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Associations between Sports Scheduling, Food "Away From Home" and Dietary Intake in Growing Girls

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Abstract:

Despite evidence that family meals promote key nutrient intakes, consumption of "away from home" food may be increasing among growing children. We hypothesized that greater consumption of food "away from home" would be associated with lower key nutrient intakes in girls, but be counteracted by predictable sports scheduling. In this cross-sectional study, we evaluated key nutrient intakes, measures of food "away from home" ("Fried Food Away From Home" (FFAH); "Dinner Out"), gymnast status, and body mass index (BMI) in 67 growing girls. Girls completed the Youth Adolescent Questionnaire to assess dietary intake. Independent samples t-tests or ANOVAs were used to examine differences in nutrients by frequency of consumption of food "away from home" and by gymnast status. Subject ages ranged from 8.4 to 14.4 yo (11.4± 0.2); BMI for age percentiles ranged from 8.1 to 98.2 % (50.4 % ±3.1). Girls who consumed "Dinner Out" never/less than once a week had lower BMI% than girls who consumed "Dinner Out" 1-2 times per week ($p<0.05$). Greater intakes of kcalories ($p<0.05$), total fat ($p<0.01$), saturated fat ($p<0.01$), cholesterol ($p<0.05$), carbohydrates ($p<0.05$), total and added sugar ($p<0.05$ for both), sodium ($p<0.01$), and vitamins A ($p<0.05$), C ($p<0.05$), and E ($p<0.01$) were found in girls consuming FFAH 1-3 times per week compared to never/less than once per week. No associations between gymnast status and "Dinner Out" or FFAH consumption were found. There were significant differences in the intakes of carbohydrates, dietary iron, and dietary folate (all $p<0.05$) between gymnasts and non-gymnasts. Further study of the relationship between food "away from home", dietary intakes, and sports participation is warranted, with a focus on how family scheduling may play a role in greater consumption of food "away from home".

Associations between Sports Scheduling, Food "Away From Home" and Dietary Intake, in Growing Girls

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The United States' adolescent population has been the subject of rising obesity rates over the past few decades. It has become important to understand what factors are contributing to this trend. It is essential for researchers to find evidence for why these rates are rising and use that information to devise effective strategies to provide better health and dietary support to adolescents. This literature review will be examining one factor that impacts obesity prevalence in this population, children and adolescents' dietary intakes. By assessing adolescents' diets, researchers can discover how food "away from home" impacts diet quality and how it influences adolescent eating patterns. It is also important to discover why food "away from home" has become so prevalent among children and adolescents. Researchers have reported that time demands (namely school, extracurricular activities, and sports) play into the increased reliance upon food prepared "away from home". This literature review will set the foundation for the current study that examines the diets and frequency of eating "away from home" in a sample of growing girls. These same factors will be assessed when the girls are grouped by their participation in gymnastics.

Assessment of Overweight/Obesity in Children and Adolescents

To understand how diet plays a role in obesity, it is important to understand how obesity is assessed in children and adolescents. There has been much debate over how healthcare providers should assess and diagnose overweight and obesity in children and adolescents. This population is unique, for they are in a stage of growth and development, precluding physicians from using the adult measures of overweight and obesity to define them. Body mass index (BMI) is a useful tool to help in the diagnosis of overweight and obesity. The measurements are easy to obtain and are noninvasive. Researchers has found that BMI is "correlated strongly with body fat percentage" (especially at extreme BMI levels).[1] The literature suggests that these factors are what make BMI a popular assessment measure in children and adolescents.[1,2]

Height and weight data of children and adolescents are collected to calculate their BMIs (kg/m^2). These BMI values are then charted on the Centers of Disease Control and Prevention's (CDC) growth charts against the subjects' age to derive their body mass index percentiles (BMI%). Healthcare providers can use these BMI% to decide if children are classified as underweight, normal weight, overweight, or obese. In 2005, the Institute of Medicine reworded the two upper categories to make them clearer for parents; children and adolescents who fell between the 85^{th} and 94^{th} percentiles are classified as "overweight", while children with a BMI% $\geq 95^{th}$ are classified as "obese".[1,2]

Prevalence of Overweight and Obesity in Children and Adolescents

The prevalence of overweight and obesity is high in the United States. Ogden et al.[3] reported the overweight and obesity trends in US children and adolescents from the 2011-2012 National Health and Nutrition Examination Survey (NHANES).[3] Approximately 32% of children and adolescents were classified as overweight and 17% of children and adolescents were classified as obese.[3]

The researchers found that there was no difference in obesity prevalence between the genders, but there was a difference among ethnicities.[3] Obesity was more prevalent amongst non-Hispanic black and Hispanic children and adolescents compared to non-Hispanic Caucasian children and adolescents.[3] Differences in age classifications were also observed. "More than 8% of 2- to 5-year olds were obese compared with 17.7% of 6- to 11-year olds and 20.5% of 12- to 19-year olds".[3] Ogden et al.[3] found that there was no significant change in overall obesity prevalence in US children and adolescents between 2003-2004 and 2011-2012, an important finding in this population.

The Adolescent Diet Today

To promote better dietary health for adolescents, it is important for researchers to first explore what comprises the adolescent diet. In a paper by Sebastian et al.,[4] the researchers provide a holistic view into the adolescents' consumption of the main food groups. The researchers collected their data from What We Eat in America, the dietary component of the 2003-2004 NHANES.[4] They limited their population to adolescents aged 12 to 19 years (n=1,956).[4] The researchers found that for the female participants (n=949), their consumption of the main food groups (fruit, vegetables, grains, dairy, and meat) were well below the recommended guidelines.[4] For the whole female population of this study, the mean intake of grains was 6.7 oz equivalents per day (45% met the recommendation); the mean vegetable intake was 1.2 cup equivalents per day (5% met the recommendation); the mean intake of fruit was 0.9 cup equivalents per day (13% met the recommendation); the mean intake of milk/dairy was 1.8 cup equivalents per day (11% met the recommendation); the mean intake of meat/beans was 4.5 oz equivalents per day (22% met the recommendation).[4] With this holistic view of the adolescent diet, researchers can better understand areas that need improvement and formulate interventions that can be effective in providing adolescents with a better dietary intake.

While Sebastian et al.[4] looked at adolescent consumption of all the main food groups, Lorson et al.[5] focused solely on fruit and vegetable intakes in children and adolescents. The researchers gathered data from children and adolescents aged 2 to 18 years from the 1999-2002 NHANES (n=6,513).[5] The data revealed that the "mean intakes for both total vegetable and total fruit were 1.0 cup per day".[5] Boys were found to consume significantly more vegetables than girls (1.1 cups per day versus 0.98 cups per day, respectively), but there was no significant difference between the genders when examining fruit consumption.[5] The researchers found that the "leading source of vegetables was French fries, which accounted for more than 28% of total vegetable intake".[5] "The leading source of total fruit was 100% fruit juice" and was consumed significantly more in the 2-5 year demographic than the 6-11 year- and the 12-18 year-old demographics.[5] Similar to the findings of Sebastian et al.[4], these researchers determined that US children and adolescents fall short of the stated recommendations for fruit and vegetable intake.[5]

Like Lorson et al.[5], Reicks et al.[6] examined one part of the American adolescents' diet; or, namely, their intake of whole grains and dietary fiber. Utilizing the data from the 2009-2010 NHANES, the researchers selected 9,042 subjects that fit their inclusion criteria (3,124 participants were children and adolescents, aged 2-18 years).[6] The data revealed that 38.8% of the children and adolescents consumed no whole grains at all. More than half of the children and adolescents (58.3%) consumed less than three 1-oz equivalents per day.[6] The researchers found that a small amount (2.9%) of this population consumed more than three 1-oz equivalents of whole grains per day.[6] For children and adolescents, the "mean daily intake of whole grains was 0.57oz equivalents per day".[6] Sources of whole grains in the diets of children and adolescents were ready-to-eat cereals, yeast breads, oatmeal, and popcorn.[6] Trends of total fiber intakes followed whole grain intake trends. Greater dietary fiber intakes were associated with greater whole grain intakes.[6] Children and adolescents who consumed more than three 1-oz equivalents of whole grains per day had a total dietary fiber intake of 24.5g per day.[6]

Influences That Impact the Preadolescent Diet

In two studies conducted by Cutler et al.[7,8], the researchers used a prospective, cross-sectional study design to examine dietary changes in male and female adolescents over a five-year period. In the first paper, the researchers focused on diet quality of 4,746 adolescents[7] while the second paper examined the sociodemographic reasons behind adolescent dietary choices.[8] They utilized a food frequency questionnaire, the Youth Adolescent Questionnaire (YAQ), to collect the necessary dietary data.[7,8] The researchers compared their findings to the objectives of Healthy People 2010 to examine if adolescents were meeting the guidelines. Adolescents who were ranked in the highest quintile (ate the highest amount of that food group) for fruit, vegetable, and starchy foods met the objectives the best.[7] Adolescents who were ranked in the highest quintile for sweet/salty snacks were found to not be able to meet the objectives of Healthy People 2010.[7] The researchers also discovered an increasing fast food consumption trend emerging during the five-year follow-up in older boys and girls (approximately 15-16 years old).[7,8] Cutler et al.[8] also found that healthy food availability was significantly associated with healthy dietary intake patterns. The frequency of family meals at home and the presence of healthy foods in the home led to increased consumption of fruits and vegetables in the diets of adolescents.[8] Through this research, it can be said that the diets of adolescents are varied and are influenced by many factors.

While many research articles discuss differences between genders in terms of examining different food groups, Videon and Manning[9] found that male and female adolescents have major differences in eating patterns. The data revealed that female adolescents actually have a greater risk for poor diet quality compared to their male counterparts. The researchers attributed this finding to the concept that female adolescents are more prone to skipping breakfast than their male peers.[9] Like many articles highlighted later in this review, Videon and Manning[9] discussed the influence of parental involvement in food choices and in the family meals; the authors found that adolescents who had a parent present at family meals were less likely to have a decreased consumption of fruits, vegetables, and dairy products and were more likely to eat breakfast in the morning.[9] This research showcased the eating patterns of different genders and highlighted that more research is needed to further understand why these differences exist.

While the three previous studies look at overall diet quality of adolescents, Larson et al.[10] examined adolescent consumption of a single food group – whole grains. Unlike Videon and Manning[9], who found a difference between male and female adolescents, Larson et al.[10] found that both genders had low intake of whole grains. Using the Youth Adolescent Questionnaire (YAQ) to assess the dietary intakes of 2,478 adolescents and young adults, Larson et al.[10] found that males consumed slightly more whole grains than females, but the difference was not significant. Similar to Videon and Manning[9], whole grain availability at home led to an increase in whole grain consumption for both genders.[10] The researchers also discovered that adolescents who consumed fast food more frequently had decreased whole grain consumption.[10] The researchers found that overall whole grain consumption amongst adolescents has declined, but found that two factors – parental influence and fast food – have a strong influence over whole grain consumption.

Lee et al.[11] looked exclusively at the dietary intakes of 150 adolescent females, ages 9-16, over a two-year period using three-day food records. The researchers found that over time the females had no significant changes for total energy, carbohydrates, fat, saturated fat, fiber, protein, sodium, and calcium.[11] The biggest significant difference between the first assessment period and the second assessment period was the increased consumption of sugar-sweetened beverages.[11] The researchers found that the subjects were consuming “three times the amount specified by the Dietary Guidelines”.[11]

Many factors contribute to the change in adolescent dietary habits. One element that is beginning to be explored is the concept of food consumed “away from home”. According to Eneli et al.,[12] the percentage of total kcalories consumed outside the home by children and adolescents has increased by 36% over the past two decades. This increase in kcalories is not something to ignore and may be an indication that food consumed “away from home” is having a larger presence in the diet than in previous decades. The next steps are to understand what foods fall under the food “away from home” umbrella, how they influence adolescents’ key nutrient intakes, and how other sociodemographic factors, like family dynamics, influence food “away from home” consumption.

Food Consumption “Away From Home”

Similar to Eneli et al.,[12] Guthrie et al.[13] found that the American diet has changed greatly over the past twenty years. The researchers found that food consumed “away from home” went from an occasional occurrence to making up approximately one third of the average American’s diet today.[13] The study went beyond examining just kcalories consumed “away from home”; researchers also found that besides having increased kcalories, food “away from home” has less dietary fiber, calcium, and iron than food prepared inside the home.[13] Researchers now have evidence about food consumed outside the home and its potential impact on dietary quality. This opens areas where they can probe to understand where this food is offered and consumed.

Ebbeling et al.[14] cover similar concepts to the ones highlighted in the paper by Guthrie et al.[13] The researchers found that children and adolescents are consuming more saturated fat and carbohydrates, mostly from food prepared outside the home.[14] The paper also discussed food "away from home" portions, which are usually bigger than the servings of food inside the home.[14]

Researchers are beginning to recognize the heightened prevalence and overall influence of food "away from home" not only on the American population as a whole, but specifically on adolescents and their key nutrient intake. Food "away from home" can be consumed in many different settings, from fast food restaurants to potluck suppers at the neighbors', but much of the literature focuses on the food coming from fast food establishments and other restaurants as food "away from home".

Fast Food and Restaurants

Fast food is a good starting point when examining food consumed outside the home. The food is cheap, abundant, and appealing, which plays to adolescents' desire for independence in making their own food choices. Several studies have examined this relationship and have found that fast food contributed to increased intake of total kcalories,[15,16] total fat, saturated fat,[17] and sodium,[15] and decreased intakes of fruits and vegetables, whole grains, and dairy products for adolescents.[18]

A study conducted by Poti and Popkin[16] collected data from four national surveys – Nationwide Food Consumption Survey, two versions of the Continuing Survey of Food Intake by Individuals (CSFII89 and CSFII94), and the 2003-2004 and 2005-2006 National Health and Nutrition Examination Surveys (NHANES) – to create a subject base of 29,217 children and adolescents. Poti and Popkin[16] found that food "away from home" provided approximately 255 kcals per day, while the kcalories consumed inside the home declined 76 kcals per day. The researchers found that fast food was responsible for the largest part of that increase in kcalories.[16]

Bowman et al.[17] used a cross-sectional study design using data from the USDA Continuing Survey of Food Intakes by Individuals (CSFII) 1994-1996 and the Supplemental Children's Survey (1998) to examine the relationship between fast food consumption and negative health effects in 6,212 children. The researchers found that children and adolescents who consumed fast food regularly consumed an excess of 187 kcalories per day to their diets,[17] which is slightly lower than the amount found by Poti and Popkin.[16] This study demonstrates that the regular addition of fast food to the diet may lead to higher energy intake in children and adolescents. The researchers also concluded that the inclusion of fast food in the diet may displace nutrient-dense foods, like non-starchy leafy, green vegetables and low-fat milk.[17] This is an important finding for this age group because adolescents are still growing and need the nutrients in these foods to flourish and thrive.

In a study conducted by French et al.,[18] researchers looked at the frequency of fast food restaurant use (FFFRU) and nutrient intake in 4,746 adolescents. The researchers collected demographic and behavioral data using surveys, frequency of fast food restaurant use (FFFRU) data, dietary intake data using the Youth Adolescent Questionnaire (YAQ), and anthropometric data (height and weight).[18] Frequency of FFFRU was defined by the question, "In the past week, how often did you eat something from a fast food restaurant?"[18] There was a range of responses from "Never" to "Five or more times a week".[18] The data showed that the greater FFFRU was associated with a lower intake of fruit (23% less), vegetable (29% less), grain, and dairy consumption (21% less).[18] Female participants consumed 2.6 and 2.3 servings of fruit and vegetables, respectively, daily if they never visited a fast food restaurant in the past week, compared to females who visited a fast food restaurant ≥3 times a week (1.9 and 1.7 servings per day, respectively).[18]

The researchers also found a significantly higher intake of traditional fast food consumption in female adolescents – the participants who visited a fast food restaurant at least three times in the last week reported "45% greater soft drink consumption ($p < 0.05$), 100% greater cheeseburger consumption ($p < 0.01$), and 60% greater French fries consumption ($p < 0.01$)".[18] There was no relationship between body mass index and FFFRU in females.[18] When examining the female adolescents' diets and team sports participation, the researchers found no relationship between the diets of those that participated in sports teams versus those that did not.[18] Additionally, the researchers did not find any relationship between physical activity hours and FFFRU.[18]

Another research group examined the relationship between fast food consumed "away from home" and dietary intake of children and adolescents. Tarveras et al.[19] utilized both cross-sectional and longitudinal study designs to look for any associations between fast food consumption and dietary intake of 7,745 children and adolescents through three one-year periods. Similar to Bowman et al.,[16] the researchers discovered that a greater presence of fast food in children and adolescents' diets led to a higher intake of total fat, and red and processed meats, and a lower intake of nutrient-dense foods, like fruits and vegetables.[19]

Sebastian et al.[4] compared adolescent dietary intakes to the MyPyramid recommendations. The researchers' main goal was to examine if fast food intake influenced adolescents' dietary intake and if the amount of fast food consumed affected the meeting of the MyPyramid recommendations.[4] The researchers split the female participants into four groups – "No Fast Food", 1st tertile (≤14.5% of total energy from fast food), 2nd tertile (14.51-29.86% of total energy from fast food), and 3rd tertile (≥29.87% of total energy from fast food).[4] In girls not consuming fast food (reference group), the mean intake of grains was 6.6 oz equivalents per day (36% met recommendation); the mean intake of vegetables was 1.2 cup equivalent per day (8% met the recommendation); the mean intake of fruit was 1.0 cup equivalents per day (19% met the recommendation); the mean intake of milk/dairy was 1.0 cup equivalent per day (15% met the recommendation). Finally, the mean intake of meat/beans was 4.5 oz equivalents per day (22% met the recommendation).[4] Girls consuming the most fast food (3rd tertile) had a mean grain intake of 7.2 oz equivalents (55% met the recommendation); the mean intake of vegetables was 1.1 cup equivalents (2% met the recommendation; significant difference, $p<0.05$); the mean fruit intake was 0.6 cup equivalents (8% met the recommendation; significant difference, $p<0.01$); the mean intake of milk/dairy was 1.6 cup equivalents (6% met the recommendation); the mean meat/beans intake was 4.3 oz equivalents (18% met the recommendation).[4] This study has demonstrated that girls are who consume more fast food per day have a lesser consumption of the key food groups that contain the nutrients for proper growth and development.

Food Consumed "Away From Home" and Key Nutrient Intake

Much of the research discussed in this literature review has highlighted how food consumed "away from home" displaces nutrient-dense foods from of the diets of adolescents. The researchers examined the excess consumption of energy and fat, yet little is mentioned about key nutrients, such as iron, fiber, and folate. An evaluation of how food consumed "away from home" influences key nutrient intake in adolescents is essential, for they are in a period of growth and need these key nutrients to flourish.

One such research group looked at fast food and its influence on adolescent diet quality. Paeratakul et al.[15] utilized the 1994-1996, 1998 Continuing Survey of Food Intakes by Individuals (CSFII) to examine a cross-section of 17,370 United States adults and children over the age of 2. The researchers collected sociodemographic data (age, gender, income, education, etc.) and dietary data using two "nonconsecutive 24-hour recalls".[15] The only food "away from home" data that the authors focused on were what food the participants obtained from fast food establishments.[15] The researchers found that adolescents who consumed fast food on a given day had lower intakes of vitamin A, vitamin C, and beta-carotene compared to a day that they did not eat fast food.[15]

Whereas Paeratakul et al.[15] examined adolescent food intake and discovered deficits in a few vitamins, the study conducted by Cluskey et al.[20] chose to focus on one specific micronutrient – calcium. The researchers used a qualitative research design that allowed them to examine 201 children's consumption of calcium-fortified beverages, namely milk.[20] The data revealed that during "away from home" meals, milk was not seen as the beverage of choice. Parents saw milk as a beverage served at home with certain foods, whereas soda and other beverages were seen as more appropriate when eating "away from home".[20] With a greater intake of food consumed outside the home, there is lower intake of milk and calcium in children.[20] The deficit in calcium intake in this population is not beneficial for proper growth and development.

Food Consumed "Away From Home" And the Home Food Environment

To gain a more thorough understanding of how food "away from home" influences adolescents' key nutrient intakes, it is important to understand whether those food choices have any sway over food served inside the home. Food "away from home" is usually higher in kcalories, larger in portion size, and has a higher level of fat and could influence eating patterns in other food environments. Researchers have conducted studies to examine if there is a relationship between food "away from home" and the home food environment.

Family Meals and Nutrient Intake

Before looking at the relationship between food "away from home" and the home food environment, it is important to understand the different aspects of the home food environment, specifically family meals, and how they influence adolescents' key nutrient intake in isolation.

Neumark-Sztainer et al.[21] examined the influence of family dinners eaten at home on key nutrient intake of 4,746 adolescents. The researchers discovered that the intake of key nutrients, such as fiber, folate, calcium, iron, and vitamins A, B_6, C, and E, was positively associated with family meal frequency[21]; the more frequently families ate together at home, the more key vitamins and minerals the adolescents consumed. The data also illustrated that a higher frequency of family meals was related to a lower intake of saturated fat.[21]

Gillman et al.[22] reported results similar to the ones highlighted by Neumark-Sztainer et al.[21] In a study of 16,202 adolescents (children of participants of the Nurses' Health Study II), the researchers found that adolescents had a higher intake of fiber, folate, calcium, iron, and vitamins B_6, B_{12}, C, and E when eating more frequently at home (most days to every day) with their family.[22] In addition to lower saturated fat intake, the researchers discovered that a higher frequency of family meals was also associated with lower levels of *trans* fat, soda, and fried food consumption.[22]

Berge et al.[23] also utilized data from Project EAT to examine the relationship between family meals, body mass index, and consumption of fruits and vegetables. Participants included 40 adolescents and their parents, who had previously been a part of the Project EAT or Project F-EAT.[23] The researchers found that adolescents who have routine family meals consumed more vegetables and had a lower body mass index than their peers.[23]

Family Meals At Home and "Away from Home" Food Consumption

With Neumark-Sztainer et al.[21] and Gillman et al.[22] reporting the positive influences of family meals on adolescents' key nutrient intakes, do the healthy eating skills learned around the dinner table influence adolescent food choices outside the home? Hammons and Fiese[24] examined the relationships between family meal frequency and obesity, unhealthy eating, and disordered eating. To determine family meal frequency, the researchers split the data into two groups – families who consumed at least three family meals a week together and families who consumed less than three meals a week together, which came to a total of 182,836 adolescents. Foods were deemed "healthy" and "unhealthy" by a food frequency checklist.[24] "Unhealthy" foods included "soda, fast food, fried food, and sweets/candy",[24] while "healthy" foods included fruits and vegetables and healthful dietary patterns, like "multivitamin use and breakfast consumption".[24] The researchers demonstrated that adolescents and their families who shared "at least three meals per week have a 20% reduction of eating unhealthy foods compared to families who shared less than three meals a week".[24] The researchers found that family meals and a healthier home food environment promoted a greater consumption of fruits and vegetables compared with families who shared less than three meals per week.[24]

Burgess-Champoux et al.[25] utilized Project EAT data for 677 adolescents to examine the longitudinal impact of regular family meals and diet habits among adolescents. Expanding on the concept of female adolescents and breakfast highlighted by Videon and Manning[9], the researchers found that frequent family meals were positively associated with breakfast consumption in female adolescents.[25] Only adolescent males showed a significantly lower intake of fast food with a greater frequency of family meals.[25] These findings were consistent with those of Neumark-Sztainer et al.[21] and Gillman et al.[22] Adolescents who ate regularly with their families had a greater intake of calcium, potassium, magnesium, iron, zinc, vitamin B_6, and folate.[25]

Family meals and a healthy home food environment provide opportunities for adolescents to learn good eating habits that will allow them to have a more optimal nutrient intake over their peers who do not participate in family meals as frequently.

Family Dynamics and Food "Away From Home"

Just as a healthy home food environment (and frequent family meals) can promote a lower intake of "unhealthy" "away from home" food, food consumed "away from home" can in turn influence the home food environment. Much of the research on this topic highlights the eating habits of parents or caregivers, rather than focusing solely on adolescents. Since many children and adolescents are reliant upon these individuals to provide most or all of their home food supply, parents and caregivers have a great deal of influence over what their children and adolescents eat and where they eat it.

Siwik and Senf[26] highlighted the concept of parental influence over adolescent dietary intake. In this survey-based study design, researchers asked 277 parents the frequency of foods consumed away from home.[26] The researchers found that if parents craved certain foods “away from home”, the parent’s craving “was positively related to the number of meals their youngest child ate away from home”.[26]

Fraser et al.,[27] investigated the consumption of fast food and its relationship with body mass index (BMI) in teenage adolescents. Utilizing the Avon Longitudinal Study of Parents and Children, the researchers performed anthropometry on 3,620 subjects and had them fill out a food frequency questionnaire.[27] The researchers reported that if there were unhealthy foods (pizza, burgers, French fries, and pies) in the home, adolescents were more likely to eat at fast food restaurants outside the home and have higher mean BMI Z-scores.[27]

Fulkerson et al.[28] and Boutelle et al.[29] looked at the relationship between parental purchase of “away from home” foods, like fast food, for home family meals and its influence upon adolescent diet quality. The researchers utilized family eating habit surveys, which were sent to 107 parents.[28] Fulkerson et al.[28] stated that a quarter of parents reported purchasing fast food for their family dinner meal at least once a week. Since adolescents are eating with their families, they eat the fast food because that is the only food available for mealtime.

Boutelle et al.[29] extended these findings by reporting that when there was a higher frequency of fast food purchases for family meals, it was associated with overweight in mothers and unhealthful snacks and breakfasts served to the adolescents at home.[29] The “away from home” food consumption may create a vicious circle that results in poor intake of key nutrients in adolescents.

Dietary intake is not a static entity but one that is influenced by many different factors. Family dynamics can either promote healthful eating habits and family meals can be protective of diet quality, or they could be the cause of why adolescents consume food “away from home”.

Food "Away From Home" and Scheduling

The studies reviewed above have examined how the adolescent diet has changed over the past twenty years. Increased consumption of food "away from home" has been associated with deficits in key nutrient intakes. Family meals at home seem to promote the consumption of key nutrients, and parental food choices have an impact on adolescent eating. Food consumed "away from home" has become a major part of the dietary habits of American adolescents, despite its negative impacts. Researchers have found that food "away from home" has become more popular because of its convenience.[25,30,31] Adolescents are becoming increasingly busy with more activities, requiring quick access to food during free moments.

Larson et al.[30] examined nutrition information collected from the Minnesota-based Project EAT-II survey to determine 1,687 adolescents' attitudes towards eating in light of different social and behavioral characteristics of meals. Consistent with other studies on this topic, the authors found that adolescents participating in the Project EAT-II survey were consuming less fruits, vegetables, and calcium than recommended and over-consuming sugar-sweetened beverages and sodium-laden foods.[30] The authors postulated that this disparity in adolescent eating behaviors could be blamed on high demands on their time (like sports, extracurricular activities, etc.) that force them to rely on food prepared (and consumed) outside the home.[30]

Bauer et al.[31] used the earlier version of the Project EAT survey (Project EAT-I) to select their subjects (n=806) and gather data for a study on predictors of adolescent fast food consumption. The data revealed that approximately 33% of the adolescents reported consuming fast food "at least three times in the past week".[31] The researchers speculated that demands on adolescents' time were responsible for the higher intake of fast food. They discovered that adolescent sport participation in middle school had an influence on fast food consumption in high school; researchers posited that this relationship emerged because adolescents on sports teams have limited time for meals and rely on fast food because it is quick and convenient.[31]

Food "Away From Home" Consumption Is Influenced By Greater Demands on Time

While many papers have postulated about the relationship between food consumption "away from home" and increased time demands, several papers have chosen to examine this relationship directly. Rockett[32] found that with an increase in activities filling the familial schedule, not only could adolescents be eating more outside the home, but also parents could be bringing food prepared "away from home" into the house for family meals. This reflects the findings in Fulkerson et al.[28] More recent papers support these theories put forth by Rockett[32] and have found that time demands on the family schedule (afterschool activities, sports, work, etc.) play a role in the greater reliance on food consumed outside the home.

Bauer et al.[33] examined the relationships between parental work obligations, stress, and the family food environment. The researchers utilized the data collected from the Project F-EAT, a study of the parents of adolescents participating in Project EAT. The researchers recruited 3,709 parents for this study.[33] The researchers found that mothers who worked had families who ate meals together less frequently, had more frequent fast food family meals, and spent less time on meal preparations.[33] Since adolescents rely on their parents/caregivers for some or all of their meals, hectic schedules for parents can lead to increased "away from home" food consumption for the adolescents by default.

Another study took a different approach to addressing the relationship between food "away from home" and multiple demands on families' time. Instead of looking at a family's busy schedule and determining if they ate fast food, McIntosh et al.[34] examined children's time spent in fast food versus full-service restaurants. The researchers utilized data from the Parental Time, Income, Role Strain, Coping, and Children's Diet and Nutrition study, randomly selecting 312 families.[34] They found that parents who have schedules that varied day-to-day frequented fast food restaurants more than full-service restaurants.[34] The authors also found that when children spent more time traveling in the car, they spent more time in fast food and full-service restaurants.[34]

Sport Participation and Food "Away From Home"

McIntosh et al.[34] raised an interesting concept surrounding food consumed "away from home": children who spent time in the car eat more fast food. Children and adolescents spend much of their time in the car, being shuttled from school to extracurricular activities to errands. A busy schedule of activities may force the parent to rely on fast food for meals, as it is quick, convenient, and "car-friendly". Another activity that requires "car time" is the shuffle to and from sports practices, games, clinics, and tournaments. McIntosh et al.[34] postulated that because sports require car time, adolescent athletes might be more reliant on fast food for meals. Two have been conducted to examine this concept and found that demanding sport schedules can lead to outside food consumption and possible deficits in key nutrient intakes.

Travis et al.[35] examined female athletes and how their hectic sports schedule is associated with different eating practices. By interviewing both parents and the adolescent athletes (n=20), the researchers could get a broad understanding of the eating habits of competitive athletes, i.e., the food their parents provide and the food the adolescents seek out on their own. Instead of coming to firm conclusions, the researchers reported that each family had their own way of coping with the increasingly busy schedule.[35] Some may rely on fast food while others may have a plan in place that ensures dinner happens at home. Despite the lack of firm findings, this paper provides researchers with areas to probe and continue to understand the factors that influence planning, preparing, and eating family meals.

Thomas et al.[36] examined the actual food environment surrounding youth sports and how that environment influences the dietary habits of the players. The researchers looked at group sports, like soccer and basketball, which usually have large games and big tournaments.[36] The researchers held eight separate focus group discussions for the parents of children and adolescents (n=60) who participated in these sports.[36] They reported on a large presence of fast food meals, because they are convenient, common, and "easy to transport" in the car,[36] consistent with findings related to the conclusions drawn by McIntosh et al.[34] about children's time in the car and their fast food consumption. Parents shared that food habits differ depending on the child's sport participation level.[36] Adolescents who are a part of traveling sports teams are more likely to have more obligations (traveling farther away, longer meets and tournaments, etc.) than adolescents participating in an intramural league.[36] Parents cited time constraints preventing them from planning snacks ahead, cooking family dinners, and reliance on food prepared outside the home.[36]

Sports Participation and Dietary Quality

Contrary to findings suggesting that sports participation can lead to greater consumption of food from outside the home, two studies have reported that sports participation actually assists in improved nutrition of adolescent athletes. Cavadini et al.[37] compared diet quality of Swiss adolescent athletes and non-athlete adolescents. The researchers found that the athletes had healthier food patterns than their non-athlete counterparts. The athletes consumed more dairy products, ready-to-eat cereals, fruit, fruit juices, and salads compared to the non-athletic adolescents.[37]

Cupisti et al.[38] was more specific when selecting subjects for a study comparing "dietary intake and nutrition knowledge" of adolescent female Italian athletes compared to their non-athletic counterparts. Using a case-control design, they specifically chose participants based on their sport (gymnastics, tennis, and fencing), age-matched them with non-athlete female adolescents (n=60, N=59),[38] and assessed food consumption and nutrient intakes. The researchers found that the female athletes consumed more fiber, iron, and vitamin A compared to the non-athletes. The data also revealed that the adolescent athletes had better nutrition knowledge than their non-athlete counterparts.[38]

Gymnastic Participation and Key Nutrient Intake

Much of this literature review has been focused on food "away from home" and its influence on key nutrient intakes of adolescents. The current study is focused not just on adolescents, but specifically female gymnasts. Understanding which key nutrients these athletes lack may improve understanding of how food away from home affects diet quality.

In an older study, Jonnalagadda et al.[39] assessed the key nutrient intakes of United States of America National Team artistic gymnasts (n=33). The researchers discovered that the gymnasts' vitamin E intake met only 50% of the RDA.[39] Yet, their intake of vitamin C, thiamin, riboflavin, and niacin were higher than the levels previous studies had found. The researchers attributed the higher intakes of these vitamins to the "widespread use of supplements" by team members.[39]

The dietary intake of twelve elite gymnasts was investigated by Filare and Lac.[40] The researchers found that the gymnasts consumed more carbohydrates, protein, and fat than the age-matched, non-gymnast comparison group, but consumed less fiber and vitamins E and B_6 than the non-gymnasts.[40] These findings were consistent with those of Jonnalagadda et al.[39] Further research could explore gymnasts' key nutrient intakes and the effect of food consumed outside the home.

Summary

The adolescent diet of today is suboptimal and has been found to fall short of the dietary recommendations. Factors that impact adolescent diet quality are the appeal of food "away from home", the relationship between family dynamics and the home food environment, and the increasingly busy familial schedule (specifically from sports participation). Research has shown that food consumed "away from home" is negatively associated with diet quality, which can greatly impact children and adolescents. These individuals are in a period of growth and development and require proper nutrition to thrive. Food "away from home" not only provides excesses of undesirable nutrients (i.e., saturated fat and sodium), but also can lead to deficits in desired nutrients (i.e., folate and calcium).

Specific Aims

Overall, the existing evidence has shown that the adolescent diet is lacking in key food groups (namely fruits, vegetables, and whole grains) that provide beneficial nutrients for growth and development. These nutrient-dense foods appear to be replaced by energy-dense foods (sugar-sweetened beverages, fast food, etc.), which do not provide the same nutritional benefits. The pace of the American way of life has increased over the years, leading to greater reliance on food prepared outside the home (restaurants, fast food, etc.) rather than the traditional family meal at home. With school, extracurricular activities, and sports, adolescents and their families may be reliant upon food "away from home" for their family meals. The literature highlighted in this review builds the case that scheduling for sports and time in the car may lead to this increased reliance upon food prepared "away from home". These food items have been shown to push out nutrient-dense foods, resulting in a decreased consumption of key nutrients by adolescent athletes. These findings have provided the foundation for the current study exploring the relationship between food "away from home" and the key nutrient intakes of calcium, magnesium, sodium, and key vitamins (A, B_{12}, C, D, E, K) among growing girls.

This study will expand upon previous research on sport schedules and food "away from home" consumption in growing girls. This study will not only examine the key nutrient intake and food "away from home" frequency, but will also identify any differences between female gymnasts and non-gymnasts. It can be hypothesized that female gymnasts have a more regular schedule than non-gymnasts; and if they have a more consistent schedule, it can allow for more opportunities to plan family meals around that schedule – compared to active non-gymnasts who may have more variable schedules. By assessing the frequency of food "away from home" consumption and key nutrient intakes of girls as a whole, a relationship among food consumption outside the home and key nutrient intake can be identified. We will evaluate the sport schedules as a factor in the association between FFAH and key nutrient intakes to assess associations among regular sporting schedules, food consumed "away from home", and key nutrient intake.

Research Questions

The following research questions will be addressed in the current study: How do the nutrient intakes of premenarcheal girls compare to recommendations? What is the frequency of dinner consumed that is prepared outside the home among premenarcheal girls? What is the frequency of fried food consumed outside the home among premenarcheal girls? Are there major differences in key nutrient intake between gymnasts and non-gymnasts? Is there a difference between food “away from home” consumption between female gymnasts and female non-gymnasts?

INTRODUCTION

Over the past two decades, the diets of American children and adolescents have evolved. Twenty years ago, most meals were eaten at home, while consumption of foods prepared "away from home" was a rare occurrence. Today, approximately 36% of the total kcalories consumed by children and adolescents come from sources outside the home.[1] Food "away from home" can be classified as any food prepared and usually consumed outside the home environment – fast food venues, restaurants, grocery store prepared meals, etc.

The existing literature focuses mostly on fast food when examining the presence of food "away from home" on adolescents' diets. Fast food is popular because it is cheap, abundant, appealing, and convenient.[2] Previous studies have examined the influence of fast food intake on diet and have found that fast food contributed to a greater intake of total kcalories,[3,4] total fat and saturated fat,[2] sodium[3] and an overall lower intake of fruits and vegetables, whole grains, and dairy products.[5]

With the concern that fast food may be pushing nutrient-dense foods out of the pediatric diet, it is essential to understand how fast food consumption influences key nutrient intakes in this population. Several studies have found that adolescents who consume fast food on a given day have lower intakes of calcium, iron, fiber, and vitamins A and C.[3,6,7] Evidence suggests that food "away from home" may be partly responsible for a population-wide decline in important key nutrients in pediatrics' diets, several of which are crucial to future growth and development. Yet, the existing literature only looks at a few key nutrients, and nothing is said about the various other nutrients that are also needed for healthy growth.

Evidence that frequent consumption of family meals at home promotes the intake of key nutrients among youths,[8,9] stresses on family time and schedules may be a key reason behind the rise in reliance on foods prepared "away from home". Researchers have found that food "away from home" is becoming more prevalent because of its convenience and low cost, which can fit into the busy family landscape.[10-12] Children and their families are becoming increasingly busy with more activities, requiring quick access to food during free moments.

Researchers are beginning to explore the influence of organized sports on family schedules; specifically how organized sports impact family meals at home. Thomas et al.[13] posited that sports participation can lead to a greater consumption of food from outside the home, such as stopping for fast food for the family dinner. Sports practices, games, and tournaments can lead to greater time away from home, in the car, and may leave parents and caregivers pressed for time.[13] Researchers found that the demands on the family schedule prevented them from planning snacks ahead, cooking a family dinner, and increased reliance on food prepared outside the home.[13] More research is needed to understand how the schedules of growing athletes influence their eating patterns and if there is a link between sports participation and food "away from home" consumption.

The current analysis will expand upon the existing knowledge already conducted on sport scheduling and food "away from home" consumption. Instead of looking at children and adolescents who participate in seasonal sports (with their potentially unpredictable schedule), this study will focus on a year-round (and more routine) sport – gymnastics. It can be postulated that female gymnasts who practice year-round have a more regular schedule that active non-gymnasts, which may lead to benefits in diet composition and quality. The purpose of this analysis is to examine the frequency of food "away from home" consumption in relation to the intakes of key nutrient within a group of growing girls. Additionally, these factors will be assessed between gymnasts and active non-gymnasts, to see if there is a relationship between a more regular sporting schedule, food consumed "away from home", and key nutrient intake.

METHODS

Study Design and Participants

The data for this study are a subset from an ongoing prospective longitudinal study of human growth in relation to physical activity and dietary composition. The institutional review board at SUNY Upstate Medical University approved this study, which was performed in compliance with the Declaration of Helsinki and provision of informed consent/assent by parents and children as appropriate.

The current cross sectional analysis examined physical activity, gymnast status, and dietary intake. Data collected in 2011 were included based on the following criteria: subject age between 8 and 15; premenarcheal status; subject in good physical health; valid Youth Adolescent Questionnaire data with complete activity, maturation, and anthropometric data.[14] The whole group was divided into two subgroups of gymnasts and non-gymnasts. Gymnasts were defined as any subjects practicing gymnastics ≥6 hours per week. Non-gymnasts were defined as any subjects practicing gymnasts <6 hours per week. Of all the participants in the parent study, 67 girls met the inclusion criteria, with 36 classified as non-gymnasts and 31 classified as gymnasts. Race was not formally assessed in the parent study and was not an inclusion criterion for this analysis.

Measures

Anthropometric and Body Composition Data

The participants in the parent study came to SUNY Upstate Medical University for anthropometric measurements, including height (via a wall-mounted stadiometer) and weight (via an electronic digital scale). Body mass index (BMI; kg/m^2) was calculated and converted to BMI-for-age percentiles based on the Centers for Disease Control and Prevention BMI-for-age growth charts.[16]

Dietary Data

Dietary data collection began in 2008, so all the data included in the current analysis was from 2008 or later. The survey utilized in the parent study is the Harvard Youth Adolescent Questionnaire (YAQ; 1995 version).[17,18] This survey created specifically to quantify children's dietary habits. The YAQ was derived from the Willett's preliminary children's semiquantitative food frequency questionnaire.[18] After a pilot study, the food frequency questionnaire was reevaluated and the draft of the Youth Adolescent Questionnaire was created.[18] The questionnaire was formatted similarly to the Nurse's Health Instrument and contained 151 food items, with 27 of those items being snack foods.[18,19] The reproducibility of the YAQ was established using a multiethnic population of 178 subjects aged 9-18 years old; these subjects completed the YAQ twice in one year and the results were compared to evaluate discrepancies.[18] Rockett et al. demonstrated that adolescent dietary intake can be estimated reasonably well with the YAQ.[19]

Variables

The frequency of dinner consumed "away from home" was assessed by the YAQ questions, "How many times each week (including weekdays and weekends) do you usually eat dinner prepared away from home?" This variable was selected because the literature has implied that dinner seemed to be the meal that the participants and their families would be often responsible for, because breakfast, lunch, and snacks could be provided by other organizations (school, aftercare programs, extracurricular groups, etc.), which is why they have been left out of the classification of food "away from home".[8,20] Neumark-Sztainer et al.[20] chose to analyze the dinner meal because it is the meal that most families share together on a regular basis.

The key nutrient intakes that were assessed included total energy, carbohydrates, protein, total fat, saturated fat, added sugar, fiber, and key vitamins and minerals, specifically calcium, folate, iron, magnesium, and vitamins A, B_{12}, C, E, and K. These specific key nutrients were chosen because the literature has found that changes in these nutrient intakes (both positive and negative) are related to the frequency of family meal consumption.[8,9] Additionally, Jonnalagadda et al.[21] and Filare and Lac[22] found that gymnasts consumed certain key nutrients either more than their non-gymnast peers (carbohydrates, proteins, fat, calcium, vitamin C) or less (fiber and vitamin E). When using the YAQ data, the key nutrients assessed were values that included intakes from both dietary sources and multivitamin/multimineral sources.

Finally, the YAQ contains a specific question pertaining to the frequency of fast food consumption – the frequency of fried food consumed "away from home" (FFAH) (i.e. chicken nuggets, French fries, etc.). With the influence of the reliance and convenience of food "away from home" due to the hypothesized hectic familial schedule (potentially due to sports), it is important to compare the fried food consumption of gymnasts and non-gymnasts to discover if there is a link between FFAH and nutritional status. Fried foods are also frequently mentioned in the literature discussing fast food and food "away from home" in general, which was why it was selected for examination in this study.

Statistical Analysis

All data were analyzed using SPSS statistical software (IBM; version 21). Descriptive statistics assessed frequencies and measures of central tendency for variables of interest. The variables highlighted in the "Measures" section were analyzed for the total sample and then compared between gymnasts and non-gymnasts. The level of significance was set at α=.05 to determine statistical significance. Kolmogorov-Smirnov tests were run to evaluate normality of data distributions; all variables were normally distributed. Analysis of Variance (ANOVA) was used to examine differences in key nutrients between girls grouped by their frequency of eating dinner "away from home". For whole group analyses, subjects were grouped by their frequencies of eating dinner "away from home" ("Never/less than once per week"; "1-2 times per week"; "3-4 times per week"; "5 or more times per week"). Tukey post-hoc tests were used to specify individual differences between the groups. In order to determine whether there were differences in consumption of key nutrients between participants who ate fried food "away from home" (FFAH) more (1-3 times per week) or less (never/less than once per week) frequently, independent samples t-tests were run. Descriptive statistics were run on all key nutrients to examine the intakes of the participants as a whole and to compare them to Dietary Reference Intake (DRI) recommendations.[23]

The total sample was separated into two subgroups – gymnasts and non-gymnasts – using the measure of weekly gymnastic hours (non-gymnast: <6 h/wk; gymnast: >6 h/wk). This cutoff point was the midpoint in the gymnast hour data – it provided a clear delineation between gymnast and non-gymnast subgroups. Independent sample t-tests were also conducted to examine the intakes of key nutrients between groups (gymnasts and non-gymnasts). Two-factor ANOVA was conducted to assess the nutrient intakes of gymnasts and non-gymnast by their frequency of dinner consumed “away from home”. Chi-square tests were used to determine if there were any differences between gymnast and non-gymnast status and the frequencies of dinner and fried food consumed “away from home”.

RESULTS

Total Sample

The participants were almost divided evenly between gymnast (n=31) and non-gymnast (n=36) groups. Subject characteristics are shown in Table 1. Mean key nutrient intakes are presented in Appendix Table 1. The whole group analysis revealed that the mean key nutrient intakes were above the Estimated Average Requirements (EARs)/Required Dietary Allowances (RDAs) for carbohydrates, protein, sodium, iron, folate, and vitamins A, B_{12}, C, and K. Mean intake of total fat fell into the recommended range. The girls’ mean intakes were below the EARs/RDAs for calcium and vitamin E. (Appendix Table 1)

The whole group frequencies of dinner consumed “away from home” are in Table 2. There were no significant differences in any key nutrients when examining intakes between subjects based on frequency of dinner consumed “away from home”. The whole group mean intakes of the key nutrients are listed in Table 3.

Independent samples t-tests revealed significantly higher intakes of total kcalories ($p<0.05$), total fat ($p<0.01$), saturated fat ($p<0.01$), cholesterol ($p<0.05$), carbohydrates ($p<0.05$), total sugar ($p<0.05$), added sugar ($p<0.05$), sodium ($p<0.01$), Vitamin A ($p<0.05$), Vitamin C ($p<0.05$), and Vitamin E ($p<0.01$) (Table 4) based on the frequency of FFAH (never/less than once per week; 1-3 times per week). No significant associations were found between subjects consuming FFAH never/less than once per week and those consuming FFAH 1-3 times per week for protein, added solid or liquid fats, whole grains, calcium, folate, iron, or other key vitamins (B_{12}, K) (Table 4).

Activity Group Comparisons

Due to the low number of responses within some options of food "away from home", two of the frequency groups ("1-2 times per week" and "3-4 times per week") were collapsed into one group and an independent t-test was performed. No significant differences were found for nutrient intakes betweens gymnasts and non-gymnasts based on frequency of dinner "away from home" consumption. No significant associations were found between gymnast status and the frequency of consumption of food "away from home". Similarly, Chi-square test between gymnast status and the frequency of fried food "away from home" was not significant, χ^2 (1, n=67) = 0.387, p=0.534. Table 2 presents details on consumption frequencies for food "away from home" in gymnasts and non-gymnasts.

Gymnasts had significantly greater intakes of carbohydrates, dietary iron, and dietary folate than non-gymnasts ($p<0.05$) (Table 5). No differences between gymnasts and non-gymnasts were detected for the other macro- and micronutrients of interest.

DISCUSSION

This study was conducted to evaluate potential associations between frequency of food "away from home" consumption and key nutrient intakes in a sample of growing girls as a whole and subdivided by level of gymnastic participation. The lack of association between dinner consumed "away from home" and gymnast status corroborated the findings of a similar studying outside influences (like sports participation) on adolescent diet quality.[5] French et al.[5] compared eating patterns in adolescents and found that athlete status (participating in sports vs. not) was not associated with high frequency of fast food restaurant use. The findings, both in this study and in French et al., contradict other papers. Thomas et al.[13] detected a significant positive association between sports participation and food "away from home, especially fast food. In the current study, analyses detected between gymnast status and the two measures of food "away from home", contrary to the findings by Thomas et al.[13].

Our results are supported by the findings of Bowman et al.[2] and Poti and Popkin[4], who found that a greater intake of fried foods from fast food establishments led to higher daily calorie consumption. In our total sample, girls who more frequently consumed fried foods "away from home" had higher mean calorie intakes.

Nickols-Richardson compared the dietary intake of gymnasts with the intakes of non-athlete controls and other athletes (swimmers, speed skaters, etc.).[24] She found that gymnasts' intake of kcalories, calcium, and iron were lower than the RDA.[24] This is contrary to our findings that the gymnasts exceeded the recommended calorie and iron allowances. However, in our gymnasts, mean calcium intake was borderline, as it was below the RDA of 1300mg, but exceeded the EAR of 1,100mg.

Cupisti et al. compared female athletes' dietary intake against non-athletes. Our findings align with theirs in that they found that the athletes consumed more iron than their non-athlete counterparts.[25] Our findings differed from those of Cupisti et al. when examining vitamin A. Cupisti et al. reported that female athletes consumed more vitamin A than the non-athletes,[25] where we found that there was no significant difference between gymnast and non-gymnast vitamin A intake.

Finally, our findings were similar to those found by Jonnalagadda et al.[21] and Filare and Lac[22]. These researchers both examined the dietary patterns of gymnasts, either by themselves (Jonnalagadda et al.[21]) or compared against age-matched controls (Filare and Lac[22]). Both groups reported that gymnasts consumed less vitamin E than their control counterparts. Filare and Lac[22] stated that gymnasts consumed "less vitamin E" than controls, while Jonnalagadda et al.[21] specifically found that gymnasts only met 50% of the RDA for vitamin E. While most of our findings looking at key nutrients and gymnast status were not significantly different, the mean intakes of vitamin E (Appendix Table 1) were lower in gymnasts in comparison to the EAR and the RDA. This is in line to the findings discussed by Filare and Lac.[22] Jonnalagadda et al.[21] found that gymnasts consume more vitamin C (mean=827mg) than the levels found in previous studies. These researchers suggested that this phenomenon is attributable to greater supplement use in this population.[21] This finding by Jonnalagadda et al.[21] is much greater than the levels found in this current study, but the elevated vitamin C levels found in this current analysis could be reflected from an increased supplement intake amongst this population.

Our findings provide additional support to the body of research exploring the differences between gymnasts' versus non-gymnasts' key nutrient intakes. Our data supported findings by Cupisti et al., Jonnalagadda et al., and Filare and Lac on athlete dietary micronutrient consumption. Female adolescent gymnasts consumed more iron than their control counterparts and are not receiving enough vitamin E from their diets. Our findings also support the conclusions made by Filare and Lac[21] concerning the macronutrients; the current analysis found that gymnasts exceed the RDAs and consume more carbohydrates, protein, and fat than the non-gymnasts, which corroborates the findings by Filare and Lac.[21] Except for calcium and vitamin E, our total sample's nutrient intakes were above the RDAs and EARs put forth by the federal government and other health care professionals. Our gymnasts' nutrient intakes were only significantly higher than the non-gymnasts' for carbohydrates, dietary iron, and dietary folate. These findings suggest that despite not finding a significant difference between the gymnasts and the non-gymnasts for the majority of the key nutrients (except carbohydrates, dietary iron, and dietary folate), our findings exhibit similar patterns to those found in other studies examining a comparable population.

Evaluation of the descriptive data revealed that our sample was fairly homogeneous. Age, weight, and ethnicity were similar for a majority. A potential factor in the limited results of this study is potentially a similarity in sociodemographic status. There was a lack of formal evaluation of this factor, but the location of recruitment (local gymnastics schools and private schools) and the number of hours spent at gymnastics suggest that the participants in this study come from families of some financial means. Travis et al.[26] proposed a conceptual model of food and eating in adolescent athletes from middle to upper class families that had similar sociodemographic backgrounds. They reported that each family had their own ways of coping with the increasingly busy schedule. Some may rely on fast food, while others may have a plan in place that ensures dinner happens at home. As in the current study, Travis et al.[26] had inconclusive findings on the relationship between food "away from home" and female adolescents' sport schedules.

One of the biggest limitations of this study was the sample size. With only 67 girls, despite an almost even split between the two groups (gymnasts, n=31; non-gymnasts, n=36), there might not have been enough participants to detect associations between food "away from home" and components of dietary intake. The current study also utilized secondary data. Future studies should be specifically designed to include a large number of subjects and focus primarily on the association between food consumed “away from home” and sports scheduling among various sports.

Another limitation of the current study was that the comparison group was composed of active girls. Despite not participating in gymnastics, many of the non-gymnasts participated in multiple sports and other physical activities. Non-gymnasts were not inactive controls, they simply did not exceed the gymnastics participation threshold. The lack of differences between groups when examining food “away from home” could be attributed to other factors besides scheduling – gymnasts may eat more food at home because their families can plan meals around their regular sport schedules, while the non-gymnasts in our study may participate in fewer activities allowing for eating away from home occasions to occur infrequently.

The cross-sectional study design is another limitation. The study data were sampled from a single period of time in the year and the participants were selected based on characteristics from a larger sample. A longitudinal observation of changes in dietary patterns associated with changes in training schedules across a year would be better suited for our purposes. This design might allow detection of significant associations between scheduling and diet within individuals..

Use of the Youth Adolescent Questionnaire (YAQ) presents both strengths and limitations to this current analysis. Research has shown that when children reach age 12, they become accurate reporters of their dietary intake. Before this point, parents usually act as a proxy reporter of their child’s food intake.[27] Our mean age for this population was 11.7 years old, just below this threshold. Food frequency questionnaires can lead to misreporting of dietary intakes in children and adolescents. Research has found that over-reporting is an issue when using this method of dietary assessment.[27] Another criticism of assessing the dietary intakes of children and adolescents with a food frequency questionnaire (FFQ) is that there are not enough “child” foods on the questionnaire.[28] Because the YAQ includes “child-friendly” foods, such as tacos and chicken nuggets, it provides a better measure of pediatric food preferences and intake.

Since the participants completed the food frequency questionnaires at different times of the year, seasonality may have confounded our analyses. In a study of Shanghi women, Fowke et al.[29] reported that season of food frequency questionnaire (FFQ) completion influenced FFQ responses. The researchers discovered that summertime food intakes were driven by fresh fruit, while wintertime eating patterns were characterized by greater intakes of “fat, meat, and vegetables”.[29] Our summer YAQs might have an over reporting of “warm weather food”, such as ice cream, popsicles, etc., while winter YAQs may have over reporting of other foods. This could impact the dietary assessment findings.

CONCLUSIONS

Our findings of our study corroborate other studies, indicating that female adolescent gymnasts have a better diet quality than non-gymnasts (both athletes and non-athletes) despite having higher average hours per week spent training. Despite these findings, we found no discernable relationship between gymnast status and food “away from home”. In our subjects, key nutrient intakes were not adversely affected by eating “away from home”. However, meals “away from home” were associated with greater fat and calorie intakes. Still, more research is needed to further understand the relationship between organized physical activity, family scheduling, food “away from home”, and dietary intake.

Table 1: Subject Characteristics (n=67)

Variable		Means (standard deviations) Gymnast (n = 31)	Non-Gymnast (n = 36)
Age (yr)		11.7 (0.2)	11.1 (0.2)
Body Mass Index Percentile (%)		46.9 (25.0)	53.5 (28.8)
Weight Status (n)	< 85th %ile	28	31
	85th – 94th %ile	3	1
	≥ 95th %ile	0	4
Tanner Breast Maturation Stage (n)	Stage 1	8	15
	Stage 2	17	15
	Stage 3	6	6
Tanner Pubic Maturation Stage (n)	Stage 1	13	25
	Stage 2	11	4
	Stage 3	5	7
	Stage 4	2	0
Weekly Physical Activity (h/wk)		13.5 (3.6)**	4.1 (2.5)**
Gymnastics Training (h/wk)		12.4 (3.8)**	0.4 (0.1)**
Ethnicity (n)	Caucasian	29	33
	Asian	2	2
	Native American	0	1

* indicates $p < 0.05$
** indicates $p < 0.01$

Table 2: Frequency of Food "Away From Home"

Measure	Frequency	Total (n)	Gymnast Status		Chi-Square Results
			Gymnast (n)	Non-gymnast (n)	
Dinner Consumed "Away From Home"	<1	21	9	12	χ^2 (1, n=67) = 0.143, p=0.705*
	1-2 times per week	39	18	21	
	3-4 times per week	7	4	3	
Fried Food Consumed "Away From Home"	< 1time per week	33	14	19	χ^2 (1, n=67) = 0.387, p=0.534
	1-3 times per week	34	17	17	

Table 3: Key Nutrient Intake in Relation to the Frequency of Dinner Consumed "Away From Home" in Growing Girls (n=67)

Nutrient	Frequency of Dinner Consumed "Away From Home" (times per week)	Mean (standard deviation)		
		Total (n=67)	Gymnast (n=31)	Non-gymnast (n=36)
Calories (kcal)	<1	1954.1 (426.8)	2148.9 (312.2)	1807.9 (453.9)
	1-2	2097.4 (554.2)	2164.4 (350.8)	2039.9 (686.7)
	3-4	2112.8 (190.7)	2078.6 (256.1)	2158.4 (71.9)
Carbohydrates (g)	<1	266.4 (58.5)	299.6 (51.1)	241.6 (53.1)
	1-2	279.3 (79.7)	293.2 (49.7)	267.4 (98.3)
	3-4	281.0 (29.6)	283.7 (40.5)	277.5 (11.9)
Protein (g)	<1	77.2 (21.3)	79.9 (17.9)	75.1 (24.0)
	1-2	88.2 (24.3)	90.1 (18.6)	86.6 (28.6)
	3-4	85.6 (24.3)	82.9 (7.4)	89.1 (4.9)
Total Fat (g)	<1	66.9 (19.5)	72.6 (17.3)	62.6 (20.6)
	1-2	72.6 (21.6)	73.1 (17.4)	72.2 (25.1)
	3-4	74.5 (11.5)	70.7 (14.2)	79.7 (4.9)
Saturated Fat (g)	<1	24.6 (8.1)	27.1 (6.6)	22.7 (8.8)
	1-2	25.5 (8.3)	25.3 (7.1)	25.6 (9.3)
	3-4	26.1 (5.5)	24.0 (6.2)	28.9 (3.7)
Cholesterol (mg)	<1	227.1 (85.5)	221.1 (77.4)	231.6 (94.3)
	1-2	235.5 (76.2)	239.6 (69.5)	231.9 (82.9)
	3-4	260.2 (65.8)	241.9 (83.4)	284.7 (31.7)
Sodium (mg)	<1	231.3 (521.1)	2559.1 (447.8)	2142.9 (516.7)
	1-2	2540.1 (740.7)	2604.0 (573.6)	2485.2 (869.5)
	3-4	2564.6 (343.1)	2584.9 (457.8)	2537.6 (192.2)
Calcium (mg)	<1	1118.4 (388.9)	1271.8 (368.6)	1003.4 (377.6)
	1-2	1226.1 (424.9)	1215.9 (438.9)	1234.8 (423.3)
	3-4	1063.3 (309.9)	989.6 (247.8)	1161.7 (413.0)

Iron (mg)	<1	22.9 (12.6)	22.6 (12.7)	23.2 (13.1)
	1-2	24.8 (12.6)	27.2 (11.8)	22.7 (13.3)
	3-4	23.1 (14.1)	30.5 (15.1)	13.3 (0.49)
Folate (mcg)	<1	651.9 (295.9)	644.2 (291.5)	657.6 (311.9)
	1-2	661.1 (290.2)	717.5 (217.3)	612.7 (338.4)
	3-4	630.5 (325.9)	809.1 (331.7)	392.5 (69.8)
Vitamin A (RAE)	<1	1538.1 (1108.8)	1447.1 (1017.3)	1606.4 (1212.7)
	1-2	1596.3 (907.8)	1633.8 (777.7)	1564.1 (1024.4)
	3-4	1670.1 (1063.8)	2043.9 (1265.7)	1171.8 (583.6)
Vitamin B_{12} (mcg)	<1	8.9 (5.4)	8.1 (3.7)	9.4 (6.5)
	1-2	9.0 (3.8)	9.7 (2.9)	8.4 (4.5)
	3-4	9.6 (5.7)	11.6 (5.6)	6.8 (5.4)
Vitamin C (mg)	<1	133.8 (64.1)	135.0 (57.7)	132.9 (71.0)
	1-2	130.7 (75.6)	138.6 (58.2)	123.8 (83.8)
	3-4	155.7 (60.8)	184.6 (66.7)	117.3 (22.9)
Vitamin E (mg)	<1	6.6 (2.0)	6.9 (1.9)	6.4 (2.1)
	1-2	7.3 (2.4)	7.6 (1.7)	7.0 (2.8)
	3-4	7.1 (1.3)	7.6 (1.2)	6.6 (1.5)
Vitamin K (mcg)	<1	114.9 (70.9)	121.9 (91.7)	109.6 (54.3)
	1-2	98.3 (61.8)	77.1 (30.8)	116.4 (75.6)
	3-4	189.1 (72.6)	240.3 (241.4)	120.9 (105.1)

For all comparisons between gymnasts and non-gymnasts, group differences were not detected $p > 0.05$.

Table 4: Differences in Key Nutrient Intakes with Dietary and Supplement Use in Girls (n=67) by their Frequency of Consumption of Fried Food "Away From Home" (FFAH)

Key Nutrient	Frequency of FFAH	Mean (standard deviation)	Independent t-test Results *p-value*
Calories (kcal)	Never/less than once per week	1872.1 (405.3)	0.002
	1-3 times per week	2230.7 (505.4)	
Protein (g)	Never/less than once per week	79.9 (21.4)	0.107
	1-3 times per week	88.9 (22.9)	
Total Fat (g)	Never/less than once per week	61.6 (15.8)	0.00
	1-3 times per week	80.2 (19.7)	
Saturated Fat (g)	Never/less than once per week	21.9 (7.1)	0.001
	1-3 times per week	28.3 (7.4)	
Added Solid Fat (g)	Never/less than once per week	33.3 (10.9)	0.744
	1-3 times per week	34.2 (12.3)	
Added Liquid Fat (g)	Never/less than once per week	23.0 (7.9)	0.650
	1-3 times per week	22.1 (8.6)	
Cholesterol (mg)	Never/less than once per week	214.8 (66.8)	0.035
	1-3 times per week	255.4 (83.2)	
Carbohydrates (g)	Never/less than once per week	254.9 (62.1)	0.016
	1-3 times per week	295.3 (71.3)	
Whole Grains (g)	Never/less than once per week	18.3 (14.8)	0.568
	1-3 times per week	16.7 (7.1)	

Total Sugar (g)	Never/less than once per week	116.5 (40.1)	0.022
	1-3 times per week	140.1 (42.2)	
Added Sugar (g)	Never/less than once per week	55.3 (19.4)	0.003
	1-3 times per week	72.2 (25.3)	
Sodium (mg)	Never/less than once per week	2257.7 (551.6)	0.006
	1-3 times per week	2684.1 (672.5)	
Calcium (mg)	Never/less than once per week	1114.5 (419.9)	0.226
	1-3 times per week	1234.4 (382.8)	
Iron (mg)	Never/less than once per week	22.4 (13.7)	0.292
	1-3 times per week	25.6 (11.4)	
Folate (mcg)	Never/less than once per week	624.1 (319.4)	0.396
	1-3 times per week	685.0 (262.1)	
Vitamin A (RAE)	Never/less than once per week	1399.4 (1042.3)	0.035
	1-3 times per week	1766.6 (883.8)	
Vitamin B_{12} (mcg)	Never/less than once per week	8.3 (5.2)	0.213
	1-3 times per week	9.7 (3.6)	
Vitamin C (mg)	Never/less than once per week	115.1 (70.4)	0.023
	1-3 times per week	152.9 (61.7)	
Vitamin E (mcg)	Never/less than once per week	6.3 (2.0)	0.004
	1-3 times per week	7.8 (2.1)	
Vitamin K (mcg)	Never/less than once per week	100.6 (61.9)	0.216
	1-3 times per week	124.9 (107.8)	

Table 5: Independent t-tests Between Gymnast Status and Key Nutrient Intake

Variable	Gymnast Status	Mean (standard deviation)	*p*
Calories (kcal)	Non-gymnast	1972.5 (591.1)	0.128
	Gymnast	2148.8 (321.1)	
Carbohydrates (g)	Non-gymnast	259.6 (81.2)	0.044
	Gymnast	293.8 (47.8)	
Protein (g)	Non-gymnast	82.9 (26.1)	0.546
	Gymnast	86.2 (17.6)	
Total Fat (g)	Non-gymnast	69.6 (22.9)	0.530
	Gymnast	72.7 (16.5)	
Saturated Fat (g)	Non-gymnast	24.9 (8.9)	0.704
	Gymnast	25.7 (9.6)	
Calcium (mg)	Non-gymnast	1151.6 (410.6)	0.606
	Gymnast	1202.9 (398.9)	
Sodium (mg)	Non-gymnast	2375.5 (738.9)	0.170
	Gymnast	2588.5 (511.2)	
Cholesterol (mg)	Non-gymnast	236.2 (83.7)	0.931
	Gymnast	234.5 (71.5)	
Iron (mg)	Non-gymnast	22.1 (12.7)	0.177
	Gymnast	26.3 (12.3)	
Dietary Iron (mg)	Non-gymnast	13.4 (4.6)	0.011
	Gymnast	16.1 (4.1)	
Folate (mcg)	Non-gymnast	609.3 (318.0)	0.161
	Gymnast	708.1 (251.1)	
Dietary Folate (mcg)	Non-gymnast	415.9 (150.7)	0.033
	Gymnast	483.4 (90.6)	
Vitamin A (RAE)	Non-gymnast	1545.5 (1046.3)	0.755

	Gymnast	1632.5 (900.9)	
Vitamin B_{12} (mcg)	Non-gymnast	8.6 (5.2)	0.433
	Gymnast	9.4 (3.6)	
Vitamin C (mg)	Non-gymnast	126.3 (75.2)	0.300
	Gymnast	143.5 (59.3)	
Vitamin E (mcg)	Non-gymnast	6.8 (2.5)	0.251
	Gymnast	7.4 (1.7)	

Appendix

Appendix Table 1: Key Nutrient Intakes of the Full Sample of Girls and by their Participation in Gymnastics

Key Nutrient	Means (standard deviations)			Dietary Reference Intakes	
	All Girls (n=67)	Gymnasts (n=31)	Non-Gymnasts (n=36)	Estimated Average Requirements	Recommended Dietary Allowances
Calories (kcal)	2054.1 (489.9)	2148.8 (321.1)	1972.5 (591.1)	1600-2000	
Carbohydrate (g)	275.4 (69.5)	293.8 (47.8)	259.6 (81.2)	100	130
Fiber (g)	17.2 (5.1)	17.9 (3.8)	16.5 (6.0)	N/A	26
Total Fat (g)	71.0 (20.1)	72.7 (16.5)	69.6 (22.9)	25-35% of total kcal 400 – 700 kcal per day 44.4 – 77.8g per day	
Saturated Fat (g)	25.3 (7.9)	25.7 (6.7)	24.9 (8.9)	As low as possible	
Protein (g)	84.5 (22.5)	86.2 (17.6)	82.9 (26.1)	0.76/kg/d	34
Cholesterol (mg)	235.4 (77.7)	234.5 (71.5)	236.2 (83.7)	As low as possible	
Sodium (mg)	2474.1 (647.9)	2588.5 (511.2)	2375.5 (738.9)	N/A	1500

Calcium (mg)	1175.3 (403.0)	1202.9 (398.9)	1151.6 (410.6)	1100	1300
Iron (mg) (dietary plus supplementation)	24.0 (12.6)	26.3 (12.3)	22.1 (12.7)	5.7	8
Dietary Iron (mg)	14.7 (4.5)	16.1 (4.1)	13.4 (4.6)	-	-
Folate (mcg) (dietary plus supplementation)	655.0 (291.1)	708.1 (251.1)	609.3 (318.0)	250	300
Dietary Folate (mcg)	447.1 (130.1)	483.4 (90.6)	415.9 (150.7)	-	-
Vitamin A (RAE)	1585.8 (975.4)	1632.5 (900.9)	1545.5 (1046.3)	420	600
Vitamin B_{12} (mcg)	9.0 (4.5)	9.5 (3.6)	8.6 (5.2)	1.5	1.8
Vitamin C (mg)	134.3 (68.3)	143.5 (59.3)	126.3 (75.2)	39	45
Vitamin E (mg)	7.1 (2.2)	7.4 (1.7)	6.8 (2.5)	9	11
Vitamin K (mcg)	112.9 (88.4)	111.2 (107.5)	114.5 (69.6)	N/A	60

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