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Examination of Dietary Intake and Supplement Use Among Girls Ages 9-18, with Emphasis on Calcium and Iron

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Examination of Dietary Intake and Supplement Use Among Girls Ages 9-18, With Emphasis on Calcium and Iron

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I. ABSTRACT

Diets of children and adolescents are often lacking in key nutrients due to their low intakes of important food groups (e.g. fruits, vegetables, whole grains, and dairy). This study examined nutrients of concern for growing girls compared to dietary recommendations. Specifically iron and calcium were analyzed to determine the highest dietary sources of these micronutrients and the impact of supplementation on girls' mean intake. This cross-sectional analysis used a subset of data from a longitudinal study of growth and development in active Caucasian girls (n=74). Dietary data and supplement use were collected using the Youth Adolescent Questionnaire (Rockett, Wolf & Colditz, 1995). Based on the girls' age groups, information on intake of the key nutrients, with and without dietary supplements, was compared to the Dietary Reference Intakes (DRIs). All girls showed a lower vitamin D and calcium intake, even with supplementation usage, than is suggested by the DRI. While all girls met iron needs with supplementation included, the older girls (n=16, ages 14-18 years old) did not meet the RDA for iron without supplementation. The younger girls (n=58, ages 9-13 years old) did meet iron needs without supplementation. About half (47 percent) of the younger girls and about a third (33 percent) of the older girls reported consuming dietary supplements. Within this population of girls, particularly those 14-18 years old, nutrients of concern were identified, which included nutrients targeted as public health concerns. Further research needs to focus on examining the intake of key nutrients over time, with consideration to bioavailability and validity of dietary assessment, to identify strategies to improve the dietary intake of children and adolescents.

II. EXECUTIVE SUMMARY

For our capstone project, we, Katelyn Castro and Sydney Carp, have been collaboratively writing a thesis research paper studying girls' nutrient intakes. After reviewing literature regarding girls' dietary intakes, we selected two nutrients of concern, iron and calcium, on which to focus our research. Since literature suggests that these two micronutrients are lacking in girls' diets, our research examined the frequency of high iron and calcium foods in girls' diets to determine specific foods that contributed to or replaced these nutrients of concern in their diet (IOM Food and Nutrition Board, 2001 & 2010). Additionally, we examined intake of energy, macronutrients, and other micronutrients. The purpose of our work was to evaluate the intake of iron and calcium among girls and compare them to recommendations to see where girls may be falling short of nutrient requirements.

To examine dietary intake, data were analyzed from an ongoing study of girls, ages 8-18, conducted by the Orthopedics Department at Upstate Medical University. Seventy-four subjects were selected who met specific criteria within this larger longitudinal study to assess girls' diets and nutrients of concern, specifically calcium and iron. The subjects included in our study came from the 2012 data collection period of the study and were selected by an age cutoff of 9-18 years old at the date of measurement. With our sample, two age groups were identified with 58 females in the 9-13 year old age group and 16 in the 14-18 year old age group. These age group categories were chosen because they correspond to dietary intake recommendations. All other participants who did not fall within the age criteria were excluded from this study. Participants who did not have complete anthropometric measurement data for the first half of the year in 2012 and any participants who had incomplete data from the measure of dietary intake (the Youth/Adolescent Questionnaire [YAQ]) were additionally excluded.

Dietary data were collected using the 1995 Youth/Adolescent Questionnaire, which was based on the validated Nurses' Health Study food frequency questionnaire and was developed to assess the eating habits of older children and girls. The YAQ includes data on the frequency with which participants consumed various foods and beverages in order to evaluate energy and nutrient intake, foods and food groups, as well as food preparation and meals eaten away from home. The YAQ has shown to be a valid and reliable tool to assess dietary intake (Rockett et al., 1995). Girls' dietary intakes were compared to dietary reference standards by age group and within the whole sample (IOM Food and Nutrition Board, 2000; 2001; 2002; 2010). Additionally, intakes were examined in relation to diet from food alone and from food plus intake from dietary supplements.

Top sources of calcium and iron were identified, as well as the frequency of consumption of these foods to determine the major contributors of calcium and iron. Top food sources of calcium included ice cream, cold cereal, milk, yogurt, and cheese. The main food sources of both heme and non-heme iron were identified separately in order to take bioavailability and absorption into consideration. Heme iron, from animal sources, has a higher bioavailability and absorption rate versus non-heme iron, from plant sources (Hurrell & Egli, 2010). The top contributors of heme iron included chicken or turkey as a main dish, chicken/turkey sandwiches, roast beef/ham sandwiches, pork, and beef. Food sources of non-heme iron most frequently consumed included mashed potatoes, cooked spinach, broccoli, beans, and fortified breakfast cereal. The consumption frequencies of these key food sources were analyzed between participants who met and did not meet the respective Recommended Daily Allowances (RDAs). The frequency of sugar-sweetened beverage consumption was also examined in order to see if these beverages displaced beverages higher in calcium.

Our capstone project was designed to identify the gaps that exist within girls' diets. We specifically looked at nutrients of concern during this critical time of growth and development as well as the negative effects associated with inadequate nutrient intake. We decided to focus on iron and calcium because these two nutrients play an especially vital role during growth and come from multiple dietary sources that we could analyze. By looking at data from the YAQ, we were able to determine the prevalence of iron and calcium in the diets of those surveyed. In doing so, we can then pinpoint elements in the diet can be increased or consumed more frequently in order to meet the designated RDAs. Determining foods or beverages that may replace high calcium and iron sources in girls' diets could also provide the evidence needed to develop strategies to help improve intake of calcium and iron.

This capstone project has allowed us to improve our research and critical thinking skills. These skills have become extremely helpful during our undergraduate studies, as we have learned how to efficiently research information on databases and analyze methods and results within various types of studies. Additionally, we have learned how to utilize statistical software to analyze data from our sample. Our analytical abilities have also improved as we have learned how to effectively summarize results in a clear and concise way, incorporating tables and figures. We feel that this experience, as well as the skills it has helped us to develop, will be useful in our future careers in the health profession.

III. LITERATURE REVIEW

Adolescence is a crucial and dynamic stage in life, filled with many changes. Such changes, both in growth and development as well as in one's social, cognitive and emotional environment, can have an affect on eating behaviors and nutritional health; therefore, adolescence represents a nutritionally vulnerable period for girls.

Girls' Physiological Growth and Development

Compared to early childhood growth, growth during adolescence is significantly more rapid. This increase in the pace of growth marks the beginning of the onset of puberty, which on average occurs at age nine in females. During the transition from childhood to adulthood, usually between the ages of 14 and 18 years, growth rate accelerates to a rate as rapid as that in early infancy. Both genetics and environmental factors contribute to the variability of the onset of puberty. While the adolescent time period is crucial for both males and females, our research will focus specifically on female development in order to identify their specific nutrient concerns and behaviors (Spear, 2002).

The chronological age of the onset of growth and development within females varies greatly among the population. Because age is a poor indicator of physiological maturity and the nutritional needs of girls, the Tanner Stages are used as a more accurate indicator that assesses the maturation of secondary sexual characteristics. These stages assign individuals on a scale of 1 (pre-pubertal), to 5 (adult) based on breast and pubic hair development.

In stage one, no pubic hair or maturation of genitalia is present. A rating of two indicates the earliest sign of puberty, where a small amount of pubic hair and breast buds are evident, as well as increased sweat gland activity and growth of 3-5 inches. By stage three, pubic hair has increased and breasts have become further developed, but there is not yet a separation of the nipple and areola. In addition, acne develops and axillary hair becomes present. In stage four, pubic hair becomes more abundant and, breasts develop further with separation of the areola and nipple. Acne becomes more severe and menarche begins. By stage five, adult pubic hair spreads to medial thighs, there is distribution of breast tissue, and an increase in fat and muscle mass. This stage is considered to be evidence of adult development, although growth in height may continue past the conclusion of this stage. In the US, the average age when girls reach menarche is 12.5 years. However, the age of onset and amount of time required for the completion of the Tanner Stages vary greatly among females. The average time elapsed between stages one and five is four years (Tanner, 1990).

During the process of puberty, girls attain approximately 15 percent of their final adult height and 45 percent of their maximal skeletal mass. In females, stature growth ceases at a median age of 17.3 years. Females who undergo puberty earlier in adolescence experience a greater stature growth for a longer period of time than those who reach menarche at an older age (Spear, 1996).

In addition to height, puberty is also a time of significant weight gain. During this time period, girls attain 50 percent of their ideal adult weight. Among girls, peak weight gain lags behind peak velocity, averaging at 9 kilograms/year at 12.5 years of age. Continuous weight loss during this period of growth may have a direct effect on adult height. Body composition also changes dramatically during menarche due to elevated levels of androgens, as they have a growth-promoting effect. Specifically in females, the sex hormones estrogen and progesterone increase the deposition of fat more than muscle tissue. On average, girls increase the percentage of body fat at a rate of 1.14 kilograms/year, with non-fat mass remaining relatively constant

(Rogol, 2002).

Girls Energy and Nutrient Recommendations

The physical and developmental changes that females experience during menarche directly affect their energy and nutrient needs. The Dietary Reference Intakes (DRIs) have been implemented as reference values in order to set quantitative estimates for the ideal consumption of specific nutrients for populations based on a specific life stage and gender. The DRIs include RDAs or Adequate Intakes (AIs), Tolerable Upper Intake Levels (ULs) and Estimated Average Requirements (EARs). The RDA is the average daily dietary intake level that is sufficient to meet the nutrient requirement of 97-98 percent of healthy individuals in an age- and gender-specific group. The AI is the recommended intake based on observed or experimentally determined estimates of nutrient intake by a specific group of individuals that are believed to be adequate and used when an RDA cannot be determined due to lack of scientific evidence. The UL is the recommended intake determined based on data regarding risks of toxicity.[1] Although these reference values can be crucial for planning and assessing appropriate dietary intake among different populations, they should be used with caution and only as general guidelines to evaluate those at risk of consuming inadequate diets (IOM Food and Nutrition Board, 2002).

Since these reference values are based on chronological age, rather than stage of maturation, girls of the same age could have very different needs depending on their level of development. In addition to girls' different growth rates, the wide variability in physical activity, metabolic rate, physiological states and adaptability among girls also can make it difficult to accurately estimate specific nutrient and energy requirements. As a result, one must remember that the DRIs do not include a safety factor, therefore intakes above or below the DRIs may be

[1] Please refer to Table 1 for specific data on the function and dietary reference intakes of micronutrients for girls 9-13 and 14-18 years old.

acceptable for some individuals. For example, a girl may have increased energy needs due to illness, trauma or stress. Clinical, biochemical, anthropometric, dietary and psychosocial assessments are additional measures to assess for adequate nutritional status on an individual basis (Spear, 2002).

Recommended intakes of energy, protein and other nutrients are based on adequate growth rather than optimal physiological functioning. The RDAs for energy are based on the Estimated Energy Requirement (EER), defined as the average dietary intake that is predicted to maintain energy balance in an individual of a defined age, gender, height and level of physical activity. The EER for active females ages nine to 13 years, is 2,071 kcal/day and for active females ages 14 to 18 years, the EER is 2,368 kcal/day. When girls fail to meet their energy requirements, linear growth may be stunted and sexual maturation may be slowed.

Protein needs for girls are determined by the amount needed in order to maintain existing lean body mass while allowing for additional amounts needed during growth. Protein serves as the main structural component of all cells in the body, functioning as enzymes, in membranes, as hormones and as transport carriers. The RDAs for protein are calculated from growth rate and body composition data, with the assumption that protein use for growth is comparable with maintenance data for adults. Protein recommendations for females are highest between the ages of 14 to 18 years with estimated protein needs at .85g/kg bodyweight/day. On average, females aged nine to 13 years old require 34 grams/day and females aged 14 to 18 years require 46 grams/day. Similar to energy needs, inadequate protein intake can lead to retarded linear growth and delayed sexual maturation.

Carbohydrates provide energy for cells in the body, especially for the brain. The recommended intake of carbohydrates among girls is 130 g/day, or 45-65 percent of total daily energy needs. Recommendations suggest that the maximal intake of added sugars, such as high fructose corn syrup and sucrose, be limited to no more than 25 percent of daily caloric intake (IOM Food and Nutrition Board, 2002).

Fiber is a non-digestible carbohydrate form that plays an important role in providing normal bowel function, reducing risk of coronary heart diseases and assisting in maintaining normal blood glucose levels. The AI for fiber is the reference intake used to cover the needs of all individuals in the groups. For girls, the AI is 26 grams/day.

Dietary fat and essential fatty acids are required for normal growth and development in girls. Fat acts as a major source of fuel in the body, and aids in the absorption of fat-soluble vitamins and precursors such as Vitamin A and caroteinoids. For girls, it is recommended that 25-35 percent of total daily energy needs come from fat, with no more than 10 percent of calories derived from saturated fat. For optimal growth and development, the AI is 10-11 grams of alpha-linoleic acids (omega 6 polyunsaturated fatty acids) and 1.0-1.1 grams of alpha-linolenic acids (omega 3 polyunsaturated fatty acids) (IOM Food and Nutrition Board, 2002).

In addition to macronutrient needs, micronutrients are of equal importance in girls' dietary intakes. Refer to Table 1 for specific dietary reference intakes for females nine to 13 and 14 to 18 years old.

Calcium needs during the period of adolescence are greater than they are both in childhood and adulthood due to the large increase in skeletal growth. With about half of peak bone mass developed during adolescence, calcium, as the main constituent of bone mass, could play a role in reducing the risk of bone fractures and osteoporosis later in life. For female girls, the RDA for calcium is 1300 mg/day (IOM Food and Nutrition Board, 2010).

Vitamin D is a fat-soluble vitamin that plays an important role in contributing to calcium and phosphorus absorption and it is essential for optimal bone formation. The RDA for female girls is set at 15 mg/day (IOM Food and Nutrition Board, 2010).

Iron is another micronutrient that plays a crucial role in female adolescent growth. With a rapid rate of linear growth, the increase in blood volume and the onset of menarche contribute to increased iron needs. For female girls, the RDA for iron intake is 15 mg/day. Although the RDA for iron is based on chronological age, more accurate iron requirements are based on sexual maturation level. For females, iron needs are highest after menarche (IOM Food and Nutrition Board, 2001).

Vitamin C is a water-soluble vitamin that is crucial for synthesis of collagen and other connective tissues, especially during the period of menarche. The RDA for female girls is set at 65 mg/day. Since Vitamin C acts as an antioxidant, recommended intake for Vitamin C is higher for smokers, due to the increased consumption of Vitamin C through oxidative reactions (IOM Food and Nutrition Board, 2000).

Folate is a B vitamin that plays an integral role in the synthesis of DNA, RNA and protein. Folate also plays a significant part in DNA synthesis and methylation, as well as aiding in rapid cell division and growth. Meeting the recommendations for folate is especially important for female girls who are sexually active because folate is essential for normal growth and development of the fetus during pregnancy. Because folate is also required for the production of healthy red blood cells and prevention of anemia, folate needs for female girls are increased during the period of menarche. The RDA for folate intake is set at 400 μg/day for female girls (IOM, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, 2000).

Zinc plays an important role in protein formation and gene expression, as well as in growth and sexual maturation. Because zinc and iron compete for absorption, girls taking iron supplements may be a higher risk of developing a mild zinc deficiency. As a result of rapid growth during adolescence, serum zinc levels decrease. Zinc deficiency can impair cognitive development, delay sexual maturation, or stunt growth. The RDA of zinc for female girls is about 7.3 mg/day (IOM, 2001).

Vitamin E is a fat-soluble vitamin with antioxidant properties, which is extremely important in the rapid development of girls during this stage of life. It can aid in the prevention of cancer, cataracts, heart disease, as well as improve immunity. The RDA for Vitamin E among female girls is 15 mg/day (IOM, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, 2000).

Physical Activity

In addition to nutrient needs, girls must also meet recommendations for physical activity in order to maintain a healthy lifestyle and optimal growth and development. The 2008 Physical Activity Guidelines for Americans, issued by the U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture, provide the most recent science-based guidance for Americans to improve their health through appropriate physical activity. Meeting these recommendations for physical activity contributes to improved cardiorespiratory and muscular fitness, improved bone health, improved metabolic health biomarkers and favorable body composition (Office of Disease Prevention and Health Promotion, 2015).

Physical activity is also associated with prevention of weight gain and reduced risk of chronic disease. In addition to these physiological benefits, there are several psychological benefits of physical activity for girls. Several studies have shown that physical activity is associated with increased self-esteem and self-concept, as well as decreased depression and anxiety. In addition, studies have found that both acute and chronic aerobic exercise promote children's cognition and academic function.

As females often experience issues with self-esteem during puberty on account of the physical and hormonal changes that take place, the psychological and social benefits of physical activity are of great importance to a female adolescent's health. Developing adequate physical activity habits during adolescence sets a strong foundation for behaviors and health outcomes in adulthood (Landry & Driscoll, 2012).

Factors Influencing Girls' Dietary Intake

Girls' food choices are not consistent with the Dietary Guidelines for Americans. As girls undergo physical, developmental and social changes, they begin to develop eating behaviors and habits that have long-term implications for their health. As girls are given greater flexibility and autonomy with age, their dietary behaviors are influenced by a variety of factors. Studies have used concepts from the social cognitive theory (McAlister, Perry, & Parcel, 2008) and ecological perspective (Bronfenbrenner, 1979) in order to understand the various factors influencing girls' dietary and health choices. The social cognitive theory considers the dynamic and reciprocal interaction between personal factors, environmental influences and behavior. In addition the ecological perspective examines the connection between people and their microsystems, mesosystems, exosystems and macrosystems (Story, Neumark-Sztainer, & French, 2002). With these two concepts, we will examine the factors influencing girls eating behaviors at four levels; intrapersonal, interpersonal, physical environment and macrosystem influences (See Figure 1).

Obesity

The prevalence of overweight and obese children and girls in the United States has increased over several decades and remains a major health problem in our country. The most recent National Health and Nutrition Examination Survey (NHANES) 2011 to 2012 studied a nationally representative sample of the US population consisting of 3355 children and girls aged two to 19 years. For children and girls, obesity was defined as a body mass index at or above the 95th percentile of sex-specific Centers for Disease Control and Prevention (CDC) BMI-for-age charts. This survey found that 16.9 percent of children and girls were obese. Overall, the most recent NHANES study found no significant change from 2003-2004 through 2011-2012 for children and girls, though obesity prevalence remains high (Ogden et al., 2014).

Although obesity-associated morbidities occur more frequently among adults, there are significant consequences of obesity among children and girls. Many cardiovascular consequences of adult obesity are preceded by abnormalities beginning in childhood. Hyperlipidemia, hypertension, abnormal glucose tolerance and infertility are now occurring with increasing frequency in obese children and girls. In addition to these physical consequences, psychological disorders, such as depression, are also more common among obese and overweight children and girls (Dietz, 1998).

While the development of obesity has a large environmental contribution, a genetic susceptibility component must also be considered as it has shown to contribute 40-70 percent to obesity. Recent findings from genome-wide association studies, have allowed researchers to detect robust associations between common genetic variants and obesity (Xia & Grant, 2013).

Obesity can be classified based on suspected etiology. Monogenic obesity occurs among severely obese individuals in absence of developmental delays. An estimated 20 single-gene disruptions cause this autosomal form of obesity. In monogenic obesity, studies have found that these gene mutations position leptin/melanocortin pathways in the central nervous system, contributing to increased appetite and diminished satiety in individuals. Syndromic obesity occurs among clinically obese subjects with mental retardation, dysmorphic features and organ-specific developmental abnormalities. Those with Syndromic obesity have discrete gene defects or chromosomal abnormalities of several genes. The most common syndromic obesity is Prader-Willi Syndrome. Polygenic obesity, also known as common obesity, occurs among the majority of the population. This occurs as a result of abnormalities in genes affecting the central nervous system function or genes peripheral, often through adipose tissue. These specific gene abnormalities may affect factors such as appetite, satiety, reward systems, energy expenditure, behavior, and fat-distribution (Herrera, 2010).

Though the current obesity epidemic does not have a pure genetic basis, genetics play a large role in susceptibility through various biological pathways. Continued research of genome-wide association studies is necessary in order to better understand the molecular and physiological characterizations of genes and pathways involved (Shawky & Sadik, 2012).

In contrast, studies have found that specific environmental factors, personal lifestyle choices, and cultural environments play a significant role in the rising prevalence of child and adolescent obesity in the United States. In order to begin to understand the factors influencing child and adolescent obesity, we must recognize how genetic determinants, environmental influence, personal factors and cultural environments interact in a complex and dynamic manner. Refer to Figure 1 for a diagram on the different factors that influence dietary intake among female children and adolescents.

INTRAPERSONAL INFLUENCES

Attitudes, beliefs, knowledge, self-efficacy, taste, food preferences and biological factors are all psychosocial factors that influence girls' eating behaviors. In addition, behavior factors, such as weight-control behaviors and snack patterns and perceived barriers such as cost and time are individual obstacles that can affect girls' dietary habits.

Self-Efficacy

Among these intrapersonal influences, self-efficacy has been shown to have a very significant association to energy consumption and positive eating behaviors among girls. Bandura defines self-efficacy as the "conviction that one can successfully execute the behavior required to produce outcomes" (1997). Self-efficacy plays an important role in the motivational and behavioral processes including health and diet related decisions (Fitzgerald, et al., 2013). In a recent study (Tanofsky-Kraff, 2013) researchers evaluated girls in order to examine the association between self-efficacy and observed eating behaviors. Participants included 111 females who were considered at-risk for inappropriate weight gain who were recruited for an excess weight gain prevention program. These females ranged in age from 12 to 17 years old and had BMIs between the 75th and 97th percentiles. The General Self-efficacy Scale and the Weight Efficacy Lifestyle Questionnaire were used for psychological measures and anthropometrics and laboratory test meals were used for body composition and dietary habits. Results from the study found that greater self-efficacy was inversely related to total intake at a meal.

Additionally, a study of 219 girls, aged 13-18 years, examined the relationship between self-efficacy for healthy eating, parent and peer support for healthy and unhealthy eating and food intake patterns. It was concluded that lower self-efficacy for healthy eating and higher peer support for unhealthy eating were associated with ‘unhealthy food intake’. Higher self-efficacy was associated with ‘healthy food intake’ (Fitzgerald et al., 2013).

Food Preferences

Although there are many factors influencing the food choices of girls, food preference has been found to be one of the greatest predictors of food choice (Story et al., 2002). Scheule surveyed 1818 3rd to 12th grade students in one Ohio school district to assess preferences for 80 different foods using a rating scale (2009). Data were separated by gender, and it was found that girls preferred fruits and vegetables more compared than boys, as well as having a higher preference for starches and sweets. Females responded less to “ethnic foods”, “fish and casseroles” and “beef, pork, and barbecue” than boys.

There are many factors that form food preferences in girls, starting from a very young age. An individual’s food environment is shaped by parent influence, exposure, and psychological conditioning of flavor and texture preference (Story et al., 2002).

Disordered Eating Behaviors

According to the 2007 Youth Risk Behavioral Surveillance System, 60 percent of female and 30 percent of male students in grades 9–12 report trying to lose weight (Eaton et al., 2008). While being health conscious is important, especially in adolescent development, many females exhibit disordered eating behaviors and become obsessed with their self-image. Girls may use unhealthy strategies such as fasting, diet pills, vomiting, and taking laxatives in order to control their weight. These behaviors often lead to more severe conditions and disorders, including anorexia nervosa, bulimia nervosa, and binge eating disorder, as well as depression and psychosocial morbidity (Eisenberg & Neumark-Sztainer, 2010).

In a 6-year retrospective cohort study from 2005 to 2010, patients 12 to 19 years old at a tertiary children's hospital were examined to assess the presence of restrictive dietary behavior leading to weight loss and hospitalization. This study sought to compare the characteristics of Anorexia Nervosa (AN) versus Eating Disorders, Not Otherwise Specified (EDNOS), in order to describe the changing incidence of these two conditions in a sample of girls whom required hospitalization after weight loss. Researchers found that there was a fivefold increase in the proportion of girls with an eating disorder characterized as EDNOS over a 6-year period. Although the patients were not underweight, the results from the study indicate that the patients' profile was similar to the life-threatening conditions of patients with Anorexia Nervosa. With higher rates of admission and increased EDNOS, these study results recognize the health implications of extensive weight loss behavior among higher-weight girls. While there is a wide spectrum of disordered eating patterns among girls, the focus on weight and body image remain significant factors in influencing girls eating habits and health (Whitelaw, 2014).

Among girls participating in disordered eating habits, researchers have found that some individuals are more likely than other to have weight dissatisfaction and dieting behaviors. In a study with a sample of 876 girls, investigating the associations among interpersonal relationships, eating behaviors and body esteem, the results showed that dieting behavior was reported more commonly among females with a higher BMI and females with an earlier age of menarche. In addition, those who had higher positive opposite-sex relational esteem, higher attributions about the importance of weight and appearance on popularity and dating, and higher externalized self-perceptions, reported higher levels of dieting behavior. The study also found that despite differences found among age of menarche, there were no significant differences in body esteem or dieting among girls ages 12 to 16 years of age. In contrast to these findings, the study found that BMI was not a significant predictor of disordered eating or dieting. While further research is needed in order to examine restrictive eating behaviors among girls more systematically in a longitudinal study, these results indicate that weight control behaviors among girls can have a significant impact on their dietary behaviors and eating habits (Lieberman et al., 2001).

INTERPERSONAL INFLUENCES

Family, friends, peer networks as well as relationships among these groups are components of individuals' social environment that influence girls' eating behaviors and food choices through mechanisms such as modeling, reinforcements, social support and perceived norms.

Family

Despite girls' increased independence over time, family remains an important influence on their dietary behaviors. A study done by Fulkerson and colleagues (2006) examined the association between the frequency of family meals and developmental behaviors. The participants consisted of 99,462 sixth to 12th grade students across the US. Equal numbers of males and females were asked questions regarding the frequency of eating together as a family each week via an anonymous survey over a one-year academic period.

The researchers found that higher frequency of family meals was associated with a lower frequency of girls performing high-risk behaviors such as drug use, excessive weight loss and eating disorders. Additionally, results showed that girls eating 5 to 7 family dinners per week reported better family support, communication, and positive parental involvement. The positive association between frequent family meals and adolescent development shows that increased efforts for time spent with family can help girls form healthy habits, values, and behaviors (Fulkerson et al, 2006).

A pilot study done by Neumark-Sztainer and colleagues in 1999 aimed to increase the understanding of family meal patterns among girls. A survey was distributed to 252 students in their 7th and 10th grade health education classes asking questions regarding factors such as family meal patterns and self-efficacy to eat healthful foods at family mealtime. Researchers found that girls felt more confident that they were eating healthfully during family meals than in other eating situations. In fact, 50 percent of the girls responded that they were "very sure" they could eat healthful foods when with their families as compared to only 11 percent when with their friends and 6 percent at fast-food restaurants (Neumark-Sztainer, Story, Perry, & Casey, 1999).

In more recent study on a group of 1,631 girls aged 14 years old, researchers explored the influence of family functionality on girls' dietary habits. Family functioning was measured through two assessments that examined family communication, affective responsiveness and behavioral control and dietary habits were assessed using a semi-quantitative food frequency questionnaire. Results from the study indicated that those who followed a healthy eating pattern also had better family functioning (Ambrosini et al., 2009).

A study done by Gillman and colleagues used a national sample of 16,202 children and girls aged 9-14 years old to analyze the nutritional impact of family dinners (2000). Evidence was found that increasing frequency of family dinners—the most commonly consumed meal by girls—positively correlated with more healthful dietary intake patterns. The results of these studies clearly show that family meals are a key factor in positive adolescent development, food choices, and behaviors (Story et al., 2002).

Peer influence

In addition to the influence of family, social networks within peer groups play an essential role in girls' diet and food choices due to both direct and indirect mechanisms of interpersonal influence. In a study published in 2010, exponential random graph models were used for social network analysis in order to determine whether behaviors including high calorie food consumption, physical activity and sedentary screen-based activities were associated with their peers' behaviors. Participants included males and females from two independent middle schools, consisting mainly of 12 and 13 year old children. Both schools were defined as separate peer networks in order to examine similarities and differences across age groups. In order to examine students' behaviors and food consumption, paper-based questionnaires were administered to middle school classrooms involving every student in the class, assessing self-reported frequency of high-calorie food consumption, physical activity and screen-time during a normal week of the school year as well as data on age, gender, year level and friendship ties within the school. The researchers found that same-sex friends presented similar behaviors in terms of physical activity, female friends presented similar screen-based behaviors, and male friends tended to present similar behaviors in terms of high-calorie foods. Popularity was an additional social pressure also associated with some of these behaviors, although their effects were specific to gender and social networks (Haye et al., 2009).

PHYSICAL ENVIRONMENT

In addition to individuals' immediate social environment and interpersonal factors, the physical environment within girls' communities also play a large role in their eating habits and food choices. The cost, availability and accessibility of different foods significantly influence both the type and amount of food that girls choose to consume.

A qualitative study with 38 focus groups consisting of 213 school-age children, grades two-11, from 34 schools, examined various factors influencing children and girls' food choices. Barriers to healthy eating among children include convenience of less healthy food alternatives, taste preference for less healthy foods and lack of parental/school support and modeling (O'Dea, 2003).

Fast Food Restaurants

Fast food is a convenient, cheap option for children and girls who want to consume their calories without allocating time for preparation, clean up, or meal planning. It has become a commodity among girls who have recently been given the freedom to make their own food choices.

Studies have shown that girls spend over $140 billion annually, with 15 percent of this spending on fast food and snacks. In addition to this discretionary spending, girls also influence parental decisions on food purchases (Larson et al., 2006).

With changes in the American family structure, children and girls are gaining more power in household decision-making processes. Results from a 2005 study show that females have a 1.44 mean value of perceived influence on food choice in the household (Chavda, Haley, & Dunn, 2005). Additionally, a study from 2007, which examined the prevalence of fast food purchases for family meals and its associations with dietary intake, BMI, and home food availability in adolescents and their parents, found that both 54.4 percent of parents and 54.4 percent of female adolescents reported to have fast food family meals one to two times per week. This study also discovered, not surprisingly, that frequent fast food purchases and fast food family meals are associated with decreased intake of vegetables and less nutritious foods with higher levels of salty snack foods among adolescents (Boutelle et al., 2007).

Various studies have examined the association between fast food and weight status among girls in the U.S. Specifically, Ding and Parks (2007) analyzed data from the survey of Health Behavior of School-Aged Children conducted on participants drawn from a nationally representative sample of students grades six through 10 in schools across the U.S. Measures such as consumption of fast food and sweets were assessed by a five-point Likert-type scale of how often girls ate these foods. Based on their responses to specific food items, participants were classified into low- and high-consumption groups. The researchers found that participants with high fast food consumption were 1.23 times as likely to be overweight than participants with lower fast food consumption (Ding & Parks, 2007).

A correlation between childhood obesity and increased consumption of fast foods is also seen in a study examining the diet quality of specific fast food menu items. In a study of 2,080 children ages four to 19 years old participating in a nationally representative Continuing Survey of Food Intake, Bowman and colleagues examined the association between fast food intake and dietary quality using between-subject comparisons. Results from the study found that children who ate fast food consumed on average 187 kcal more per day, more energy per gram of food, more fat, more carbohydrates, more added sugars, more sugar-sweetened beverages, less fiber, less milk and few fruits and non-starchy vegetables than those who did not eat fast food in the study. Increased fast-food consumption was also independently associated with higher household incomes, non-Hispanic black race/ethnicity and residing in the south (Bowman et al., 2004).

These results further demonstrate the negative effect of fast food consumption on girls' dietary quality.

Schools

Schools play a large role in influencing girls' dietary choices due to the amount of time they spend in school and the physical and normative environment within the schools. School curriculum, policies, and services, as well as the surrounding community, contribute to girls' eating behaviors during the day, particularly the availability of fast food and sugar-sweetened beverages at school vending machines, cafeterias and bake sales.

Girls identify that time is the largest barrier to eating healthy food in schools, due to short lunch breaks. As a result, girls turn to vending machines, often selecting junk food. In addition, girls perceive themselves as too busy to worry about food, nutrition, meal planning and healthy eating. They associate fun activities, such as being with friends at school, with junk food and boring activities, such as being with parents, with healthful foods, further contributing to their preference for convenient and available fast foods (Chapman & Maclean, 1993).

School environmental and policy strategies are being modified in order to address obesity among children. Several interventions aim to improve child nutrition through changes in school food service, including increasing the availability, appeal and promotion of fruit and vegetables as well as specific nutrition guidelines. In July 2012, the U.S. Department of Agriculture announced new standards for school lunches and breakfasts as part of the Healthy, Hunger-Free Kids Act. The new policies include serving more fruits, vegetables, and whole grains, offering meals that meet specific calorie ranges for each age group and using food products and ingredients with zero grams of trans fat. These new standards were largely based on recommendations made by the Institute of Medicine of the National Academies to enhance the diet and health of school children (USDA, 2015).

Though research has shown that these updated nutrition standards have been effective in emphasizing fruits, vegetables, whole grains and healthy fats, some argue that the new standards are impractical and too extreme to implement within schools. One food service manager argued that the upper limit on calorie intake and the restrictions on meat and whole grains fail to consider the varied needs of children, males versus females and active versus inactive children (Godfrey, 2013).

The USDA is working to adjust nutrition standards in schools based on feedback from school lunch programs after initial implementation of new standards. For example, revisions within the last three years have been made to increase flexibility of meat and meat alternatives and grain maximums and revise policies on salad bars and smoothies in order to ensure children, schools and supply chains have adequate time to adapt (USDA, 2015).

In a study conducted in three rural Virginia elementary schools over a five-day period, the nutritional value of school lunches participating in the 2012-2013 National School Lunch Program was compared to lunches that students brought from home. With a total of 1,314 lunches observed, the school lunches on average had fewer carbohydrates, fat, saturated fat and sugar and more protein, fiber, vitamin A and calcium than packed lunches. Although more research is needed in order to examine the effectiveness of current nutrition policies and regulations within schools, current strategies to improve child and adolescent nutrition in the school environment could be essential in reducing childhood obesity. In addition, nutrition education programs targeting children and parents who opt for packed lunches should be encouraged in order to promote healthier choices (Farris et al, 2014).

MACROSYSTEM

Beyond girls' intrapersonal factors, interpersonal factors and physical environment, their macrosystem and society also play a large role in influencing their eating behaviors. Mass media, advertisements, social and cultural norms, food production and distribution, policies and laws regulating food availability and prices are components of girls' macrosystem that play a more distal and indirect role in their eating behaviors.

With increased independence, girls' dietary choices are more heavily influenced by media and advertising, regardless of nutrition and health considerations. Today's society is "media-saturated" and girls are constantly exposed to media whether at home, school, in the car or on-the-go. (Story et al., 2002).

Television Advertisements

Food advertisements on television reinforce messages and reminders about food and food products. With more reinforcement to recall a product, girls are more likely to be influenced by these advertisements when they make dietary choices. With the majority of advertisements focused on unhealthy foods, this continues to negatively, albeit indirectly, influence girls' dietary habits.

Due to high television usage among the adolescent population, the advertising and promotion of unhealthy foods influence their consumer choices significantly. In a cross-sectional study from 2011, 12,188 Australians aged 12-17 years participated in a web-based self-report questionnaire to measure exposure to commercial television and non-broadcast food marketing, as well as their consumption of fast food, sugar-sweetened drinks, and sweet and salty snacks. Researchers found a positive correlation between digital food marketing exposure and girls' eating behaviors. Girls who watched over two hours of commercial television per day were 1.3 times more likely to report consumption of fast food and 1.91 times more likely to report consumption of sweet snacks (Scully et al., 2012).

A survey-based evaluation of 2,281 students aged 10 to 13 years examined the influence of food advertisement on girls' diet intake. Overall, the study found that 89.6 percent of the food advertisements recorded in the study were for less healthful food. In addition, the study found that overweight girls were significantly less receptive to food advertisements while normal-weight girls were more receptive to unhealthful food advertisements. Although this study provides preliminary evidence of advertisers' strategy to attract non-overweight girls who may be more likely to consume more healthful foods, longitudinal studies are needed in order to better determine this relationship (Adachi-Mejia, 2011). According to a Kaiser Family Foundation Study conducted in 2010 television is a main source of media usage for girls aged eight to 18 years old, with an average viewing of four hours and 29 minutes (Rideout et al., 2010). The U.S. food marketing system is the second largest advertiser in the economy, as well as the leading supporter of television, newspaper, and magazines. The food industry spends $11 billion annually on advertising, with a large percentage of this spent on the promotion of highly processed and packaged foods (Story et al., 2002).

NUTRIENTS OF CONCERN

Due to these interpersonal, intrapersonal, physical environment and societal factors influencing female girls' dietary intake, there are several nutrients of concern. The discrepancy between girls' actual needs and recommended dietary contributes to consequences of inadequate growth and development. The high prevalence of obesity among girls as a result of increased energy intake also coincides with increased risk of malnourishment among girls due to the consumption of foods with high energy density but low nutrient density (Tanumihardjo et al., 2007).

A study by Neumark-Sztainer et al. that compared girls' dietary intakes to the Healthy People 2010 objectives found several nutrients and food groups of concern in girls aged 11-18 years old. 47 percent of females in the study did not meet or exceed the recommended fat intake of less than or equal to 30 percent. 70 percent of girls did not meet the recommended intake for calcium. In addition, 53.8 percent of girls did not consume greater than or equal to the recommended two servings of fruit per day and 82.5 percent did not meet the recommendations for greater than or equal to three servings of vegetables per day. Results from this study also identified that female middle school age participants reported higher intakes of calcium, fruit, vegetables, and grains compared to their high school counterparts (Neumark-Sztainer et al., 2002).

In another study examining a nationally representative sample of girls grades nine through 12, researchers looked at specific food groups that were limited among girls. Story et al. (1998) examined the relationship between the consumption of fruits, vegetables and high fat foods and dietary behaviors among girls using data obtained from the 1993 Youth Risk Behavior Survey among a population of 16,296 girls. The researchers found that females characterized as extreme dieters were less likely to eat fruits and vegetables than moderate/non-dieters, and were more likely to have consumed two or more servings of high-fat foods daily. In addition, moderate dieters engaged in more health promoting eating behaviors than extreme dieters and non-dieters. These results indicate that girls engaging in extreme weight control behaviors may be at greater risk for inadequate nutrient intake (Story, 1998).

In another study conducted by the School of Public Health at the University of Minnesota, Neumark-Sztainer et al. identified a similar connection between dieting behaviors and inadequate nutrient intake. A school-based health behavior survey measured consumption of dairy products and risk factors for low consumption of dairy products among 36,284 public school students, grades seven to 12. Results from the sample population indicated that 13.1 percent of girls had extremely low dairy intakes. In addition, low intake of dairy was also associated with low weight. Dieting was strongly associated with low dairy consumption, with 62 percent of girls who reported dieting over the past year having double the risk for low dairy consumption compared with non-dieters or infrequent dieters. Consistent, modest associations were also found with other health-compromising behaviors, including binge eating and substance abuse (Neumark-Sztainer et al., 1997).

Considering the prevalence of healthy food group deficiencies and detrimental eating behaviors among girls, several studies have confirmed the inadequate consumption of nutrients in this population. According to reports on diet quality among children ages two to nine in the U.S. in 2003, folate, vitamin A, vitamin E, calcium, iron, and zinc are identified as specific nutrients of concern (Carlson et al., 2003).

Moore examined the contribution of food group intakes to micronutrient adequacy in a study of 2,379 girls in the National Growth and Healthy Study during three age periods. The girls completed eight, three-day diet records over 10 years, collected annually during study years one-five, seven, eight and 10. Data from each of the three days (averaged for each record) were then used to estimate mean intakes and whether Dietary Guidelines (DGA) recommendations for food intakes and Institute of Medicine’s recommendations for vitamins and minerals were met. The researchers found that the vast majority of girls of all ages had inadequate intakes of calcium, magnesium, potassium, and vitamins D and E. More specifically, within the female sample population between 14 and 18, they compared specific nutrients to the EARs in place in 2011. Of the female sample population, 53.2 percent met the vitamin A requirement, 2.4 percent met the vitamin D requirement, 11.3 met the calcium requirement, and 9 percent met the magnesium requirement (Moore et al., 2012).

Another study also found that iron intake was among the nutrients of concern, specifically among the female adolescent population. According to data from Gleason and Suitor (2002), 44 percent of females aged 14-18 years old reported iron intake below 80 percent of the Recommended Dietary Allowance. The greatest dietary contributors of iron reported from participants were ready-to-eat cereal, bread and beef (Gleason & Suitor, 2001). Although many female adolescents' diets may be lacking in a variety of nutrients, those of greatest concern are iron and calcium.

CALCIUM

Calcium is one of the most abundant minerals in the body with numerous functions, including normal development of the skeleton during growth, and maintenance of bone mass later in life. According to the National Institutes of Health, the human body contains about 1 kg of calcium on average, with more than 99 percent existing in bones and teeth and about one percent found in muscles and tissues. In its mineral form of hydroxyapatite, calcium contributes to bone strength due to its effect on bone mass (Office of Dietary Supplements, 2013).

Function/Role of Calcium in Development

In order to achieve adequate calcium balance and maximize bone stores, the body gets calcium by consuming certain foods or supplements or by taking it from bones. When blood calcium levels are low due to inadequate consumption, bone cells, called osteoclasts, break down bone in order to maintain blood calcium levels. Throughout the lifespan, bones are constantly being broken down by osteoclasts or built up by osteoblast bone cells in order to maintain blood calcium levels during different periods of growth and development. Bones grow at different rates throughout our lives, with maximal growth for length occurring soon after birth and continuing for the first year of life. In the second year the growth rate is half that of the first year and only a third thereafter, until a dramatic increase in bone growth occurs, known as the pre-pubertal growth spurt (Boron, 2005).

In addition to calcium's role in bone growth and maintenance, several studies have found that calcium may also function in the regulation of body weight, glucose tolerance and estrogen biosynthesis in females. While the role of calcium in bones is vital, calcium in fluids and cells of soft tissue have also been found to have important body functions. In muscles and tissues, calcium plays a role in blood clotting, nerve functions, muscle contraction, cell maintenance and functioning, enzyme reaction activation and hormone secretion (Sigel, 2004).

During the pre-pubertal and pubertal years, calcium is especially important as this is a time of rapid growth. During this period, bones continue to increase in density as more bone is being built than it is being broken down. A study done by Baxter-Jones et al. (2011) analyzed bone mineral accrual in 75 males and 89 female participants over seven successive years beginning at ages eight-15 years old. Results show that approximately 39 percent of adults' total bone minerals are gained in the four years surrounding peak height velocity. The study concludes that participants reached peak bone mass seven years following peak height velocity, which equated to a chronological age of 18.8 to 20.5 years (Baxter-Jones et al., 2011).

As mentioned before, the period of adolescence poses the highest demand of calcium in the lifetime, in order to reach peak accrual of bone mass and lower the chances of developing chronic disease, fractures, and osteoporosis later in life. Currently, the RDA of calcium for females aged 14 to 18 is 1300 mg/day; however, only about 19 percent of adolescent girls meet this recommendation. In NHANES III, the mean calcium intake of adolescent teenage girls was 809 mg/day, almost 500 mg short of their daily needs (IOM Food and Nutrition Board, 2002).

In a study of 3,251 Caucasian women from the third NHANES survey, the relationship between childhood diet and the risk of osteoporosis fracture was analyzed. This study sought to identify the effects of calcium during the adolescent period of life in order to determine the long-term consequences or benefits of calcium. Using data such as history of bone fracture and frequency of milk intake during adolescence, it was concluded that women with low milk intake during childhood were more likely to have low bone density in adulthood and greater risk of fracture. In addition, low bone mass was correlated to childhood fracture. These findings support the claim that inadequate calcium intake during childhood and adolescence can compromise the attainment of peak bone mass at skeletal maturity and predispose individuals to bone fractures (Kalkwarf, Khoury & Lanphear, 2003).

While calcium intake is one of the strongest influences of bone growth and maintenance, there are many other factors, including genetics, gender, endocrine and nutritional factors. Low calcium intake is a widespread problem across countries and age groups. Therefore, ensuring adequate calcium intake throughout the lifetime is important for bone health and the prevention of osteoporosis and related fractures (Zhu & Prince, 2012).

Calcium Bioavailability

While there may be many calcium rich foods available, not all calcium consumed is absorbed in the small intestine. On average, the human body only absorbs 30 percent of the calcium in foods (IOM Food and Nutrition Board, 2010). The percent of availability varies greatly depending on the amount and type of food consumed, age, vitamin D intake, as well as other components such as phytic and oxalic acid. One important adaptation within the body that helps to prevent inadequate blood calcium levels is its ability to increase efficiency of calcium absorption when intake is low. As a result, calcium intake decreases the efficiency of calcium absorption. In addition, net calcium absorption is as high as 60 percent during infancy and early childhood, a time of maximal growth. Following this period, absorption decreases to 15 to 20 percent during adulthood and continues to do so as people age. In addition to age and the amount of high calcium foods consumed, vitamin D intake is also essential in order to increase calcium absorption. As a fat-soluble vitamin obtained from sun exposure and several foods and supplements, vitamin D promotes calcium absorption in the intestine and maintains adequate blood calcium and phosphate concentrations in order to facilitate the mineralization of bone. In addition, vitamin D contributes to the functioning of osteoblasts and osteoclasts needed for bone growth and maintenance (IOM, 2010).

This calcium bioavailability depends on both the absorbability and the incorporation of the absorbed calcium into bone. As a result, dietary factors that influence intestinal absorption and excretion of calcium in urine can play an important role in calcium bioavailability. While dairy products have the highest concentration of absorbable calcium readily bioavailable, many people who are not of Indo-European descent are lactose intolerant and lack the enzyme necessary to digest the lactose in dairy products. This has led to the development of many lactose-free food products that are fortified with calcium in order to prevent large numbers of people from becoming calcium deficient (Office of Dietary Supplements, 2013).

Sources of Calcium

The body pulls calcium from bones when levels in the bloodstream dip to the point where it is not readily available; therefore, it is crucial to obtain calcium from foods or supplements that contain sufficient amounts of the mineral. While milk and dairy products have the highest concentration of absorbable calcium per serving, they are not the only food sources that contain the mineral. While dark leafy greens such as spinach, kale and collard greens also contain calcium, it is less well absorbed and a large quantity of such foods must be consumed in order to benefit. Additionally, canned fish, such as salmon and sardines that include bones, are good sources of calcium. While some types of tofu have high concentrations of calcium, others are not adequate sources. Beans, cottage cheese, almonds and sesame seeds are poor sources of calcium (Titchenal & Dobbs, 2007). There has been an increasing variety of calcium-fortified food products on the market in recent years, including breakfast cereals, fruit and juice beverages, pasta products, snack bars and even some soft drinks (Rafferty, Watson & Lappe, 2011).

Calcium Supplementation

In addition to calcium-fortified foods, many girls also take calcium supplements. According to Picciano, more than one-third of girls in the U.S. report using a dietary supplement. The most commonly used types of dietary supplements include vitamins A, C, and D, calcium and iron (Picciano et al., 2007).

In a nationally representative, cross-sectional study from the National Health and Nutrition Examination Survey 2003-2006 analyzed the micronutrient intakes of 7,250 children. The data was analyzed using two 24-hour recalls and an assessment of dietary supplement use. Results indicated that supplement users had higher micronutrient intakes than nonusers. Among the female sample population, ages 14 to 18 years old, those that did not take dietary supplements had an average intake of 794 mg of calcium while to those who did use dietary supplements were closer to the recommendation (1300 mg) with an average of 1118 mg. Vitamin D intake among nonusers in this same age groups was 6.0 μg while users average intake was 13.1 μg, still below the recommended intake of 15 μg. While the prevalence of inadequate intake was significantly higher among nonusers than supplement users for calcium and vitamin D, the results also indicate that supplement use is associated with increased usual intakes above Upper Levels for other micronutrients: iron, zinc, folic acid and vitamins A and C. Further research is needed to determine whether the benefits of meeting vitamin D and calcium needs outweigh the risks of reaching the Upper Levels of other micronutrients (Bailey et al., 2012).

In a more recent study, Moore examined 2,379 girls in the National Growth and Health Study during three age periods (9-13, 14-18, 19-20 years). Data was analyzed from eight 3-day diet records over 10 years in order to estimate mean intake in comparison to recommendations for vitamins and minerals. Results indicated that 36 percent of the sample took a multivitamin at follow-up. In addition, analysis of the results found that multivitamin consumers have better nutrition and healthier lifestyles overall, suggesting that those who might benefit from supplementation were less likely to take the vitamins and minerals. In addition, the researchers state that it remains unclear whether the multivitamin and mineral supplements provide health benefits equal to those of nutrient-rich foods (Moore et al., 2012).

Factors Affecting Calcium Intake

The selection and prevalence of calcium in the female adolescent diet is dependent upon many factors. There are personal, socio-environmental and behavioral factors that influence calcium intake in girls. A cross-sectional study aimed at explaining calcium and dairy intakes among girls based on these factors used the Project EAT survey along with the Youth and

Adolescent Food Frequency Questionnaire to assess usual dietary intake of calcium. Multiple measures were used and results indicate that taste preference for milk and having milk served at meals were most strongly correlated with calcium intake. Additionally, eating breakfast, health/nutrition attitudes and self-efficacy to make healthful food choices were positively related to calcium intake among girls. The study concluded that while eating breakfast may improve total calcium intake among girls, nutrition education could be extremely beneficial in developing strategies to teach girls to choose calcium-rich foods. Milk served at meals, taste preference, breakfast consumption, family socio-economic status, self-efficacy, personal health attitudes and fast food intake were identified as the most influential determinants of calcium consumption in girls (Larson, et al., 2006).

A longitudinal study of calcium and dairy intake trends during adolescence found that two-thirds of females had calcium intakes lower than recommended values. 38 percent of females reduced their daily intake of calcium over the 5-year study. Additionally, the study showed that more than 72 percent of females had calcium intakes below the Adequate Intake (AI) of 1300 mg/day.[2] Researchers concluded that specific personal and behavioral factors were associated with calcium intake in girls. For example, perceived barriers to healthful eating, snack and fast food frequency and soft drink consumption were correlated with lower calcium intake. On the other hand, concern about health and self-efficacy for healthful eating was related with higher calcium intake both at the baseline and follow-up among girls (Larson et al., 2009).

A study of 430 girls, ages 12 to 13 years old, used three questionnaires to evaluate calcium knowledge: dietary recall, knowledge of calcium rich foods and food frequency of cheese, yogurt, milk and cereal. Research found that although some girls had high levels of dairy

[2] Prior to 2010, calcium had an AI but now has a RDA.

intake, not all those with adequate calcium levels consumed healthy diets. Most of the sample population was aware that milk is high in calcium, however they were less aware that cheese and yogurt are also adequate sources. While girls were more aware as to which foods are rich in calcium, this knowledge was not indicative of higher calcium intake, as girls may have such knowledge but not apply it (Bateson & Finch, 2002).

IRON

Iron is an essential micronutrient for humans and has several important functions in the body. Iron functions as a cofactor for many proteins, including enzymes, which play an important role in several physiological functions. Additionally, because iron is an element that exists in different oxidation states, including ferric and ferrous, its conversion between these different states is important to its role as a catalyst in redox reactions, electron transfer and reversible binding to ligands.

In the body, approximately two-thirds of total iron content is in the form of functional iron. Functional iron performs metabolic functions and contributes to enzymatic systems and oxygen transport. Iron is mainly located in hemoglobin of erythrocytes, proteins found in red blood cells, which are associated with transporting oxygen from the pulmonary alveoli to the tissues. Iron is also found in muscle myoglobin, a protein that stores oxygen in tissues for future use and releases it as demanded by muscle contraction. Additionally, myoglobin supplies oxygen to enzymes that assist in biochemical reactions. Lastly, iron is stored as ferritin and hemosiderin, which make up body deposits and are bound to transferrin as ferric iron to be transported. These iron stores are regulated mainly by intestinal iron absorption (Mesías, Seiquer & Navarro, 2013).

Iron Bioavailability

Although absorption of iron varies greatly among individuals, for healthy girls, 10 to 15 percent of dietary iron is generally absorbed. One factor influencing iron absorption is the storage level of iron. This adaptive mechanism in the body allows the body to increase iron absorption when iron stores are low in order for biological processes to function normally, and decrease iron absorption when iron stores are higher in order to protect against iron overload and toxicity (Mesías, Seiquer & Navarro, 2013). A study of 28, 15-16 year old Swedish girls was conducted to investigate dietary iron intake, calculate iron absorption and compare that to requirements and iron status. They found the mean estimated iron absorption to be 10 percent, although the daily available iron intake was 11.5 mg (Hoppe et al., 2008). In addition, iron absorption varies depending on the form of dietary iron consumed, including heme iron and non-heme iron. Heme iron is found in animal tissue and makes up about 40 percent of the total iron, derived from hemoglobin, which is the protein in red blood cells necessary to deliver oxygen to other cells. In contrast, non-heme iron makes up 60 percent of total iron (Mesías, Seiquer & Navarro, 2013).

Sources of Iron

Due to their differing chemical structures, heme iron is more bioavailable than non-heme iron. While absorption of heme iron in the body ranges from 15 to 35 percent, absorption of non-heme iron is lower, varying from 2 to 20 percent. Various food components influence the absorption of non-heme iron and contribute to the large variability of iron absorption. Consuming it with vitamin C or other heme sources of iron can increase the bioavailability of non-heme iron. The most significant sources of heme iron in the diet are animal products, such as liver, beef, turkey, oysters, and chicken. Sources of non-heme iron are products such as iron-fortified ready-to-eat cereal, lentils, beans, and spinach. In contrast, tannins found in teas, calcium, polyphenols, and phytates, can decrease absorption of non-heme iron. While heme iron is mostly found in animal tissue, non-heme iron exists in plant products such as lentils and beans, and is used to produce iron-enriched and iron-fortified foods (Hurrell & Egli, 2010).

Iron Deficiency and Assessment

According the World Health Organization, iron deficiency is the most prevalent nutritional deficiency in the world, with as many as 80 percent of the global population iron deficient and 30 percent meeting the criteria for iron deficiency anemia. While food fortifications have led to decreased prevalence of iron deficiency globally, it remains a significant health concern today (WHO, 2001). Iron deficiency can result from inadequate iron intake, inadequate iron absorption, or excessive blood loss. Normally iron deficiency develops very gradually, starting initially with a negative iron balance due to inadequate daily intake of iron. As a result of the negative iron balance, the storage form of iron is first depleted, while hemoglobin levels in the blood remain normal. In contrast, iron deficiency anemia results from advanced iron depletion, in which both storage sites for iron and blood levels of iron are deficient (Ross, 2014).

In order to determine the level of iron deficiency, biochemical measures are commonly used. During the initial stages of iron deficiency, nonfunctional iron store depletion is indicated when serum ferritin levels are below 12 micrograms/L and total iron binding capacity is more than 400 micrograms/dl. If iron deficiency progresses, depleting functional iron stores, this intermediate state of deficiency can be indicated by the drop in transferrin saturation and rise in free erythrocyte protoporphyin and serum transferrin receptor levels. The most chronic iron deficiency, iron deficiency anemia, is indicated by abnormally low hemoglobin levels, less than 130 g/L in males and less than 120 g/L in females, as well as decreases in mean cell volume (Aggett, 2012).

Although not common in the U.S., in many developing countries, vitamin A deficiency can also increase one's risk of developing iron deficiency anemia. Since vitamin A plays an important role in mobilizing iron from its storage sites, a deficiency in vitamin A can limit the body's ability to utilize iron. As a result, even if the body can maintain adequate amounts of stored iron, hemoglobin levels are low and therefore may result in an apparent iron deficiency (IOM Food and Nutrition Board, 2001).

Symptoms of Iron Deficiency

While iron deficiency often remains unnoticed without common symptoms, iron deficiency anemia is normally accompanied by signs, including fatigue, decreased work and school performance, as well as slow cognitive and social development. In addition, difficulty maintaining body temperature, decreased immune functioning and glossitis, an inflamed tongue, are among several other signs of iron deficiency anemia. Although there is uncertainty in the cause of association, pica and geophagia, eating nonnutritive substances such as dirt and clay, are also often associated with iron deficiency (Ross, 2014).

High-Risk Populations

The prevalence of iron deficiency varies with age, gender and life stage, with increased prevalence among those with greater iron needs, those who tend to lose more iron, and those who do not adequately absorb iron. Women of childbearing age, pregnant women, preterm and low birth weight infants, older infants, toddlers and girls are at the greatest risk of developing iron deficiency anemia. For pregnant women, iron needs are approximately double that of non-pregnant women due to increased blood volume, increased needs of the fetus, and blood loss during delivery (WHO, 2001).

Females, specifically those who are pre- and post-menarche, are also at high risk for developing iron deficiency due to the physiological demands of growth. Both the occurrence of menarche and the subsequent regulation of menstruation during the female growth spurt increase the requirements for iron. In addition, food choices and lifestyle behaviors during this vulnerable time period may also challenge girls to maintain a positive iron balance. A recent study on iron status in girls examined iron deficiency through assessment of low serum. Results found that iron deficiency affects 25 to 39 percent of females, ages 10 to 19 years old (Deegan, Bates & McCargar, 2005). National data also suggest that while most boys (98 percent) met recommended dietary intake guidelines for iron, only half (56 percent) of girls aged 14-19 met the guidelines (Gleason & Suitor, 2001).

Vegetarians may also be at risk of iron deficiency anemia due to their restriction to non-heme iron. Generally, vegetarians who exclude animal products and heme from their diet require twice as much dietary iron each day as non-vegetarians due to the limited intestinal absorption of non-heme iron in plant foods (IOM, 2001).

Iron deficiency anemia can also be a result of chronic mal-absorption, which contributes to iron depletion through limited absorption and intestinal blood loss. Since most iron is absorbed in the small intestine, gastrointestinal disorders that cause inflammation of the small intestine, such as Celiac Disease and Crohn’s Disease, can lead to diarrhea, poor absorption of dietary iron and iron depletion. Iron intake is crucial in replacing basal losses originating from the sloughing of epithelial cells, sweat, and menstrual losses in addition to satisfying growth demands (Mesías, Seiquer & Navarro, 2013).

Comparing Iron Intake to Recommendations

The Institute of Medicine Food and Nutrition Board recommends that girls nine-13 consume eight mg of iron per day and girls 14-18 years old consume an RDA of 15 mg/day (2001). While it may seem like there is a common availability of iron in the diet, many girls do not consume sufficient amounts, which may ultimately impede successful growth and development. According to the NHANES 2011-2012 study, What We Eat in America, the mean amount of iron consumed by females aged six-19 was reported to be 12.95 mg/day (Moshfegh et al., 2009). Compared to dietary recommendations, this is an inadequate amount of iron for girls in the pre-pubertal and pubertal stages. Many American and European adolescent girls fail to achieve the recommended intake of iron. A study of adolescent girls from the U.S. and Europe found that iron intake ranged from about 8.7 mg/day to 17.2 mg/day, with most of the girls consuming less than the amount recommended (Mesías, Seiquer & Navarro, 2013).

Based on current research concerning the female adolescent population in the U.S., iron and calcium were selected as specific nutrients of concern for the present study, as these have a significant impact on girls' health and development. Although there has been previous research related to the roles of calcium and iron in the adolescent diet, this research aims to assess the dietary intake of iron and calcium within a sample of girls. The goals of our research are to better assess the dietary intake and the gaps in diet that may be related to inadequate amounts of these two valuable nutrients that contribute to development during this critical time.

IV. METHODS

STUDY DESIGN AND PARTICIPANTS

The sample population included a subset of subjects from a larger cohort participating in an ongoing longitudinal study of female gymnasts and non-gymnasts through the Orthopedics Department at the State University of New York (SUNY) Upstate Medical University (Scerpella et al., 2010). This longitudinal study was approved by the SUNY Upstate Medical University Institutional Review Board and has been performed in accordance with the ethical standards of the 1964 Declaration of Helsinki. The girls and their parents provided informed consent, as dictated by their subject age. The data from the longitudinal study have been collected over the course of eight years. The sample consisted of Caucasian females, and at the time of enrollment, all participants were between the ages of seven and 12. Gymnast subjects were recruited from local gymnastics clubs whereas non-gymnast (yet still active) subjects were recruited from local grade schools and selected to match gymnasts based on age and body size. For the purpose of this research study, all girls were grouped together by age regardless of their gymnastics participation. From this larger longitudinal study, 74 subjects were selected if they met certain criteria in order to assess girls' dietary intake. The subjects included in our study came from the 2012 data collection period and were selected by an age cutoff of nine-18 years old at the date of measurement. All other participants who did not fall within the age criteria were excluded from this study. Within our sample, two age groups were identified with 58 females in the younger age group (nine-13 years) and 16 in the older age group (14-18 years). Participants who did not have complete anthropometric measurement data for the first half of the year in 2012 and any participants who had incomplete data from the YAQ in 2012 were excluded.

VARIABLES

Weight Status

Subjects were measured every six months in order to assess anthropometry, body composition, and pubertal stage. Measured height and weight were used to calculate BMI, and age was used to determine BMI percentile based on CDC BMI-for-age growth charts for females. According to the CDC, BMI percentiles are the most commonly used indicator to assess the size and growth patterns of children and girls in the United States and to identify possible weight concerns. The BMI percentile indicates the relative position of children's BMI among children of the same sex and age. Underweight status is categorized as BMI less than the 5th percentile, healthy weight ranges from the 5th to less than the 85th percentile, overweight ranges from the 85th to less than the 95th percentile, and obesity is equal to or greater than the 95th percentile (Kuczmarski, et al., 2002).

Dietary Intake

Subjects completed the YAQ twice a year in order to report dietary intake, habits and behaviors. The YAQ includes 151 foods, each a standard serving, with nine frequency categories ranging from "never or less than once per month" to "six + per day." Questions were also asked regarding the frequency with which the older children and girls prepare food for themselves, how often they eat breakfast, as well as which beverages they frequently consume. In addition, supplement use and frequency was included in the YAQ.

To examine the reproducibility of diet, nutrients such as protein, fat, fiber, calcium and iron were included in the development of the questionnaire. Foods were grouped into eight categories for statistical analysis: snacks, meats, baked goods and cereals, fruits, vegetables, fruits and vegetables, milk and soda. Fruits and vegetables were listed together to better reflect the current guidelines for diet recommendation.

The YAQ has been assessed to determine its accuracy and reproducibility in assessing the eating habits of older children and girls over time. A study was conducted in 1995, consisting of a multiethnic sample of children recruited in the ongoing Nurses' Health Study II, with 179 children ranging from nine to 18 years old, in order to determine the reproducibility of the YAQ (Rockett et al.). The subjects in this study completed the YAQ twice, one year apart. Their responses were used to evaluate one-year test-retest reproducibility of the questionnaire by comparing their first questionnaire to their second. In order to determine reproducibility, Pearson correlation coefficients were calculated on nutrient data adjusted in relation to energy intake and on unadjusted food data. Results from the study showed that the reproducibility of the YAQ for energy-adjusted nutrients ranged from .26 for protein and iron to .58 for calcium. The reproducibility was found to be higher for girls than boys.

DATA ANALYSIS

Overall

SPSS Statistics (Version 22.0.0.0) was used to analyze the nutrient data. Nutrient data from the YAQ were analyzed to assess macro- and micronutrients of concern, with special emphasis on calcium and iron. Means, standard deviations and ranges of nutrient intake were assessed for the whole sample and by age group. Intakes were compared to the DRIs for all nutrients. Participants' intakes were also examined in relation to diet from food alone and from diet with supplement use.

Based on literature, the food sources from the YAQ that were highest in iron and calcium were identified. Frequencies were assessed in the YAQ to examine the subjects' consumption of the top food sources high in iron and calcium. The frequencies of consumption of these key food sources were analyzed between participants meeting and not meeting the RDA. For calcium, frequency of sugar-sweetened beverage consumption was also examined in order to see if the they were displacing beverages higher in calcium.

Age Group Comparison

The data from the sample were further analyzed based on the two age groups. Age groups were divided based on the age ranges listed for the Dietary Reference Intake recommendations for iron and calcium to determine how the participants in the two age groups compared in meeting these micronutrient recommendations. This division provides a comparison of the frequency of consumption of foods high in calcium and iron between the two age groups.

RDA Comparison

The sample population was divided based on those who met or exceeded the RDAs and those who did not meet the recommendations for the older and younger age groups. This made it possible to compare the amount of participants who met recommendations versus those who did not. In addition, this comparison identified gaps in the girls' dietary intakes.

V. RESULTS

Weight Status

The mean BMI percentile for the sample is 57.0 (±26.4). The mean BMI percentile of the younger girls is 57.1 (±26.1) while mean BMI percentile of the older girls is 56.4 (±28.4). Using BMI percentile to examine weight status in the sample, one, 59, 10 and four girls were considered underweight, normal weight, overweight and obese, respectively.

Energy and Macronutrient Intake

Table 2 outlines the intake of macro- and micronutrients among the whole sample and within the older and younger age groups in comparison to the appropriate DRIs. The mean energy intake for the sample was 1999 kilocalories (± 524), protein was 80 grams (± 24), fat was 69 grams (± 20), and carbohydrates was 270 grams (± 75). The participants were within the Acceptable Macronutrient Distribution Range for all macronutrients: 16 percent (±2) of calories from protein, 31 percent (±4) of calories from fat, and 54 percent (±5) calories from carbohydrates. In comparing the younger and older girls, the mean percentage of calories from macronutrients did not vary greatly.

Fiber intake among the sample was lower (mean =17 g, ± 6) than the adequate intake for both age groups (26 grams). Fiber intake did not vary greatly between age groups.

Dietary Supplement and Micronutrient Intake

Among the sample, 47 percent of the subjects reported taking a dietary supplement while 53 percent did not. In comparing the age groups, 55 percent of the younger girls and 33 percent of the older girls took supplements. Intake of most micronutrients was higher than the RDA or AI. Among the sample, older girls consistently had a lower intake of micronutrients compared to the younger girls.

When considering micronutrient intake without supplementation, vitamins A, B1, B2, B6, B12, C, niacin, folate, phosphorus and zinc were on average higher than recommendations. For both age groups, without supplementation, vitamin D and calcium were lower than recommendations. Iron intake was lower than recommended for the older age group without supplementation.

With supplementation, iron intake between both age groups was higher than recommendations. In contrast, vitamin D and calcium intake in the sample were still lower than recommended when supplements were included.

CALCIUM

Food sources in the participants' diets that were high in calcium and frequently consumed were identified. The top contributors to calcium intake included milk, yogurt, cheese, cereal and ice cream.

Among the 74 subjects in the study, 32.4 percent consumed two-three glasses of milk per day and 31.1 percent had two-six glasses per week. 31.1 percent had two-six cups of yogurt per week. 48.6 percent of the subjects consumed two-six slices of cheese per week. Of the sample population, 40.5 percent had two-four bowls of cold cereal per week. Lastly, 31.1 percent of subjects consumed ice cream two-four times each week.

Comparing Those Meeting RDA to Those Not Meeting RDA

Table 3 shows the frequency of consumption of the top five leading sources of calcium for the girls based on those meeting versus not meeting the calcium RDA. Among the 74 subjects in the study, 32 females (43.2 percent) met or exceeded the RDA for calcium (1300 mg per day).

In addition to examining the top sources of calcium, calcium intake was compared between the two age groups. **Figures 2 to 6** show the frequency of consumption of the top sources of calcium among the older and younger girls. Results showed that younger girls aged nine to 13 had higher intakes of calcium in milligrams as well as higher intakes of top food sources of calcium.

Of all types of milk, 55.2 percent of the younger girls consumed one or more glasses of milk per day, while only 33.8 percent did so among the older girls. Among the younger girls, skim milk was the most frequently consumed type of milk in regards to fat content (31 percent). In comparison, the older group of girls drank skim milk most frequently (62.5 percent). Higher fat milk choices were less frequently consumed in the older cohort. Among the younger girls, 36.2 percent drank at least one glass of chocolate milk per day versus just 12.6 percent among the older girls.

Among the younger girls, 17.2 percent had one can of soda or more per week. In comparison, 43.8 percent of subjects in the older group had 1 can or more per week. Additionally, in the younger group of girls, 6.9 percent drank sugar-sweetened iced tea at least once per week, compared to the older girls, among whom 18.8 percent drank this amount at least once per week.

In addition to finding differences between the two age groups in the sample, comparisons were made between subjects meeting the RDA for calcium (more than 1300 mg of calcium/day) and those not meeting the recommendation (less than 1300 mg of calcium/day). 32 subjects met the recommendations while 42 did not. Among the group of girls meeting recommendations, milk consumption was found to be more frequent with 81.3 percent drinking one or more glasses of milk per day. In comparison, only 31.9 percent of those not meeting recommendations drank one or more glasses per day.

In addition, for those meeting recommendations, 34.4 percent drank chocolate milk at least once a day in comparison to 19.1 percent for those not meeting recommendations.

Yogurt and cheese were other major contributors to calcium intake in the sample. In those meeting recommendations, 62.5 percent ate at least two-six cups of yogurt or more per week while only 26.2 percent of those not meeting recommendations ate this amount. In those meeting recommendations, 90.7 percent of subjects had two or more slices of cheese per week compared to 59.5 percent for those not meeting recommendations.

The relationship between sugar-sweetened beverage intake and calcium intake was examined. Results showed that soda intake was lower among those subjects meeting calcium recommendations and higher among those not meeting recommendations.

Of the group who met calcium recommendations, 9.4 percent drank one can of soda or more per week. At 33.3 percent, those in the group who did not meet recommendations were more likely to drink soda. Similar results were found with fruit juice consumption. In those meeting recommendations, 21.9 percent drank two or more glasses of orange juice per week. Of subjects who did not meet recommendations, 35.7 percent drank two or more glasses of orange juice per week.

Supplementation

Multivitamin supplementation among the sample population was also considered by comparing participants who met and did not meet recommendations for daily calcium intake. Average calcium intake was lower than recommendations and supplementation did not contribute significantly to enhance the sample population’s overall intake.

IRON

Food sources in the subjects' diets that were high in iron and frequently consumed among the sample as a whole were identified. The top contributors to iron intake were divided among heme iron and non-heme iron. Of the food sources in the YAQ, the top sources of heme iron were pork, beef, chicken or turkey as a main dish, roast beef/ham sandwich, and chicken/turkey sandwiches. As for non-heme, the top contributors included cooked spinach, broccoli, beans, mashed potatoes and fortified breakfast cereal. Heme iron was consumed more frequently than non-heme iron in the overall subjects' diets.

Table 4 shows the frequency of consumption of the top 10 leading sources of iron for the girls based on those meeting versus not meeting the iron RDA. Of the top heme sources, 82.5 percent of the sample consumed chicken or turkey as a main dish once or more per week. Beef as a main dish was consumed by 79.8 percent of the subjects once or more per month. Pork or ham, as a main dish was consumed by 25.7 percent of the population once or more per week. 20.3 percent consumed a roast beef/ham sandwich once or more per week and 36.5 percent consumed chicken/turkey sandwiches once or more per week.

Comparing Those Meeting RDA to Those Not Meeting RDA

Figures 7 to 11 show the frequency of consumption of the top sources of heme iron among the older and younger girls. In the younger group of girls, 55 of the 58 subjects met the RDA of iron, (eight mg/day). As for the older group, eight of the 16 girls met the RDA (15 mg/day). Diets of the younger group were closer to recommendations compared to the older group. Results showed that younger girls, ages nine to 13, had higher intakes of iron in milligrams as well as higher intakes of top food sources of iron.

Comparisons were made between subjects meeting the RDA for iron for each age group. The younger age girls were divided between those that met the RDA for iron of eight mg or more per day, and those that did not meet the recommendations (less than eight mg/day). 55 of the younger girls met the recommendations while three did not. The older group of girls was divided by whether they met the RDA (more than 15 mg iron/day) or not (less than 15 mg iron/day). Exactly 50 percent (eight) of the girls met the RDA and 50 percent did not.

Heme and non-heme sources as well as younger versus older girls were considered in the analysis of how top food sources contributed to meeting the RDA for iron.

For the younger group meeting the RDA, 32.7 percent had turkey/chicken once or more per week. 23 percent had roast beef/ham sandwiches at least once per week. 78.2 percent had chicken or turkey as a main dish once or more per week. 38.2 percent had beef once or more per week and 27.3 percent had pork once per week. For non-heme sources, 78.2 percent of the younger group had cold cereal, 52.7 percent had mashed potatoes, and 49.1 percent had broccoli, all at least once per week. 9.1 percent of the girls consumed beans two times per week or more, and 10.9 percent of girls had cooked spinach at least once per week.

For the younger group not meeting the RDA, 66.7 percent of the girls had turkey/chicken sandwiches one-three times per month and 100 percent had roast beef/ham sandwiches never/less than once per month. 66.7 percent consumed chicken or turkey as a main dish once per week, 66.7 percent consumed beef one-three times per month, and 66.7 percent consumed pork one-three times per month. For non-heme sources, 33.3 percent of girls had cereal two-four times per week. 66.7 percent consumed mashed potatoes one-three times per month, 33.3 percent of girls had broccoli once per week, 100 percent had beans never/less than once per month and 33.3 percent of girls consumed cooked spinach two-four times per week.

For the older group meeting the RDA, 69.3 percent of the girls had turkey/chicken sandwiches at least once per week. 15.4 percent consumed roast beef/ham sandwiches once or more per week. Of the older girls, 30.8 percent had chicken or turkey as a main dish two-four times per week, 38.5 percent had beef once per week, and 23.1 percent had pork once per week. For non-heme sources, 77 percent of ate cereal, 61.6 percent consumed mashed potatoes, and 23.1 percent had broccoli, all at least once per week. 30.8 percent of girls consumed beans once per week or less and 30.8 percent of girls consumed cooked spinach at least once per week.

For the older group not meeting the RDA, 66.7 percent of the girls had turkey/chicken sandwiches one-three times per month and 100 percent had roast beef/ham sandwiches never/less than once per month. One hundred percent consumed chicken or turkey as a main dish once per week, 66.7 percent consumed beef one-three times per month, and 33.3 percent consumed pork once per week. For non-heme sources, 33.3 percent of girls had one bowl of cereal per week. 66.7 percent consumed mashed potatoes and 66.7 percent of girls had broccoli once per week, 100 percent had beans never/less than once per month and 33.3 percent of girls consumed cooked spinach one-three times per month.

Supplementation

Multivitamin supplementation among the sample population was also considered by comparing participants who met and did not meet recommendations for daily iron intake. Younger girls met the iron recommendation when considering diet intake with and without supplementation. The older girls did not meet the recommendation without supplementation but exceeded the recommended iron intake with supplementation.

VI. DISCUSSION

Weight Status

In our sample of nine-18 year old girls, 1.3 percent, 79.7 percent, 13.5 percent and 5.4 percent were considered underweight, normal weight, overweight and obese, respectively, based on BMI-for-age percentile. More subjects in our sample were considered normal weight and less were classified as overweight and obese compared the most recent national survey data study (Ogden et al., 2014). This difference could be due to the different age ranges of the females. While the NHANES study looked at females 6-19 years old, our subjects were 9-18 years old. Additionally, our sample included gymnasts, non-gymnasts and ex-gymnasts while the NHANES study did not specify physical activity level. The lower prevalence of overweight and obesity in our sample may be due to the different levels of physical activity among the subjects. Additionally, the NHANES study used a more ethnically and economically diverse sample than did ours. Increased prevalence of obesity and overweight females in the NHANES study may also be due to increased number of Hispanic and Mexican-American subjects.

Though the prevalence of overweight and obese females varied within the two studies, child and adolescent obesity continues to be a major focus of public health efforts in the U.S. Both the short-term and long-term consequences of overweight children and adolescents confirm that reducing obesity risk among this age group should be a crucial goal (Freedman et al., 2007).

Macronutrient intake

The girls in this study met the AMDR for all macronutrients, although the percent of calories from protein was on the lower end of recommendations and the percent of calories from fat was on the higher end of recommendations. While the AMDR for carbohydrates was within a healthy range for our sample, fiber intake was lower than the recommended intakes. Inadequate intake of fruits, vegetables and whole grains among female adolescents could explain the lack of fiber in their diets.

In a 2002 study by Neumark-Sztainer et al. regarding eating patterns among girls, compared to the Healthy People 2010 objectives, females aged 11-18 years old did not meet the recommended daily intakes of fruit and vegetables. Of the 2,363 females in the study, 53.8 percent did not consume the recommended daily serving of fruit (two/day) and 82.5 percent did not meet the recommended daily serving of vegetables (3/day) (Neumark-Sztainer et al., 2002). Both the low intake of fruits and vegetables found within this study and low fiber intake among our sample indicate that increasing fruit and vegetable intake among females may contribute to a more balanced diet.

Dietary Supplement and Micronutrient Intake

Mean intakes of vitamins A, B1, B2, B6, B12, C, niacin, folate, phosphorus and zinc were higher than recommended for the subjects in our sample. In comparison, mean vitamin D and calcium intake were lower than recommendations both with dietary sources and supplementation considered. Vitamin D and calcium intakes were also lower for the older age group than the younger age group. In a longitudinal study by Moore, alcium and vitamin D intakes among girls were specifically examined. In the National Growth and Health Study, 2,379 girls' micronutrient intakes were analyzed using three-day diet records. Subjects were divided into three age ranges (nine-13, 14-18 and 19-20 years) and their intakes were monitored over 10 years. This study found that vitamin D and calcium intake were inadequate in the girls' diets. Similarly, this study also found that the older girls consistently had lower intakes of the micronutrients than the younger girls. Low consumption of dairy products, breakfast cereals and fortified food products may contribute to the low consumption of these micronutrients. This is also consistent with the 2010 Dietary Guidelines for Americans that identify calcium and vitamin D as nutrients of concern for children and adults (Moore, 2012).

The differences in the frequency and type of dairy products consumed among the older and young girls in the sample were consistent with another study among adolescents, ages 14 and 17 years old. Among a group of 1,631 adolescents in a larger cohort, subjects' dietary intakes were tracked at ages 14 and 17 years old using food frequency questionnaires. The study found that mean dairy intake decreased from 536 ± 343 g/day to 464 ± 339 g/day, due mostly to a decrease in regular milk consumption. Girls decreased from 2.2 to 1.9 servings/day of dairy, further suggesting that dairy consumption, specifically that of milk, decreases over the course of adolescence (Parker et al, 2012).

Among our sample, mean intake of iron from dietary sources was lower than recommended for the older age group; however, this group met and exceeded recommendations when supplementation was reported. A study by Gleason and Suitor (2002) looked at children's diets and found that a major nutrient of concern was iron. Results showed that 44 percent of females ages 14-18 years old had intakes of iron below 80 percent of the RDA. Similarly, the older cohort of girls in our study was found to have a mean of 13.77±6.26 mg of iron/day in their diet (without supplementation). However, Gleason and Suitor's study showed that female girls, ages 14-18, were met the RDA for iron above 80 percent of the RDA, but still did not meet the adequate benchmark that dietary guidelines recommend.

Supplement Use

Supplementation was analyzed in our sample in order to determine if the intake of micronutrients was significantly enhanced by regular supplement use. Among the sample, 47 percent of the subjects took a supplement regularly while 53 percent did not. In comparing age groups, 55 percent of the younger girls and 33 percent of the older girls reported consuming dietary supplements. Because more girls in the younger age group met the micronutrient recommendations than in the older group, this suggests that multivitamin use among the sample may have played a role in meeting micronutrient recommendations.

Similar results of supplement use were found in the National Growth and Health Study (NGHS), which examined nine-year-old females over a 10-year period. In the NGHS, 36 percent of girls (42.7 percent of whites and 29.1 percent of blacks) at the end of the follow-up reported taking multivitamins regularly. Similarly, in the 1999–2004 NHANES, 34.2 percent of children and adolescents took a multivitamin/mineral supplement (although only half of those did so daily). The NHANES data also show that multivitamin consumers tended to have better nutrition overall and healthier lifestyles. This may suggest that those who might benefit most from supplementation were least likely to take vitamins. Though supplementation may increase micronutrient intake among females, it remains unclear whether they provide health benefits that are equal to meeting micronutrient needs through dietary sources (Moore et al, 2012).

CALCIUM

Food Sources

Within our sample, the top sources of calcium were cereal, milk, yogurt, cheese and ice cream. These top sources of calcium among the entire sample population are consistent with other findings examining female calcium intake. A sample of 149 girls from a Midwestern metropolitan area participated in a randomized controlled trial from 1997 to 2008. The study examined diet intake from three-day food records and evaluated differences in selected nutrient intakes between the two study groups, a high calcium diet group and a usual diet group. Results from this study found that dairy products contributed 68 percent of the total mean of calcium intake, 1,494 mg/day, in the high calcium group, while calcium fortified food contributed 304 mg/day. The top three contributors were milk (45 percent), cheese (17 percent) and calcium-fortified foods (20 percent). In the study, calcium fortified foods included fortified fruit juice, breakfast cereals and cereal bars (Rafferty, Watson & Lappe, 2011). Though our results also found dairy foods and ready-to-eat cereals as frequent sources of calcium among the girls, our study did not differentiate between fortified and non-fortified juices and cereal bars. Considering calcium-fortified foods were a high source of calcium in the study above, encouraging both dairy foods and fortified calcium foods for females may be important to help them meet their needs. Additionally, since ready-to-eat cereals are fortified with calcium and are often consumed with milk, it may be an important food to encourage as a healthy breakfast choice among females.

Older Versus Younger Girls

The results of our study illustrate that calcium consumption, with and without supplementation, was higher in the nine-13 year old group of girls than in the 14-18 group. Although the differences between the two were not tested for statistical significance due to small sample sizes, consumption among the younger group was greater than the older cohort. The younger group met 91 percent of their calcium needs without supplementation and 94 percent of their needs with supplementation compared to the older group who only met 81 percent of their calcium needs without supplementation and 82 percent of their needs with supplementation.

Similar results were found from a five-year follow-up study of 843 females in Minneapolis, which measured changes in calcium and dietary intake during the transition from middle adolescence to young adulthood. Mean daily intake of calcium was measured at baseline, when the girls were 9 years old, and then again during adolescence at 14 years old. Findings showed that mean intakes of calcium, including absolute intake and intake density, decreased by an average of 153±19 mg during the transition to young adulthood. Our results were similar in that the older girls had lower calcium intakes compared to the younger girls. Factors that could have contributed to this change in both studies could have included, but are not limited to, health/nutrition attitudes, taste preference for milk, weight control behaviors, mealtime milk availability and intolerances such as to lactose (Larson et al., 2009). Socio-environmental factors, such as parental presence at meals, social support for healthy eating and more structured meals consumed at home could have a strong influence on younger females having a higher consumption of calcium than older girls (Larson et al., 2006).

Beverage Intake

Since our results found that milk is a major contributor of calcium among females, alternative beverage intake was also analyzed in order to see if these beverages were displacing milk in females' diets.

Among the younger girls, 17.2 percent had one can of soda or more per week while 43.8 percent of the older girls had one can or more per week. Additionally, in the younger group of girls, 6.9 percent drank sugar-sweetened iced tea at least once per week or more, compared to the older girls, among whom 18.8 percent drank this amount at least once per week.

When comparing subjects who met and did not meet recommendations, this relationship between beverage intake and low calcium intake was also found. Of the group who met calcium recommendations, 9.4 percent drank one can or more per week of soda. Of the group who did not meet recommendations, 33 percent drank soda one can or more per week. Similar results were found with fruit juice consumption. In those meeting recommendations, 21.9 percent drank two or more glasses of orange juice per week while among the subjects who did not meet recommendations, 35.7 percent drank two-six glasses of orange juice per week.

Another study examining boys and girls 14-16 years old from 1991 to 2004, also found a negative association between milk intake and the consumption of non-carbonated soft drinks (Vatanparast, 2005). Specifically this study found that milk was displaced by non-carbonated soft drinks more than carbonated beverages. Additionally, results found that girls were more at risk for this substitution than boys. Although our results showed a higher intake of soda consumption compared to non-carbonated beverages (including juice and sweetened iced-tea), this study supports that several sugar-sweetened beverages may contribute to lowering girls' calcium intake. Compared to the most frequently consumed alternative beverages that girls consumed in this study, including fruit juice, sweetened tea, and soda, milk is nutritionally superior contributing protein, fat, vitamin C, vitamin A, riboflavin and vitamin D. This suggests that milk is an important source of calcium, as well as other nutrients of concern, among girls.

IRON

Food Sources and Availability in the Diet

Within our sample, the top sources of iron were divided between heme and non-heme food sources. Heme sources included beef, pork, chicken or turkey as a main dish, chicken/turkey sandwiches, and roast beef/ham sandwiches. As for non-heme, top contributors included cooked spinach, broccoli, mashed potatoes, beans and cold cereal. Results from the data in our study showed that heme sources of iron were consumed more frequently and by a larger percentage of the sample than non-heme sources. These findings were limited by our inability to locate top food sources within children's diets within the research literature. When compared to adults, using NHANES data from 2003-2006, we found that the top food sources of iron included ready-to-eat cereal, yeast breads and rolls, beef, baked goods, pancakes and tortillas and poultry. This sample, although older than that of our study, found that similar food sources

contributed to subjects' iron intake. The NHANES data did not identify top sources of iron from vegetables, while our study concluded that broccoli, mashed potatoes, and cooked spinach were frequently consumed iron sources. Additionally, this sample found that eggs, pasta, and soft drinks were among lower ranked sources of iron (O'Neil et al., 2012). While these were not as frequently consumed by our sample, they were food sources of iron in the girls' diets.
Although heme and non-heme iron were specified in our sample, the bioavailability of various sources of iron was not examined. However, bioavailability is important to consider in order for girls to meet iron needs. Findings from a study on the impact of low dietary iron bioavailability in adolescents showed that mean iron intake was 11.5 mg among girls aged 15-16 years old, with only a 10 percent mean estimated iron absorption. This extremely low level of iron absorption does not satisfy the iron requirements for many menstruating women. In this study, 10 percent of girls consumed dietary iron at a level below recommendations, emphasizing the importance of bioavailability when evaluating dietary iron adequacy (Hoppe et al., 2008).

In order to increase iron intake among adolescents, it is important to consider bioavailability of heme versus non-heme iron as well as other factors that increase or decrease absorption. Differentiating between the two types of iron was significant as iron bioavailability differs among heme and non-heme sources, with higher bioavailability found among heme sources. Encouraging consumption of heme sources of iron among females may be important to help them meet their iron needs from dietary sources as they are more bioavailable.

Monsen found that vitamin C enhances non-heme iron absorption three to four-fold when consumed with the meal (Monsen, 1988). In contrast, non-heme iron absorption may be compromised by certain cooking and baking methods and inhibited by phytates (Hallberg, Brune & Rossander, 1989). Additionally, dietary fiber and calcium intake may inhibit iron absorption and reduce its bioavailability, although this association remains unclear (Huang, 2000). For females consuming more non-heme iron sources than heme iron, adding vitamin C to non-heme sources in meals could help females meet their iron needs.

Iron Intake Versus Iron Needs

While 95 percent of the younger girls met the recommendations for iron, only 50 percent of the girls, ages 14-18, consumed enough iron to meet the RDA. During the period of adolescence and the transition from childhood to young adulthood, iron is a crucial micronutrient for growth and development. Recommendations increase by seven mg after ages 13 to 14, a time period during which menarche usually occurs and there is an increase in blood volume, contributing to higher demands for iron (Institute of Medicine Food and Nutrition Board, 2001).

The low iron intake among the older group in our sample is consistent with other research that prompted national goals aiming to reduce the prevalence of iron deficiency among women of reproductive age (Healthy People 2010, 2000). Based on data from the 1999-2000 NHANES, the prevalence of iron deficiency was nine percent for those aged 12-15 years and 16 percent for 16- to 19-year-olds (Tucker, 2002). These results further indicate the importance of increasing iron intake among females aged 14-18 to prevent iron deficiency.

Meeting Versus Not Meeting Recommendations With & Without Supplementation

In addition to dietary sources of iron, supplementation was also considered in determining subjects' total iron intake to determine its importance in meeting iron needs in females. The younger girls met the iron recommendation when considering diet intake with and without supplementation. Since 95 percent of the younger girls met the iron RDA without supplementation, this suggests that it was not necessary for most of the younger females to meet their iron needs.

In comparison, the older girls did not meet the recommendation without supplementation but exceeded the recommended iron intake with diet and supplementation included. Since only 50 percent of the older girls met their iron needs, this suggests that encouraging consumption of high iron foods and daily iron supplementation among the girls 14-18 years old could help this population meet its iron needs.

Results from NHANES also found low iron supplementation among females aged 14-18. In a sample of 992 non-pregnant, non-lactating females, ages 14-18, only 9.2 percent consumed supplements that contain iron during the month before the study was completed. In comparing iron supplementation among various female age groups, this study found that consumption of iron supplements was lower between ages 14-18 than any other age group examined in the study, including 19-50, 51 and older, pregnant and lactating. Additionally, the study found that the prevalence of iron deficiency was generally lower among the females 14-18 years old who took supplements that contained iron than among those who did not. These results further suggest that iron supplementation among females 14-18 could help this population meet its iron needs and reduce the risk of iron deficiency (Cogswell, Kettel-Khan & Ramakrishnan, 2003).

STRENGTHS AND LIMITATIONS

Some of the strengths of our study included the data coming from a long-term study of girls with a low attrition rate, which indicated a dedicated sample of participants. Additionally, the YAQ was a validated tool to measure subjects' dietary intake. Lastly, inclusion of supplementation versus non-supplementation for calcium and iron was significant in indicating whether the girls' diets provided adequacy of specific nutrients or whether they had to obtain nutrients elsewhere. It helped to illustrate where girls met and did not meet recommendations for calcium and iron.

Within this population of girls, particularly those 14-18 years old, nutrients of concern were identified and included those that have been targeted as public health concerns. Further research needs to focus on examining intake of key nutrients over time with consideration to bioavailability and validity of dietary assessment to identify strategies to improve dietary intake for female children and adolescents.

Our sample is not representative of the population at large since it is not ethnically diverse and largely represents active females. Additionally, because of the small sample size (n=74) and the uneven nature of the two age groups, testing for true differences between younger and older girls was not possible.

Regarding weight status, BMI percentiles were used but may be an inaccurate measure of body composition due to inability to differentiate between lean body mass and body fat among the female athletes. For example, some of the subjects were considered obese based on their BMI although this may be largely due to their high lean body mass percentage versus a high body fat percentage.

In collecting and analyzing data, the nutritional value of some of the food sources was unknown since this information could not be determined from the YAQ. For example, it was unknown whether or not the juices and beverages consumed by the sample were fortified with vitamins and minerals. This made it difficult to determine whether or not these sources contributed to the subjects' specific micronutrient intakes.

An additional limitation of our study was the method used for dietary assessment, as subjects self-reported their dietary intakes using the YAQ. These self-reporting methods have moderate validity and substantial subject-specific bias (Day et al., 2001). Tactics to improve reporting accuracy and reduce the risk of participant burden may contribute to enhanced validity and lower percent error within study results (Natarajan et al., 2010).

Lastly, another limitation of our study was that our primary data included dietary data but not biochemical data. This made it difficult to know the true nutritional needs, as well as the absorption of nutrients, in subjects' diets.

VII. CONCLUSIONS

As girls transition from childhood to adolescence, nutrient needs increase for growth and development. Past research and our study indicate that there are several specific nutrients of concerns for female adolescents. Results from our study show that vitamin D, calcium and iron intakes were lower than recommended without supplementation for females in different age groups. For vitamin D and calcium specifically, all girls had lower than the DRI when examining their intake with supplementation included. For iron, while all girls met the RDA with supplementation included, the older girls (n=16, 14-18 years old) did not meet the RDA without supplementation while the younger girls (n=58, 9-13 years old) met the requirement without supplementation.

In examining nutrients of concern, supplementation was an important factor in whether or not the girls in the sample met the DRIs. Intake of several micronutrients, including vitamin D, calcium and iron, increased among the sample due to the girls' supplement intake. Over half (47 percent) of the younger girls and about a third (33 percent) of the older girls reported consuming dietary supplements.

In comparing the two age groups in our sample, our results indicate that older girls generally have lower intakes of several nutrients of concern. Considering adolescence is a time period essential for growth and development, identifying nutrients of concern and determining strategies to improve intake is crucial. Further research needs to focus on examining intake of key nutrients over time with consideration to bioavailability and validity of dietary assessment.

VII. SOURCES CITED AND CONSULTED

Adachi-Mejia, A. (2011). Adolescent weight status and receptivity to food TV advertisements. *Journal of Nutrition Education and Behavior*. 43(6): 441.

Aggett, P. J. (2012). Iron. *Present Knowledge in Nutrition* (pp. 506-520) Wiley-Blackwell. doi:10.1002/9781119946045.ch33

Ambrosini, G. L., Oddy, W. H., Robinson, M., O'Sullivan, T. A., Hands, B. P., De Klerk, N. H., ... & Beilin, L. J. (2009). Adolescent dietary patterns are associated with lifestyle and family psycho-social factors. *Public Health Nutrition*, *12*(10), 1807-1815

Bailey, R. L., Dodd, K. W., Goldman, J. A., Gahche, J. J., Dwyer, J. T., Moshfegh, A. J., ... & Picciano, M. F. (2010). Estimation of total usual calcium and vitamin D intakes in the United States. *The Journal of Nutrition*, *140*(4), 817-822.

Bailey, R. L., Fulgoni, V. L., Keast, D. R., Lentino, C. V., & Dwyer, J. T. (2012). Do dietary supplements improve micronutrient sufficiency in children and adolescents?. *The Journal of pediatrics*, *161*(5), 837-842.

Bandura, A. (1994). Self-efficacy: The exercise of control. *Encyclopedia of Human Behavior. 4: 71-81*.

Bateson, A., & Finch, P. (2002). Do adolescents eat enough calcium? *Community Practitioner*, 75(11), 428.

Baxter-Jones, A. D., Faulkner, R. A., Forwood, M. R., Mirwald, R. L., & Bailey, D. A. (2011). Bone mineral accrual from 8 to 30 years of age: An estimation of peak bone mass. *Journal of Bone and Mineral Research*, *26*(8), 1729-1739.

Boron, W. F. (2005). In Boulpaep E. L. (Ed.), *Medical physiology: A cellular and molecular approach* (2nd ed.). Philadelphia: Saunders

Boutelle, K. N., Fulkerson, J. A., Neumark-Sztainer, D., Story, M., & French, S. A. (2007). Fast food for family meals: relationships with parent and adolescent food intake, home food availability and weight status. *Public health nutrition*,*10*(01), 16-23.

Bowman, S. A., Gortmaker, S. L., Ebbeling, C. B., Pereira, M. A., & Ludwig, D. S. (2004). Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics*, *113*(1), 112-118.

Bronfenbrenner, U., & Bronfenbrenner, U. (2009). The ecology of human development: Experiments by nature and design. *Harvard university press.*

Carlson, A., Lino, M., Gerrior, S., & Basiotis, P.P. (2003). Report card on the diet quality of children ages 2 to 9. *Family Economics and Nutrition Review*, 15(2), 52-54.

Chapman, G., & Maclean, H. (1993). "Junk food" and "healthy food": Meanings of food in adolescent women's culture. *Journal of Nutrition Education*, *25*(3), 108-113.

Chavda, H., Haley, M., & Dunn, C. (2005). Adolescents' influence on family decision-making. *Young Consumers*, *6*(3), 68-78.

Cogswell, M. E., Kettel-Khan, L., & Ramakrishnan, U. (2003). Iron supplement use among women in the United States: science, policy and practice. *The Journal of Nutrition*, 133(6), 1974S-1977S.

Day, N. E., McKeown, N., Wong, M. Y., Welch, A., & Bingham, S. (2001). Epidemiological assessment of diet: A comparison of a 7-day diary with a food frequency questionnaire using urinary markers of nitrogen, potassium and sodium. *International Journal of Epidemiology*, *30*(2), 309-317.

Deegan, H., Bates, H. M., & McCargar, L. J. (2005). Assessment of iron status in adolescents: dietary, biochemical and lifestyle determinants. *Journal of Adolescent Health*, *37*(1), 75.

Dietz, W. H. (1998). Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics*, *101*(Supplement 2), 518-525.
Dietz, W. H., & Gortmaker, S. L. (2001). Preventing obesity in children and adolescents. *Annual Review of Public Health*, 22, 337-53.
Ding, C., & Parks, S. (2007). Fast food and body weight among adolescents. *International Electronic Journal of Health Education*, *10*, 65-77.
Eaton, D. K., Kann, L., Kinchen, S., Shanklin, S., Ross, J., & Hawkins, J. Centers for Disease Control and Prevention (CDC). (2008). Youth risk behavior surveillance—United States, 2007. *MMWR Surveill Summ*, *57*(4), 1-131.
Eisenberg, M. E., & Neumark-Sztainer, D. (2010). Friends' dieting and disordered eating behaviors among adolescents five years later: findings from Project EAT. *Journal of Adolescent Health*, *47*(1), 67-73.
Farris, A. R., Misyak, S., Duffey, K. J., Davis, G. C., Hosig, K., Atzaba-Poria, N., & Serrano, E. L. (2014). Nutritional Comparison of Packed and School Lunches in Pre-Kindergarten and Kindergarten Children Following the Implementation of the 2012–2013 National School Lunch Program Standards. *Journal of nutrition education and behavior*, *46*(6), 621-626.
Fitzgerald, A., Heary, C., Kelly, C., Nixon, E., & Shevlin, M. (2013). Self-efficacy for healthy eating and peer support for unhealthy eating are associated with adolescents' food intake patterns. *Appetite*, *63*, 48-58.
Freedman, D. S., Mei, Z., Srinivasan, S. R., Berenson, G. S., & Dietz, W. H. (2007). Cardiovascular risk factors and excess adiposity among overweight children and adolescents: the Bogalusa Heart Study. *The Journal of pediatrics*, *150*(1), 12-17.
Fulkerson, J. A., Story, M., Mellin, A., Leffert, N., Neumark-Sztainer, D., & French, S. A. (2006). Family dinner meal frequency and adolescent development: Relationships with developmental assets and high-risk behaviors.*Journal of Adolescent Health*, *39*(3), 337-345.
Gillman, M. W., Rifas-Shiman, S. L., Frazier, A. L., Rockett, H. R., Camargo Jr, C. A., Field, A. E., & Colditz, G. A. (2000). Family dinner and diet quality among older children and adolescents. *Archives of Family Medicine*, *9*(3), 235.
Gleason, P., & Suitor, C. (2001). *Children's diets in the mid-1990s: Dietary intake and its relationship with school meal participation* (No. 2443). Mathematica Policy Research.
Godfrey, J. R. (2013). National school lunch nutrition standards: Making kids hungry or healthy?. *Childhood Obesity*, *9*(1), 71-73.
Hallberg, L., Brune, M., & Rossander, L. (1989). Iron absorption in man: ascorbic acid and dose-dependent inhibition by phytate. *The American Journal of Clinical Nutrition*, *49*(1), 140-144.
Haye K., Mohr P, Robbins G, Wilson C.(2009) Obesity-related behaviors in adolescent friendship networks. *Social Networks.* 32(3): 161-167.
Healthy People 2010 Understanding and Improving Health and Objectives for Improving Health. (2000) U. S. Department of Health and Human Services. U. S. 2nd ed. 2 vols. Government Printing Office.
Herrera, B. M., & Lindgren, C. M. (2010). The genetics of obesity. *Current Diabetes Reports, 10*(6), 498-505.
Hoppe, M., Sjöberg, A., Hallberg, L., & Hulthén, L. (2008). Iron status in Swedish teenage girls: impact of low dietary iron bioavailability. *Nutrition*, *24*(7), 638-645.
Huang, Y. C. (2000). Nutrient intakes and iron status of vegetarians. *Nutrition*,16(2), 147-148.
Hurrell, R., & Egli, I. (2010). Iron bioavailability and dietary reference values. *The American Journal of Clinical Nutrition*, *91*(5), 1461S-1467S.

Institute of Medicine, Food and Nutrition Board, Committee on the Scientific Evaluation of Dietary Reference Intakes. (2001). Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. *National Academy of Sciences.* Retrieved from: http://www.nal.usda.gov/fnic/DRI/DRI_Energy/energy_full_report.pdf

Institute of Medicine, Food and Nutrition Board, Committee to Review Dietary Reference Intakes for Vitamin D and Calcium. (2010).Dietary Reference Intakes for Calcium and Vitamin D. *National Academy Press.*

Institute of Medicine, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Panel on Folate Other B Vitamins and Choline, Subcommittee on Upper Reference Levels of Nutrients. (2000). Dietary reference intakes for thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, pantothenic acid, biotin, and choline; a report. *National Academy Press.*

Institute of Medicine, Food and Nutrition Board, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Subcommittees on Upper Reference Levels of Nutrients and Interpretation and Uses of Dietary References Intakes, Panel on Micronutrients. (2002). Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and amino acids (macronutrients), *National Academy Press*.

Jaime, P.C., & Lock, K. (2009). Do school based food and nutrition policies improve diet and reduce obesity? *Preventive Medicine*, *48*(1), 45-53.

Kalkwarf, H. J., Khoury, J. C., & Lanphear, B. P. (2003). Milk intake during childhood and adolescence, adult bone density, and osteoporotic fractures in US women. *The American Journal of Clinical Nutrition*, *77*(1), 257-265.

Kuczmarski, R. J., Ogden, C. L., Guo, S. S., Grummer-Strawn, L. M., Flegal, K. M., Mei, Z., ... & Johnson, C. L. (2002). 2000 CDC Growth Charts for the United States: methods and development. *Vital and health statistics. Series 11, Data from the national health survey*, (246), 1-190.

Landry BW, Driscoll SW (2012). Physical Activity in Children and Adolescents. *Journal of the American Academy of Physical Medicine and Rehabilitation.* 4(11): 826-832.

Larson, N. I., Neumark-Sztainer, D., Harnack, L., Wall, M., Story, M., & Eisenberg, M. E. (2009). Calcium and dairy intake: Longitudinal trends during the transition to young adulthood and correlates of calcium intake. *Journal of nutrition education and behavior*, *41*(4), 254-260.

Larson, N. I., Story, M., Eisenberg, M. E., & Neumark-Sztainer, D. (2006). Food preparation and purchasing roles among adolescents: associations with sociodemographic characteristics and diet quality. *Journal of the American Dietetic Association*, *106*(2), 211-218.

Larson, N. I., Story, M., Wall, M., & Neumark-Sztainer, D. (2006). Calcium and dairy intakes of adolescents are associated with their home environment, taste preferences, personal health beliefs, and meal patterns. *Journal of the American Dietetic Association*, *106*(11), 1816-1824.

Lieberman, M., Gauvin, L., Bukowski, W. M., & White, D. R. (2001). Interpersonal influence and disordered eating behaviors in adolescent girls: The role of peer modeling, social reinforcement, and body-related teasing. *Eating behaviors*, *2*(3), 215-236.

McAlister, A. L., Perry, C. L., & Parcel, G. S. (2008). How individuals, environments, and health behaviors interact. *HEALTH BEHAVIOR*, *169*.

Mesías, M., Seiquer, I., & Navarro, M. P. (2013). Iron nutrition in adolescence. *Critical reviews in food science and nutrition*, *53*(11), 1226-1237.

Monsen, E. R. (1988). Iron nutrition and absorption: dietary factors which impact iron bioavailability. *Journal of the American Dietetic Association*, *88*(7), 786-790.

Moore, L. L., Singer, M. R., Qureshi, M. M., Bradlee, M. L., & Daniels, S. R. (2012). Food group intake and micronutrient adequacy in adolescent girls. *Nutrients*, *4*(11), 1692-1708.

Moshfegh A, Goldman J, Jaspreet A et al.: What We Eat In America NHANES 2005-2006: Usual nutrient intake from food and water compared to 1997 Dietary Reference Intake for Vitamin D, Calcium, Phosphorus, and Magnesium. (2009). *U.S. Department of Agriculture, Agricultural Research Service*.

Natarajan, L., Pu, M., Fan, J., Levine, R. A., Patterson, R. E., Thomson, C. A., ... & Pierce, J. P. (2010). Measurement error of dietary self-report in intervention trials. *American Journal of Epidemiology*, *172*(7), 819-827.

National Institutes of Health. (2012). Calcium and vitamin D: Important at every age. Retrieved July 14, 2014, from http://www.niams.nih.gov/Health_Info/Bone/Bone_Health/Nutrition/

Neumark-Sztainer, D., Story, M., Dixon, L. B., Resnick, M. D., & Blum, R. W. (1997). Correlates of inadequate consumption of dairy products among girls. *Journal of Nutrition Education*, *29*(1), 12-20.

Neumark-Sztainer, D., Story, M., Hannan, P. J., & Croll, J. (2002). Overweight status and eating patterns among girls: Where do Youths Stand in Comparison with the Healthy People 2010 objectives?. *American Journal of Public Health*, *92*(5), 844-851..

Neumark-Sztainer, D., Story, M., Perry, C., & Casey, M. A. (1999). Factors influencing food choices of girls: Findings from focus-group discussions with girls. *Journal of the American Dietetic Association*, *99*(8), 929-937

Nutrition Standards for School Meals. (2015, March 10). Retrieved April 7, 2015, from http://www.fns.usda.gov/school-meals/nutrition-standards-school-meals

O'Dea, J. A. (2003). Why do kids eat healthful food? Perceived benefits of and barriers to healthful eating and physical activity among children and adolescents. *Journal of the American Dietetic Association*, *103*(4), 497-501.

O'Neil, C. E., Keast, D. R., Fulgoni, V. L., & Nicklas, T. A. (2012). Food sources of energy and nutrients among adults in the US: NHANES 2003–2006.*Nutrients*, *4*(12), 2097-2120.

Office of Dietary Supplements. (2013). Calcium-dietary supplement fact sheet. Retrieved July 14, 2014, from http://ods.od.nih.gov/factsheets/Calcium-HealthProfessional/

Office of Disease Prevention and Health Promotion (2015) 2008 Physical Activity Guidelines for Americans: Chapter 3. Retrieved June 17, 2014, from http://www.health.gov/paguidelines/guidelines/chapter3.aspx

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *JAMA*, *311*(8), 806-814.

Parker, C. E., Vivian, W. J., Oddy, W. H., Beilin, L. J., Mori, T. A., & O'Sullivan, T. A. (2012). Changes in Dairy food and nutrient intakes in Australian adolescents. *Nutrients*, *4*(12), 1794-1811.

Picciano, M. F., Dwyer, J. T., Radimer, K. L., Wilson, D. H., Fisher, K. D., Thomas, P. R., Marriott, B. M. (2007). Dietary supplement use among infants, children, and adolescents in the United States, 1999-2002. *Archives of Pediatrics & Adolescent Medicine*, *161*(10), 978-985.

Rafferty, K., Watson, P., & Lappe, J. M. (2011). The selection and prevalence of natural and fortified calcium food sources in the diets of adolescent girls. *Journal of Nutrition Education and Behavior*, *43*(2), 96-102.

Rickert, V. I., Hassed, S. J., Hendon, A. E., & Cunniff, C. (1996). The effects of peer ridicule on depression and selfimage among adolescent females with Turner syndrome. *Journal of Adolescent Health*, *19*(1), 34-38.

Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). Media in the lives of 8-to 18-year-olds. *Henry J. Kaiser Family Foundation*.

Rockett, H. R. H., Wolf, A. M., & Colditz, G. A. (1995). Development and reproducibility of a food frequency questionnaire to assess diets of older children and adolescents. *Journal of the American Dietetic Association*, 95(3), 336-340.

Ross, A.C. (2014) Iron. *Modern Nutrition in Health and Disease*. 11th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2014:176-88.

Scheule, B. (2009). Gender Differences in Food Preferences of School-Aged Children and Adolescents. *Journal of School Health*, 532-540.

Scully, M., Wakefield, M., Niven, P., Chapman, K., Crawford, D., Pratt, I. S.. (2012). Association between food marketing exposure and adolescents' food choices and eating behaviors. *Appetite*, *58*(1), 1-5.

Shawky, R. M., & Sadik, D. I. (2012). Genetics of obesity. *The Egyptian Journal of Medical Human Genetics*, 13(1), 11-17.

Sigel, A. (Ed.). (2004). *Metal Ions in Biological Systems: Volume 41: Metal Ions and Their Complexes in Medication*. CRC Press.

Spear, B. A. (2002). Adolescent Growth and Development. *Journal of the American Dietetic Association*, 102: S23-S29.

Story, M., Neumark-Sztainer, D., & French, S. (2002). Individual and environmental influences on adolescent eating behaviors. *Journal of the American Dietetic Association*, *102*(3), S40-S51.

Story, M., Neumark-Sztainer, D., Sherwood, N., Stang, J., & Murray, D. (1998). Dieting status and its relationship to eating and physical activity behaviors in a representative sample of US adolescents. *Journal of the American Dietetic Association*, *98*(10), 1127-1135.

Tanner, J. M. (1990). Fetus into man: Physical growth from conception to maturity. *Harvard University Press*, 3(2): 217-218.

Tanofsky-Kraff, M. (2013). Self-efficacy beliefs and eating behavior in adolescent girls at-risk for excess weight gain and binge eating disorder. *International Journal of Eating Disorders*, 32: 663-668.

Tanumihardjo SA, Anderson C, Kaufer-Horwitz M, et al. (2007). Poverty, obesity, and malnutrition: An international perspective recognizing the paradox. *Journal of Academy of Nutrition and Dietetics.* 107(11):1966-1972.

Titchenal, C. A., & Dobbs, J. (2007). A system to assess the quality of food sources of calcium. *Journal of Food Composition and Analysis*, *20*(8), 717-724.

Tucker, Miriam E. (2002). "Iron deficiency. (Pediatric Briefs)." Pediatric News: 5. Health Reference Center Academic.

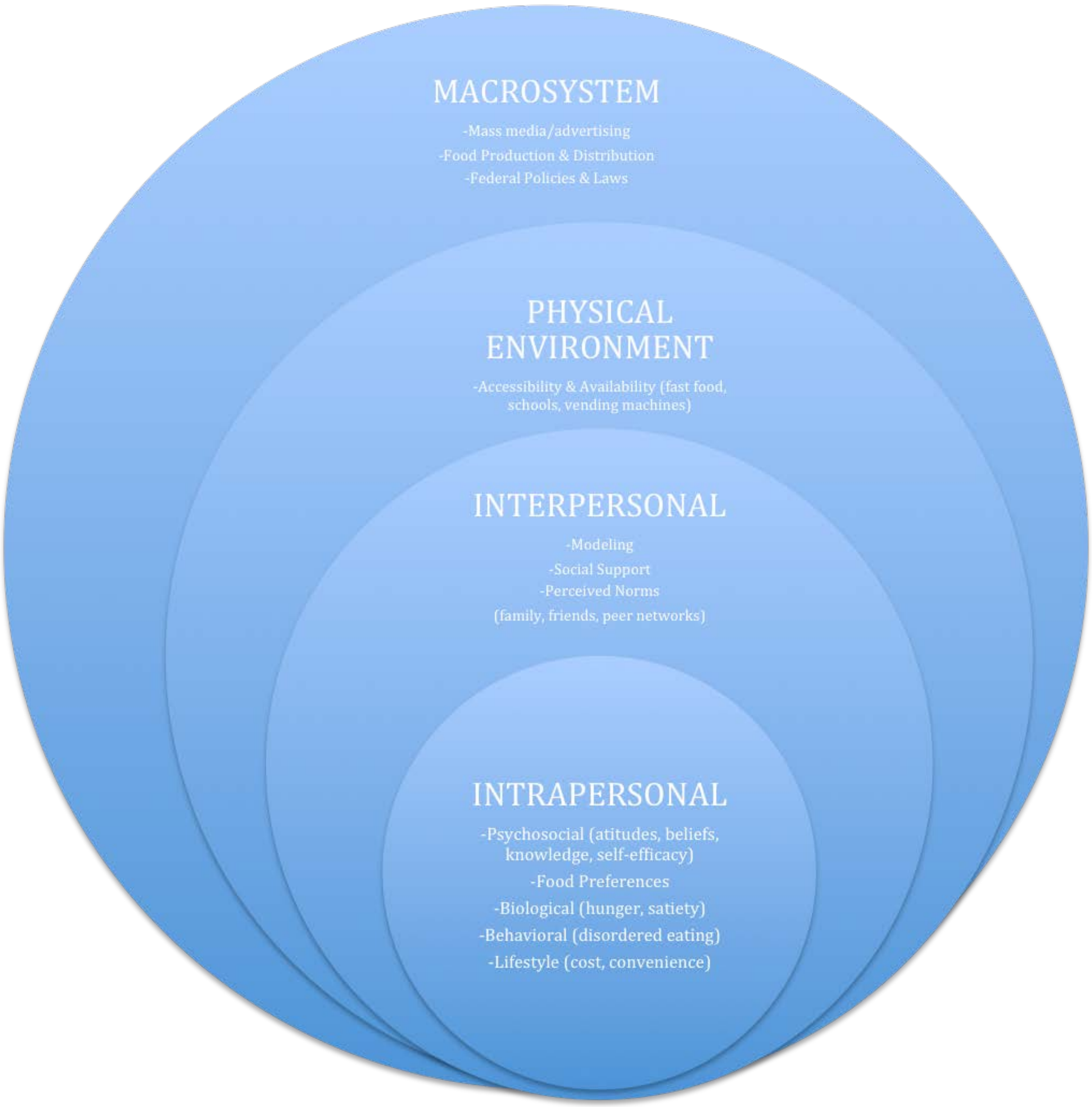
U.S. Department of Agriculture, Agricultural Research Service, Beltsville Human Nutrition Research Center, Food Surveys Research Group (Beltsville, MD) and U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics (Hyattsville, MD). (2015). What We Eat in America, NHANES 2010-2011 Data: Dietary Interview – Nutrient Intakes from Foods and Beverages—Mean Amounts Consumed Per Individual, by Gender and Age, in the US. Available from: http://www.ars.usda.gov/SP2UserFiles/Place/80400530/pdf/1112/Table_1_NIN_GEN_11.pdf

Vatanparast, H., Lo, E., Henry, C. J., & Whiting, S. J. (2006). A negative trend in calcium intake was accompanied by a substitution of milk by noncarbonated soft drinks in Canadian female students. *Nutrition Research*, 26(7), 325-329.

Whitelaw, M. (2014). Restrictivee eating disorders among adolescent inpatients, *American Academy of Pediatrics*. 134(3): 758-764.
World Health Organization. (2001). Iron deficiency anemia: assessment, prevention and control: a guide for programme managers.
Xia, Q., & Grant, S.F. (2013). The genetics of human obesity. *Annals of the New York Academy of Sciences*, 1281(1), 178-190.
Zhu, K., & Prince, R. L. (2012). Calcium and bone. *Clinical Biochemistry*, *45*(12), 936-942.

IX. **APPENDICES**

Figure 1. Levels of Influence on Girls Dietary Intake (Story, 2002)



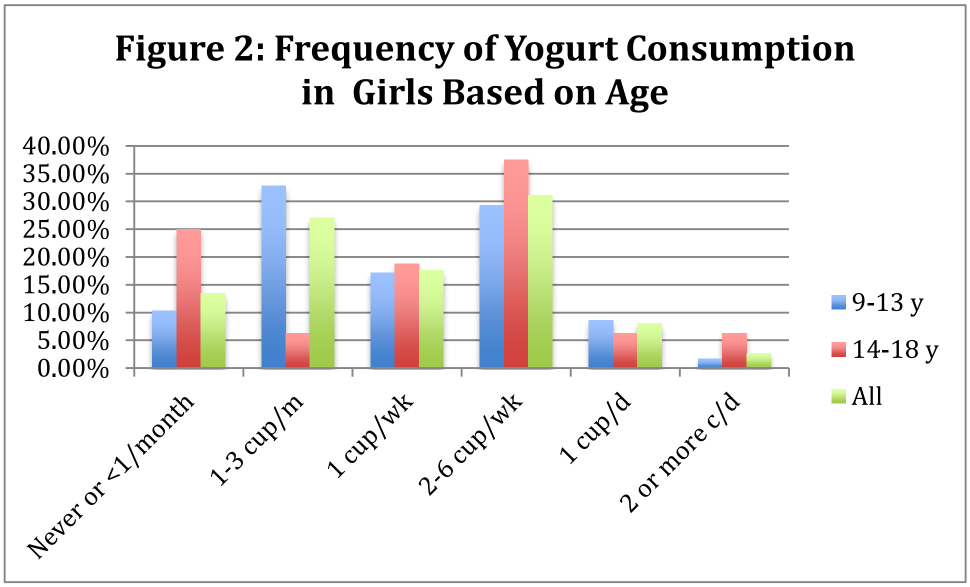


Figure 2: Frequency of Yogurt Consumption in Girls Based on Age
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Never or <1/month
1-3 cup/m
1 cup/wk
2-6 cup/wk
1 cup/d
2 or more c/d
9-13 y
14-18 y
All

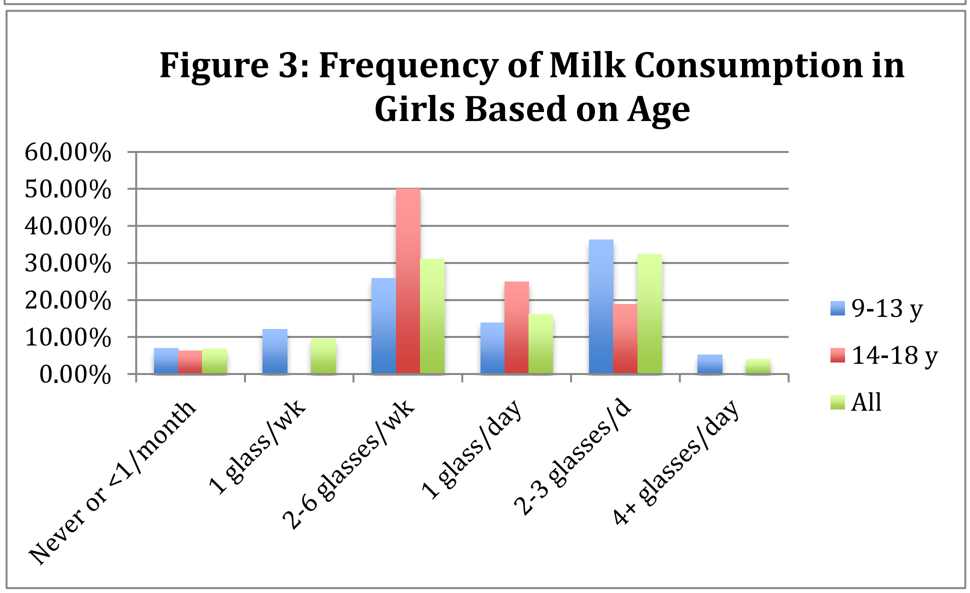


Figure 3: Frequency of Milk Consumption in Girls Based on Age
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Never or <1/month
1 glass/wk
2-6 glasses/wk
1 glass/day
2-3 glasses/d
4+ glasses/day
9-13 y
14-18 y
All

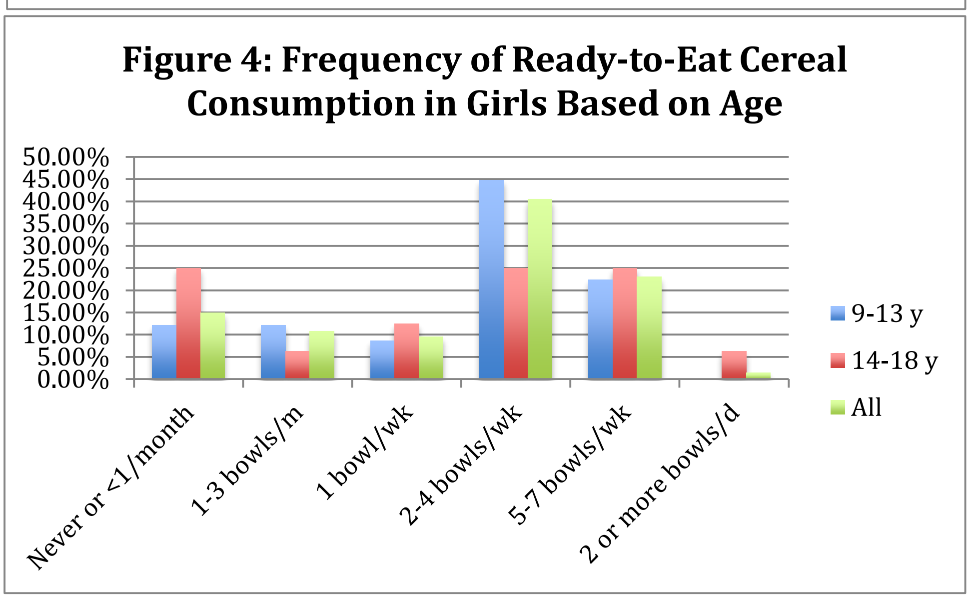


Figure 4: Frequency of Ready-to-Eat Cereal Consumption in Girls Based on Age
50.00%
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Never or <1/month
1-3 bowls/m
1 bowl/wk
2-4 bowls/wk
5-7 bowls/wk
2 or more bowls/d
9-13 y
14-18 y
All

Figure 5: Frequency of Cheese Consumption in Girls Based on Age

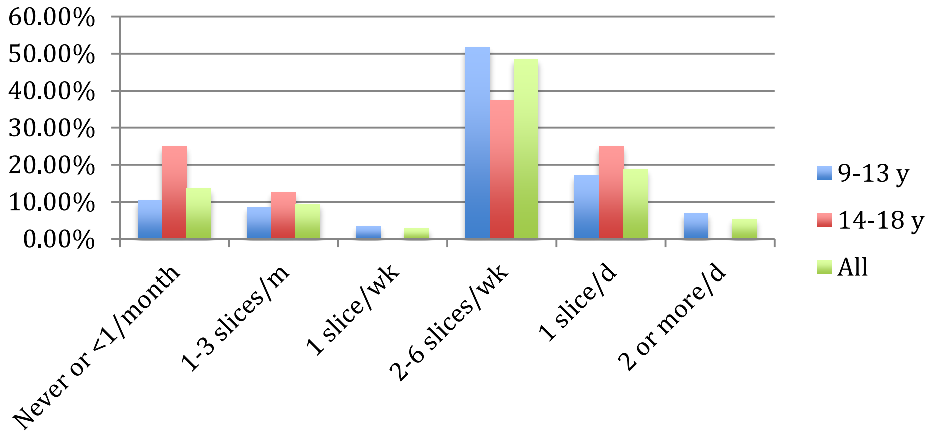


Figure 6: Frequency of Ice-Cream Consumption in Girls Based on Age

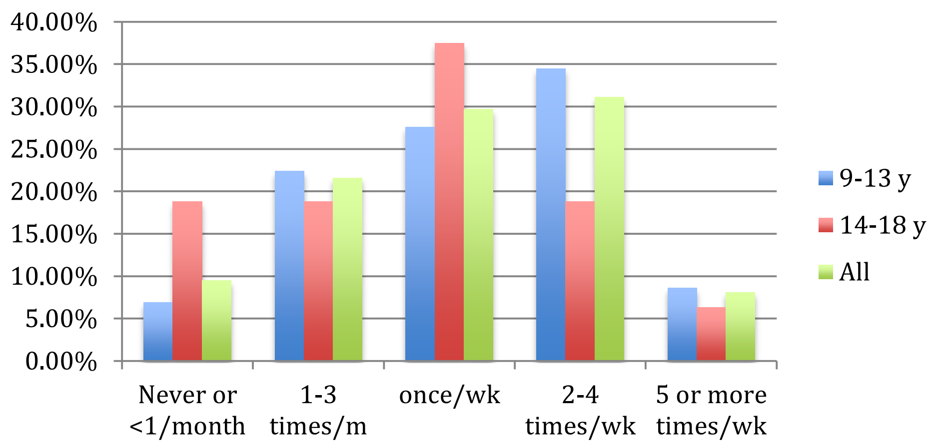


Figure 7: Frequency of

Figure 8: Frequency of Chicken/Turkey Main Dish Consumption in Girls Based on Age

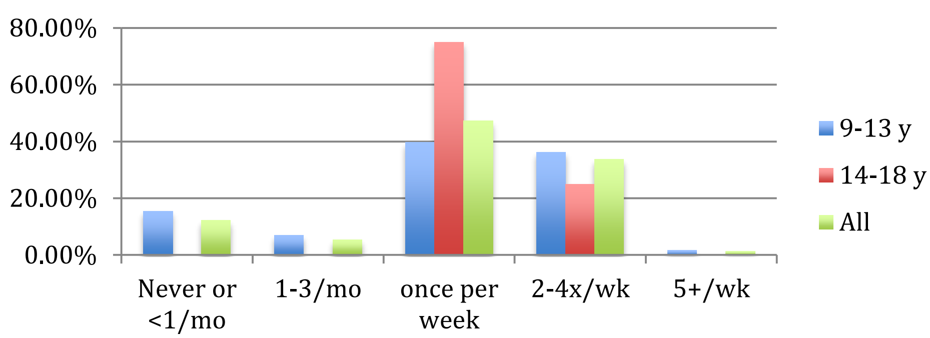


Figure 9: Frequency of Roast beef/Ham Sandwich Consumption in

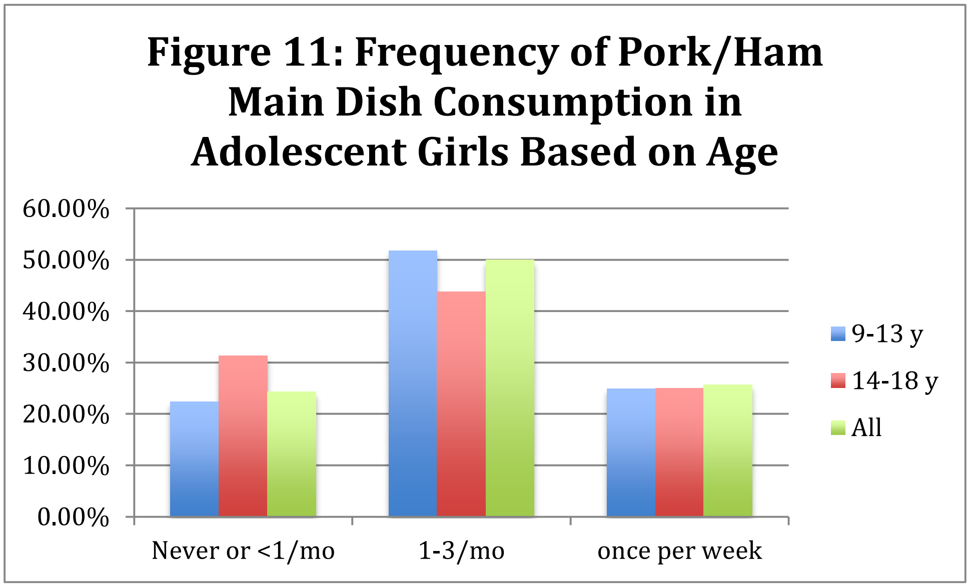


Figure 11: Frequency of Pork/Ham Main Dish Consumption in Adolescent Girls Based on Age
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Never or <1/mo
1-3/mo
once per week
9-13 y
14-18 y
All

Table 1. Recommended Dietary Allowances (RDA) and Functions of Micronutrients for Girls

Vitamins	**RDA** (9-13 years)	**RDA** (14-18 years)	**Function**
Vitamin A (mcg)	600	700	Vital role in vision, reproduction, growth, and immune function
Thiamin (mg)	0.9 mg	1.0 mg	Energy metabolism and maintenance of nervous system function
Vitamin B2 (Riboflavin)	0.9 mg	1.0 mg	Energy metabolism and promotion of vision and skin
Vitamin B3 (Niacin)	12 mg	14 mg	Energy metabolism, enzyme function and digestion
Vitamin B6	1.0 mg	1.2 mg	Aids in protein metabolism and RBC formation
Vitamin B9 (Folate)	300 µg	400 µg	Energy metabolism and synthesis of DNA, RNA and protein
Vitamin B12	1.8 µg	2.4 µg	Aids in synthesis of genetic material, production of RBC, and functioning of brain and nervous system
Vitamin C	45 mg	65 mg	Synthesis of collagen and other connective tissue
Vitamin D	15 µg	15 µg	Contributes to calcium and phosphorus absorption and essential for optimal bone formation
Vitamin E	11 mg	15 mg	Antioxidant properties
Minerals	**RDA** (9-13 years)	**RDA** (14-18 years)	**Function**
Calcium	1300 mg	1300 mg	Main constituent of bone mass, reduces risk of bone fractures and osteoporosis.
Iron	8 mg	15 mg	Synthesis of hemoglobin and myoglobin
Magnesium	240 mg	360 mg	Synthesis of protein, muscle and nerve function, blood glucose control, blood pressure regulation.
Phosphorus	1250 mg	1250 mg	Works with calcium for bones and teeth. Important in energy metabolism and acid-base balance.
Zinc	8 mg	9 mg	Protein formation and gene expression. Growth and sexual maturation.

Table 2: Nutrient Intakes of Girls Compared to Recommendations

Nutrient	Age Group	RDA	Mean	Standard Deviation	Range
Energy (kcal)	All 9-13 14-18	none	1999 2026 1899	524 507 588	696-3173 696-3173 886-2579
Protein (g)	All 9-13 14-18	 34 46	80 81 76	24 24 22	27-165 27-165 40-108
Calories from Protein (percent)	All 9-13 14-18	 10-30 10-35	16 16 16	2.3 2.4 2.1	11.0-21 11.0-21 13.5-20
Total Fat (g)	All 9-13 14-18	None	69 70 76	19.7 19.9 21	29-110 30-110 29-87
Calories from Fat (percent)	All 9-13 14-18	25-35	31 31 30	3.8 3.8 3.7	22-40 22-40 25-37
Carbohydrates (g)	All 9-13 14-18	130	270 272 263	75 70 93	82-431 82-431 117-395
Calories from CHO (percent)	All 9-13 14-18	45-65	54 54 55	4.6 4.4 4.9	43-64 45-64 43-62
Fiber (g)	All 9-13 14-18	26* (AI)	16.9 17.2 16.1	5.6 5.4 6.3	5.0-31 5.9-31 8.4-29
Sodium (mg)	All 9-13 14-18	1.5* (AI)	2.44 2.48 2.29	.65 .65 .66	849.62-4034.97 849.62-4034.97 905.96-3224.77
Vitamin A (µg)	All 9-13 14-18	 600 700	2618 2694 2343	1422 1469 1238	58-903 58-903 2204-13612
Vitamin A w/o supplementation	All 9-13 14-18		1956 1926 2062	1007 994 1079	491-6032 491-6032 661-408
Vitamin B1 (mg)	All 9-13 14-18	 0.9 1.0	2.24 2.36 1.83	1.11 1.13 .99	0.7-5.4 0.7-5.4 0.7-3.7
Vitamin B1 w/o supplementation	All 9-13 14-18	 0.9 1.0	1.58 1.59 1.54	.45 .40 .61	0.6-2.7 0.6-2.7 0.7-2.6
Vitamin B2 (mg)	All 9-13	 0.9	3.2 3.3	1.4 1.4	0.8-8.0 0.8-8.0

	14-18	1.0	2.59	1.1	0.9-4.8
Vitamin B2 w/o supplementation	All		2.4	0.7	0.8-4.6
	9-13	0.9	2.5	0.7	0.8-4.6
	14-18	1.0	2.3	0.7	0.9-3.1
Vitamin B6 (mg)	All	1.0	2.7	1.4	0.7-6.9
	9-13	1.2	2.8	1.5	0.7-6.9
	14-18		2.1	1.2	0.8-4.3
Vitamin B6 w/o supplementation	All		1.8	0.7	0.7-4.7
	9-13		1.8	0.7	0.7-4.7
	14-18		1.8	0.6	0.8-3.0
Vitamin B12 (µg)	All		8.33	4.81	1.37-31.86
	9-13	1.8	8.73	4.88	1.37-31.86
	14-18	2.4	6.89	4.40	2.10-17.44
Vitamin B12 w/o supplementation	All		5.68	3.07	1.15-19.86
	9-13		5.66	2.90	1.15-19.86
	14-18		5.77	3.70	2.10-17.44
Vitamin C (mg)	All		129	77	14.5-402
	9-13	45	132	80	14.5-402
	14-18	65	117	69	39-238
Vitamin C w/o supplementation	All		102	55	14-282
	9-13		101	55	14-282
	14-18		105	58	39-211
Vitamin D (µg)	All	15	10.4	7.2	0.6-35
	9-13		11.4	7.4	1.25-35
	14-18		6.8	5.2	0.6-19.5
Vitamin D w/o supplementation (µg)	All		6.0	3.5	0.6-15.1
	9-13		6.3	3.6	0.7-15.1
	14-18		4.9	2.9	0.6-12.5
Calcium (mg)	All	1300	1194	419	282-2297
	9-13		1228	415	383-2097
	14-18		1068	422	282-1793
Calcium w/o supplementation (mg)	All	1300	1150	408	282-2097
	9-13		1177	406	383-2097
	14-18		1050	411	282-1793
Iron (mg)	All		22	12.9	4.8-55
	9-13	8	23	13.1	6.3-55
	14-18	15	17.1	11.2	4.8-43
Iron w/o supplementation (mg)	All		14.1	4.6	4.8-27
	9-13	8	14.2	4.1	5.9-27
	14-18	15	13.8	6.3	4.8-25
Folate (µg)	All		625	308	165-1519
	9-13	300	654	309	204-1510
	14-18	400	520	292	165-1017
Folate w/o supplementation	All		448	156	165-930
	9-13		449	140	170-930
	14-18		445	212	165-913

Zinc (mg)	All 9-13 14-18	 8 9	18.1 19.2 14.1	10.6 10.9 8.2	4.9-48 5.1-48 4.9-30
Zinc w/o supplementation	All 9-13 14-18		11.5 11.6 11.3	3.4 3.2 4.0	4.9-21 5.1-21 4.9-20
Niacin (mg)	All 9-13 14-18	 12 14	30 32 26	14.8 15.1 13.3	9.0-72 9.0-72 11.8-53
Folic Acid	All 9-13 14-18		403 430 240	281 287 303	48-1189 58-1189 48-758
Phosphorus (mg)	All 9-13 14-18	1250 1250	1462 1500 1325	424 418 431	553-2424 553-2424 556-1959

Table 3: Frequency of Consumption of Highest Sources of calcium based on Girls meeting and not meeting the RDA

Calcium Source	Frequency	All (n=74)	Met RDA (n=32)	Didn't Meet RDA (n=42)
Milk	Never/less than one per month	5 (7 percent)	0	5 (12 percent)
	1 glass per week or less	7 (10 percent)	1 (3 percent)	6 (14 percent)
	2-6 glasses per week	23 (31 percent)	5 (16 percent)	18 (43 percent)
	1 glass per day	12 (16 percent)	3 (9 percent)	9 (21 percent)
	2-3 glasses per day	24 (32 percent)	20 (63 percent)	4 (10 percent)
	4+ glasses per day	3 (4 percent)	3 (9 percent)	0
Yogurt	Never/less than 1 per month	10 (14 percent)	2 (6 percent)	8 (19 percent)
	1-3 cups per month	20 (27 percent)	5 (16 percent)	15 (35 percent)
	1 cup per week	13 (18 percent)	5 (16 percent)	8 (19 percent)
	2-6 cups per week	23 (31 percent)	13 (41 percent)	10 (24 percent)
	1 cup per day	6 (8 percent)	5 (16 percent)	1 (2.4 percent)
	2 or more cups per day	2 (3 percent)	2 (6 percent)	0
Cheese	Never/less than 1 per month	10 (14 percent)	2 (6 percent)	8 (19 percent)
	1-3 slices per month	7 (10 percent)	1 (3 percent)	6 (14 percent)
	1 slice per week	2 (3 percent)	0	2 (5 percent)
	2-6 slices per week	36 (49 percent)	17 (53 percent)	19 (45 percent)

	1 slice per day	14 (19 percent)	10 (31 percent)	4 (10 percent)
	2 or more slices per day	4 (5 percent)	2 (6.3 percent)	2 (5 percent)
	7	1 (1 percent)	0	1 (2 percent)
Ice Cream	Never/less than 1 month	7 (10 percent)	1 (3 percent)	6 (14 percent)
	1-3 times per month	16 (22 percent)	7 (22 percent)	9 (21 percent)
	Once per week	22 (30 percent)	12 (37 percent)	10 (24 percent)
	2-4 times per week	23 (31 percent)	10 (31 percent)	13 (31 percent)
	5 or more times per week	6 (8 percent)	2 (6.3 percent)	4 (9.5 percent)
Cereal	Never/less than 1 month	11 (15 percent)	3 (10 percent)	8 (19.0 percent)
	1-3 bowls per month	8 (11 percent)	3 (10 percent)	5 (12 percent)
	1 bowl per week	7 (10 percent)	4 (12.5 percent)	3 (7 percent)
	2-4 bowls per week	30 (41 percent)	16 (50 percent)	14 (33 percent)
	5-7 bowls per week	17 (23 percent)	6 (19 percent)	11 (26 percent)
	2 or more bowls per day	1 (1 percent)	0	1 (2 percent)

Table 4: Frequency of Consumption of Highest Sources of Iron based on Girls meeting and not meeting the RDA

		All (n=74)	**Met RDA** Younger: n=55 Older: n=13	**Didn't Meet RDA** Younger: n=3 Older: n=3
Heme:	**Chicken/turkey Sandwich**			
	Never/less than 1 per month	35.1 percent	Younger: 21 (38 percent) Older: 3 (23 percent)	Younger: 1 (33 percent) Older: 1 (33 percent)
	1-3 per month	28.4 percent	Younger: 16 (29 percent) Older: 1 (8 percent)	Younger: 2 (67 percent) Older: 2 (67 percent)
	1 per week	14.9 percent	Younger: 8 (15 percent) Older: 3 (23 percent)	Younger: 0 Older: 0
	2 or more per week	21.6 percent	Younger: 10 (18 percent) Older: 6 (46 percent)	Younger: 0 Older: 0
	Roast beef/ham sandwich			
	Never/less than 1 per month	58.1 percent	Younger: 29 (53 percent) Older: 61.5 percent (8)	Younger: 100 percent (3) Older: 100 percent (3)
	1-3 per month	21.6 percent	Younger: 13 (24 percent) Older: 3 (23 percent)	Younger: 0 Older: 0
	Once per week	12.2 percent	Younger: 8 (15 percent) Older: 1 (8 percent)	Younger: 0 Older: 0
	2 or more per week	8.1 percent	Younger: 5 (9 percent) Older: 1 (8 percent)	Younger: 0 Older: 0
	Beef			
	Never/less than 1 per month	20.3 percent	Younger: 11 (20 percent) Older: 2 (15 percent)	Younger: 1 (33 percent) Older: 1 (33 percent)
	1-3 times per month	44.6 percent	Younger: 23 (42 percent) Older: 6 (46.2 percent)	Younger: 2 (67 percent) Older: 2 (67 percent)
	Once per week	28.4 percent	Younger: 16 (29 percent) Older: 5 (39 percent)	Younger: 0 Older: 0
	Pork			

	Never/less than 1 per month	24.3 percent	Younger: 12 (21.8 percent) Older: 4 (30.8 percent)	Younger: 1 (33 percent) Older: 1 (33 percent)
	1-3 times per month	50 percent	Younger: 28 (51 percent) Older: 6 (46 percent)	Younger: 2 (67 percent) Older: 1 (33 percent)
	Once per week	25.7 percent	Younger: 15 (27 percent) Older: 3 (23 percent)	Younger: 0 Older: 1 (33.3 percent)
	Chicken/turkey as Main Dish			
	Never/less than 1 per month	12.2 percent	Younger: 9 (16 percent) Older: 0	Younger: 0 Older: 0
	1-3 times per month	5.4 percent	Younger: 3 (6 percent) Older: 0	Younger: 1 (33 percent) Older: 0
	Once per week	47.3 percent	Younger: 21 (38 percent) Older: 9 (69 percent)	Younger: 2 (67 percent) Older: 3 (100 percent)
	2-4 times per week	33.8 percent	Younger: 21 (38 percent) Older: 4 (31 percent)	Younger: 0 Older: 0
	5 or more times per week	1.4 percent	Younger: 2 (2 percent) Older: 0	Younger: Older: 0
Non-heme:	**Cooked spinach**			
	Never/less than 1 per month	52.7 percent	Younger: 28 (51 percent) Older: 7 (54 percent)	Younger: 2 (67 percent) Older: 2 (67 percent)
	1-3 times per month	32.4 percent	Younger: 21 (38 percent) Older: 2 (5 percent)	Younger: 0 Older: 1 (33 percent)
	Once per week	8.1 percent	Younger: 4(7 percent) Older: 2 (15 percent)	Younger: 0 Older: 0
	2-4 times per week	5.4 percent	Younger: 1 (2 percent) Older: 2 (15 percent)	Younger: 1 (33 percent) Older: 0
	5 or more times per week	1.4 percent	Younger: 1 (2 percent) Older: 0	Younger: 0 Older: 0
	Broccoli			
	Never/less than 1 per month	27 percent	Younger: 15 (27 percent) Older: 3 (23 percent)	Younger: 2 (67 percent)

				Older: 0
	1-3 times per month	28.4 percent	Younger: 13 (24 percent) Older: 7 (54 percent)	Younger: 0 Older: 33.3 percent (1)
	Once per week	31.1 percent	Younger: 18 (33 percent) Older: 2 (15 percent)	Younger: 1 (33 percent) Older: 2 (67 percent)
	2-4 times per week	13.5 percent	Younger: 9 (16 percent) Older: 1 (8 percent)	Younger: 0 Older: 0
	Beans			
	Never/less than 1 per month	62.2 percent	Younger: 31 (55 percent) Older: 9 (70 percent)	Younger: 100 percent (3) Older: 100 percent (3)
	Once per week or less	31.1 percent	Younger: 19 (35 percent) Older: 4 (31 percent)	Younger: 0 Older: 0
	2-4 times per week	5.4 percent	Younger: 0 Older: 0	Younger: 0 Older: 0
	4 or more times per week	1.4 percent	Younger: 0 Older: 0	Younger: 0 Older: 0
	Breakfast Cereal			
	Never/less than 1 bowl per month	14.9 percent	Younger: 6 (11 percent) Older: 2 (15 percent)	Younger: 1 (33 percent) Older: 2 (67 percent)
	1-3 bowls per month	10.8 percent	Younger: 6 (11 percent) Older: 1 (8 percent)	Younger: 1 (33 percent) Older: 0
	1 bowl per week	9.5 percent	Younger: 5 (9 percent) Older: 1 (8 percent)	Younger: 0 Older: 1 (33 percent)
	2-4 bowls per week	40.5 percent	Younger: 25 (46 percent) Older: 4 (31 percent)	Younger: 1 (33 percent) Older: 0
	5-7 bowls per week	23 percent	Younger: 13 (24 percent) Older: 4 (31 percent)	Younger: 0 Older: 0
	2 or more bowls per day	1.4 percent	Younger: 0 Older: 1 (8 percent)	Younger: 0 Older: 0
	Mashed Potato			

	Never/less than 1 per month	16.2 percent	Younger: 9 (16 percent) Older: 2 (15 percent)	Younger: 1 (33 percent) Older: 0
	1-3 times per month	31.1 percent	Younger: 17 (31 percent) Older: 3 (23 percent)	Younger: 2 (67 percent) Older: 1 (33 percent)
	Once per week	36.5 percent	Younger: 19 (35 percent) Older: 6 (46 percent)	Younger: 0 Older: 2 (67 percent)
	2-4 times per week	16.2 percent	Younger: 10 (18 percent) Older: 2 (15 percent)	Younger: 0 Older: 0