (46.1 ± 3.5% and 48.2 ± 3.3%, respectively). Non-Hispanic whites had the highest prevalence of fruits (69.8 ± 3.6%), salty snacks (53.3 ± 2.4%), fat-free/low-fat milk (37.3 ± 3.3%), and soft drinks (51.1 ± 4.0%) always available. Non-Hispanic blacks had the highest prevalence of dark green vegetables

always available (63.0 ± 3.0%). Several statistically significant associations were found between family food characteristics and race-ethnicity, PIR, and food availability.

Conclusions: Several factors appear to influence home food availability, family meal patterns, and family food expenditures in homes of youth. These factors include race-ethnicity and PIR, indicating that racial and socioeconomic health disparities may be influenced by differences in the home food environment.

Introduction

Dietary intake data in the United States indicates that children and adolescents are failing to meet dietary recommendations (1, 2). Consumption of snack foods, soft drinks, and total energy have increased in the past 30 years in youth (3-5). In addition, many children and adolescents are consuming inadequate amounts of fruits and vegetables (6, 7). These diet trends can lead to short and long term health consequences for the U.S. youth population, including an increased risk of obesity. Researchers have suggested that obesity is a normal response to an "obesigenic" environment (8). The home food environment (Figure 1) is emerging as an influential environment in obesity and behavior development (9).

The home food environment may strongly influence eating patterns in youth. Despite the growing trend of away-from-home food consumption, approximately 60% of the food children and adolescents consume is from home (10). Several studies have demonstrated that availability of food in the home is related to food consumption in youth (11-19). Specifically, fruit and vegetable availability in the home is related to child and adolescent consumption (11-14). The same availability/consumption relationship has been reported for energy dense foods like soft drinks and snack foods (15-17).

This evidence indicates that the home food environment, specifically food availability, is a modifiable area that could aid in obesity prevention in children and adolescents. Food available in the home is most often dictated by parents as children and adolescents have limited control over food shopping for the family. Several parent/family factors may influence home food availability and therefore, dietary intake in youth.

Factors include parent education level, parent knowledge of/motivation for healthy behaviors, family income level, and race-ethnicity.

However, few studies have examined factors that influence home food availability. Factors that have been examined include socioeconomic status and race-ethnicity. Adolescents living in low socioeconomic households, defined by parent education level, have reported higher availability of energy-dense foods and lower availability of fruits and vegetables compared to those in high socioeconomic homes (20, 21). Income is a second identifier of socioeconomic status and high income homes have an increased availability of healthful foods (19). Cultural differences may also influence food availability, however, studies examining the influence of race-ethnicity on food availability are contradictory (22-24).

While limited studies have considered factors that influence food availability in the home, these relationships should be examined to understand why home food environments differ. Knowledge of factors that influence the home food environment could assist in tailoring nutrition education programs to meet the needs of different populations. Therefore, the purpose of this study was to examine how various factors, including poverty income ratio and race-ethnicity, affect the home food environment in a nationally representative sample of U.S. children and adolescents using NHANES data. Food availability, family meal patterns, and family food expenditures are three aspects of the home food environment addressed in this study.

Subjects and Methods

Data and variables

Data from the 2007-2008 NHANES conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention (CDC) was utilized for this study. The NHANES is a cross-sectional, nationally representative health and nutrition survey of the U.S. civilian noninstitutionalized population and includes a home interview and standardized physical examination at a mobile examination center. The NHANES protocol was approved by the National Center for Health Statistics Research Ethics Review Board and all participants provided informed consent. Details regarding the survey design, content, operations, and procedures are available online (25).

The NHANES 2007-2008 sample consisted of 2500 participants 6-19 years of age, all of whom were interviewed. Demographic data and Consumer Behavior Questionnaire data from the NHANES were used in this study.

Demographic data

NHANES Demographic Questionnaire data were obtained in the home and were used to assess the distribution of demographic information in the youth population. The household interview was conducted in-person with a trained interviewer. Participants 16 years of age and older were interviewed directly and a proxy respondent provided information for survey participants less than 16 years of age. NHANES demographic variables used in this study included age, gender, race-ethnicity, and poverty income ratio (PIR).

Race-ethnicity were self-reported and categorized as non-Hispanic white, non-Hispanic black, Mexican American, other Hispanics, and other. Race-ethnicity categories used in this study include non-Hispanic white, non-Hispanic black, and Hispanic (includes Mexican American and other Hispanics). The "other" category included Asian and multiracial participants and was used in total estimates but did not have a large enough sample size for separate analysis.

PIR was provided in the NHANES demographic survey information and was calculated using a ratio of the family's income to their poverty threshold as defined by the US Census Bureau. PIR accounts for inflation and family size. In 2008, a PIR of 350% was equivalent to approximately $77,000 for a family of four and a PIR of 130% was equivalent to approximately $29,000 for a family of four. The cut point for participation in the Supplemental Nutrition Assistance Program is 130% of the poverty level (26). Poverty income categories used in this study were identical to those used in NHANES analyses conducted by the CDC (27) and were <130% (low income), 130-349% (middle income), and ≥350% (high income).

Consumer Behavior Questionnaire data

Consumer Behavior Questionnaire data were obtained in the home as part of the NHANES Family Questionnaire (25). One adult respondent from each family answered questions regarding food availability in the home, family food expenditures, time spent cooking dinner, number of meals eaten together as a family, and number of meals eaten together cooked at home. Food availability in the home was reported as being always, most of the time, sometimes, rarely, or never available. Hand cards showing response categories were used for some questions. Consumer Behavior questions included in this study and a detailed description of each question can be found in Appendix A-1.

Statistical Analysis

Data were analyzed with SAS version 9.2 (SAS Institute). All analyses followed NHANES data analysis protocol including the use of appropriate sample weights to account for unequal probability of selection from over-sampling, non-response, and for the stratified multistage probability sample design. Standard errors were estimated using Taylor series linearization (28).

Prevalence of food availability (based on 5-point scale: *always, sometimes, most of the time, rarely, never*) in homes of youth was assessed for the entire sample. Differences in the prevalence of food availability were estimated by race-ethnicity (non-Hispanic white, non-Hispanic black, Hispanic), PIR (<130%, 130-349%, ≥350%), and race-ethnicity by PIR. Comparisons of prevalence values between classifications were tested using a *t-test* statistic. To examine the relationship between family food characteristics and race-ethnicity, multiple linear regression models adjusted for PIR and family size were used. To examine the relationship between family food characteristics and PIR, multiple linear regression models adjusted for race-ethnicity were used. To examine the relationship between family food characteristics and food availability, multiple linear regression models adjusted for race-ethnicity and PIR were used. The reference category for food availability regression analyses was never for dark green vegetable, salty snack, fat-free/low-fat milk, and soft drink availability. The reference category for fruit availability regression analyses was rarely due to the small sample size of the never category. Significance for all analyses was set at $p<0.05$.

Results

Food Availability

Food availability demographics for the entire youth sample are noted in Table 1. The highest prevalence of availability was found for fruits, with fruit *always* available in 66.8 ± 2.2% of homes. Food availability was assessed based on race-ethnicity (Table 2), PIR (Table 3), and race-ethnicity by PIR (Table 4). Home food availability varied based on race-ethnicity groups. Non-Hispanic whites had the highest prevalence of fruits (69.8 ± 3.6%), salty snacks (53.3 ± 2.4%), fat-free/low-fat milk (37.3 ± 3.3%), and soft drinks (51.1 ± 4.0%) *always* available. Non-Hispanic blacks had the highest prevalence of dark green vegetables *always* available (63.0 ± 3.0%).

Similarly, food availability varied based on PIR. High income homes had the highest prevalence of fruits (79.7 ± 3.4%), dark green vegetables (57.1 ± 4.1%), salty snacks (55.8 ± 3.6%), and fat-free/low-fat milk (48.1 ± 4.1%) *always* available. Middle and low income homes had the highest prevalence of soft drinks *always* available (46.1 ± 3.5% and 48.2 ± 3.3%, respectively).

Food availability was assessed based on a combination of race-ethnicity and PIR categories (Table 4). High income homes for all race-ethnicity groups had the highest prevalence of fruits *always* available compared to low and middle income homes. High income non-Hispanic white and Hispanic homes had a significantly higher prevalence of fat-free/low-fat milk *always* available in the home compared to low and middle income homes ($p<0.05$). Non-Hispanic black homes had the lowest levels of fat-free/low-fat milk *always* available. Low income non-Hispanic blacks had the highest prevalence of dark green vegetables and soft drinks *always* available in the home; however, few significant differences between groups existed for soft drink availability.

Family food expenditures and meal patterns

Significant positive associations were found between all family food characteristic variables (money spent on food and family meal patterns) and race-ethnicity (Table 5). Non-Hispanic blacks spent the least amount of money at the supermarket/grocery store, Hispanics spent the most money on eating out, and non-Hispanic blacks spent the most money on carry out/delivered foods (Table 5). The number of times someone cooked dinner at home, the number of family meals eaten together, and the number of meals eaten together cooked at home was lowest for non-Hispanic blacks (Table 6)

Significant associations between money spent on carryout/delivered foods, number of times someone cooked dinner at home and PIR categories were found (Table 5). Low income homes spent the least amount of money on carry out/delivered foods per month compared to middle and high income homes with high income homes spending the most (Table 5). The number of times someone cooked dinner at home was significantly higher for low income homes compared to high income homes ($+0.7 \pm 0.2$, $p=0.0035$; Table 6.1). No significant associations were found between money spent on eating out, money spent at the supermarket/grocery store, number of family meals eaten together, number of meals eaten together cooked at home and PIR.

Several statistically significant associations were found between food availability and family food expenditures as well as family meal patterns (Table 7 and 8). Families who *always* had fruit available spent significantly more money at the supermarket/grocery store compared to families who had fruit *rarely* available (+$188.80 ± 60.3, p=0.006). Similarly, families who had dark green vegetables available *always* and most of the time spent significantly more money at the supermarket/grocery store compared to families who had dark green vegetables *never* available (+$176.00 ± 58.5, p=0.01 and +$145.90 ± 66.1, p=0.04, respectively). Increased dark green vegetable availability was positively associated with an increase in the number of times someone cooked dinner at home, number of meals family ate together, and number of meals ate together cooked at home.

Discussion

Analyses of a representative sample of U.S. youth indicated that several factors influence the food environment in homes of children and adolescents. Differences in food availability were found for race-ethnicity categories. Studies examining the influence of race-ethnicity on home food availability in youth are contradictory and limited. Skala et al. (24) analyzed food availability in homes of Hispanic and African-American Head Start preschoolers and found that Hispanic homes were more likely to have fresh vegetables and soft-drinks available. However, work by Cullen et al. (22, 23) reported that food availability did not differ based on race-ethnicity for children and adolescents. For African-American, Euro-American, and Mexican American children aged 9-12 years, home availability of fruits, juices, and vegetables did not differ between race-ethnicity categories (22). Similarly, fruit and vegetable availability between African-American and European American homes of adolescent Boy Scouts did not differ (23). The Skala et al. (24) and Cullen et al. (22, 23) studies lacked large sample sizes, were limited in geographic range, and were limited in the age groups studied. Variations in food availability may exist between race-ethnicity groups (Table 2), as found in our study, due to cultural food preferences, education level of parents, and higher rates of poverty in certain racial-ethnic groups.

Home food availability was also found to differ based on PIR categories for youth. High income homes had an increased availability of healthful foods including fruits, dark green vegetables, and fat-free/low-fat milk as well as unhealthful foods including salty snacks. Ding et al. (19) also found that high income was significantly related to an increased availability of healthful foods in the home; however, few studies have examined the influence of family income on home food availability. Income level may directly influence food availability in the home due to cost differences in energy-dense and nutrient dense-foods. Beyond food costs, knowledge and application of healthy behaviors may influence food availability in high income homes as high income families often have more educated parents. MacFarlane et al. (20) examined the relationship between socioeconomic status, identified by maternal education level, and food availability in homes of Australian adolescents. Low socioeconomic households reported a higher prevalence of unhealthful foods always available including soft drinks, salty snacks, sports drinks, and confectionaries. Adolescents of lower socioeconomic status tend to consume lower amounts of fruits, vegetables, fiber rich foods, and dairy products (29). This may be the result of reduced availability of healthful foods in low socioeconomic status homes as defined by either income level or parent education level.

In the present study, race-ethnicity and income level may dually influence home availability of certain foods. Fat-free/low-fat milk was *always* available in 37.3 ± 3.3% of non-Hispanic white homes, 11.2 ± 1.5% of non-Hispanic black homes, and 17.1 ± 1.9% of Hispanic homes (Table 3). When race-ethnicity groups were further stratified based on PIR, 55.7 ± 4.7% of high income non-Hispanic white homes, 11.5 ± 3.6% of non-Hispanic black homes, and 34.1 ± 5.9% of Hispanic homes *always* had fat-free/low-fat milk available (Table 5). These results indicate that income influences food availability for some race-ethnicities for certain food groups. Several factors may influence home food availability, two of which include race-ethnicity and PIR. Furthermore, these factors may be confounded with one another indicating a complexity to the home food environment (30). Home availability of foods is one of the strongest correlates of intake in youth (11-19).

Race-ethnicity and PIR were associated with family meal patterns and family food expenditures in our study. Other researchers have found that family meals are correlated with an increase in healthy dietary patterns including increased fruit and vegetable availability and consumption (21, 32, 33). However, limited studies have examined what factors influence family meal patterns. Race-ethnicity was strongly associated with family meal patterns in our study. Non-Hispanic black families ate the least number of family meals together and consistently had the poorest family meal patterns while non-Hispanic white families had the highest frequency of family meals. Contrary to prior studies (21, 31), no significant associations were found between socioeconomic status and family meal frequency. This may be due to the way that socioeconomic status was defined. Prior studies defined socioeconomic status by parent education level (21, 31), whereas our study defined socioeconomic status by PIR.

Race-ethnicity and PIR were also found to be associated with family food expenditures. Income was strongly associated with the amount of money spent on carryout/delivery foods and non-Hispanic blacks spent the least amount of money at the supermarket/grocery store. High income homes spent significantly more money on carryout/delivery foods possibly due to an increased workload by one or both parents leaving less time for at home food preparation or due to a decreased concern about the cost of carryout/delivery foods. The reduced spending at the supermarket/grocery store found in non-Hispanic black participants may be due to reduced access to supermarkets. Zenk et al. (34) found that among the most impoverished neighborhoods in Metropolitan Detroit, non-Hispanic blacks were on average 1.1 miles further from the nearest supermarket compared to non-Hispanic whites. This racial disparity was not found for the least impoverished neighborhoods, suggesting that limited access to supermarkets is more readily a problem for low-income non-Hispanic blacks.

Families with fruits and dark green vegetables *always* available spent the most amount of money at the supermarket/grocery store. Additionally, families that had fruits and dark green vegetables more readily available in the home had an increase in family meals and home cooked dinners. Family meals appear to play a positive role in the development of eating habits in youth (21, 32, 33, 35-37). The reason for this is complex and remains unclear but may be related to an increase in the availability of fruits and vegetables (32, 33, 35, 36).

This study does not go without limitations. NHANES is a cross-sectional study; therefore, causal statements could not be made in this study. NHANES 2007-2008 represents the most recent data set for which consumer behavior data were available, limiting the ability to combine the 2007-2008 survey data with another NHANES 2-year dataset.

Conclusions

The home food environment is complex and may be influenced by several factors. These factors may interact with one another increasing the difficulty of examining the relationship of the home food environment to consumption. Food availability, family meal patterns, and family food expenditures are three aspects of the home food environment addressed in this study. This study showed that race-ethnicity and PIR influence all three of these aspects and that race-ethnicity and PIR may confound upon one another as they affect the home food environment. Knowledge of what factors influence food availability could assist nutrition educators in tailoring education to increase home availability and therefore consumption of healthful foods in youth. Additional research examining factors that influence the home food environment are warranted to assist nutrition educators and nutrition policy in developing effective strategies to improve the food environments for youth. Researchers need to continue addressing racial and socioeconomic disparities in home food environments to provide insight into effective public policy development.

Figure 1. Model of the Home Food Environment

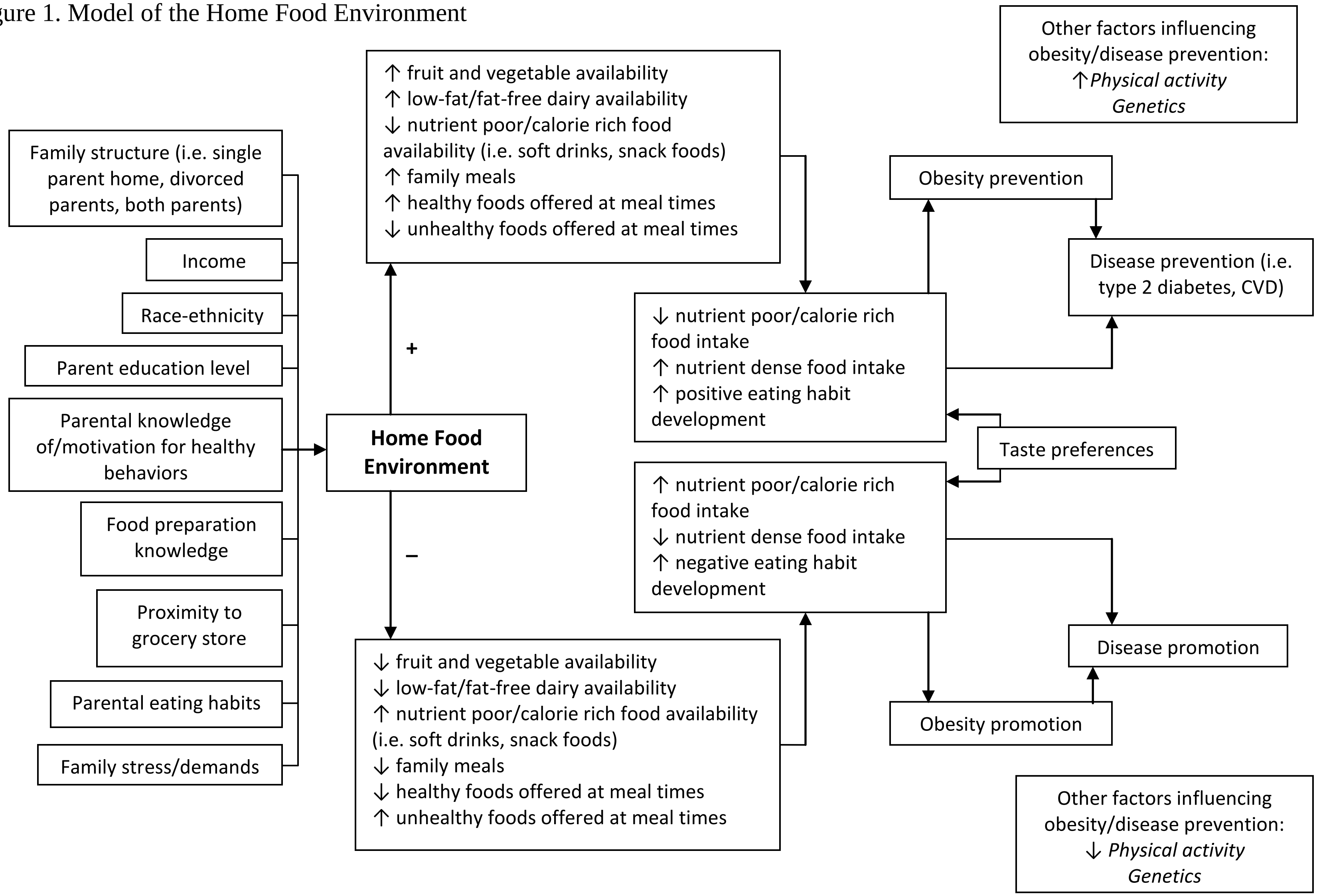

Table 1. Food availability in homes of youth 6-19 years in the United States, 2007-2008

	Fruits % (SE)	Dark green vegetables % (SE)	Salty snacks % (SE)	Fat-free/low fat milk % (SE)	Soft drinks % (SE)
Always	66.8 (2.2)	54.1 (1.6)	47.0 (2.0)	28.7 (1.9)	48.2 (2.4)
Most of the time	21.7 (1.3)	24.5 (1.5)	20.7 (1.3)	3.0 (0.6)	14.1 (0.9)
Sometimes	8.6 (0.8)	14.0 (1.1)	23.0 (1.8)	4.2 (0.6)	16.1 (1.7)
Rarely	2.7 (0.8)	3.7 (0.6)	7.4 (0.9)	5.0 (0.9)	13.8 (1.4)
Never	0.2 (0.1)	3.8 (1.0)	2.0 (0.4)	59.1 (1.7)	7.8 (0.9)

Table 2. Food availability in homes of youth 6-19 based on race-ethnicity in the United States, 2007-2008

	Non-Hispanic white % (SE)	Non-Hispanic black % (SE)	Hispanics % (SE)
Fruit Availability			
Always	69.8 (3.6)[b]	56.7 (3.9)	61.1 (4.1)
Most of the time	20.3 (2.0)	26.0 (2.2)	25.7 (2.5)
Sometimes	7.3 (1.0)	12.4 (1.8)[a]	11.5 (1.9)
Rarely	2.6 (1.1)	4.0 (1.3)	1.4 (0.8)
Never	0 (0)	0.8 (0.3)	0.3 (0.2)
Dark green vegetable availability			
Always	51.8 (2.2)	63.0 (3.0)[a c]	51.4 (3.8)
Most of the time	25.8 (2.1)	22.5 (2.5)	22.3 (2.1)
Sometimes	13.5 (1.4)	12.0 (1.4)	18.5 (2.6)
Rarely	4.0 (1.0)	1.9 (1.1)	4.9 (0.7)
Never	5.0 (1.5)[b]	0.6 (0.4)	3.0 (0.6)[b]
Salty snack availability			
Always	53.3 (2.4) [b c]	40.7 (3.3)	33.6 (1.9)
Most of the time	22.2 (2.1)	20.0 (1.4)	17.5 (1.6)
Sometimes	17.9 (2.2)	25.9 (2.8)[a]	35.2 (2.6)[a b]
Rarely	5.2 (0.9)	10.2 (2.0)	11.1 (1.3)[a]
Never	1.3 (0.5)	3.2 (0.9)	2.7 (0.6)
Fat-free/low-fat milk availability			
Always	37.3 (3.3)[b c]	11.2 (1.5)	17.1 (1.9)[b]
Most of the time	2.9 (0.9)	4.5 (1.0)	2.8 (0.7)
Sometimes	3.1 (0.6)	4.5 (1.0)	6.7 (1.0)[a]
Rarely	4.6 (1.5)	7.1 (1.6)	4.1 (1.1)
Never	52.2 (3.3)	72.6 (2.7)[a]	69.3 (2.9)[a]
Soft drink availability			
Always	51.1 (4.0)[c]	48.3 (2.6)[c]	38.6 (1.4)
Most of the time	12.9 (0.9)	17.3 (2.4)	15.5 (2.5)
Sometimes	12.8 (2.3)	21.0 (2.9)	22.3 (1.0)[a]
Rarely	15.0 (2.2)[b]	9.0 (1.2)	15.2 (1.7)[b]
Never	8.2 (1.2)	4.4 (1.4)	8.5 (1.1)

[a] Significantly different than Non-Hispanic white; [b] Significantly different than Non-Hispanic black;
[c] Significantly different than Hispanics; Significance set at $p<0.05$

Table 3. Food availability in homes of youth 6-19 years based on PIR[1] in the United States, 2007-2008

	≤ 130% % (SE)	131% - 349% % (SE)	≥ 350% % (SE)
Fruit availability			
Always	58.0 (3.0)	60.5 (4.3)	79.7 (3.4) [a b]
Most of the time	26.3 (2.0) [c]	27.2 (3.1) [c]	13.5 (2.6)
Sometimes	12.0 (1.5) [b c]	7.6 (1.2)	6.0 (1.7)
Rarely	3.2 (1.0) [c]	4.4 (1.7) [c]	0.9 (0.5)
Never	0.4 (0.3)	0.2 (0.2)	0 (0)
Dark green vegetable availability			
Always	52.4 (2.8)	52.3 (3.7)	57.1 (4.1)
Most of the time	24.1 (2.0)	22.3 (3.4)	26.9 (3.7)
Sometimes	17.0 (1.9) [c]	15.7 (1.6) [c]	8.9 (2.2)
Rarely	3.8 (1.0)	4.0 (1.2)	4.0 (1.6)
Never	2.7 (0.9)	5.7 (2.4)	3.2 (1.5)
Salty snack availability			
Always	34.6 (2.4)	48.3 (4.0) [a]	55.8 (3.6) [a]
Most of the time	20.0 (2.3)	20.5 (1.9)	23.2 (3.8)
Sometimes	32.3 (3.5) [c]	22.8 (3.0) [c]	14.0 (2.2)
Rarely	10.0 (1.6)	6.7 (1.1)	5.8 (1.8)
Never	3.1 (1.0)	1.7 (0.6)	1.2 (0.7)
Fat-free/low-fat milk availability			
Always	15.3 (2.1)	24.5 (3.1)[a]	48.1 (4.1)[a b]
Most of the time	3.0 (1.0)	4.2 (1.5)	2.4 (0.6)
Sometimes	4.9 (1.2)	4.5 (0.8)	3.6 (1.3)
Rarely	5.7 (1.7)	5.0 (1.2)	4.5 (1.1)
Never	71.1 (1.9)[b c]	61.9 (2.9)[c]	41.4 (3.1)
Soft drink availability			
Always	46.1 (3.5)	48.2 (3.3)	45.6 (3.1)
Most of the time	17.5 (2.1)[c]	15.3 (2.0)	11.0 (1.8)
Sometimes	16.4 (2.2)	18.2 (3.1)	14.8 (2.3)
Rarely	13.2 (2.8)	13.2 (2.5)	16.5 (2.2)
Never	6.9 (1.3)	5.2 (1.1)	12.1 (2.2)[a b]

[1]PIR category of ≤ 130%=low income, 131-349%=middle income, ≥ 350%=high income

[a] Significantly different than low income; [b] Significantly different than middle income; [c] Significantly different than high income; Significance set at $p<0.05$

Table 4. Food availability (always availability) based on race-ethnicity and PIR[1,2] in the United States, 2007-2008

	Low income % (SE)	Middle income % (SE)	High income % (SE)
Fruit availability			
Non-Hispanic white	59.5 (5.4)	62.8 (6.0)	80.8 (4.2)[a b]
Non-Hispanic black	50.9 (6.5)	55.7 (5.0)	65.7 (5.2)[d f]
Hispanic	56.0 (5.0)	58.9 (3.6)	78.3 (5.7)[a b]
Dark green vegetable availability			
Non-Hispanic white	47.6 (4.0)	51.0 (5.3)	56.1 (4.8)
Non-Hispanic black	63.6 (4.7)[d f]	60.3 (4.0)	58.1 (7.3)
Hispanic	49.5 (3.9)	49.8 (6.1)	60.5 (8.5)
Salty snack availability			
Non-Hispanic white	33.7 (3.9)	58.0 (4.6)[a]	60.1 (3.9)[a]
Non-Hispanic black	40.9 (3.0)	41.1 (5.7)[d]	40.5 (5.0)[d]
Hispanic	30.5 (3.9)	33.2 (2.7)[d]	41.9 (6.1)[d]
Fat-free/low-fat milk availability			
Non-Hispanic white	19.0 (4.0)	30.6 (5.0)[a]	55.7 (4.7)[a b]
Non-Hispanic black	6.5 (1.5)[d f]	14.8 (2.7)[ad]	11.5 (3.6)[d f]
Hispanic	14.6 (3.2)	16.6 (4.0)	34.1 (5.9)[a b d]
Soft drink availability			
Non-Hispanic white	48.7 (6.2)	52.2 (5.6)	47.0 (4.1)
Non-Hispanic black	49.4 (4.8)[f]	48.2 (5.4)	43.1 (5.1)
Hispanic	33.9 (3.7)	43.1 (2.8)	37.9 (6.9)

[1]PIR category of ≤ 130%=low income, 131-349%=middle income, ≥ 350%=high income.

[2]Food availability data for always availability category only.

[a]Significantlydifferent than low income; [b]Significantly different than middle income; [c]Significantly different than high income.

[d]Significantlydifferent than non-Hispanic white; [e]Significantly different than non-Hispanic black; [f]Significantly different than Hispanic.

Significance set at p<0.05.

Table 5. Regression analysis of family food expenditures and sociodemographic characteristics, for youth 6-19 years in the United States, 2007-2008

	Money spent at supermarket/grocery store (dollars/30 d)			**Money spent on eating out (dollars/30 d)**			**Money spent on carry out/delivery foods (dollars/30 d)**		
Demographic characteristic	β	SE	*P*	β	SE	*P*	β	SE	*P*
Race-ethnicity[3]									
Hispanic	-62.4	22.8	**0.01**[2]	31.0	6.1	**0.0001**[2]	-2.6	13.6	0.85
Non-Hispanic black	-134.4	19.9	**<0.001**[2]	5.1	11.3	0.65	-48.0	11.1	**0.0005**[2]
Non-Hispanic white (reference)	0	0	-	0	0	-	0	0	-
PIR[1,4]									
Low	-52.6	36.1	0.16	-19.7	9.5	0.0555	-210.0	22.6	**<0.0001**[2]
Middle	-20.2	25.3	0.44	-4.4	13.8	0.7528	-160.9	24.6	**<0.0001**[2]
High (reference)	0	0	-	0	0	-	0	0	-

Data are presented as β, standard error (SE), and P-value.
[1]PIR category of ≤ 130%=low income, 131-349%=middle income, ≥ 350%=high income.
[2]Statistically significant at p<0.05.
[3]Regression analyses adjusted for PIR and family size.
[4]Regression analyses adjusted for race-ethnicity.

Table 6. Regression analysis of family meal patterns and sociodemographic characteristics, for youth 6-19 years in the United States, 2007-2008

	Number of times someone cooked dinner at home (# times/7 days)			Number of meals family ate together (# meals/7 days)			Number of meals ate together cooked at home (# meals/7 days)		
Demographic characteristic	β	SE	*P*	β	SE	*P*	β	SE	*P*
Race-ethnicity[3]									
Hispanic	0.1	0.1	0.32	-0.2	0.5	0.62	-0.4	0.3	0.31
Non-Hispanic black	-0.5	0.2	**0.0047**[2]	-1.5	0.4	**0.0022**[2]	-1.1	0.3	**0.0019**[2]
Non-Hispanic white (reference)	0	0	-	0	0	-	0	0	-
PIR[1,4]									
Low	0.7	0.2	**0.0035**[2]	0.0	0.6	0.93	0.7	0.4	0.15
Middle	0.2	0.2	0.19	-0.5	0.5	0.28	-0.1	0.3	0.76
High (reference)	0	0	-	0	0	-	0	0	-

Data are presented as β, standard error (SE), and P-value.

[1]PIR category of ≤ 130%=low income, 131-349%=middle income, ≥ 350%=high income.

[2]Statistically significant at $p<0.05$.

[3]Regression analyses adjusted for PIR and family size.

[4]Regression analyses adjusted for race-ethnicity.

Table 7. Regression analysis of family food expenditures and food availability by availability categories, for youth 6-19 years in the United States, 2007-2008

	Money spent at supermarket/grocery store (dollars/30 d)			Money spent on eating out (dollars/30 d)			Money spent on carry out/deliver foods (dollars/30 d)		
Food Availability	β	SE	*P*	β	SE	*P*	β	SE	*P*
Fruit									
Always	188.8	60.3	**0.006**[1]	-3.1	40.8	0.94	-5.5	16.4	0.74
Most of the time	100.3	60.8	0.12	8.8	49.5	0.86	0.7	19.7	0.97
Sometimes	57.4	64.4	0.39	-18.9	45.4	0.68	3.2	15.6	0.84
Rarely (reference)	0	0	-	0	0	-	0	0	-
Dark green vegetable									
Always	176.0	58.5	**0.01**[1]	-41.5	31.3	0.20	-10.0	17.8	0.58
Most of the time	145.9	66.1	**0.04**[1]	-35.1	32.7	0.30	-4.7	18.7	0.80
Sometimes	74.0	58.1	0.22	-52.9	33.7	0.13	-15.9	17.9	0.39
Rarely	97.3	80.6	0.24	1.9	75.5	0.98	60.9	55.3	0.29
Never (reference)	0	0	-	0	0	-	0	0	-
Salty snacks									
Always	15.5	39.1	0.70	39.2	26.9	0.16	24.8	10.6	**0.03**[1]
Most of the time	11.2	45.0	0.81	24.4	31.1	0.44	19.8	11.1	0.09
Sometimes	-34.7	35.3	0.34	8.2	25.7	0.75	9.6	9.7	0.34
Rarely	-99.2	36.1	**0.01**[1]	-23.3	29.4	0.44	3.9	12.9	0.77
Never (reference)	0	0	-	0	0	-	0	0	-
Fat-free/low-fat milk									
Always	43.9	33.9	0.21	-1.3	17.9	0.94	-8.3	5.6	0.16
Most of the time	-24.5	39.9	0.55	-51.1	23.6	0.05	-10.6	7.4	0.17
Sometimes	-80.2	34.9	**0.04**[1]	-1.7	22.8	0.94	0.8	13.7	0.95
Rarely	0.7	29.4	0.98	66.5	75.5	0.39	-2.7	6.8	0.70
Never (reference)	0	0	-	0	0	-	0	0	-
Soft drinks									
Always	16.2	81.2	0.84	63.5	36.6	0.10	21.5	6.2	**0.003**[1]
Most of the time	-62.5	72.0	0.40	3.6	37.1	0.92	9.7	5.6	0.10
Sometimes	-2.4	69.4	0.97	18.5	33.9	0.59	11.6	7.1	0.12
Rarely	-37.3	81.0	0.65	22.1	41.3	0.60	7.9	10.1	0.44
Never (reference)	0	0	-	0	0	-	0	0	-

Data are presented as β, standard error (SE), and P-value.
[1]Statistically significant at $p<0.05$.

Table 8. Regression analysis of family meal patterns and food availability by availability categories, for youth 6-19 years in the United States, 2007-2008

	Number of times someone cooked dinner at home (# times/7 days)			Number of meals family ate together (# meals/7 days)			Number of meals ate together cooked at home (# meals/7 days)		
Availability	β	SE	*P*	β	SE	*P*	β	SE	*P*
Fruit									
Always	1.1	0.4	**0.007**[1]	0.5	0.8	0.54	0.0	0.7	0.98
Most of the time	0.4	0.4	0.32	0.2	0.7	0.76	0.0	0.7	0.95
Sometimes	-0.4	0.5	0.42	-1.2	0.9	0.19	-1.0	0.8	0.20
Rarely (reference)	0	0	-	0	0	-	0	0	-
Dark green vegetables									
Always	1.9	0.3	**<0.001**[1]	2.6	0.7	**0.003**[1]	1.8	0.4	**0.003**[1]
Most of the time	1.3	0.4	**0.005**[1]	2.5	0.9	**0.01**[1]	1.7	0.5	**0.004**[1]
Sometimes	1.1	0.3	**0.005**[1]	1.8	0.7	**0.02**[1]	0.8	0.5	0.11
Rarely	0.6	0.6	0.34	0.9	1.0	0.36	0.2	0.6	0.76
Never (reference)	0	0	-	0	0	-	0	0	-
Salty snacks									
Always	0.4	0.6	0.51	-0.7	0.9	0.47	-0.1	1.3	0.94
Most of the time	0.3	0.7	0.65	-0.7	1.1	0.49	-0.2	1.3	0.90
Sometimes	0.7	0.6	0.29	-0.2	1.0	0.87	0.4	1.4	0.78
Rarely	0.5	0.6	0.46	-0.0	1.0	0.96	0.2	1.1	0.87
Never (reference)	0	0	-	0	0	-	0	0	-
Fat-free/low-fat milk									
Always	0.1	0.2	0.64	0.2	0.2	0.41	0.4	0.3	0.14
Most of the time	-0.2	0.3	0.63	-1.1	0.8	0.20	-0.8	0.7	0.28
Sometimes	-0.1	0.3	0.83	0.5	0.6	0.41	0.3	0.6	0.63
Rarely	-0.0	0.2	0.83	1.3	1.5	0.42	1.8	1.6	0.28
Never (reference)	0	0	-	0	0	-	0	0	-
Soft drinks									
Always	-0.5	0.2	**0.04**[1]	-0.8	0.6	0.24	-1.4	0.5	**0.02**[1]
Most of the time	-0.5	0.3	0.14	-0.2	0.7	0.78	-0.9	0.7	0.25
Sometimes	-0.1	0.2	0.56	0.2	0.9	0.84	-0.3	0.8	0.69
Rarely	-0.3	0.3	0.32	-0.7	0.8	0.41	-1.5	0.7	**0.04**[1]
Never (reference)	0	0	-	0	0	-	0	0	-

Data are presented as β, standard error (SE), and P-value.
[1]Statistically significant at $p<0.05$.

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Study II:

Influence of home food availability on food consumption and obesity in US youth, aged 6-19

Influence of home food availability on food consumption and obesity in US youth, aged 6-19

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Abstract

Background: Many U.S. youth fail to meet dietary recommendations indicating a need to examine factors that influence dietary consumption. The availability of food in the home is associated with dietary consumption in youth and therefore, home food availability may influence obesity development.

Objective: The purpose of this analysis was to examine the influence of home food availability on dietary consumption and obesity using data from the National Health and Nutrition Examination Survey among youth ages 6-19 years in 2007-2008 (n=2425).

Methods: Youth were classified as consumers or non-consumers of five food groups (fruits, dark green vegetables, salty snacks, fat-free/low-fat milk, and soft drinks) based on a single 24-hour dietary recall. The percentage of consumers within each food group was stratified based on food availability, race-ethnicity, gender, age groups, poverty income ratio, and BMI categories. Associations between BMI and food availability were examined.

Results: Variations in the percentage of consumers for the five food groups were found for race-ethnicity, PIR, and food availability groups. Approximately 41.4 ± 2.1% of youth were consumers of fruit, 4.2 ± 0.9% consumers of dark green vegetables, 33.5 ± 1.8% consumers of salty snacks, 16.6 ± 1.7% consumers of fat-free/low-fat milk, and 46.1 ± 2.6% consumers of soft drinks based on a single 24-hour diet recall. Based on home food availability, the highest percentage of consumers was found for youth living in homes with fruits (29.9 ± 1.8%), dark green vegetables (2.9 ± 0.8%), salty snacks (16.7 ± 1.9%), and fat-free/low-fat milk (10.5 ± 1.5%) always available. For soft drinks, the

highest percentage of consumers was found for youth living in homes with soft drinks never available (26.9 ± 2.4%). No associations between food availability and BMI were found.

Conclusions: Consumption of food appears to be influenced by gender, race-ethnicity, income level, and availability of foods in the home. The influence of food availability on dietary intake and the disparities in dietary consumption due to race-ethnicity and income level should be addressed in dietary intake related initiatives.

Introduction

Youth obesity is an ongoing problem in the United States. During the past 30 years, obesity in children aged 6-11 has increased from 7 to 20% and from 5 to 18% in adolescents aged 12-19 (1). Obese children and adolescents are likely to be obese as adults and have an increased risk of developing chronic diseases earlier in life (2). The multifactorial nature of obesity continues to challenge researchers and health professionals to determine methods for preventing and reducing childhood obesity. Researchers have suggested that obesity is a normal response to an "obesigenic" environment (3). The home food environment is possibly emerging as one of the most influential environments in obesity and behavior development (4).

Development of dietary habits begins in childhood and these habits have the potential to influence weight status, chronic disease development, and dietary habits into adulthood (5). Diet trends for U.S. children and adolescents indicate that youth are failing to meet dietary recommendations (6, 7). Research has indicated that youth consumption of unhealthful, obesity promoting foods, like snack foods and soft drinks, has increased (8-10). Inadequate consumption of healthful, obesity preventing foods, like fruits and vegetables, is a diet trend that increases the risk of health consequences in youth (11, 12).

Dietary consumption has been found to be associated with food availability, or the presence of foods, in the home for youth (12-19). More specifically, researchers have reported that fruit and vegetable availability in the home is related to child and adolescent consumption (12-16). The same availability-consumption relationship has been reported for energy dense foods like soft drinks and snack foods (17-19). These results indicate that the home food environment, specifically food availability in the home, has the potential to influence dietary intake and therefore, may influence obesity development in youth. Although away-from-home food consumption has increased over the past 30 years, approximately 60% of meals and snacks are still consumed at home (20) indicating that the home food environment is a suitable target for nutrition education and obesity prevention programs.

While the relationship between home food availability and dietary consumption in youth has been examined, limitations in current studies exist. The availability-consumption relationship for foods other than fruits and vegetables has been minimally studied indicating a need to examine this relationship in obesity-promoting foods such as soft drinks and snack foods. Additionally, no studies have examined the availability-consumption relationship in a nationally representative sample of youth. If home food availability influences dietary consumption in youth, then home food availability may also influence obesity development or prevention. Research examining the relationship of food availability in the home and body mass index does not exist.

Knowledge of the relationship between home food availability and dietary consumption could aid in developing nutrition education to increase youth compliance of dietary guidelines. Research examining the relationship of home food availability and obesity in youth is needed to develop a better understanding of environmental contributors of obesity development and prevention. Therefore, the purpose of this study was to examine the relationship between home food availability and dietary consumption as well as obesity in a nationally representative sample of U.S. children and adolescents using 2007-2008 NHANES data.

Subjects and Methods

Data and Variables

Data from the 2007-2008 NHANES conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention was utilized for this study (21). NHANES is a complex, stratified, multistage probability cluster sampling design that provides data representative of the U.S. civilian noninstitutionalized population and includes a home interview and standardized physical examination at a mobile examination center. Details regarding the survey design, content, operations, and procedures are available online (21).

The NHANES 2007-2008 sample consisted of 2500 participants aged 6-19 years of age, 2425 of whom were interviewed and examined. Demographic, Consumer Behavior Questionnaire, Dietary, and Body Measures data from NHANES were utilized for analyses.

Demographic data

NHANES Demographic Questionnaire data were obtained in the home and were used to assess the distribution of demographic information in the youth population. The household interview was conducted in-person with a trained interviewer. Participants 16 years of age and older were interviewed directly and a proxy respondent provided information for survey participants younger than 16 years of age. NHANES demographic variables used in the current study included age, gender, and race-ethnicity.

Race-ethnicity were self-reported and categorized as non-Hispanic white, non-Hispanic black, Mexican American, other Hispanics, and other. Race-ethnicity categories used in this study include non-Hispanic white, non-Hispanic black, and Hispanic (includes Mexican American and other Hispanics). The “other” category included Asian and multiracial participants and was used in total estimates in this study but did not have a large enough sample size for separate analysis.

Poverty income ratio (PIR) was provided in the NHANES demographic survey information and was calculated using a ratio of the family’s income to their poverty threshold as defined by the US Census Bureau. PIR accounts for inflation and family size. In 2008, a PIR of 350% was equivalent to approximately $77,000 for a family of four and a PIR of 130% was equivalent to approximately $29,000 for a family of four. The cut point for participation in the Supplemental Nutrition Assistance Program is 130% of the poverty level (22). Poverty income categories used in this study were identical as those used in NHANES analyses conducted by the CDC (23) and were <130% (low income), 130-349% (middle income), and ≥350% (high income).

Consumer Behavior Questionnaire data

Consumer Behavior Questionnaire data were obtained in the home as part of the NHANES Family Questionnaire (21). One adult respondent from each family answered questions regarding food availability in the home. Food availability in the home was reported as being *always*, *most of the time*, *sometimes*, *rarely*, or *never* available. Consumer Behavior questions included in this study and a detailed description of each question can be found in Appendix A-1.

Dietary Intake data

NHANES dietary intake data were obtained from in-person 24-hour dietary recall interviews using an automated multiple-pass method (21). Children aged 6-11 years were assisted by an adult during the interview and adolescents aged 12-19 years completed the interview independently. Detailed descriptions of dietary interview methods used in NHANES are provided in the Dietary Interview Procedures Manual (21). Child and adolescent recalls that were found to be incomplete or unreliable by National Center for Health Statistic staff were excluded from this study.

Two 24-hour dietary recalls were collected in the 2007-2008 NHANES, the first in-person, the second via telephone; however, only one recall was utilized for this study based on NHANES study analysis protocol (21). Data from the first 24-hour dietary recall, completed in-person, was utilized. The survey food codes in the USDA Food and Nutrient Database for Dietary Studies (FNDDS), Version 4.1 (24), were used to determine intake of fruits (fresh, canned, dried, or frozen), dark green vegetables, salty snacks, and soft drinks (excluding diet) for the 2425 children and adolescents included in this study.

Body Measures data

NHANES height and weight measurements were collected at a mobile examination center according to examination protocols. Body mass index was calculated as body weight, in kilograms, divided by height, in meters squared (kg/m^2). NHANES BMI data was utilized in this study, and the percentile of BMI-for-age was calculated for male and female youth using the Centers for Disease Control and Prevention (CDC) growth charts (25; Appendices A-2 and A-3). Normal weight was defined as a 5th to < 85^{th} percentiles, overweight as 85^{th} to < 95^{th} percentiles, and obese as ≥ 95^{th} percentile.

Statistical Analysis

Data were analyzed with SAS version 9.2 (SAS Institute). All analyses followed NHANES data analysis protocol including the use of appropriate sample weights to account for unequal probability of selection from over-sampling, nonresponse, and for the stratified multistage probability sample design. Standard errors were estimated using Taylor series linearization (21).

Consumption of fruits, dark green vegetables, salty snacks, fat-free/low-fat milk, and soft drinks were assessed for all youth. Youth were classified as either consumers or non-consumers of foods in the aforementioned food groups based on a single 24-hour dietary recall. Consumers were defined as those participants consuming any amounts of foods found in each of the five food categories (fruits, dark green vegetables, salty snacks, fat-free/low-fat milk, soft drinks). The percentage of consumers within each food group was assessed for the entire sample based on food availability (always, most of the time, sometimes, rarely, never). The percentage of consumers within each food group for the total youth sample was stratified based on race-ethnicity (non-Hispanic white, non-Hispanic black, Hispanic), gender, age groups (6-11, 12-19), and BMI categories (normal weight, overweight, obese). Comparisons of the percentage of consumers within each food group were tested using a *t-test* statistic.

Differences in the prevalence of food availability were estimated by BMI (normal weight, overweight, obese). Comparisons of prevalence values between BMI categories were tested using a *t-test* statistic. To examine the relationship between food availability and BMI, multiple linear regression models controlled for race-ethnicity and PIR were used. Reference category for food availability regression analyses was *never* for dark green vegetable, salty snack, fat-free/low-fat milk, and soft drink availability. Reference category for fruit availability regression analyses was *rarely* due to small sample size of the *never* category. Significance for all analyses was set at $p<0.05$.

Results

Consumption based on demographic classifications

Percentages of consumers, based on a single 24-hr recall, of the five food categories for the entire youth sample are found in Table 1. The percentage of consumers varied based on the food category with 41.1 ± 2.1% of youth consuming fruit, 4.2 ± 0.9% consuming dark green vegetables, 33.5 ± 1.8% consuming salty snacks, 16.6 ± 1.7% consuming fat-free/low-fat milk, and 46.1 ± 2.6% consuming soft drinks. Consumer percentages were stratified based on gender, age groups, race-ethnicity, PIR, and BMI categories (Table 1).

Few significant differences were found between gender, age, and BMI groups for the percentages of consumers. A significantly larger percentage of male youth were consumers of soft drinks compared to female youth (49.8 ± 3.6% vs. 42.6 ± 2.4%, respectively; $p<0.05$). A significantly larger percentage of 6-11 year old youth were consumers of fruit compared to youth 12-19 years of age (51.8 ± 3.3% vs. 34.1 ± 2.3%, respectively; $p<0.05$). A significantly larger percentage of normal weight youth were consumers of dark green vegetables compared to overweight and obese youth (5.4 ± 1.4% vs. 3.4 ± 0.9% and 2.0 ± 0.5%, respectively; $p<0.05$).

Several significant differences were found between race-ethnicity and PIR groups. A significantly larger percentage of non-Hispanic white and Hispanic youth were consumers of fruit, fat-free/low-fat milk, and soft drinks compared to non-Hispanic black youth ($p<0.05$). Additionally, a significantly lower percentage of non-Hispanic white youth were consumers of salty snacks compared to non-Hispanic black youth ($p<0.05$). A significantly smaller percentage of middle and low income youth were consumers of fat-free/low-fat milk ($p<0.05$) and a significantly larger percentage of middle and low income youth were consumers of soft drinks ($p<0.05$).

Consumption based on food availability

The percentage of consumers, determined based on a single 24-hour recall, in each of the five food categories was analyzed based on home food availability (Tables 2 and 3). The largest percentage of consumers of fruit, dark green vegetables, salty snacks, and fat-free/low-fat milk were youth living in homes with these foods *always* available. Of the 41.4 ± 2.1% of youth that were consumers of fruit, 29.9 ± 1.8% were youth living in homes with fruit *always* available. Dark green vegetables were consumed by 4.2 ± 0.9% of all youth and 2.9 ± 0.8% of these youth lived in homes with dark green vegetables *always* available. Of the 33.5 ± 1.8% of youth that were consumers of salty snacks, 16.7 ± 1.9% lived in homes with salty snacks *always* available. Fat-free/low-fat milk was consumed by 16.6 ± 1.7% of youth and 10.5 ± 1.5% of the consumers lived in homes with fat-free/low-fat milk *always* available. The largest percentage of consumers of soft drinks lived in homes with soft drinks *never* available. Of the 46.1 ± 2.6% of soft drink consumers, 26.9 ± 2.4% lived in homes with soft drinks *never* available and 12.9 ± 1.6% lived in homes with soft drinks *always* available.

Home food availability and BMI

Food availability in homes of youth was assessed based on BMI categories of normal weight, overweight, and obese. Percentages of homes with foods *always*, *most of the time*, *sometimes*, *rarely*, and *never* available were calculated for all five different food categories based on BMI. No significant differences were found between BMI categories for the availability of foods in the home (Table 4). When regression analyses were conducted to examine the association between home food availability and BMI, no significant associations were found (Table 5)

Discussion

Soft drinks had the largest percentage of consumers compared to fruits, dark green vegetables, salty snacks, and fat-free/low-fat milks. Differences in the percentage of soft drink consumers were found between gender and race-ethnicity groups. A significantly higher percentage of soft drink consumers were found for males compared to females ($p<0.05$). Non-Hispanic whites and Hispanics had a higher percentage of soft drink consumers compared to non-Hispanic black youth. Similar results were found in an analysis of high school youth participating in the National Youth Physical Activity and

Nutrition Study that examined sugar-sweetened beverage intake based on intake of four non-diet beverages including soda (26). In our study, the percentage of soft drink consumers also varied based on PIR, with low income youth having the highest percentage of soft drink consumers.

The percentage of youth meeting fruit recommendations has been shown to decline with age (11). Results from the current study indicated that a larger percentage of children, ages 6-11, consumed fruit compared to adolescents. These results are similar to a study utilizing the 1999-2002 NHANES data to examine total fruit intake, defined by cup equivalents. Youth 6-11 y consumed more total fruit per day compared to youth 12-19 y (11). The percentage of fruit consumers in the current study also differed based on race-ethnicity with non-Hispanic white and Hispanic youth having a higher percentage of fruit consumers compared to non-Hispanic black youth. Lorson et al. (11) reported that Mexican Americans consumed more fruit compared to non-Hispanic white and non-Hispanic black youth. However, Lorson et al. (11) assessed amounts of fruit, not percentage of consumers of fruit. The current study also found that low and high income youth had a higher percentage of fruit consumers compared to middle income youth (Table 1). These results are similar to the Lorson et al. (11) study which reported lowest amounts of fruit consumption in middle income youth.

The percentage of fat-free/low-fat milk consumers was higher for non-Hispanic white and Hispanic youth compared to non-Hispanic black youth and for high income youth compared to low and middle income youth. Kit et al (23) examined low-fat milk consumption based on a 30 day consumption reporting for youth participating in the 2007-2008 NHANES and found that non-Hispanic white youth reported low-fat milk as their usual milk type more often that non-Hispanic black and Hispanic youth. In addition, similar to the current study, Kit et al. (23) found that high income youth reported low-fat milk as their usual milk type more often that middle or low income youth. Results from the Kit study (27) indicate that the differences in the percentage of dairy consumers for race-ethnicity and income found in our study may be occurring due to fat-free/low-fat milk being the usual intake in certain groups or an increased availability of fat-free/low-fat milk in the homes of certain groups. Non-Hispanic black youth may consume fat-free/low-fat milk less often due to issues with lactose intolerance or taste preferences for fuller fat milk. Availability may also influence consumption and fat-free/low-fat milk has been reported to be more available in non-Hispanic white, Hispanic, and high income homes (27).

Results from analyzing the percentage of consumers based on home food availability indicate that availability more strongly influences consumption for certain food groups. The percentage of consumers of fruits and dark green vegetables was highest for youth of families who had these foods always available. Granner et al. (13), Neumark-Sztainer et al. (12), and Ding et al. (14), reported similar results when analyzing fruit and vegetable availability and consumption. However, these studies only assessed the availability-consumption relationship in youth 12 years and older. In our study, the percentage of fat-free/low-fat milk consumers was highest for youth living in homes with fat-free/low-fat milk always available. Larson et al. (28) reported that for youth aged 11-18 participating in Project EAT, the availability of milk at meals was positively related to calcium intake. Snack foods and soft drinks tend to be energy-dense and may contribute to the development of excess weight in children and adolescence. The percentage of salty snack consumers in our study was highest for youth living in homes with salty snacks always available. Campbell et al. (17) examined the relationship between the availability of energy-dense snacks in the home with consumption in Australian adolescents and reported that the availability of snack foods was positively related to savory snack consumption. This relationship has been found in children as young as preschool age (19). In our study, the largest percentage of consumers of soft drinks was found for youth living in homes with soft drinks never available followed by homes with soft drinks always available. Soft drink availability in the home has been reported to be associated with soft drink consumption in youth (18, 19). However, away-from-home sources of soft drinks, including restaurants and school vending machines, have been reported to be increasingly important (8, 18).

Food consumption behaviors in youth are complex, and food availability is only one possible contributor to food consumption patterns in youth. Several other factors may influence food consumption in youth including parental eating habits and taste preferences (18). This study did not analyze other factors that may have influenced food consumption in the youth examined.

Food availability was not found to be associated with youth BMI. Studies examining relationships between the home food environment and youth BMI have focused mainly on family meal patterns (29, 30, 31). It is possible that no associations between food availability and BMI were found due to a relationship not existing or due to the cross-sectional nature of the data. Overweight and obesity develop over time indicating the limitations with single-measure BMI data utilized in NHANES.

Limitations of this study included the use of a single 24-hour dietary recall to analyze consumption of foods. A single 24-hour dietary recall is not representative of usual intake and is subject to several inherent limitations including underreporting and their dependence on memory. NHANES 2007-2008 represents the most recent data for which home food availability data is available. Therefore, the NHANES 2007-2008 sample was not combined with a previous study resulting in a smaller sample size.

Conclusion

Several factors appear to influence food consumption in youth including gender, race-ethnicity, PIR, and food availability. As diet trends in U.S. youth indicate that many are failing to meet dietary recommendations (6, 7), development of comprehensive strategies to improve dietary intake are needed. Within these strategies, the influence of home food availability on consumption of foods should be addressed and the influence of limiting foods in the home on food consumption away from home should be examined. Disparities in dietary intake due to race-ethnicity and income level should also be considered when developing effective initiatives aimed at improving dietary intake in youth.

Table 1. Percentage of consumers[1] for youth 6-19 years based on demographic characteristics in the United States, 2007-2008

	Food categories				
	Fruit	Dark green vegetables	Salty snacks	Fat-free/low-fat milk	Soft drinks
	% (SE)	% (SE)	% (SE)	% (SE)	% (SE)
All youth	41.4 (2.1)	4.2 (0.9)	33.5 (1.8)	16.6 (1.7)	46.1 (2.6)
Gender					
Male	37.8 (2.7)	4.0 (1.0)	31.4 (2.5)	16.2 (2.4)	49.8 (3.6)[a]
Female	45.0 (3.6)	4.4 (1.0)	35.4 (2.4)	17.1 (1.5)	42.6 (2.4)
Age					
6-11	51.8 (3.3)[b]	4.3 (1.0)	35.6 (2.2)	17.7 (2.0)	44.2 (2.6)
12-19	34.1 (2.3)	4.2 (1.1)	31.9 (2.8)	15.9 (2.1)	47.5 (3.0)
Race-Ethnicity					
Non-Hispanic White	42.2 (3.3)[c]	4.0 (1.4)	30.8 (2.3)[c]	19.9 (2.7)[c]	47.8 (3.9)[c]
Non-Hispanic Black	33.4 (2.1)	6.6 (1.7)	43.4 (4.3)	7.0 (1.9)	36.2 (2.6)
Hispanic	42.8 (2.5)[c]	2.9 (0.8)	34.5 (2.5)	15.5 (2.0)[c]	50.4 (2.4)[c]
BMI					
Normal Weight	43.6 (2.2)	5.4 (1.4)	33.9 (1.7)	17.5 (3.0)	45.4 (3.2)
Overweight	40.9 (4.7)	3.4 (0.9)	36.1 (4.8)	20.6 (3.9)	48.0 (4.7)
Obese	38.3 (2.6)	2.0 (0.5)	32.1 (2.6)	14.8 (3.0)	45.6 (4.4)
PIR					
High	50.2 (3.3)	5.0 (1.2)	28.8 (2.3)	28.6 (4.8)	38.7 (2.8)
Middle	32.4 (3.3)[d]	3.9 (1.0)	35.0 (2.0)	11.7 (1.5)[d]	46.7 (2.7)[d]
Low	40.4 (3.4)	4.2 (1.8)	34.9 (3.0)	11.2 (1.8)[d]	53.9 (4.8)[d]

[1]Classification as consumer based on data from a single 24-hr recall.
[a]Significantly different than females.
[b]Significantly different than 12-19 year olds.
[c]Significantly different than non-Hispanic blacks.
[d]Significantly different than high income.

Table 2. Percentage of consumers[1] based on food availability for youth 6-19 years in the United States, 2007-2008

	Percentage of consumers	Percentage of consumers based on food availability categories				
		Always	Most of the time	Sometimes	Rarely	Never
	% (SE)	% (SE)	% (SE)	% (SE)	% (SE)	% (SE)
All youth						
Fruit	41.4 (2.1)	29.9 (1.8)	8.3 (1.1)	1.8 (0.4)	1.0 (0.4)	0.1 (0.1)
Dark green vegetable	4.2 (0.9)	2.9 (0.8)	0.6 (0.2)	0.6 (0.2)	0.0 (0)	0.1 (0.1)
Salty snacks	33.5 (1.8)	16.7 (1.9)	7.4 (0.5)	7.3 (1.0)	1.5 (0.3)	0.4 (0.1)
Fat-free/low-fat milk	16.6 (1.7)	10.5 (1.5)	0.3 (0.2)	0.9 (0.3)	0.6 (0.2)	4.4 (0.7)
Soft drinks	46.1 (2.6)	12.9 (1.6)	1.2 (0.2)	2.2 (0.4)	2.6 (0.6)	26.9 (2.4)

[1]Classification as consumer based on data from a single 24-hr recall.

Table 3. Percentage of total consumers[1] for food availability categories for youth 6-19 years in the United States, 2007-2008

	Percentage of consumers	Percentage of total consumers for food availability categories				
		Always	Most of the time	Sometimes	Rarely	Never
	% (SE)	%	%	%	%	%
All youth						
Fruit	41.4 (2.1)	72.2	20.0	4.3	2.4	0.2
Dark green vegetable	4.2 (0.9)	69.0	14.3	14.3	0.0	2.4
Salty snacks	33.5 (1.8)	49.9	22.1	21.8	4.5	1.2
Fat-free/low-fat milk	16.6 (1.7)	63.3	1.8	5.4	3.6	26.5
Soft drinks	46.1 (2.6)	28.0	2.6	4.8	5.6	58.4

[1]Classification as consumer based on data from a single 24-hr recall.

Table 4. Food availability in homes of youth 6-19 years based on BMI[1] in the United States, 2007-2008

	Normal weight % (SE)	Overweight % (SE)	Obese % (SE)
Fruit availability			
Always	68.8 (2.6)	65.2 (3.2)	65.5 (2.9)
Most of the time	20.2 (1.8)	24.8 (2.7)	24.7 (2.2)
Sometimes	8.5 (1.0)	8.1 (2.1)	7.4 (1.1)
Rarely	2.4 (0.8)	1.7 (0.5)	2.4 (1.5)
Never	0.2 (0.1)	0.2 (0.2)	0.1 (0.1)
Dark green vegetable availability			
Always	56.1 (2.2)	51.9 (4.2)	48.6 (3.5)
Most of the time	24.4 (1.5)	23.9 (3.5)	25.5 (2.3)
Sometimes	13.4 (1.4)	16.0 (2.3)	15.9 (3.3)
Rarely	2.9 (0.4)	3.6 (0.7)	4.8 (2.0)
Never	3.3 (1.1)	4.6 (1.8)	5.1 (1.7)
Salty snack availability			
Always	48.4 (1.8)	44.2 (1.6)	43.0 (4.9)
Most of the time	21.6 (1.6)	21.5 (2.3)	19.4 (3.2)
Sometimes	21.6 (1.8)	25.2 (2.7)	26.3 (3.4)
Rarely	7.1 (1.0)	7.1 (1.3)	8.7 (1.3)
Never	1.3 (0.4)	2.0 (0.9)	2.6 (0.8)
Fat-free/low-fat milk availability			
Always	30.0 (2.1)	32.0 (4.7)	24.8 (3.3)
Most of the time	2.9 (0.7)	3.0 (1.7)	2.2 (0.7)
Sometimes	3.3 (0.8)	3.5 (0.8)	5.8 (1.5)
Rarely	5.6 (1.0)	3.8 (1.5)	3.4 (1.1)
Never	58.2 (1.6)	57.7 (4.8)	63.8 (3.7)
Soft drink availability			
Always	47.9 (2.3)	46.5 (4.9)	48.2 (4.4)
Most of the time	13.3 (1.8)	16.6 (3.2)	15.8 (2.2)
Sometimes	16.7 (1.9)	16.5 (3.3)	14.5 (2.7)
Rarely	14.4 (2.0)	13.3 (2.3)	14.5 (1.5)
Never	7.7 (1.1)	7.1 (1.4)	7.1 (1.6)

[1]BMI categories: normal weight = 5^{th} - $<85^{th}$ percentiles, overweight = 85^{th} - $<95^{th}$ percentiles, obese = $\geq 95^{th}$ percentile

No significant differences between BMI categories at $p<0.05$

Table 5. Regression analysis for BMI and Food Availability for youth 6-19 years in the United States, 2007-2008

	Fruit [1]	Dark green vegetables[2]	Salty snacks[2]	Fat-free/low-fat milk[2]	Soft drinks[2]
Variable	P-value	P-value	P-value	P-value	P-value
BMI	0.6820	0.5243	0.2279	0.1726	0.9015

Data are presented as P-value for regression analysis. All analyses adjusted for race-ethnicity and poverty income ratio.

[1]Fruit availability categories used for regression analyses were always, most of the time, sometimes, and rarely (reference category).

[2]Dark green vegetable, salty snack, fat-free/low-fat milk, and soft drink availability categories used for regression analyses were always, most of the time, sometimes, and rarely (reference category).

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Study III:

Relation of obesity with blood lipid levels in US youth, aged 6-19

Relation of obesity with blood lipid levels in US youth, aged 6-19

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Abstract

Background: Adverse lipid concentrations are related to measures of body fatness and body mass index (BMI) and may increase atherosclerosis development in youth. BMI is an indirect measure of body fat and may inadequately predict risk for adverse lipid concentrations in youth.

Objective: The purpose of this analysis was to examine the relation between obesity, measured by BMI and skinfold thicknesses, and adverse lipid concentrations using data from the National Health and Nutrition Examination Survey among youth ages 6-19 years in 2007-2010 (n=3834).

Methods: Prevalence of adverse total cholesterol, HDL cholesterol, LDL cholesterol and triglyceride levels were measured according to BMI categories (normal weight, overweight, obese). Mean levels of lipid concentrations were also measured according to BMI categories. Associations between lipid concentrations and BMI, triceps skinfold thickness, and subscapular skinfold thickness were examined.

Results: Prevalence of adverse total and HDL cholesterol were significantly greater in obese youth compared to normal weight youth ($p<0.05$). No difference in the prevalence of high LDL cholesterol or triglycerides was found between BMI categories. Overweight and obese youth had significantly higher mean levels of total cholesterol ($p<0.05$) and significantly lower mean levels of HDL cholesterol levels ($p<0.05$). Obese youth also had significantly higher mean levels of LDL cholesterol and triglyceride levels compared to normal weight youth ($p<0.05$). In multiple linear regressions adjusted for age and race-ethnicity, several significant associations were found between skinfold thicknesses and lipid concentrations and a single significant association was found between BMI and HDL cholesterol levels. Variations in the relationship between BMI or skinfold thickenesses and adverse lipid concentrations were found when stratified for gender, race-ethnicity, and age groups.

Conclusions: BMI is associated with an increased prevalence of adverse lipid concentrations in youth. However, skinfold thicknesses may be a strong predictor in determining youth at risk for cardiovascular disease.

Introduction

Atherosclerosis is believed to begin in childhood and progress slowly into adulthood being influenced by several factors including excess weight (1, 2). Adverse lipid concentrations in childhood and adolescence is a second factor that may contribute to the development of atherosclerosis (3-6). Several studies have reported an association between excess body fat, defined by BMI, in youth and adverse lipid concentrations (7-11). As increasing rates of childhood obesity occur, it is possible that atherosclerosis is increasing in youth due to the apparent associations between BMI and adverse lipid concentrations.

The American Academy of Pediatrics (AAP) states that youth with a BMI $\geq 95^{th}$ percentile, based on the 2000 CDC BMI-for-age charts, belong to a special category of children and are in need of cholesterol screening regardless of family history or other risk factors (12). Additionally, AAP recommends that children ≥ 8 years old with risk factors for cardiovascular disease (including BMI $\geq 95^{th}$ percentile) and an LDL concentration consistently ≥ 160 mg/dL despite diet therapy, receive pharmacologic treatment. Due to the use of BMI as a means to measure the need for cholesterol screening and pharmacologic treatment, a strong research base is needed that examines the associations between BMI and adverse lipid concentrations in both children and adolescents.

Studies examining the association of BMI with adverse lipid concentrations in nationally representative samples of youth are contradictory (7, 13). Controversy over the use of BMI as a measure of excess body fat exists. BMI, a measure of body mass, fails to distinguish between fat and lean mass (14), however, children with a BMI-for-age $\geq 95^{th}$

percentile are likely to have excess body fat (15, 16). Due to this limitation of BMI as well as the use of BMI to define the need for cholesterol screenings, more studies examining the relationship between BMI and adverse lipid concentrations in a nationally representative sample of youth are needed. In addition, there is a lack of studies examining this relationship in a nationally representative sample of youth less than 8 years of age.

Measures of body fat percentage may more precisely predict adverse lipid concentrations in youth. Lamb et al. (17) found significant associations between body fat percentage, measured by dual X-ray absorptiometry (DXA), and adverse lipid concentrations in a nationally representative sample of youth aged 8-19 years. Skinfold thickness measurements are strongly associated with body fatness (18-21) and may be a more cost effective measure of body fat percentage for youth screening. However, few studies have examined the relationship between skinfold thicknesses and adverse lipid concentrations and no studies have examined this relationship in a nationally representative sample of youth less than 8 years of age.

Therefore, the purpose of this study was to examine the prevalence of adverse lipid concentrations and mean levels of lipid values based on BMI categories stratified for gender, race-ethnicity, and age groups. Finally, associations between lipid concentrations and BMI, subscapular skinfold thickness, and triceps skinfold thickness were assessed.

Subjects and Methods

Data and Variables

Data from the 2005-2008 NHANES conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention was utilized for this study (Centers for Disease Control and Prevention). NHANES is a complex, stratified, multistage probability cluster sampling design that provides data representative of the U.S. civilian noninstitutionalized population and includes a home interview and standardized physical examination at a mobile examination center. Details regarding the survey design, content, operations, and procedures are available online (22).

The NHANES 2005-2008 sample consisted of 5096 participants aged 6-19 years of age, 4957 of whom were interviewed and examined. Demographic, Laboratory Measures, and Body Measures data from NHANES were utilized for analyses. Individuals with missing data for laboratory or body measures were excluded from the study (n=1123) resulting in a total analysis sample of 3834. Of the 3834 participants in the total analysis sample, 825 participants aged 12-19 years reported that they had fasted for 8.5-23 hours before phlebotomy in the morning examination. Fasting LDL and triglyceride values were available for these 825 youth.

Demographic data

NHANES Demographic Questionnaire data were obtained in the home and were used to assess the distribution of demographic information in the youth population. The household interview was conducted in-person with a trained interviewer. Participants 16 years of age and older were interviewed directly and a proxy respondent provided information for survey participants less than 16 years of age. NHANES demographic variables used in the current study included age, gender, and race-ethnicity.

Race-ethnicity were self-reported and categorized as non-Hispanic white, non-Hispanic black, Mexican American, other Hispanics, and other. Race-ethnicity categories used in this study include non-Hispanic white, non-Hispanic black, and Hispanic (includes Mexican American and other Hispanics). The "other" category included Asian and multiracial participants and was used in total estimates in this study but did not have a large enough sample size for separate analysis.

Body Measurement data

NHANES body measurements were collected at a mobile examination center according to examination protocols. The body measurements used in the present study included weight, height, subscapular skinfold, and triceps skinfold, each of which was measured between 3 and 10 repeated standard measures. Weight was measured using a Toledo digital scale and was calculated in pounds then converted to kilograms via the automated system. Standing height was measured using a fixed stadiometer with a vertical backboard and a moveable headboard. Body mass index was calculated as body weight, in kilograms, divided by height, in meters squared (kg/m^2). The percentile of BMI-for-age was calculated for male and female youth using the Centers for Disease Control and Prevention (CDC) growth charts (23; Appendices A-2 and A-3). Normal weight was defined as a 5th to < 85^{th} percentiles, overweight as 85^{th} to < 95^{th} percentiles, and obese as $\geq 95^{th}$ percentile. Subscapular and triceps skinfold thicknesses were measured to the nearest 0.1 millimeter using a calibrated Holtain skinfold calipers and were utilized in regression analyses in this study.

Laboratory Measures data and adverse lipid concentration definitions

Total cholesterol, HDL cholesterol, LDL cholesterol, and triglyceride values were utilized in this study. Total cholesterol, HDL cholesterol, and triglycerides were measured in serum for NHANES participants 3 years of age and older. LDL cholesterol was calculated using Friedewald's equation for participants with triglyceride levels ≤ 400 mg/dL (22). Fasting triglyceride and LDL cholesterol values were available only for participants aged ≥ 12 years who had fasted for 8.5-23 hours prior to the morning examination (22). Children less than 12 years of age were not asked to fast. Adverse lipid concentrations were defined as follows: total cholesterol > 200 mg/dL, HDL cholesterol < 35 mg/dL, LDL cholesterol > 130 mg/dL, and triglycerides > 150 mg/dL (4, 24).

Statistical Analysis

Data were analyzed with SAS version 9.2 (SAS Institute). All analyses followed NHANES data analysis protocol including the use of sample weights to account for unequal probability of selection from over-sampling, nonresponse, and for the stratified multistage probability sample design. Standard errors were estimated using Taylor series linearization (22).

Differences in the prevalence of adverse lipid concentrations between normal weight, overweight, and obese youth according to BMI, were estimated for gender, race-ethnicity (non-Hispanic white, non-Hispanic black, and Hispanic), and age groups (6-11 and 12-19). Mean levels of lipid concentrations were calculated and differences in mean values between BMI categories were estimated by gender, race-ethnicity, and age groups. To test differences in the prevalence of adverse lipid concentrations and mean levels of lipid concentrations, a Student's *t* statistic was utilized. To examine the relation between body fat percentage (defined by BMI, subscapular, and triceps skinfold measurements) and lipid concentrations, multiple linear regression analyses adjusted for age, gender, and race-ethnicity were used. Gender, age, and race-ethnicity specific multiple linear regression analyses were also conducted. Gender specific analyses were adjusted for age and race-ethnicity, age specific analyses for gender and race-ethnicity, and race-ethnicity specific analyses for gender and age. Significance for all analyses was set at $p<0.05$.

Results

Prevalence of adverse lipid concentrations

Prevalences of adverse lipid concentrations based on BMI for the total sample and for gender, race-ethnicity, and age specific groups are found in Table 1. For the total sample, prevalences of high total cholesterol and low HDL cholesterol were significantly greater in obese youth compared to normal weight youth ($p<0.05$). No difference in the prevalence of high LDL cholesterol or triglycerides was found between BMI categories for the total sample. Overweight and obese male youth had a significantly higher prevalence of adverse total and HDL cholesterol levels compared to normal weight youth ($p<0.05$). For female youth, a significantly higher prevalence of adverse total and HDL cholesterol compared to normal weight females was found for obese ($p<0.05$) but not overweight females. Non-Hispanic white and Hispanic obese youth had a significantly higher prevalence of adverse total and HDL cholesterol levels compared to normal weight youth ($p<0.05$). Similar differences were found for 6-11 year olds. No significant differences in the prevalence of adverse LDL cholesterol or triglyceride levels were found between BMI categories for any groups, with the exception of Hispanics. Compared to normal weight Hispanics, obese Hispanic youth had a significantly higher prevalence of adverse LDL cholesterol and triglyceride levels ($p<0.05$).

Differences in mean lipid concentrations

Mean lipid concentrations were calculated based on BMI categories for gender, race-ethnicity, and age specific groups (Table 2.3). In the overall sample, overweight and obese youth had significantly higher mean levels of total cholesterol and significantly lower mean levels of HDL cholesterol levels ($p<0.05$). Obese youth also had significantly higher mean levels of LDL cholesterol and triglyceride levels compared to normal weight youth ($p<0.05$). Several significant differences in mean lipid concentrations were found for males based on BMI. Overweight and obese male youth had significantly higher mean levels of total cholesterol and LDL cholesterol as well as lower mean levels of HDL cholesterol compared to normal weight males ($p<0.05$). Few significant differences in mean lipid concentrations were found for females based on BMI. Overweight and obese female youth had a significantly lower mean level of HDL cholesterol compared to normal weight females ($p<0.05$). Likewise, in all three race-ethnic groups and both age groups, HDL cholesterol means were significantly lower in overweight and obese youth

($p<0.05$). The mean total cholesterol concentration in overweight and obese Hispanic youth and youth aged 6-11 was significantly higher compared to normal weight youth.

Associations between measures of body mass or fat mass and lipid concentrations

Multiple linear regression analyses showed that measures of fat mass had stronger associations with lipid concentrations compared to BMI, a measure of body mass (Table 3). BMI was inversely correlated with HDL cholesterol levels ($p=0.007$). Triceps skinfold measurement was positively correlated with total cholesterol and triglycerides and inversely correlated with HDL cholesterol ($p=0.0004$, $p<0.0001$, and $p<0.0001$, respectively). Subscapular skinfold was positively correlated with total cholesterol, LDL cholesterol, and triglycerides and inversely correlated with HDL cholesterol ($p=0.0008$, $p=0.03$, $p<0.0001$, and $p<0.0001$, respectively).

Skinfold measurements were positively associated with total cholesterol and triglycerides in male youth but not female youth (Table 4). Inverse associations between BMI, skinfold measurements, and HDL cholesterol were found for males and females (Table 4). All race-ethnic groups showed positive associations between skinfold measurements and triglycerides and inverse associations between skinfold measurements and HDL cholesterol (Table 4). Positive associations between skinfold thicknesses and total cholesterol were found for Hispanic and non-Hispanic white youth and Hispanic youth showed positive associations between skinfold measurements and triglycerides (Table 4). BMI and skinfold thicknesses were positively associated with total cholesterol and inversely associated with HDL cholesterol in youth aged 6-11. Youth aged 12-19 showed inverse associations between HDL cholesterol and all three measures of body mass or fat mass. Subscapular skinfold was positively correlated with LDL cholesterol and triglycerides. Triceps skinfold was positively correlated with total cholesterol and triglycerides in 12-19 year olds (Table 4).

Discussion

Analyses of a representative sample of U.S. youths indicated that overweight and obese youth have a higher prevalence of adverse lipid concentrations and that the differences in prevalence of adverse lipid concentrations between BMI categories varied by gender, race-ethnicity, and age groups. Similar results were reported by Lamb et al. (17) who examined of the prevalence of adverse lipid concentrations for youth with or without high adiposity, measured by DXA, using NHANES data. Our study also found that mean lipid concentrations differed between BMI categories and that these differences varied by gender, race-ethnicity, and age groups.

Several international studies have examined associations between BMI or body fatness and adverse lipid concentrations (25-30), however, few have examined these relationships in a representatives sample of U.S. youth. Regression analysis results from our study suggest associations between BMI or skinfold thickness, a measure of body fat, and adverse lipid concentrations. These results were consistent with those shown by analyses of NHANES data that examined the association between body fat percentage, measured by DXA, and adverse lipid concentrations (17) and the association between BMI and adverse lipid concentrations (7). Similar to Lamb et al. (17), our study found that associations between body fat or body mass and adverse lipid concentrations varied by gender, race-ethnicity, and age groups.

Skinfold thickness measures were a stronger predictor of adverse lipid concentrations as indicated by more significant associations between skinfold thicknesses and lipid concentrations than between BMI and lipid concentrations in our study. These results are inconsistent with those reported by Freedman et al. (10) who examined the strength of associations between adverse lipid concentrations and skinfold thicknesses and BMI in youth aged 5-17 y participating in the Bogalusa Heart Study reported that BMI was at least as accurate as skinfold thickness sums identifying youth with cardiovascular risk. Both BMI and skinfold thickness measurements have limitations. BMI does not distinguish between lean mass and fat mass, limiting its ability to accurately predict adiposity especially in normal-weight youth (14-16). Accuracy of skinfold thicknesses in predicting adiposity varies according to site selection and measurement errors that occur with increasing degree of adiposity (31).

The AAP recommends fasting lipid profile screening for youth with BMI-for-age $\geq 85^{th}$ percentile on the 2000 CDC growth charts (12). In our study, youth with BMI-for-age $\geq 85^{th}$ percentile showed an increased prevalence of adverse lipid concentrations supporting the recommendation for lipid profile screening in these youth. However, associations between BMI and lipid concentrations were limited, suggesting that more accurate measures of body fatness may assist clinicians in determining youth most at risk for cardiovascular disease.

Strengths of the current study included the use of a large nationally representative sample of youth, and the use of both BMI and skinfold thicknesses in measurements of associations with lipid concentrations. Limitations included the small number of youth that provided fasting blood samples. Second, family history of hypercholesterolemia was not taken into consideration in this analysis. Family history explains a large percentage of variance in adverse lipid concentrations and the inclusion of family history may provide more accurate results (32). Finally, pubertal time periods were not taken into consideration in the analyses in this study. Lipid concentrations and body fat percentages have been reported to change during the pubertal period (33).

Conclusion

The majority of U.S. youth did not have adverse lipid concentrations, regardless of BMI classification. However, an increased prevalence of adverse lipid concentrations was found for youth classified as obese according to BMI and the prevalence varied based on gender, race-ethnicity, and age group. Few significant associations were found between BMI and lipid concentrations, suggesting that direct measures of body fat percentage may provide a stronger prediction of cardiovascular risk in youth. Future research should take into consideration pubertal time periods and family history of hypercholesterolemia when analyzing the relation of body fat with adverse lipid concentrations in youth.

Table 1. Prevalence of adverse lipid concentrations for youth aged 6-19 based on BMI categories estimated for gender, race-ethnicity, and age groups in the United States, 2007-2008

	Total sample	Total cholesterol >200 mg/dL	HDL cholesterol <35 mg/dL	Fasting subsample[1]	LDL cholesterol >130 mg/dL	Triglycerides >150 mg/dL
	n	% ± SE	% ± SE	*n*	% ± SE	% ± SE
Overall						
Normal Weight	2304	5.6 ± 0.6[4]	2.9 ± 0.5	487	6.2 ± 1.4	6.2 ± 1.3
Overweight	644	8.9 ± 1.6	5.7 ± 1.1[2,3]	155	5.0 ± 1.8	7.8 ± 2.5
Obese	876	11.3 ± 1.2[2]	13.8 ± 1.5[2]	183	9.0 ± 2.0	10.5 ± 2.7
Gender						
Male						
Normal Weight	1203	5.4 ± 0.8	2.6 ± 0.6	273	5.0 ± 1.8	6.2 ± 1.8
Overweight	280	11.2 ± 2.2[2]	6.3 ± 1.6[2]	66	6.1 ± 3.1	11.0 ± 4.7
Obese	478	13.1 ± 2.1[2]	15.2 ± 2.0[2,3]	105	10.5 ± 3.2	15.3 ± 4.7
Female						
Normal Weight	1101	5.8 ± 0.9	3.2 ± 0.7	214	7.4 ± 2.0	6.2 ± 2.5
Overweight	364	7.0 ± 1.8	5.2 ± 1.5	89	4.2 ± 2.9	5.3 ± 2.4
Obese	398	9.0 ± 1.5[2]	12.1 ± 2.5[2,3]	78	7.2 ± 2.3	4.6 ± 2.1
Race-ethnicity						
Non-Hispanic white						
Normal Weight	796	5.3 ± 0.9	3.5 ± 0.8	178	6.7 ± 2.1	7.8 ± 1.9
Overweight	175	9.3 ± 2.5	6.0 ± 1.7[2]	41	5.3 ± 2.8	8.0 ± 4.1
Obese	214	12.6 ± 2.3[2]	15.7 ± 2.5[2,3]	50	10.3 ± 3.5	10.1 ± 4.5
Non-Hispanic black						
Normal Weight	500	6.8 ± 1.0	0.4 ± 0.3	98	6.0 ± 2.4	1.0 ± 1.0
Overweight	152	5.9 ± 2.4	0.0 ± 0.0	43	4.9 ± 3.2	6.3 ± 3.5
Obese	213	8.8 ± 2.0	5.8 ± 1.8[2,3]	40	10.3 ± 5.1	1.8 ± 1.8
Hispanic						
Normal Weight	872	5.3 ± 0.8	2.8 ± 0.5	181	2.0 ± 0.9	4.9 ± 1.5
Overweight	286	8.0 ± 1.6	8.9 ± 1.7[2]	64	6.0 ± 2.9	11.1 ± 3.7
Obese	402	9.9 ± 1.3[2]	16.2 ± 2.2[2,3]	86	6.6 ± 1.9[2]	18.6 ± 3.7[2]
Age groups						
6-11 y						
Normal Weight	1209	5.8 ± 0.8	2.2 ± 0.6	NA	NA	NA
Overweight	298	11.0 ± 2.6	2.9 ±1.2[3]	NA	NA	NA
Obese	427	14.3 ± 2.2[2]	12.0 ± 2.0[2]	NA	NA	NA
12-19 y						
Normal Weight	1095	5.5 ± 0.8	3.5 ± 0.7	487	6.2 ± 1.4	6.2 ± 1.3
Overweight	346	7.6 ± 2.1	7.5 ± 2.1[2,3]	155	5.0 ± 1.8	7.8 ± 2.5
Obese	449	9.2 ± 1.9	15.1 ± 2.2[2]	183	9.0 ± 2.0	10.5 ± 2.7

[1]Fasting subsample only for participants aged 12-19 who fasted.
[2]Significantly different than normal weight
[3]Significantly different that obese
[4]Prevalence ± SE (all values).

Table 2. Mean lipid concentrations for youth aged 6-19 based on BMI categories estimated for gender, race-ethnicity, and age groups in the United States, 2007-2008

	Total sample	Total cholesterol	HDL cholesterol	Fasting subsample[1]	LDL cholesterol	Triglycerides
	n	Mean ± SE	Mean ± SE	*n*	Mean ± SE	Mean ± SE
Overall						
Normal Weight	2304	157.2 ± 0.8	55.0 ± 0.4	487	85.2 ± 1.7	78.1 ± 2.6
Overweight	644	160.8 ± 1.4[2]	50.2 ± 0.7[2,3]	155	90.4 ± 2.2	80.8 ± 4.8
Obese	876	163.4 ± 1.4[2]	45.3 ± 0.4[2]	183	95.6 ± 2.1[2]	91.9 ± 4.2[2]
Gender						
Male						
Normal Weight	1203	155.2 ± 0.9	54.9 ± 0.4	273	81.9 ± 1.9	77.9 ± 3.6
Overweight	280	161.8 ± 1.9[2]	49.8 ± 1.0[2,3]	66	92.4 ± 3.3[2]	90.7 ± 7.2
Obese	478	164.1 ± 2.2[2]	44.6 ± 0.5[2]	105	96.6 ± 3.7[2]	100.5 ± 6.6[2]
Female						
Normal Weight	1101	159.3 ± 1.3	55.0 ± 0.5	214	88.5 ± 2.5	78.3 ±5.0
Overweight	364	160.1 ± 2.2	50.5 ± 0.7[2,3]	89	88.9 ± 3.8	73.2 ± 6.1
Obese	398	162.5 ± 1.3	46.2 ± 0.6[2]	78	94.5 ± 2.6	81.4 ± 3.5
Race-ethnicity						
Non-Hispanic white						
Normal Weight	796	156.9 ± 1.2	53.6 ± 0.5	178	85.7 ± 2.6	84.0 ± 3.1
Overweight	175	161.9 ± 2.6	49.1 ± 1.0[2,3]	41	92.4 ± 4.0	76.2 ± 6.5
Obese	214	165.3 ± 2.7[2]	44.9 ± 0.7[2]	50	98.4 ± 3.6[2]	93.5 ± 7.7
Non-Hispanic black						
Normal Weight	500	159.2 ± 1.2	59.6 ± 0.8	98	85.9 ± 2.3	54.1 ± 1.9
Overweight	152	157.4 ± 2.7	56.5 ± 1.2[2,3]	43	88.3 ± 4.0	72.8 ± 6.2[2]
Obese	213	157.6 ± 2.5	47.5 ± 0.8[2]	40	92.6 ± 4.7	67.6 ± 5.2[2]
Hispanic						
Normal Weight	872	155.7 ± 1.0	55.2 ± 0.4	181	83.1 ± 1.2	77.5 ± 3.8
Overweight	286	160.7 ± 1.6[2]	49.4 ± 0.8[2,3]	64	90.3 ± 3.4	96.9 ± 7.6[2]
Obese	402	161.9 ± 1.1[2]	44.0 ± 0.7[2]	86	92.4 ± 2.2[2]	106.7 ± 4.6[2]
Age groups						
6-11 y						
Normal Weight	1209	159.7 ± 1.1	56.1 ± 0.5	NA	NA	NA
Overweight	298	163.6 ± 1.6[2]	51.9 ± 0.8[2,3]	NA	NA	NA
Obese	427	167.5 ± 1.8[2]	46.5 ± 0.7[2]	NA	NA	NA
12-19 y						
Normal Weight	1095	155.3 ± 1.1	54.1 ± 0.5	487	85.2 ± 1.7	78.1 ± 2.6
Overweight	346	159.1 ± 2.1	49.2 ± 0.9[2,3]	155	90.4 ± 2.2	80.8 ± 4.8
Obese	449	160.5 ± 2.1[2]	44.4 ± 0.6[2]	183	95.6 ± 2.1[2]	91.9 ± 4.2[2]

[1]Fasting subsample only for participants aged 12-19 who fasted.
[2]Significantly different than normal weight
[3]Significantly different that obese
[4]Prevalence ± SE (all values).

Table 3. Associations between measures of body mass or fat mass (defined by BMI, subscapular skinfold, or triceps skinfold) and lipid concentrations for youth 6-19 years in the United States, 2007-2008

	BMI			Subscapular skinfold			Triceps skinfold		
	β	SE	*P*	β	SE	*P*	β	SE	*P*
Total cholesterol	0.01	0.03	0.72	0.34	0.10	**0.0008**	0.39	0.10	**0.0004**
HDL cholesterol	-0.11	0.02	**0.0007**	-0.57	0.04	**<0.0001**	-0.46	0.04	**<0.0001**
LDL cholesterol	0.04	0.06	0.49	0.47	0.21	**0.03**	0.30	0.20	0.14
Triglycerides	0.07	0.08	0.42	1.2	0.2	**<0.0001**	1.3	0.3	**<0.0001**

Table 4. Gender, race-ethnicity, and age group specific associations between measures of body mass or fat mass (defined by BMI, subscapular skinfold, or triceps skinfold) and lipid concentrations for youth 6-19 years in the United States, 2007-2008

	BMI			Subscapular skinfold			Triceps skinfold		
	β	SE	*P*	β	SE	*P*	β	SE	*P*
Gender									
Male									
Total cholesterol	0.01	0.03	0.84	0.55	0.16	**0.002**	0.50	0.17	**0.007**
HDL cholesterol	-0.06	0.02	**0.005**	-0.66	0.04	**<0.0001**	-0.53	0.05	**<0.0001**
LDL cholesterol	0.02	0.05	0.68	0.59	0.31	0.07	0.42	0.29	0.15
Triglycerides	0.03	0.07	0.66	1.80	0.38	**<0.0001**	1.80	0.40	**0.0001**
Female									
Total cholesterol	0.10	0.17	0.53	0.17	0.11	0.17	0.23	0.12	0.06
HDL cholesterol	-0.81	0.06	**<0.0001**	-0.52	0.05	**<0.0001**	-0.50	0.06	**<0.0001**
LDL cholesterol	0.42	0.42	0.32	0.37	0.30	0.22	0.20	0.29	0.48
Triglycerides	0.94	0.51	0.08	0.60	0.36	0.09	0.80	0.42	0.07
Race-ethnicity									
Non-Hispanic white									
Total cholesterol	-0.00	0.04	0.95	0.41	0.16	**0.01**	0.48	0.17	**0.009**
HDL cholesterol	-0.08	0.03	**0.02**	-0.54	0.06	**<0.0001**	-0.38	0.06	**<0.0001**
LDL cholesterol	0.03	0.08	0.70	0.47	0.34	0.17	0.21	0.32	0.51
Triglycerides	-0.00	0.09	0.95	0.88	0.38	**0.03**	1.17	0.45	**0.01**
Non-Hispanic black									
Total cholesterol	-0.05	0.11	0.64	-0.05	0.20	0.80	0.06	0.19	0.77
HDL cholesterol	-0.39	0.20	0.06	-0.66	0.06	**<0.0001**	-0.61	0.05	**<0.0001**
LDL cholesterol	0.02	0.10	0.81	0.41	0.33	0.23	0.57	0.41	0.17
Triglycerides	0.10	0.20	0.64	1.0	0.32	**0.003**	1.12	0.30	**0.0006**
Hispanic									
Total cholesterol	0.04	0.05	0.50	0.39	0.10	**0.0005**	0.37	0.10	**0.0008**
HDL cholesterol	-0.11	0.04	**0.005**	-0.61	0.05	**<0.0001**	-0.54	0.05	**<0.0001**
LDL cholesterol	0.06	0.08	0.41	0.53	0.15	**0.001**	0.46	0.14	**0.002**
Triglycerides	0.28	0.17	0.11	1.94	0.31	**<0.0001**	1.50	0.34	**<0.0001**
Age groups									
6-11									
Total cholesterol	0.69	0.20	**0.001**	0.56	0.12	**<0.0001**	0.59	0.14	**0.0003**
HDL cholesterol	-1.08	0.07	**<0.0001**	-0.66	0.05	**<0.0001**	-0.58	0.05	**<0.0001**
LDL cholesterol	NA	NA	NA	NA	NA	NA	NA	NA	NA
Triglycerides	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-19									
Total cholesterol	0.01	0.03	0.66	0.25	0.13	0.07	0.29	0.13	**0.04**
HDL cholesterol	-0.07	0.02	**0.004**	-0.56	0.05	**<0.0001**	-0.48	0.05	**<0.0001**
LDL cholesterol	0.04	0.06	0.49	0.47	0.21	**0.03**	0.30	0.20	0.14
Triglycerides	0.07	0.08	0.42	1.15	0.23	**<0.0001**	1.28	0.27	**<0.0001**

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Appendix

Appendix A-1

NHANES Consumer Behavior Questionnaire variables[1]

Question	Additional Details
1. How often (does your family/do you) have fruits available at home?	Included fresh, dried, canned, and frozen fruits 5-point scaled answer (Always, Most of the time, Sometimes, Rarely, Never)
2. How often (does your family/do you) have any of these dark green vegetables available at home?	Included fresh, dried, canned, and frozen vegetables 5-point scaled answer (Always, Most of the time, Sometimes, Rarely, Never) Use of hand card showing a list of dark green vegetables
3. How often (does your family/do you) have salty snacks such as chips and crackers available at home?	Not to include nuts 5-point scaled answer (Always, Most of the time, Sometimes, Rarely, Never)
4. How often (does your family/do you) have 1% fat, skim or fat-free milk available at home?	Not to include 2% milk 5-point scaled answer (Always, Most of the time, Sometimes, Rarely, Never)
5. How often (does your family/do you) have soft drinks, fruit-flavored drinks, or fruit punch available at home?	Not to include diet drinks, 100% juice, or sports drinks 5-point scaled answer (Always, Most of the time, Sometimes, Rarely, Never)
6. During the past 30 days, how much money (did your family/did you) spend at supermarkets or grocery stores?	Included purchases made with food stamps Answer presented in dollars/30 days
7. During the past 30 days, how much money (did your family/did you) spend on eating out?	Included money spent in cafeterias at work or at school or on vending machines, for all family members Answer presented in dollars/30 days
8. During the past 30 days, how much money (did your family/did you) spend on food carried out or delivered?	Not to include money already allocated in a previous question Answer presented in dollars/30 days
9. During the past 7 days, how many times did (you or someone else in your family/you) cook food for dinner or supper at home?	Answer presented in number of times/7 days
10. During the past 7 days, how many meals did all or most of your family sit down and eat together at home?	Answer presented in number of times/7 days
11. How many of these meals were cooked at home?	Reference to previous question Answer presented in number of meals

[1]Questions 1-5 are food availability questions. Questions 6-11 are family food characteristic questions.

Appendix A-2

Centers for Disease Control and Prevention Body Mass Index for Age (in months) Tables

Body Mass Index, or BMI, is calculated using the following formula:
BMI = Weight (in kilograms)/Height (in meters)^2

Male Children, Ages 2-20 years

Age (in months)	3rd Percentile BMI Value	5th Percentile BMI Value	10th Percentile BMI Value	25th Percentile BMI Value	50th Percentile BMI Value	75th Percentile BMI Value	85th Percentile BMI Value	90th Percentile BMI Value	95th Percentile BMI Value	97th Percentile BMI Value
24	14.52095	14.73732	15.09033	15.74164	16.57503	17.55719	18.16219	18.60948	19.33801	19.85986
24.5	14.50348	14.71929	15.07117	15.71963	16.54777	17.52129	18.11955	18.56111	19.2789	19.79194
25.5	14.46882	14.68361	15.03336	15.67634	16.49443	17.45135	18.03668	18.4673	19.16466	19.66102
26.5	14.4346	14.64843	14.9962	15.63403	16.4426	17.38384	17.957	18.37736	19.05567	19.53658
27.5	14.40083	14.61379	14.95969	15.59268	16.39224	17.31871	17.88047	18.29125	18.95187	19.41849
28.5	14.36755	14.57969	14.92385	15.55226	16.34334	17.25593	17.80704	18.20892	18.85317	19.30665
29.5	14.33478	14.54615	14.88866	15.51275	16.29584	17.19546	17.73667	18.13031	18.75949	19.20097
30.5	14.30257	14.51319	14.85414	15.47414	16.24972	17.13726	17.66932	18.05538	18.67078	19.10132
31.5	14.27093	14.48084	14.82027	15.43639	16.20495	17.0813	17.60495	17.98408	18.58695	19.00761
32.5	14.23989	14.44909	14.78707	15.39951	16.1615	17.02753	17.54351	17.91635	18.50792	18.91973
33.5	14.20948	14.41798	14.75453	15.36345	16.11933	16.97592	17.48496	17.85215	18.43363	18.83758
34.5	14.17972	14.3875	14.72264	15.32822	16.07843	16.92645	17.42927	17.79143	18.364	18.76106
35.5	14.15063	14.35767	14.69142	15.29379	16.03876	16.87907	17.37639	17.73414	18.29895	18.69006
36.5	14.12223	14.32851	14.66086	15.26016	16.0003	16.83376	17.32627	17.68022	18.23842	18.62449
37.5	14.09453	14.30002	14.63096	15.22731	15.96304	16.79048	17.27889	17.62963	18.18231	18.56425
38.5	14.06756	14.27222	14.60173	15.19523	15.92695	16.7492	17.23419	17.58231	18.13057	18.50924
39.5	14.04132	14.2451	14.57316	15.16392	15.89203	16.70988	17.19213	17.5382	18.08311	18.45938
40.5	14.01582	14.21868	14.54527	15.13337	15.85824	16.67251	17.15266	17.49725	18.03986	18.41456
41.5	13.99107	14.19297	14.51805	15.10359	15.82559	16.63704	17.11575	17.45941	18.00074	18.37469
42.5	13.96707	14.16796	14.49151	15.07458	15.79406	16.60345	17.08135	17.42462	17.96568	18.33969
43.5	13.94383	14.14367	14.46566	15.04633	15.76364	16.5717	17.04941	17.39282	17.93459	18.30947
44.5	13.92133	14.12009	14.4405	15.01886	15.73434	16.54177	17.01988	17.36395	17.90741	18.28393
45.5	13.89959	14.09723	14.41604	14.99218	15.70614	16.51364	16.99272	17.33795	17.88405	18.263
46.5	13.87858	14.07509	14.39229	14.96629	15.67904	16.48726	16.96789	17.31477	17.86444	18.24658
47.5	13.85832	14.05366	14.36926	14.9412	15.65305	16.46262	16.94533	17.29434	17.8485	18.23459
48.5	13.83877	14.03296	14.34695	14.91694	15.62817	16.4397	16.92501	17.27661	17.83614	18.22694
49.5	13.81995	14.01296	14.32537	14.89351	15.60441	16.41846	16.90688	17.26151	17.8273	18.22354
50.5	13.80182	13.99367	14.30453	14.87093	15.58176	16.39889	16.89089	17.24899	17.82189	18.22431
51.5	13.78439	13.97509	14.28444	14.84921	15.56025	16.38097	16.87701	17.23899	17.81983	18.22915
52.5	13.76763	13.95722	14.2651	14.82838	15.53987	16.36468	16.86519	17.23145	17.82104	18.23799

53.5	13.75152	13.94003	14.24651	14.80844	15.52065	16.35001	16.8554	17.22632	17.82544	18.25071
54.5	13.73606	13.92353	14.22868	14.78941	15.50258	16.33693	16.8476	17.22354	17.83295	18.26725
55.5	13.72123	13.90771	14.21162	14.7713	15.48569	16.32545	16.84176	17.22306	17.84349	18.2875
56.5	13.70702	13.89257	14.19532	14.75414	15.46998	16.31554	16.83784	17.22483	17.85699	18.31136
57.5	13.6934	13.87809	14.17979	14.73792	15.45546	16.3072	16.8358	17.2288	17.87335	18.33875
58.5	13.68036	13.86426	14.16503	14.72266	15.44214	16.30042	16.83563	17.23493	17.89252	18.36957
59.5	13.6679	13.85108	14.15103	14.70836	15.43003	16.29518	16.83729	17.24315	17.9144	18.40373
60.5	13.656	13.83855	14.1378	14.69504	15.41914	16.29148	16.84076	17.25344	17.93893	18.44112
61.5	13.64464	13.82665	14.12534	14.68269	15.40947	16.28932	16.846	17.26575	17.96602	18.48166
62.5	13.63383	13.81537	14.11363	14.67133	15.40103	16.28868	16.853	17.28003	17.99562	18.52525
63.5	13.62355	13.80472	14.10268	14.66094	15.39382	16.28955	16.86173	17.29625	18.02764	18.57179
64.5	13.61379	13.79469	14.09249	14.65154	15.38783	16.29192	16.87217	17.31437	18.06201	18.6212
65.5	13.60456	13.78527	14.08305	14.64312	15.38307	16.29578	16.88428	17.33435	18.09868	18.67337
66.5	13.59584	13.77646	14.07436	14.63567	15.37953	16.30113	16.89805	17.35616	18.13758	18.72823
67.5	13.58764	13.76825	14.06642	14.6292	15.37721	16.30794	16.91346	17.37975	18.17863	18.78569
68.5	13.57996	13.76065	14.05921	14.62369	15.37609	16.3162	16.93048	17.4051	18.22179	18.84564
69.5	13.57278	13.75364	14.05274	14.61914	15.37618	16.3259	16.94909	17.43217	18.26698	18.90802
70.5	13.56612	13.74724	14.04701	14.61555	15.37745	16.33702	16.96925	17.46092	18.31416	18.97273
71.5	13.55998	13.74144	14.042	14.6129	15.37991	16.34955	16.99096	17.49133	18.36325	19.03969
72.5	13.55435	13.73624	14.03772	14.6112	15.38353	16.36346	17.01418	17.52335	18.41421	19.10882
73.5	13.54925	13.73164	14.03417	14.61042	15.38831	16.37875	17.03888	17.55696	18.46699	19.18005
74.5	13.54467	13.72764	14.03134	14.61057	15.39423	16.39537	17.06505	17.59212	18.52152	19.25329
75.5	13.54062	13.72424	14.02922	14.61163	15.40127	16.41333	17.09265	17.6288	18.57775	19.32847
76.5	13.5371	13.72145	14.02783	14.61359	15.40943	16.4326	17.12166	17.66696	18.63564	19.40551
77.5	13.53412	13.71927	14.02714	14.61645	15.41869	16.45315	17.15206	17.70658	18.69513	19.48434
78.5	13.53168	13.71769	14.02717	14.6202	15.42902	16.47496	17.1838	17.74762	18.75617	19.5649
79.5	13.5298	13.71672	14.02791	14.62483	15.44042	16.49801	17.21688	17.79004	18.81872	19.6471
80.5	13.52846	13.71637	14.02935	14.63032	15.45288	16.52229	17.25126	17.83382	18.88272	19.73089
81.5	13.52768	13.71663	14.0315	14.63668	15.46636	16.54776	17.28691	17.87892	18.94814	19.81619
82.5	13.52747	13.71751	14.03435	14.64389	15.48087	16.5744	17.3238	17.92532	19.01491	19.90294
83.5	13.52782	13.71901	14.03791	14.65194	15.49637	16.60219	17.36192	17.97296	19.083	19.99107
84.5	13.52874	13.72113	14.04216	14.66082	15.51287	16.63112	17.40122	18.02183	19.15236	20.08052
85.5	13.53025	13.72387	14.04711	14.67054	15.53034	16.66114	17.44168	18.0719	19.22295	20.17123
86.5	13.53233	13.72724	14.05276	14.68107	15.54876	16.69225	17.48329	18.12312	19.29471	20.26314
87.5	13.535	13.73124	14.0591	14.69241	15.56812	16.72442	17.52599	18.17548	19.36761	20.35618
88.5	13.53826	13.73587	14.06613	14.70455	15.58841	16.75763	17.56978	18.22893	19.44161	20.45031
89.5	13.54212	13.74113	14.07386	14.71749	15.60961	16.79185	17.61462	18.28344	19.51666	20.54545
90.5	13.54657	13.74702	14.08228	14.73121	15.63171	16.82707	17.66049	18.33899	19.59272	20.64155
91.5	13.55163	13.75355	14.09138	14.74571	15.65469	16.86325	17.70736	18.39554	19.66974	20.73856
92.5	13.55729	13.76071	14.10116	14.76099	15.67853	16.90039	17.7552	18.45306	19.74769	20.83643
93.5	13.56356	13.76852	14.11163	14.77703	15.70323	16.93845	17.80398	18.51152	19.82652	20.93509
94.5	13.57044	13.77695	14.12279	14.79382	15.72877	16.97742	17.85369	18.57089	19.9062	21.03449

95.5	13.57793	13.78603	14.13462	14.81136	15.75513	17.01727	17.90429	18.63115	19.98668	21.13459
96.5	13.58604	13.79575	14.14712	14.82965	15.78231	17.05799	17.95575	18.69225	20.06793	21.23532
97.5	13.59477	13.8061	14.1603	14.84867	15.81029	17.09955	18.00807	18.75418	20.1499	21.33665
98.5	13.60411	13.8171	14.17416	14.86841	15.83905	17.14193	18.0612	18.8169	20.23256	21.43852
99.5	13.61408	13.82873	14.18868	14.88888	15.86858	17.18512	18.11512	18.88038	20.31587	21.54088
100.5	13.62467	13.84101	14.20387	14.91006	15.89888	17.22909	18.16981	18.94459	20.39979	21.64368
101.5	13.63588	13.85392	14.21972	14.93194	15.92992	17.27383	18.22525	19.00952	20.48429	21.74689
102.5	13.64771	13.86747	14.23624	14.95453	15.96169	17.31932	18.28141	19.07512	20.56933	21.85044
103.5	13.66017	13.88166	14.25341	14.9778	15.99419	17.36552	18.33827	19.14137	20.65487	21.9543
104.5	13.67325	13.89648	14.27124	15.00176	16.02741	17.41244	18.3958	19.20825	20.74089	22.05842
105.5	13.68696	13.91194	14.28972	15.0264	16.06132	17.46005	18.45398	19.27573	20.82733	22.16276
106.5	13.70129	13.92804	14.30884	15.05172	16.09591	17.50833	18.5128	19.34378	20.91417	22.26727
107.5	13.71624	13.94476	14.32862	15.07769	16.13119	17.55726	18.57222	19.41238	21.00138	22.37192
108.5	13.73182	13.96212	14.34903	15.10433	16.16712	17.60683	18.63222	19.48149	21.08893	22.47666
109.5	13.74801	13.9801	14.37008	15.13161	16.20371	17.65702	18.69279	19.5511	21.17677	22.58145
110.5	13.76483	13.99871	14.39177	15.15954	16.24094	17.7078	18.7539	19.62118	21.26488	22.68625
111.5	13.78227	14.01795	14.41409	15.1881	16.2788	17.75918	18.81554	19.69171	21.35323	22.79103
112.5	13.80033	14.0378	14.43703	15.2173	16.31728	17.81112	18.87767	19.76266	21.44178	22.89575
113.5	13.819	14.05828	14.46059	15.24712	16.35637	17.86361	18.94028	19.83401	21.53051	23.00036
114.5	13.83828	14.07937	14.48478	15.27755	16.39606	17.91664	19.00336	19.90573	21.61938	23.10484
115.5	13.85818	14.10107	14.50957	15.30859	16.43633	17.9702	19.06688	19.97781	21.70837	23.20915
116.5	13.87868	14.12338	14.53498	15.34024	16.47718	18.02425	19.13081	20.05021	21.79745	23.31326
117.5	13.89979	14.1463	14.56099	15.37248	16.5186	18.07879	19.19516	20.12292	21.88659	23.41712
118.5	13.92151	14.16982	14.5876	15.40531	16.56057	18.13381	19.25988	20.19592	21.97576	23.52071
119.5	13.94382	14.19394	14.61481	15.43872	16.60309	18.18929	19.32497	20.26919	22.06494	23.624
120.5	13.96673	14.21866	14.6426	15.4727	16.64614	18.24521	19.39041	20.3427	22.15409	23.72696
121.5	13.99024	14.24396	14.67098	15.50725	16.68972	18.30156	19.45618	20.41643	22.2432	23.82955
122.5	14.01433	14.26985	14.69994	15.54236	16.73381	18.35833	19.52226	20.49036	22.33224	23.93175
123.5	14.03901	14.29633	14.72948	15.57803	16.7784	18.4155	19.58864	20.56448	22.42118	24.03353
124.5	14.06427	14.32338	14.75958	15.61424	16.8235	18.47306	19.6553	20.63877	22.51	24.13486
125.5	14.09011	14.35101	14.79025	15.65099	16.86907	18.53099	19.72222	20.7132	22.59868	24.23571
126.5	14.11653	14.3792	14.82148	15.68826	16.91512	18.58928	19.78938	20.78775	22.68719	24.33606
127.5	14.14351	14.40796	14.85326	15.72607	16.96164	18.64792	19.85678	20.86242	22.77551	24.43589
128.5	14.17106	14.43727	14.88558	15.76439	17.00862	18.70689	19.92439	20.93718	22.86363	24.53516
129.5	14.19916	14.46714	14.91845	15.80322	17.05604	18.76619	19.9922	21.01201	22.95151	24.63386
130.5	14.22782	14.49756	14.95184	15.84255	17.1039	18.82579	20.06019	21.0869	23.03915	24.73197
131.5	14.25703	14.52852	14.98577	15.88237	17.15218	18.8857	20.12835	21.16183	23.12651	24.82945
132.5	14.28678	14.56001	15.02022	15.92268	17.20089	18.94588	20.19667	21.23679	23.21358	24.9263
133.5	14.31707	14.59203	15.05519	15.96347	17.25	19.00634	20.26514	21.31175	23.30035	25.02249
134.5	14.34789	14.62458	15.09066	16.00473	17.29951	19.06706	20.33373	21.38671	23.38679	25.11801
135.5	14.37924	14.65765	15.12664	16.04646	17.34942	19.12803	20.40243	21.46165	23.47289	25.21283
136.5	14.41111	14.69122	15.16311	16.08864	17.3997	19.18924	20.47124	21.53655	23.55863	25.30693

137.5	14.44349	14.72531	15.20007	16.13127	17.45036	19.25067	20.54013	21.61141	23.644	25.40031
138.5	14.47638	14.75989	15.23751	16.17434	17.50138	19.31232	20.6091	21.6862	23.72897	25.49294
139.5	14.50977	14.79496	15.27543	16.21784	17.55276	19.37417	20.67814	21.76091	23.81354	25.58481
140.5	14.54365	14.83052	15.31381	16.26177	17.60448	19.43622	20.74722	21.83554	23.89769	25.67591
141.5	14.57802	14.86655	15.35265	16.30612	17.65653	19.49845	20.81635	21.91006	23.98141	25.76623
142.5	14.61287	14.90306	15.39195	16.35087	17.70892	19.56086	20.88551	21.98447	24.06469	25.85575
143.5	14.64819	14.94002	15.43169	16.39603	17.76162	19.62342	20.95468	22.05876	24.1475	25.94446
144.5	14.68398	14.97745	15.47187	16.44158	17.81463	19.68614	21.02386	22.1329	24.22985	26.03234
145.5	14.72022	15.01532	15.51248	16.48751	17.86795	19.74901	21.09304	22.2069	24.31172	26.11941
146.5	14.75692	15.05363	15.5535	16.53382	17.92155	19.812	21.1622	22.28075	24.3931	26.20563
147.5	14.79406	15.09238	15.59495	16.5805	17.97544	19.87512	21.23134	22.35442	24.47397	26.29101
148.5	14.83163	15.13155	15.6368	16.62754	18.02961	19.93836	21.30045	22.42791	24.55434	26.37553
149.5	14.86963	15.17113	15.67904	16.67494	18.08404	20.0017	21.36951	22.50122	24.6342	26.4592
150.5	14.90804	15.21113	15.72168	16.72267	18.13873	20.06514	21.43852	22.57433	24.71352	26.54201
151.5	14.94687	15.25152	15.7647	16.77074	18.19367	20.12866	21.50748	22.64724	24.79232	26.62395
152.5	14.98609	15.2923	15.80809	16.81914	18.24884	20.19227	21.57636	22.71993	24.87058	26.70501
153.5	15.02571	15.33347	15.85184	16.86786	18.30426	20.25594	21.64517	22.7924	24.94829	26.78521
154.5	15.06571	15.37501	15.89595	16.91689	18.35989	20.31968	21.71389	22.86465	25.02545	26.86453
155.5	15.10609	15.41692	15.94041	16.96621	18.41574	20.38347	21.78252	22.93666	25.10206	26.94297
156.5	15.14683	15.45918	15.9852	17.01583	18.4718	20.44731	21.85104	23.00842	25.17811	27.02054
157.5	15.18793	15.50179	16.03032	17.06574	18.52805	20.51119	21.91946	23.07994	25.2536	27.09724
158.5	15.22938	15.54474	16.07576	17.11592	18.5845	20.5751	21.98777	23.15121	25.32853	27.17307
159.5	15.27116	15.58801	16.12151	17.16636	18.64113	20.63903	22.05596	23.22221	25.40289	27.24802
160.5	15.31327	15.63161	16.16756	17.21706	18.69793	20.70298	22.12402	23.29295	25.47668	27.32211
161.5	15.3557	15.67551	16.21391	17.26801	18.75489	20.76694	22.19194	23.36342	25.5499	27.39534
162.5	15.39843	15.71971	16.26054	17.3192	18.81202	20.8309	22.25973	23.43362	25.62256	27.46771
163.5	15.44147	15.7642	16.30743	17.37062	18.86929	20.89486	22.32737	23.50354	25.69464	27.53924
164.5	15.48479	15.80897	16.3546	17.42227	18.9267	20.9588	22.39487	23.57318	25.76616	27.60992
165.5	15.52839	15.85401	16.40201	17.47412	18.98424	21.02272	22.46221	23.64253	25.83712	27.67977
166.5	15.57226	15.89931	16.44967	17.52618	19.04191	21.08663	22.52939	23.7116	25.90751	27.74879
167.5	15.61638	15.94486	16.49756	17.57843	19.0997	21.15049	22.5964	23.78038	25.97734	27.817
168.5	15.66076	15.99065	16.54568	17.63086	19.15759	21.21433	22.66325	23.84887	26.04662	27.88441
169.5	15.70536	16.03667	16.594	17.68347	19.21558	21.27811	22.72993	23.91706	26.11535	27.95102
170.5	15.75019	16.0829	16.64254	17.73624	19.27366	21.34185	22.79643	23.98496	26.18353	28.01686
171.5	15.79524	16.12934	16.69126	17.78917	19.33182	21.40554	22.86275	24.05257	26.25117	28.08193
172.5	15.84049	16.17598	16.74017	17.84225	19.39006	21.46916	22.92889	24.11987	26.31828	28.14624
173.5	15.88593	16.2228	16.78924	17.89546	19.44837	21.53272	22.99485	24.18689	26.38485	28.20983
174.5	15.93155	16.2698	16.83848	17.9488	19.50673	21.5962	23.06062	24.25361	26.45091	28.27269
175.5	15.97734	16.31696	16.88787	18.00225	19.56514	21.65961	23.12619	24.32003	26.51646	28.33484
176.5	16.02329	16.36427	16.9374	18.05581	19.6236	21.72294	23.19158	24.38616	26.58151	28.39632
177.5	16.06939	16.41172	16.98706	18.10947	19.68208	21.78618	23.25677	24.452	26.64606	28.45712
178.5	16.11562	16.4593	17.03683	18.16322	19.7406	21.84932	23.32177	24.51755	26.71014	28.51728

179.5	16.16198	16.507	17.08672	18.21704	19.79912	21.91237	23.38657	24.58281	26.77374	28.57682
180.5	16.20844	16.55481	17.1367	18.27093	19.85766	21.97532	23.45117	24.64778	26.83688	28.63575
181.5	16.25501	16.60271	17.18676	18.32488	19.9162	22.03816	23.51557	24.71247	26.89958	28.6941
182.5	16.30166	16.6507	17.23689	18.37887	19.97473	22.10089	23.57978	24.77688	26.96184	28.75189
183.5	16.34839	16.69875	17.28709	18.4329	20.03324	22.1635	23.64378	24.84102	27.02368	28.80915
184.5	16.39519	16.74687	17.33734	18.48696	20.09172	22.226	23.70758	24.90489	27.08511	28.8659
185.5	16.44203	16.79503	17.38763	18.54102	20.15017	22.28837	23.77119	24.96848	27.14616	28.92217
186.5	16.48892	16.84323	17.43794	18.5951	20.20858	22.35061	23.83459	25.03182	27.20683	28.97798
187.5	16.53583	16.89146	17.48827	18.64916	20.26694	22.41272	23.89779	25.0949	27.26714	29.03337
188.5	16.58276	16.93969	17.53861	18.70321	20.32524	22.47469	23.9608	25.15773	27.3271	29.08835
189.5	16.62969	16.98792	17.58893	18.75723	20.38346	22.53652	24.02361	25.22032	27.38675	29.14297
190.5	16.67661	17.03615	17.63924	18.81121	20.44162	22.59821	24.08622	25.28267	27.44609	29.19725
191.5	16.72351	17.08434	17.68951	18.86514	20.49968	22.65976	24.14864	25.34478	27.50514	29.25123
192.5	16.77038	17.1325	17.73974	18.919	20.55765	22.72115	24.21087	25.40668	27.56393	29.30493
193.5	16.8172	17.18061	17.78991	18.97279	20.61551	22.78239	24.27291	25.46835	27.62247	29.35838
194.5	16.86396	17.22865	17.84001	19.0265	20.67326	22.84346	24.33476	25.52982	27.68078	29.41164
195.5	16.91065	17.27662	17.89003	19.08011	20.73089	22.90438	24.39642	25.59109	27.7389	29.46472
196.5	16.95725	17.3245	17.93995	19.13361	20.78839	22.96514	24.4579	25.65217	27.79683	29.51767
197.5	17.00375	17.37229	17.98977	19.187	20.84574	23.02572	24.5192	25.71306	27.85461	29.57051
198.5	17.05015	17.41995	18.03947	19.24025	20.90294	23.08614	24.58033	25.77379	27.91225	29.6233
199.5	17.09642	17.46749	18.08904	19.29335	20.95999	23.14638	24.64128	25.83436	27.96979	29.67606
200.5	17.14256	17.51489	18.13846	19.3463	21.01686	23.20645	24.70207	25.89477	28.02724	29.72885
201.5	17.18854	17.56214	18.18773	19.39908	21.07356	23.26633	24.76269	25.95504	28.08464	29.78169
202.5	17.23437	17.60923	18.23682	19.45168	21.13007	23.32604	24.82315	26.01519	28.142	29.83463
203.5	17.28002	17.65613	18.28573	19.50409	21.18638	23.38556	24.88346	26.07522	28.19937	29.88771
204.5	17.32548	17.70284	18.33444	19.55629	21.24248	23.4449	24.94362	26.13515	28.25676	29.94097
205.5	17.37074	17.74935	18.38294	19.60827	21.29836	23.50404	25.00363	26.19498	28.3142	29.99447
206.5	17.41579	17.79564	18.43121	19.66002	21.35402	23.563	25.0635	26.25474	28.37173	30.04824
207.5	17.46061	17.8417	18.47925	19.71153	21.40944	23.62176	25.12324	26.31443	28.42937	30.10232
208.5	17.50518	17.88751	18.52703	19.76278	21.46461	23.68033	25.18286	26.37407	28.48716	30.15677
209.5	17.54951	17.93306	18.57455	19.81376	21.51952	23.7387	25.24235	26.43368	28.54513	30.21164
210.5	17.59356	17.97834	18.62179	19.86445	21.57417	23.79687	25.30173	26.49326	28.6033	30.26696
211.5	17.63734	18.02333	18.66873	19.91485	21.62854	23.85484	25.361	26.55284	28.66171	30.3228
212.5	17.68082	18.06802	18.71537	19.96493	21.68262	23.91261	25.42017	26.61243	28.72041	30.3792
213.5	17.72399	18.11239	18.76168	20.01469	21.7364	23.97018	25.47925	26.67204	28.77941	30.4362
214.5	17.76683	18.15644	18.80766	20.06412	21.78988	24.02754	25.53824	26.73169	28.83875	30.49387
215.5	17.80934	18.20014	18.85328	20.11319	21.84304	24.0847	25.59716	26.79141	28.89848	30.55225
216.5	17.8515	18.24349	18.89854	20.1619	21.89587	24.14166	25.65601	26.8512	28.95862	30.6114
217.5	17.89329	18.28646	18.94342	20.21022	21.94836	24.19841	25.71481	26.91109	29.01921	30.67137
218.5	17.93471	18.32904	18.98791	20.25816	22.00051	24.25495	25.77355	26.97108	29.0803	30.73222
219.5	17.97573	18.37122	19.03198	20.30569	22.05229	24.31129	25.83225	27.03121	29.14191	30.794
220.5	18.01634	18.41299	19.07563	20.35279	22.10371	24.36742	25.89093	27.09149	29.20409	30.85677

221.5	18.05652	18.45432	19.11884	20.39947	22.15476	24.42335	25.94958	27.15194	29.26687	30.92058
222.5	18.09626	18.4952	19.16159	20.44569	22.20541	24.47907	26.00823	27.21259	29.3303	30.9855
223.5	18.13555	18.53562	19.20387	20.49145	22.25567	24.53459	26.06687	27.27344	29.39442	31.05158
224.5	18.17437	18.57556	19.24567	20.53674	22.30553	24.58991	26.12553	27.33452	29.45926	31.11888
225.5	18.2127	18.615	19.28696	20.58153	22.35497	24.64502	26.18422	27.39585	29.52487	31.18746
226.5	18.25052	18.65393	19.32773	20.62582	22.40399	24.69994	26.24294	27.45746	29.5913	31.25739
227.5	18.28782	18.69233	19.36797	20.66959	22.45257	24.75466	26.30171	27.51936	29.65857	31.32872
228.5	18.32459	18.73019	19.40766	20.71283	22.50072	24.80919	26.36054	27.58159	29.72674	31.40152
229.5	18.3608	18.76748	19.44678	20.75552	22.54841	24.86352	26.41945	27.64415	29.79585	31.47585
230.5	18.39643	18.8042	19.48531	20.79766	22.59565	24.91767	26.47844	27.70707	29.86595	31.55178
231.5	18.43148	18.84031	19.52325	20.83922	22.64243	24.97163	26.53753	27.77039	29.93707	31.62937
232.5	18.46591	18.87581	19.56057	20.88019	22.68873	25.02542	26.59675	27.83411	30.00927	31.70868
233.5	18.49972	18.91068	19.59726	20.92056	22.73456	25.07902	26.65609	27.89828	30.08258	31.78979
234.5	18.53287	18.94489	19.6333	20.96032	22.7799	25.13246	26.71558	27.9629	30.15706	31.87275
235.5	18.56536	18.97844	19.66867	20.99946	22.82474	25.18572	26.77522	28.02801	30.23276	31.95764
236.5	18.59716	19.01129	19.70335	21.03795	22.86909	25.23883	26.83505	28.09363	30.30971	32.04453
237.5	18.62825	19.04343	19.73733	21.07579	22.91293	25.29179	26.89507	28.15978	30.38797	32.13348
238.5	18.65861	19.07484	19.7706	21.11296	22.95626	25.34459	26.9553	28.2265	30.46758	32.22457
239.5	18.68822	19.10551	19.80312	21.14946	22.99908	25.39725	27.01575	28.29381	30.54859	32.31787
240	18.70274	19.12055	19.8191	21.16745	23.02029	25.42353	27.04607	28.3277	30.58964	32.36537
240.5	18.71706	19.1354	19.83489	21.18526	23.04138	25.44978	27.07645	28.36174	30.63106	32.41344

Appendix A-3

Centers for Disease Control and Prevention Body Mass Index for Age (in months) Tables

Body Mass Index, or BMI, is calculated using the following formula:
BMI = Weight (in kilograms)/Height (in meters)^2

Female Children, Ages 2-20 years

Age (in months)	3rd Percentile BMI Value	5th Percentile BMI Value	10th Percentile BMI Value	25th Percentile BMI Value	50th Percentile BMI Value	75th Percentile BMI Value	85th Percentile BMI Value	90th Percentile BMI Value	95th Percentile BMI Value	97th Percentile BMI Value
24	14.14735	14.39787	14.80134	15.52808	16.4234	17.42746	18.01821	18.44139	19.10624	19.56411
24.5	14.13226	14.38019	14.77965	15.49976	16.38804	17.38582	17.97371	18.39526	19.05824	19.51534
25.5	14.10241	14.34527	14.73695	15.44422	16.31897	17.30485	17.88749	18.30611	18.96595	19.42198
26.5	14.07297	14.31097	14.69516	15.39015	16.25208	17.22693	17.80489	18.22103	18.87853	19.3341
27.5	14.04396	14.27728	14.65429	15.33754	16.18735	17.15202	17.72586	18.13997	18.79591	19.25163
28.5	14.01538	14.2442	14.61434	15.2864	16.12475	17.08009	17.65035	18.06285	18.718	19.17448
29.5	13.98723	14.21175	14.57531	15.23671	16.06429	17.01107	17.5783	17.98962	18.64472	19.10255
30.5	13.9595	14.17992	14.5372	15.18848	16.00593	16.94495	17.50965	17.92019	18.57599	19.03578
31.5	13.93221	14.14871	14.50003	15.14171	15.94967	16.88168	17.44435	17.85452	18.51173	18.97407
32.5	13.90536	14.11813	14.46378	15.09638	15.89548	16.82123	17.38235	17.79253	18.45187	18.91733
33.5	13.87893	14.08818	14.42846	15.0525	15.84336	16.76355	17.3236	17.73416	18.39632	18.86548
34.5	13.85295	14.05885	14.39406	15.01007	15.79329	16.70862	17.26804	17.67936	18.345	18.81843
35.5	13.82741	14.03016	14.3606	14.96907	15.74526	16.65641	17.21564	17.62805	18.29784	18.77609
36.5	13.8023	14.00209	14.32806	14.9295	15.69924	16.60687	17.16634	17.58019	18.25475	18.73838
37.5	13.77763	13.97466	14.29645	14.89136	15.65523	16.55998	17.12009	17.53571	18.21567	18.7052
38.5	13.75341	13.94786	14.26576	14.85465	15.61321	16.5157	17.07685	17.49455	18.18051	18.67647
39.5	13.72964	13.92169	14.23599	14.81934	15.57317	16.474	17.03658	17.45667	18.14919	18.6521
40.5	13.70631	13.89615	14.20714	14.78544	15.53508	16.43486	16.99923	17.422	18.12165	18.632
41.5	13.68343	13.87124	14.1792	14.75293	15.49893	16.39824	16.96476	17.39049	18.09781	18.61608
42.5	13.66101	13.84697	14.15218	14.7218	15.4647	16.36411	16.93312	17.3621	18.07759	18.60425
43.5	13.63905	13.82333	14.12606	14.69205	15.43238	16.33244	16.90428	17.33676	18.06093	18.59643
44.5	13.61756	13.80033	14.10084	14.66365	15.40193	16.3032	16.8782	17.31442	18.04775	18.59253
45.5	13.59654	13.77796	14.07653	14.63661	15.37335	16.27636	16.85483	17.29505	18.03799	18.59246
46.5	13.57599	13.75624	14.05311	14.61091	15.34661	16.25188	16.83413	17.27858	18.03158	18.59614
47.5	13.55592	13.73516	14.03059	14.58652	15.32168	16.22973	16.81606	17.26497	18.02844	18.60348
48.5	13.53635	13.71472	14.00895	14.56345	15.29855	16.20988	16.80058	17.25417	18.02851	18.61441
49.5	13.51728	13.69493	13.9882	14.54167	15.27719	16.19229	16.78765	17.24613	18.03174	18.62883
50.5	13.4987	13.67579	13.96833	14.52117	15.25757	16.17693	16.77723	17.24081	18.03805	18.64667
51.5	13.48065	13.65731	13.94933	14.50194	15.23967	16.16378	16.76927	17.23815	18.04738	18.66785
52.5	13.46311	13.63948	13.93121	14.48396	15.22347	16.15278	16.76375	17.23811	18.05967	18.69229

53.5	13.4461	13.62231	13.91396	14.46721	15.20894	16.14391	16.7606	17.24065	18.07486	18.71992
54.5	13.42963	13.6058	13.89757	14.45169	15.19606	16.13714	16.75981	17.24571	18.09289	18.75065
55.5	13.4137	13.58997	13.88205	14.43738	15.1848	16.13242	16.76132	17.25326	18.1137	18.78441
56.5	13.39833	13.5748	13.86739	14.42427	15.17513	16.12972	16.76509	17.26324	18.13722	18.82113
57.5	13.38352	13.56031	13.85358	14.41233	15.16703	16.12901	16.77108	17.2756	18.16341	18.86074
58.5	13.36927	13.54649	13.84062	14.40156	15.16047	16.13025	16.77925	17.29031	18.19221	18.90315
59.5	13.35561	13.53336	13.82852	14.39194	15.15543	16.1334	16.78956	17.30732	18.22355	18.94832
60.5	13.34252	13.52091	13.81726	14.38345	15.15188	16.13843	16.80197	17.32657	18.25738	18.99615
61.5	13.33003	13.50915	13.80684	14.37609	15.1498	16.14531	16.81644	17.34803	18.29365	19.04659
62.5	13.31814	13.49808	13.79726	14.36984	15.14917	16.154	16.83292	17.37165	18.3323	19.09957
63.5	13.30685	13.4877	13.78852	14.36469	15.14995	16.16446	16.85138	17.39739	18.37327	19.15501
64.5	13.29618	13.47802	13.78061	14.36062	15.15213	16.17665	16.87177	17.42519	18.41651	19.21286
65.5	13.28612	13.46903	13.77353	14.35762	15.15567	16.19056	16.89405	17.45502	18.46197	19.27305
66.5	13.27668	13.46075	13.76728	14.35567	15.16056	16.20613	16.91819	17.48683	18.50959	19.33552
67.5	13.26788	13.45317	13.76185	14.35478	15.16678	16.22334	16.94415	17.52057	18.55932	19.4002
68.5	13.2597	13.4463	13.75724	14.35491	15.17429	16.24214	16.97187	17.5562	18.61111	19.46703
69.5	13.25217	13.44013	13.75345	14.35606	15.18309	16.26252	17.00134	17.59369	18.6649	19.53594
70.5	13.24528	13.43467	13.75047	14.35823	15.19313	16.28443	17.03249	17.63297	18.72064	19.60689
71.5	13.23904	13.42991	13.7483	14.36138	15.20441	16.30785	17.06531	17.67402	18.77829	19.6798
72.5	13.23345	13.42587	13.74694	14.36552	15.2169	16.33273	17.09974	17.71678	18.83778	19.75462
73.5	13.22851	13.42254	13.74637	14.37063	15.23058	16.35906	17.13575	17.76122	18.89907	19.83129
74.5	13.22423	13.41992	13.74661	14.3767	15.24543	16.38679	17.17331	17.8073	18.96211	19.90976
75.5	13.22062	13.41801	13.74764	14.38372	15.26142	16.41589	17.21237	17.85496	19.02685	19.98995
76.5	13.21766	13.41681	13.74946	14.39168	15.27854	16.44633	17.2529	17.90417	19.09324	20.07183
77.5	13.21538	13.41632	13.75206	14.40056	15.29676	16.47809	17.29485	17.95489	19.16123	20.15533
78.5	13.21376	13.41654	13.75544	14.41035	15.31607	16.51113	17.3382	18.00708	19.23077	20.2404
79.5	13.21281	13.41748	13.75961	14.42104	15.33644	16.54542	17.38291	18.06069	19.30182	20.32698
80.5	13.21253	13.41912	13.76454	14.43263	15.35785	16.58094	17.42894	18.11569	19.37432	20.41502
81.5	13.21293	13.42147	13.77024	14.44509	15.38029	16.61764	17.47626	18.17203	19.44822	20.50447
82.5	13.214	13.42453	13.7767	14.45842	15.40374	16.65551	17.52482	18.22968	19.52349	20.59528
83.5	13.21574	13.42829	13.78393	14.47261	15.42817	16.69451	17.5746	18.28859	19.60008	20.68739
84.5	13.21816	13.43276	13.7919	14.48765	15.45357	16.73462	17.62557	18.34873	19.67794	20.78075
85.5	13.22125	13.43793	13.80063	14.50352	15.47991	16.7758	17.67768	18.41007	19.75702	20.87531
86.5	13.22502	13.4438	13.8101	14.52021	15.50718	16.81803	17.7309	18.47255	19.83728	20.97103
87.5	13.22946	13.45037	13.8203	14.53772	15.53537	16.86129	17.7852	18.53615	19.91867	21.06786
88.5	13.23458	13.45764	13.83124	14.55603	15.56444	16.90553	17.84055	18.60082	20.00116	21.16573
89.5	13.24037	13.4656	13.8429	14.57513	15.59439	16.95075	17.89692	18.66653	20.08469	21.26462
90.5	13.24683	13.47425	13.85529	14.59501	15.6252	16.9969	17.95426	18.73325	20.16923	21.36447
91.5	13.25397	13.48359	13.86839	14.61566	15.65684	17.04396	18.01256	18.80093	20.25473	21.46524
92.5	13.26177	13.49362	13.88221	14.63706	15.6893	17.09191	18.07177	18.86955	20.34116	21.56688
93.5	13.27025	13.50432	13.89673	14.65922	15.72257	17.14072	18.13187	18.93906	20.42846	21.66935
94.5	13.27939	13.51571	13.91194	14.68211	15.75662	17.19037	18.19283	19.00943	20.51661	21.77259

95.5	13.28919	13.52777	13.92785	14.70572	15.79143	17.24082	18.2546	19.08063	20.60555	21.87658
96.5	13.29966	13.5405	13.94445	14.73005	15.827	17.29206	18.31718	19.15262	20.69525	21.98126
97.5	13.31079	13.5539	13.96173	14.75508	15.86329	17.34405	18.38051	19.22537	20.78568	22.0866
98.5	13.32257	13.56797	13.97968	14.78081	15.9003	17.39678	18.44458	19.29884	20.87678	22.19255
99.5	13.33502	13.58269	13.99829	14.80722	15.93802	17.45022	18.50936	19.37301	20.96853	22.29907
100.5	13.34811	13.59807	14.01757	14.8343	15.97641	17.50434	18.57481	19.44784	21.06089	22.40613
101.5	13.36185	13.6141	14.03751	14.86204	16.01546	17.55912	18.64091	19.52329	21.15381	22.51367
102.5	13.37624	13.63077	14.05809	14.89043	16.05517	17.61454	18.70762	19.59935	21.24727	22.62168
103.5	13.39126	13.64809	14.07931	14.91946	16.09551	17.67057	18.77493	19.67596	21.34123	22.73009
104.5	13.40693	13.66605	14.10116	14.94911	16.13646	17.7272	18.8428	19.75312	21.43565	22.83889
105.5	13.42323	13.68463	14.12364	14.97938	16.17801	17.78438	18.91121	19.83077	21.53049	22.94803
106.5	13.44016	13.70384	14.14675	15.01026	16.22014	17.84212	18.98012	19.9089	21.62573	23.05747
107.5	13.45772	13.72368	14.17046	15.04173	16.26284	17.90037	19.04952	19.98748	21.72133	23.16719
108.5	13.4759	13.74413	14.19478	15.07378	16.30609	17.95912	19.11937	20.06647	21.81725	23.27714
109.5	13.4947	13.76519	14.2197	15.10641	16.34988	18.01835	19.18965	20.14584	21.91347	23.3873
110.5	13.51411	13.78685	14.2452	15.1396	16.39418	18.07803	19.26034	20.22558	22.00996	23.49762
111.5	13.53412	13.80911	14.27129	15.17334	16.43899	18.13815	19.3314	20.30564	22.10667	23.60808
112.5	13.55474	13.83197	14.29796	15.20762	16.48428	18.19867	19.40282	20.38601	22.20358	23.71865
113.5	13.57596	13.85541	14.32519	15.24242	16.53005	18.25959	19.47457	20.46665	22.30066	23.82929
114.5	13.59777	13.87943	14.35298	15.27775	16.57627	18.32088	19.54662	20.54754	22.39789	23.93997
115.5	13.62017	13.90402	14.38132	15.31358	16.62293	18.38251	19.61895	20.62866	22.49522	24.05066
116.5	13.64315	13.92918	14.4102	15.3499	16.67002	18.44447	19.69154	20.70997	22.59264	24.16134
117.5	13.6667	13.9549	14.43962	15.38671	16.71751	18.50675	19.76436	20.79145	22.69011	24.27198
118.5	13.69082	13.98118	14.46957	15.42399	16.7654	18.5693	19.83739	20.87308	22.78761	24.38254
119.5	13.7155	14.008	14.50003	15.46173	16.81368	18.63213	19.91061	20.95484	22.88511	24.49299
120.5	13.74074	14.03535	14.531	15.49992	16.86231	18.6952	19.984	21.03669	22.98258	24.60333
121.5	13.76653	14.06324	14.56247	15.53855	16.9113	18.7585	20.05753	21.11861	23.08	24.71351
122.5	13.79287	14.09166	14.59444	15.57761	16.96062	18.82202	20.13118	21.20059	23.17734	24.82351
123.5	13.81974	14.12059	14.62688	15.61709	17.01026	18.88572	20.20493	21.28259	23.27458	24.93331
124.5	13.84714	14.15003	14.6598	15.65696	17.06021	18.94959	20.27876	21.3646	23.3717	25.04288
125.5	13.87506	14.17997	14.69319	15.69724	17.11045	19.01362	20.35264	21.44659	23.46867	25.15221
126.5	13.9035	14.21041	14.72703	15.73789	17.16097	19.07779	20.42657	21.52854	23.56546	25.26126
127.5	13.93244	14.24133	14.76132	15.77891	17.21174	19.14207	20.50052	21.61043	23.66206	25.37002
128.5	13.96188	14.27272	14.79605	15.8203	17.26277	19.20645	20.57446	21.69224	23.75845	25.47846
129.5	13.99182	14.30459	14.8312	15.86203	17.31403	19.27091	20.64838	21.77396	23.8546	25.58657
130.5	14.02224	14.33691	14.86677	15.9041	17.36551	19.33544	20.72227	21.85555	23.95049	25.69432
131.5	14.05314	14.36969	14.90275	15.94649	17.41719	19.40001	20.79609	21.937	24.0461	25.80169
132.5	14.0845	14.4029	14.93913	15.98919	17.46907	19.46462	20.86984	22.01829	24.14141	25.90868
133.5	14.11633	14.43656	14.9759	16.0322	17.52112	19.52924	20.94349	22.0994	24.23641	26.01525
134.5	14.1486	14.47063	15.01305	16.07549	17.57333	19.59386	21.01703	22.18031	24.33108	26.12139
135.5	14.18132	14.50512	15.05056	16.11907	17.6257	19.65846	21.09045	22.26101	24.42539	26.22709
136.5	14.21447	14.54002	15.08844	16.1629	17.6782	19.72302	21.16371	22.34148	24.51933	26.33233

137.5	14.24805	14.57531	15.12666	16.207	17.73082	19.78754	21.23681	22.4217	24.61288	26.43709
138.5	14.28204	14.61099	15.16522	16.25134	17.78356	19.85199	21.30974	22.50166	24.70603	26.54136
139.5	14.31643	14.64705	15.20411	16.2959	17.83638	19.91636	21.38246	22.58133	24.79876	26.64513
140.5	14.35122	14.68347	15.24332	16.34069	17.88929	19.98063	21.45498	22.66071	24.89106	26.74838
141.5	14.3864	14.72025	15.28283	16.38568	17.94227	20.0448	21.52727	22.73977	24.98291	26.8511
142.5	14.42195	14.75737	15.32264	16.43087	17.99531	20.10884	21.59931	22.8185	25.0743	26.95328
143.5	14.45788	14.79484	15.36274	16.47625	18.04838	20.17274	21.67111	22.89689	25.16522	27.0549
144.5	14.49415	14.83262	15.40311	16.52179	18.10149	20.23648	21.74263	22.97493	25.25564	27.15596
145.5	14.53078	14.87073	15.44374	16.5675	18.15461	20.30006	21.81386	23.05259	25.34557	27.25645
146.5	14.56773	14.90914	15.48462	16.61335	18.20774	20.36346	21.8848	23.12987	25.43498	27.35636
147.5	14.60502	14.94784	15.52574	16.65934	18.26085	20.42667	21.95543	23.20675	25.52387	27.45567
148.5	14.64262	14.98682	15.5671	16.70546	18.31395	20.48967	22.02573	23.28323	25.61223	27.55439
149.5	14.68052	15.02607	15.60867	16.75168	18.36701	20.55245	22.0957	23.35928	25.70005	27.6525
150.5	14.71871	15.06559	15.65044	16.79801	18.42002	20.61499	22.16532	23.43491	25.78731	27.75
151.5	14.75718	15.10535	15.69241	16.84442	18.47298	20.67729	22.23458	23.51008	25.87401	27.84688
152.5	14.79592	15.14535	15.73456	16.89091	18.52586	20.73934	22.30346	23.58481	25.96013	27.94314
153.5	14.83492	15.18558	15.77689	16.93746	18.57866	20.80112	22.37196	23.65907	26.04568	28.03877
154.5	14.87417	15.22602	15.81937	16.98407	18.63136	20.86261	22.44007	23.73285	26.13065	28.13377
155.5	14.91365	15.26666	15.86199	17.03071	18.68396	20.92382	22.50777	23.80615	26.21502	28.22813
156.5	14.95335	15.30749	15.90476	17.07738	18.73643	20.98472	22.57506	23.87895	26.2988	28.32185
157.5	14.99326	15.34849	15.94764	17.12407	18.78878	21.04531	22.64192	23.95126	26.38197	28.41494
158.5	15.03336	15.38966	15.99063	17.17076	18.84098	21.10557	22.70835	24.02305	26.46453	28.50739
159.5	15.07365	15.43098	16.03372	17.21744	18.89302	21.1655	22.77434	24.09433	26.54648	28.59919
160.5	15.11411	15.47244	16.0769	17.26409	18.9449	21.22508	22.83987	24.16508	26.62782	28.69036
161.5	15.15473	15.51403	16.12014	17.31072	18.9966	21.28431	22.90494	24.23529	26.70853	28.78088
162.5	15.19549	15.55572	16.16345	17.35729	19.04811	21.34317	22.96954	24.30497	26.78862	28.87077
163.5	15.23639	15.59752	16.2068	17.40381	19.09942	21.40166	23.03366	24.37411	26.86808	28.96002
164.5	15.2774	15.63941	16.25018	17.45026	19.15052	21.45977	23.09731	24.44269	26.94692	29.04864
165.5	15.31852	15.68136	16.29358	17.49662	19.20139	21.51749	23.16045	24.51071	27.02513	29.13663
166.5	15.35972	15.72338	16.33699	17.54289	19.25204	21.5748	23.22311	24.57818	27.1027	29.22399
167.5	15.40101	15.76544	16.38039	17.58905	19.30243	21.63171	23.28525	24.64508	27.17965	29.31073
168.5	15.44235	15.80753	16.42378	17.63509	19.35257	21.68819	23.34689	24.71141	27.25597	29.39686
169.5	15.48374	15.84964	16.46712	17.68099	19.40245	21.74426	23.40801	24.77716	27.33167	29.48237
170.5	15.52517	15.89175	16.51042	17.72675	19.45204	21.79989	23.46861	24.84234	27.40673	29.56729
171.5	15.56661	15.93385	16.55366	17.77236	19.50136	21.85508	23.52868	24.90694	27.48118	29.6516
172.5	15.60805	15.97592	16.59682	17.81779	19.55037	21.90982	23.58823	24.97096	27.555	29.73533
173.5	15.64949	16.01795	16.63989	17.86304	19.59907	21.96411	23.64723	25.0344	27.6282	29.81848
174.5	15.69089	16.05992	16.68286	17.90809	19.64746	22.01794	23.7057	25.09725	27.70079	29.90107
175.5	15.73225	16.10183	16.72571	17.95294	19.69552	22.0713	23.76363	25.15951	27.77277	29.98309
176.5	15.77356	16.14364	16.76842	17.99756	19.74325	22.12419	23.82101	25.22119	27.84414	30.06456
177.5	15.81478	16.18536	16.81099	18.04195	19.79062	22.1766	23.87784	25.28228	27.91491	30.1455
178.5	15.85592	16.22696	16.8534	18.0861	19.83764	22.22852	23.93412	25.34279	27.98509	30.22591

179.5	15.89695	16.26842	16.89563	18.12998	19.88429	22.27996	23.98985	25.40271	28.05468	30.3058
180.5	15.93785	16.30974	16.93767	18.1736	19.93057	22.3309	24.04503	25.46204	28.12369	30.3852
181.5	15.97862	16.35089	16.97951	18.21693	19.97646	22.38135	24.09964	25.5208	28.19213	30.46411
182.5	16.01923	16.39185	17.02112	18.25996	20.02195	22.43128	24.1537	25.57897	28.26	30.54255
183.5	16.05966	16.43262	17.0625	18.30269	20.06704	22.48072	24.20721	25.63656	28.32732	30.62053
184.5	16.0999	16.47318	17.10363	18.3451	20.11172	22.52963	24.26015	25.69357	28.39408	30.69807
185.5	16.13993	16.51351	17.14448	18.38717	20.15598	22.57804	24.31254	25.75002	28.46031	30.77519
186.5	16.17973	16.55358	17.18506	18.42889	20.19981	22.62592	24.36437	25.80589	28.52602	30.8519
187.5	16.21929	16.5934	17.22534	18.47025	20.2432	22.67329	24.41564	25.8612	28.5912	30.92822
188.5	16.25859	16.63293	17.2653	18.51124	20.28614	22.72013	24.46636	25.91595	28.65588	31.00417
189.5	16.2976	16.67216	17.30494	18.55184	20.32862	22.76644	24.51653	25.97014	28.72007	31.07976
190.5	16.33631	16.71107	17.34423	18.59205	20.37064	22.81222	24.56614	26.02379	28.78378	31.15502
191.5	16.37471	16.74965	17.38316	18.63184	20.41219	22.85747	24.61521	26.07689	28.84702	31.22997
192.5	16.41277	16.78787	17.42171	18.67121	20.45326	22.90219	24.66372	26.12945	28.90981	31.30462
193.5	16.45047	16.82573	17.45986	18.71015	20.49383	22.94637	24.7117	26.18148	28.97215	31.379
194.5	16.4878	16.8632	17.49761	18.74863	20.53392	22.99002	24.75913	26.23299	29.03407	31.45314
195.5	16.52473	16.90025	17.53492	18.78665	20.57349	23.03313	24.80603	26.28399	29.09558	31.52704
196.5	16.56124	16.93689	17.5718	18.82419	20.61256	23.07571	24.8524	26.33448	29.1567	31.60075
197.5	16.59733	16.97308	17.60821	18.86125	20.65111	23.11774	24.89824	26.38446	29.21743	31.67427
198.5	16.63295	17.0088	17.64415	18.8978	20.68912	23.15924	24.94356	26.43396	29.27781	31.74764
199.5	16.66811	17.04404	17.67959	18.93384	20.72661	23.2002	24.98836	26.48298	29.33784	31.82088
200.5	16.70276	17.07879	17.71452	18.96935	20.76355	23.24062	25.03265	26.53153	29.39755	31.89401
201.5	16.7369	17.11301	17.74892	19.00432	20.79994	23.28051	25.07643	26.57962	29.45695	31.96706
202.5	16.77051	17.14669	17.78278	19.03874	20.83578	23.31986	25.11972	26.62726	29.51606	32.04007
203.5	16.80356	17.17981	17.81607	19.07258	20.87105	23.35867	25.16251	26.67447	29.57491	32.11305
204.5	16.83603	17.21234	17.84878	19.10585	20.90576	23.39696	25.20482	26.72125	29.6335	32.18603
205.5	16.8679	17.24429	17.88089	19.13852	20.93988	23.43471	25.24665	26.76761	29.69187	32.25905
206.5	16.89915	17.2756	17.91238	19.17059	20.97343	23.47193	25.28802	26.81358	29.75004	32.33212
207.5	16.92975	17.30628	17.94324	19.20204	21.00638	23.50863	25.32892	26.85915	29.80802	32.40529
208.5	16.95969	17.3363	17.97344	19.23285	21.03874	23.5448	25.36937	26.90436	29.86584	32.47859
209.5	16.98894	17.36564	18.00298	19.26301	21.07049	23.58045	25.40938	26.9492	29.92352	32.55204
210.5	17.01749	17.39427	18.03182	19.29252	21.10163	23.61558	25.44895	26.9937	29.98109	32.62567
211.5	17.0453	17.42218	18.05996	19.32135	21.13216	23.65019	25.4881	27.03787	30.03857	32.69952
212.5	17.07236	17.44935	18.08737	19.34949	21.16206	23.68429	25.52684	27.08173	30.09599	32.77362
213.5	17.09864	17.47576	18.11403	19.37693	21.19134	23.71788	25.56517	27.12528	30.15337	32.84802
214.5	17.12413	17.50137	18.13993	19.40366	21.21997	23.75097	25.60311	27.16856	30.21074	32.92272
215.5	17.14879	17.52618	18.16505	19.42965	21.24797	23.78356	25.64067	27.21157	30.26812	32.99779
216.5	17.1726	17.55015	18.18937	19.45491	21.27532	23.81564	25.67786	27.25433	30.32554	33.07324
217.5	17.19555	17.57328	18.21286	19.47941	21.30202	23.84724	25.7147	27.29686	30.38304	33.14912
218.5	17.2176	17.59553	18.23552	19.50314	21.32805	23.87835	25.75118	27.33918	30.44063	33.22546
219.5	17.23874	17.61689	18.25732	19.52608	21.35343	23.90898	25.78733	27.3813	30.49835	33.30231
220.5	17.25894	17.63733	18.27824	19.54823	21.37812	23.93912	25.82317	27.42325	30.55623	33.37969

221.5	17.27818	17.65683	18.29826	19.56957	21.40215	23.9688	25.85869	27.46505	30.6143	33.45766
222.5	17.29643	17.67537	18.31736	19.59008	21.42548	23.99801	25.89392	27.50671	30.6726	33.53624
223.5	17.31367	17.69293	18.33552	19.60975	21.44813	24.02676	25.92887	27.54826	30.73114	33.61548
224.5	17.32987	17.70948	18.35273	19.62857	21.47008	24.05505	25.96356	27.58971	30.78997	33.69542
225.5	17.34501	17.725	18.36896	19.64651	21.49134	24.08289	25.99799	27.63109	30.84911	33.77609
226.5	17.35907	17.73946	18.38419	19.66358	21.51188	24.11029	26.03219	27.67242	30.90861	33.85756
227.5	17.37203	17.75286	18.39841	19.67975	21.53171	24.13725	26.06617	27.71372	30.96849	33.93984
228.5	17.38385	17.76515	18.41159	19.695	21.55082	24.16378	26.09993	27.75502	31.0288	34.023
229.5	17.39451	17.77632	18.42371	19.70933	21.56921	24.18988	26.13351	27.79633	31.08956	34.10707
230.5	17.40399	17.78635	18.43475	19.72272	21.58686	24.21557	26.16692	27.83769	31.15082	34.1921
231.5	17.41226	17.79521	18.4447	19.73516	21.60378	24.24084	26.20016	27.8791	31.21261	34.27814
232.5	17.4193	17.80288	18.45352	19.74662	21.61996	24.26571	26.23326	27.92061	31.27496	34.36522
233.5	17.42508	17.80934	18.46121	19.7571	21.63539	24.29019	26.26624	27.96223	31.33793	34.45341
234.5	17.42958	17.81456	18.46773	19.76658	21.65006	24.31427	26.29911	28.00399	31.40154	34.54273
235.5	17.43278	17.81852	18.47308	19.77505	21.66397	24.33798	26.33189	28.04591	31.46583	34.63326
236.5	17.43465	17.82119	18.47722	19.78248	21.67712	24.3613	26.36459	28.08801	31.53085	34.72503
237.5	17.43515	17.82256	18.48014	19.78887	21.68949	24.38426	26.39723	28.13034	31.59664	34.8181
238.5	17.43427	17.82259	18.48182	19.7942	21.70108	24.40686	26.42984	28.17291	31.66324	34.9125
239.5	17.43199	17.82127	18.48223	19.79846	21.71189	24.4291	26.46243	28.21574	31.73069	35.00831
240	17.43031	17.82009	18.48196	19.80018	21.717	24.4401	26.47872	28.23727	31.76474	35.05675
240.5	17.42827	17.81856	18.48136	19.80162	21.72191	24.45101	26.49502	28.25888	31.79903	35.10556

Appendix A-4

Body Mass Index for Age (in years) Percentile Tables
for Male and Female Children and Adolescents Aged 6-19

Body Mass IndexCategories for Males[1,2]

AGE (in years)	Normal	Overweight	Obese
6	13.7 - <17.0	17.0 - <18.4	≥18.4
7	13.7 - < 17.4	17.4 - <19.2	≥19.2
8	13.8 - <18.0	18.0 - <20.1	≥20.1
9	14.0 - <18.6	18.6 - <21.1	≥21.1
10	14.2 - <19.4	19.4 - <22.2	≥22.2
11	14.6 - <20.2	20.2 - <23.2	≥23.2
12	15.0 - <21.0	21.0 - <24.2	≥24.2
13	15.5 - <21.9	21.9 - <25.2	≥25.2
14	16.0 - <22.7	22.7 - <26.0	≥26.0
15	16.6 - <23.5	23.5 - <26.8	≥26.8
16	17.1 - <24.2	24.2 - <27.6	≥27.6
17	17.7 - <24.9	24.9 - <28.3	≥28.3
18	18.2 - <25.7	25.7 - <29.0	≥29.0

[1] Body mass index categories are defined according to Centers for Disease Control and Prevention BMI percentiles with normal weight being 5th - <85th percentiles, overweight being 85th - <95th percentiles, obese being ≥95th percentile.
[2] Age-in-year BMI values are the average of twelve age-in-month BMI values taken from Body Mass Index for Age Tables from the Centers for Disease Control and Prevention.

Appendix A-4, continued

Body Mass Index Categories for Females[1,2]

AGE (in years)	Normal	Overweight	Obese
6	13.4 - <17.1	17.1 - <18.8	≥18.8
7	13.4 - <17.6	17.6 - <19.7	≥19.7
8	13.5 - <18.3	18.3 - <20.7	≥20.7
9	13.7 - <19.1	19.1 - <21.8	≥21.8
10	14.0 - <20.0	20.0- <23.0	≥23.0
11	14.4 - <20.9	20.9 - <24.1	≥24.1
12	14.8 - <21.7	21.7 - <25.3	≥25.3
13	15.3 - <22.6	22.6 - <26.3	≥26.3
14	15.8 - <23.3	23.3 - <27.3	≥27.3
15	16.3 - <24.0	24.0 - <28.1	≥28.1
16	16.8 - <24.7	24.7 - <28.9	≥28.9
17	17.2 - <25.2	25.2 - <29.6	≥29.6
18	17.6 - <25.7	25.7 - <30.3	≥30.3

[1] Body mass index categories are defined according to Centers for Disease Control and Prevention BMI percentiles with normal weight being 5th - <85th percentiles, overweight being 85th - <95th percentiles, obese being ≥95th percentile.
[2] Age-in-year BMI values are the average of twelve age-in-month BMI values taken from Body Mass Index for Age Tables from the Centers for Disease Control and Prevention.