FUEL YOUR GAME: A NUTRITION EDUCATION MINI-SERIES FOR HIGH SCHOOL ATHLETES IN RURAL APPALACHIA

A Thesis
by
FAITH M. WRIGHT

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APPROVED BY:

Laurel M. Wentz, Ph.D.
Chairperson, Thesis Committee

Melissa Gutschall, Ph.D.
Member, Thesis Committee

Benjamin Sibley, Ph.D.
Member, Thesis Committee

Margaret Barth, Ph.D.
Chairperson, Department of Nutrition & Health Care Management

Marie Hoepfl, Ed.D.
Interim Dean, Cratis D. Williams School of Graduate Studies

Abstract

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Faith M. Wright
B.S., Appalachian State University
M.S., Appalachian State University

Chairperson: Laurel Wentz, Ph.D.

Introduction: Research shows adolescents do not practice healthy eating behaviors and possess limited nutrition knowledge, which holds true for adolescent athletes with increased energy needs as well. There is limited research regarding nutrition interventions for high school athletes; therefore, the objective of this study was to pilot an interactive nutrition education program designed for this population.

Methods: Twenty-five student athletes were recruited from a high school in rural Appalachia to participate in this study consisting of three nutrition education sessions focusing on 1) general nutrition for health; 2) hydration and performance related nutrition; and 3) food related skill building. Each session consisted of a lecture led by graduate students in Appalachian State's nutrition program, as well as an interactive component like healthy snack preparation. Data were gathered pre and post intervention using a validated sport related nutrition knowledge questionnaire and the Automated

Self-Administered 24-hour (ASA24) Dietary Assessment Tool, Version 2020, developed by the National Cancer Institute, Bethesda, MD. All data collected were analyzed using SPSS statistical software, Version 27, IBM Corp (2020), Armonk, NY. Descriptive statistics like age, sex, and sport were utilized to define sample characteristics while data in knowledge, self-efficacy, and dietary behaviors were analyzed using paired t-tests.

Results and Discussion: Baseline data revealed sport related nutrition knowledge deficits with mean scores in all questionnaire categories below 50%. Poor eating habits were observed per ASA24, with 36% of athletes reporting regularly skipping meals, and on average participants failed to meet the recommended daily amounts for proteins, fruits, vegetables, whole grains, and dairy. In total, ten students completed all nutrition sessions in the study. While there was no significant change in dietary intake following the intervention, significant improvements in knowledge were seen for protein ($p=0.022$), fat ($p=0.003$), hydration ($p<0.001$), and weight management ($p<0.001$) categories, showing that an increase in nutrition knowledge did not influence dietary behaviors during the course of study A limitation to this study was that only 40% of the students finished the intervention. Future research should explore different methods of engagement with this population to increase the probability of observing an improvement in dietary behaviors. Increasing the program's accessibility by incorporating it into health or physical education curriculum should also be considered to reduce the time commitment for student athletes who already have busy schedules.

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Foreword

Chapter 1 will be submitted to *The Journal of Nutrition Education and Behavior (JNEB)*, the official peer-reviewed journal of the Society for Nutrition Education and Behavior; it has been formatted according to the style guide for that journal and follows the American Medical Association Manual of Style, 11th edition for referencing. A guide for authors and submission requirements can be found at: https://www.elsevier.com/journals/journal-of-nutrition-education-and-behavior/1499-4046/guide-for-authors

Chapter 1: Introduction

Problem

During the adolescent stage in the life cycle, energy demands are increased due to rapid growth and development; this is especially true for the adolescent athlete who have even higher energy needs related to vigorous physical activity.[1] At this stage, adolescents are also finding more independence in food choice as well as developing dietary behaviors that could extend into adulthood.[1,2] While this proves to be a nutritionally essential time that lays the foundation for future health, most adolescents don't follow dietary guidelines, opting for convenience foods and sugar-sweetened beverages over recommended fruits and vegetables, whole grains, and calcium rich foods like low-fat dairy products.[1-5] Studies have revealed low dietary intakes of vitamin D and calcium among adolescents despite their associations with bone mineral density, which is being built at an accelerated rate during this stage in the life cycle.[1,4,6] These trends of poor dietary behaviors and insufficient nutrient intakes extend to adolescent athletes who have higher energy and nutrient needs due to increased physical demands related to sport.[1,7] With little nutrition education implemented for children or adolescents, most gain their perceptions of healthy dietary behaviors from parents, friends, coaches, and online sources like social media.[7,8,9,10] While educational interventions for adolescents have shown increases in nutrition based knowledge, this isn't often reflected in the dietary behaviors of this age group, and there is limited research examining interventions geared towards improving dietary behaviors in adolescents that are involved in athletics.[3,7]

Implications of poor health choices and eating patterns may not always be apparent at this stage in life; however, as adolescents progress into young adulthood these behaviors can have long term consequences. Inadequate consumption of nutrient dense foods such as fruits and vegetables, whole grains, and low-fat dairy products accompanied by high intakes of ultra-processed foods and sugar-sweetened beverages can have negative consequences on long term health and aid in the development of osteoporosis, cardiovascular disease, and other chronic conditions.[2,4,6] Along with potentially impacting long term health, poor dietary habits and insufficient energy intake can also inhibit athletic performance by increasing the risk of injuries like stress fractures or nutrient-related conditions such as iron deficiency anemia.[1,6,7] These are especially of concern for adolescent female athletes due to iron loss through menstruation, and lower energy and calcium intakes.[1,4,7]

Other common dietary trends displayed by active adolescents include skipping meals, consuming convenience foods rather than nutrient dense foods, putting more emphasis on protein intake than carbohydrate intake before and after exercise, and taking dietary supplements to gain muscle and enhance sport performance.[7,10,11] In one group of active high schoolers, the majority reported believing nutrition to be an important aspect of performance, yet only 57.5% reported consuming breakfast daily and only 23% claimed to eat carbohydrate rich foods after exercise.[11] These behaviors limit the available energy athletes need to perform in their respective sport, and potentially lead to insufficient intakes of vital nutrients needed for growth and development. Physically active adolescents identify that there is a positive relationship between proper nutrition and athletic performance, however the dietary behaviors exemplified by this age group convey otherwise. This gap presents the need to explore why active adolescents choose not to practice healthful eating habits despite possessing knowledge of its importance to sport performance.

Scientific Rationale

Most studies that have specifically focused on dietary patterns of adolescent athletes have explored total energy intake, nutrition knowledge, and attitudes about nutrition by the use of questionnaires and diet recalls, but have utilized a cross-sectional approach and lacked interventions to improve these measures.[7,10] When examining nutrition behaviors, results have shown intakes that do not reflect the dietary guidelines, with frequencies of fruit and vegetable intake below recommendations and junk foods such as chips and pretzels being the most common choices for snacks between meals.[11,12] Furthermore, studies assessing the nutrition knowledge of physically active adolescents have identified knowledge deficits related to meal timing and macronutrient intake around exercise, and the use of dietary supplements for increasing sport performance.[10,11] This gives a snapshot of nutrition knowledge and eating behaviors in this age group and assists in identifying deficits, but it doesn't allow for any measure of change that could be useful in identifying strategies to improve the dietary choices made by adolescents. In studies that have implemented nutrition-based interventions for this population, they have either lacked an interactive component by relying heavily on the use of lectures, educational posters, and social media campaigns; or the study has included an interactive component centered around skill-building, but has been sport specific (only including soccer players) and demanding of participants in duration (two years), resulting in only a 50% retention rate of participants.[11,13,14] While educational interventions involving skill-building to increase food literacy have shown improvements in sports nutrition based knowledge (10% increase from baseline) and self-reported food behaviors by adolescent soccer players, a condensed program involving athletes from all sports with less of a time burden on its participants could be a more feasible approach to engaging a broader range of active adolescents.[14]

Conclusions from studies assessing adolescent perspectives about their own dietary habits have revealed a need for further nutrition education that will focus on increasing knowledge, skill development, and self-efficacy since deficits in these factors often prevent adolescents from engaging in healthier dietary behaviors.[3,7] Furthermore, some studies have discovered that even when adolescents do possess an understanding of nutrition and healthy eating habits, this knowledge is not reflected in their dietary choices. This age group has demonstrated an understanding of dietary guidelines and can acknowledge that eating a healthy balanced diet plays an active role in overall health, yet many still choose to consume foods they themselves identify as being unhealthy, such as sugar-sweetened beverages and prepackaged foods/snacks.[12] Similar trends have been identified in active adolescents who express interest in nutrition and its relation to sports performance. In a study examining nutrition beliefs and behaviors in active adolescents where the majority (greater than 85%) of participants recognized nutrition as an important aspect of athletic performance, only 36.6% reported consuming any food 1-2 hours prior to practice or exercise.[7] This presents a need for more research exploring interactive skill-building approaches to nutrition education for active adolescents as they demonstrate poor dietary habits despite having increased energy needs, and possessing some knowledge that nutrition plays a significant role in sport performance. Involving skill-based learning, such as planning and preparing balanced meals, has been identified as an educational tool that may assist this age group in developing the confidence and skills needed to facilitate healthy eating behaviors.[2,3,7,10,13,14]

Significance

Current research shows active adolescents practice poor dietary choices despite identifying nutrition as a key aspect of physical performance; therefore, an interactive approach is needed to provide them with the confidence and ability to select and prepare healthy foods. As student athletes typically lead an active lifestyle and show an interest in nutrition for the reasons of increasing sport performance, this group shows potential to benefit from such an intervention.[7] Also, with this age group following dietary trends and behaviors of their peers, who may or may not be practicing healthful dietary trends, receiving nutrition education from individuals knowledgeable in nutrition and its relationship with health and performance could be beneficial in helping student athletes separate fact from fiction when being exposed to new nutrition information in the future.[9] Teaching this age group how to adopt healthful dietary behaviors like eating before and after exercise, not skipping meals, and choosing healthier options over convenience and prepackaged foods could help them develop better eating patterns now, lowering their chances of developing nutrition related chronic diseases later in life.[2,4,15] Furthermore, nutrition education aimed at increasing these healthful behaviors in athletes could also lead to smarter meal and snack selection around exercise, as well as increased energy and nutrient intakes benefiting sport performance.[14]

Not only was this study geared towards improving the overall health and performance of adolescent athletes, but it also specifically targeted a rural population that expressed a need for such an intervention. The development of this program was guided by information gathered from a need’s assessment survey completed by parents of athletes from a local high school in rural Appalachia. The hands-on involvement this intervention required from participants including educational group activities and food preparation also showed promise in equipping participants with the cooking and food selection skills needed to follow a nutritious diet. With most nutrition studies taking a cross-sectional approach with limited intervention, this longitudinal study expands upon the literature and may lead to subsequent studies exploring feasible interactive approaches to promote healthy dietary behaviors among adolescents.

Goals

The purpose of this study was to gain more information on the sport related nutrition knowledge, nutrition self-efficacy, and dietary habits of high school athletes, and to examine the impact of a nutrition education program that incorporates food preparation and other skill-building activities on these factors. A secondary objective was to pilot an interactive nutrition education mini-series for adolescent athletes residing in rural Appalachia.

Aim 1: To determine nutrition knowledge gaps among 14 to 18 year old athletes.

Aim 2: To determine the influence of the interactive nutrition intervention on dietary knowledge and behaviors in this population. It was hypothesized that this intervention would improve both dietary knowledge and behaviors from baseline.

Chapter 2: Methods

Participants and Recruitment

The study aimed to recruit two groups of 30 students (n=60) from a local high school in rural Appalachia through the Family ID Network emailing system. This was the most effective route of reaching parents in the school system and was utilized to first gauge parent interest in a nutrition education series for student athletes which resulted in parents showing most interest in healthy snacking, smart hydration, and general nutrition as topics to be covered. To be included in this study, participants were required to either be enrolled at the high school or be a rising Freshman enrolled at the middle school, actively engaged in an organized sport, and give personal and parental consent to participate. Both male and female athletes from all sports were targeted for this program. Recruitment took place on a first come first serve basis until the start of the study. Along with the incentive of increasing student knowledge, confidence, and ability to make healthful food choices to support athletic performance, the student athletes who participated in all three sessions also received gift cards in the amount of $15 per participant to Clean Eatz, a local grab and go food establishment offering healthy and affordable pre-made meals. This study received exemption status from Appalachian State University's Institutional Review Board (IRB) and received funding from the Health Interdisciplinary Research Seed Allocations (HIRSA) program through Appalachian State University's Blue Cross NC Institute for Health and Human Services (IHHS).

Study Design

Study subjects participated in a three-part interactive nutrition education session geared toward adolescent athletes. Each lesson lasted approximately 60 to 90 minutes in duration and lessons were spaced out every other week for a total duration of six weeks. Spacing the series out biweekly allowed for make-up days in the case of bad weather conditions, and more time between sessions for a better chance of capturing behavior change among participants. Participants were split into two cohorts for a smaller educator to participant ratio with one group beginning the series in January of 2022 and the second in March of 2022. The presentations were developed and led by graduate students from Appalachian State University's combined Master of Science in Nutrition and Dietetic Internship program with advisement from faculty in the nutrition and exercise science departments. Each session included a lecture as well as an interactive component consisting of online group quizzes, meal planning, calculating protein and hydration needs, or healthy snack preparation. Research supports educational interventions targeted towards adolescent athletes and dietary supplement use, as well as nutrient specific education relating to how each macronutrient impacts performance.[10,11] These recognized gaps in knowledge, the identified need for food literacy skills among this age group, along with parent identified knowledge deficits were all considered when developing the educational materials for this program.[3]

At the time of the first session, an overview of the program and content was also presented to the parents to inform them of learning objectives and foster support for healthy dietary behaviors exemplified by students. Topics included utilizing MyPlate[16] to build balanced meals with appropriate portion sizes, understanding food labels, nutrient density versus calorie density, and detailed information about the macronutrients and how they relate to sport performance. The major topic for the first session was general nutrition concepts for healthy eating. Students participated in interactive activities like working together to build healthy performance plates, competing on teams in nutrition trivia using Quizizz[17], using recipe cards to prepare protein dense snacks in small groups, and facilitated discussions. Each session of the mini-series incorporated some form of interactive learning to increase participant engagement with the material. The second session covered content on hydration, specific nutrient requirements for athletes, nutrient timing around exercise, and easy snack and meal preparation. The third and final session addressed healthy body image, supplementation, and pitfalls of fad diets. Differences in participant's dietary behaviors, sports nutrition knowledge, and nutrition self-efficacy from baseline to conclusion of the study were measured and assessed from this pre-test/posttest design.

Data Collection

Quantitative data including nutrition self-efficacy, food security, sport related nutrition knowledge, and dietary intake were collected from students at baseline and conclusion of the study. Each tool used for data collection was coded with a participant specific identification number so information gathered after the intervention could be compared to baseline for each participant. To assess household food security, a modified version of the USDA Economic Research Service Six-Item Short Form Food Security Module[18] was administered to students prior to the intervention. To gauge each student's ability and confidence in making healthy dietary choices, a shortened form of a validated self-efficacy 37-item scale published in the International Journal of Behavioral Nutrition and Physical Activity[19] was completed by students at baseline and completion of the study. At these times, sport related nutrition knowledge of participants including information on specific macronutrients and their impact on performance was also measured using an adapted form of the 49-Item Sports Nutrition Knowledge Instrument.[20]

While an observed increase in nutrition related knowledge and self-efficacy scores after the intervention would be favorable, this may not be reflected in the actual food choices made by the student athletes, which is something this study aimed to explore. To investigate baseline dietary behaviors as well as behavior change, dietary intake data (24-hour recalls) was collected and analyzed using the Automated Self-Administered 24-hour (ASA24) Dietary Assessment Tool, Version 2020, developed by the National Cancer Institute, Bethesda, MD.[21] These recalls were completed by each participant prior to and upon completion of the intervention with assistance from nutrition graduate students that were experienced with the ASA24 assessment tool. This dietary data collection tool allows respondents to search specific foods and ingredients before prompting for details such as serving size and actual amount consumed. Other prompts from the self-administered system include where the food was eaten, if the food was eaten in the company of another person and relation to said person, and whether an electronic device such as a computer or television was in use during the meal or snack. Respondents were also asked specifics about supplement use and fluid intake and were given a nutrition report once the recall was finished. The generated nutrition report provides an in-depth breakdown of each participant's energy intake including information on total calories, macronutrients, micronutrients, and food groups. The data collected by ASA24 was analyzed for changes in dietary behaviors among the student athletes before and after participating in the interactive nutrition education mini-series. Dietary behaviors that were assessed pre and post intervention included total energy and macronutrient intake, eating occasions including skipped meals, and intakes of specific nutrients and food groups such as dairy products, whole grains, fruits, vegetables, added sugars, fiber, vitamin D, and calcium.

Data Analysis

SPSS statistical software, Version 27, IBM Corp (2020), Armonk, NY was used to analyze all data collected from the study. To define characteristics of the sample, descriptive statistics such as age, sex, and participant sport were utilized. Inferential statistics for dietary intakes including mean amounts of categorical variables such as whole grains, fruits, vegetables, dairy foods/soy alternatives were also analyzed for change along with intakes of added sugars, fiber, vitamin D, and calcium. Quantitative data were compared pre and post intervention using paired t-tests. Since distribution of the data were not normal, non-parametric testing (Wilcoxon) was used to compare means. Changes in knowledge, self-efficacy, and dietary behaviors were assessed. A p-value of < 0.05 was considered to be statistically significant.

Chapter 3: Results

Part 1: Baseline Data

In total, 32 student athletes initially volunteered to participate in this study, including 19 students in the first cohort and 13 in the second cohort. However, only 25 participants submitted both a participant and parental consent form; because of this only 25 students were included in data collection. Out of these participants, there were 9 female and 16 male students, with 44% (n=11) reporting as rising freshman or freshman, 36% (n=9) as sophomores, and 20% (n=5) as juniors. The most common sports played by participants were Football (32%), and Track (28%); 32% of participants reported being involved in more than one sport.

Out of the 25 students that filled out the Athlete History Form, 60% reported having a sport-related injury in the past. While only 12% of the student athletes selected yes when asked if they had poor eating habits, 32% reported usually only eating two meals or less most days, and 36% said they often skipped meals. When asked about supplement use, 46% of participants reported using supplements, with 24% using protein powders, 20% taking vitamin D or a fish oil supplement, and 12% taking creatine, pre-workout, and/or herbal supplements. Details on demographics and athlete history are shown in Table 1.

Table 1: Athlete History/Demographics

Demographics	**Total[1] (n=25)**	**Females (n=9)**	**Males (n=16)**
Year in School n (%)			
Freshman or rising	11 (44%)	5 (56%)	6 (38%)
Sophomore	9 (36%)	4 (44%)	5 (31%)
Junior	5 (20%)	0 (0%)	5 (31%)
Sport			
Football	8 (32%)	0 (0%)	8 (50%)
Soccer	5 (20%)	3 (33%)	2 (13%)
Track	7 (28%)	1 (11%)	6 (38%)

Baseball	2 (8%)	0 (0%)	2 (13%)
Basketball	6 (24%)	1 (11%)	5 (31%)
Cheerleading	3 (12%)	3 (33%)	0 (0%)
Other[2]	5 (20%)	1 (11%)	4 (25%)
Involved in 2+ sports	8 (32%)	1 (11%)	7 (44%)
Reported Injuries			
Reports of sport related injuries	15 (60%)	5 (56%)	10 (63%)
Reported eating habits			
Skips meals	9 (36%)	6 (67%)	3 (19%)
≤ 2 meals per day	8 (32%)	4 (44%)	4 (25%)
3 meals per day	9 (36%)	5 (56%)	4 (25%)
≥ 4 meals per day	8 (32%)	0 (0%)	8 (50%)
Poor eating habits	3 (12%)	1 (11%)	2 (13%)
Fair eating habits	13 (52%)	4 (44%)	9 (56%)
Good eating habits	9 (36%)	4 (44%)	5 (31%)
Reported Supplement use			
Use supplements	10 (46%)	3 (33%)	7 (44%)
Protein powder	6 (24%)	1 (11%)	5 (31%)
Vitamins[3]	5 (20%)	2 (22%)	3 (19%)
Other[4]	3 (12%)	0 (0%)	3 (19%)

[1] Percent in total column is percent of total, percent in M/F columns is percent of M/F.
[2] Other sports-swim, strength training, track & field, boxing, wrestling.
[3] Vitamins include fish oil and vitamin D.
[4] Other supplements include creatine, pre workout, or herbal medicines.
[5] Percentages for sport played do not add up to 100% since some students reported being involved in more than one sport.

A total of 24 participants completed the sport-related nutrition knowledge questionnaire at baseline. The questions were split into six categories including carbohydrates, protein, fat, hydration, micronutrients, and weight management. All questions about nutrition were directly related to sport performance (the Sport Nutrition Knowledge Instrument is included in the Appendix C). All categories of the questionnaire had an average score below 50%. The highest average score was the carbohydrate category with a mean of 4.4 ± 3.2 out of 9 questions (49%), and the lowest scoring category was micronutrients with a mean of 1.4 ± 1.2 out of 4 questions (35%). Results of nutrition knowledge scores are found in table 2.

Table 2: Sport Related Nutrition Knowledge (n=24)

Sports Nutrition Related Knowledge Categories	% Average	Mean (SD)*	Median
Carbohydrate questions (out of 9)	49%	4.4 (3.2)	5
Protein questions (out of 5)	39%	2 (1.4)	2
Fat related (out of 5)	43%	2.2 (1.3)	2
Hydration questions (out of 4)	43%	1.7 (1.3)	2
Micronutrient questions (out of 4)	35%	1.4 (1.2)	1
Weight management questions (out of 3)	36%	1.1 (0.8)	1

*Mean scores indicate how many questions were answered correctly.

Table 3 shows results from the 24 participants that completed the Nutrition Self-efficacy questionnaire at baseline. Students were asked how much they agreed with each statement by selecting a number on a scale from 1-6 with 1 being strongly disagree and 6 being strongly agree. Statements ranged from each student's sense of ease consuming fruits and vegetables and healthy portion sizes, knowledge on how eating healthy can contribute to physical health and reduce the risk of certain diseases, and food security related questions about food availability at home. The mean for prompts such as "I find it easy to eat at least 3 servings of fruits a day;" "I find it easy to eat at least 4 servings of vegetables a day;" and "I find it easy to choose a healthy snack in between meals" were all between 3.5-3.8 indicating that the student athletes slightly agreed with these statements. For questions related to the availability of healthy foods at home like fruits, vegetables, drinks, and healthy snacks, the means ranged between 5.0-5.4 indicating that the participants mostly agreed with these statements. Means for the statements regarding how healthy eating impacts health were also high ranging from 5.0-5.8, meaning most participants agreed or strongly agreed with the statements. Full details on the results from this questionnaire are found in table 3. A copy of the Self-efficacy Scale is located in Appendix D.

Table 3: Self-efficacy (n=24)

Nutrition Self-efficacy Statements	Mean (SD)*	Median
I find it difficult to choose low-fat foods (e.g. fruit or "light" milk rather than "full cream" milk).	2.9 (1.2) Slightly disagree	2.5
I find it easy to choose a healthy snack when I eat in between meals (e.g. fruit or reduced-fat yogurt).	3.9 (1.3) Slightly agree	4
I believe I have the knowledge and ability to choose/prepare healthy snacks.	4.8 (1.2) Agree	5
I find it difficult to choose healthy meals/snacks when I am eating out with my friends.	3.8 (1.4) Slightly agree	4
I find it easy to eat at least 3 servings of fruit each day.	3.5 (1.4) Slightly agree	3
I find it easy to eat at least 4 servings of vegetables/salad each day.	3.5 (1.5) Slightly agree	3
I find it easy to have healthy portion sizes during meals (e.g. not eating till I feel full).	4.1 (1.5) Slightly agree	4
At home there are healthy snacks available to eat.	5.0 (1.0) Agree	5
At home there are healthy drinks available (e.g. cold water, sugar-free drinks, reduced-fat milk).	5.4 (0.8) Agree	6
At home fruit is always available to eat (including fresh, frozen, canned, or dried).	5.1 (1.2) Agree	5.5
At home vegetables are always available to eat (including fresh, frozen, or canned).	5.0 (1.2) Agree	5
Healthy eating can reduce my risk for some illnesses and diseases	5.6 (0.6) Strongly agree	6

(e.g. heart disease, diabetes, some cancers etc.).		
Healthy eating can help me to feel better physically.	5.8 (0.4) Strongly agree	6
Healthy eating (e.g. not skipping meals) can help to improve my concentration at school.	5.0 (1.0) Agree	5
Healthy eating can help me to feel more energetic throughout the day.	5.5 (0.8) Strongly agree	6

*On a scale from 1-6 with 1= strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree, and 6 = strongly agree

Table 4 shows the means of energy and nutrient intakes of students at baseline compared to the RDAs for specific nutrients and food groups. Recall data was collected from each participant using the ASA24 recall system, students were asked to include all foods and drinks consumed from the time they woke up until the time they went to bed the day prior to the study. The overall mean energy intake for the 18 student athletes that completed the recall was 1602 kcals, which is roughly 800 kcals below the lower range of recommended kcals for active adolescents in this age group. The recommendation for energy intake for this age group (which is dependent on individual weight and activity level) is between 2400-3200 kcals per day with the lower range being recommended for active females and the higher range for active males.

The mean intakes for several nutrients also fell below the daily recommendations including fiber with an average intake of 13.4 g ± 8.1 g when the RDA is 25 g for females and 31 g for males. Intakes of some micronutrients that are of higher importance for athletes due to the oxidative stress from exercise, such as antioxidants, were also below recommendations. The average intake of vitamin A was 579 mcg ± 489.4 mcg compared to the recommended 700 mcg for females and 900 mcg for males, and vitamin E had an average intake of 5.9 mg ± 3.2 mg compared to the recommended 15 mg. The average intakes of calcium and vitamin D, which have a higher RDA in this age group due to rapid bone development, were both below recommendations with a mean calcium intake of 885.1 mg ± 682.4 mg (RDA 1300 mg) and a mean vitamin D intake of 6.2 mcg ± 8.2 mcg (RDA 15 mcg). These low reported intakes are of special concern not only because of the accelerated growth in this age group, but also because of the increased risk of injuries like stress fractures for adolescents involved in athletics.

Table 4: Diet Recall (n=18)

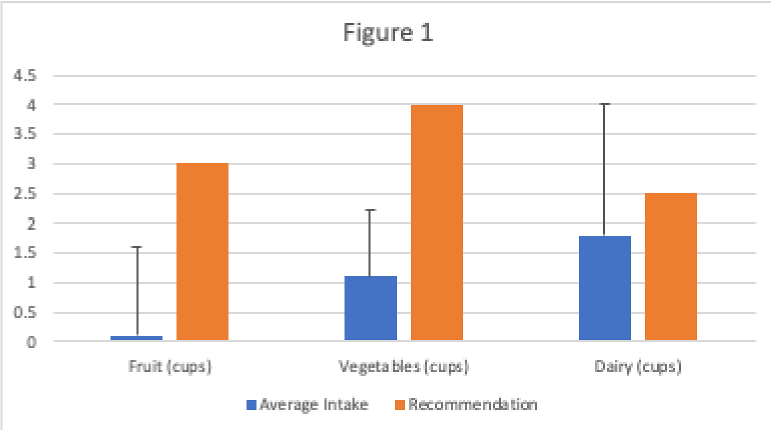
Variable	Mean (SD)	Range	RDA[1]
Total energy, water, and macronutrients			
Calories (kcals)[2]	1602 (854)	267 - 3027	2400 - 3200
Protein (g)	64 (36)	7 – 123	10 – 35 % kcal
Carbohydrates (g)	195 (113)	57 – 401	45 – 65 % kcal
Fat (g)	65 (40)	2 – 148	25 – 35 % kcal
Water (g)	1667 (1205)	63 - 4573	0.5 – 1 oz/ lb. bw
Micronutrients			
Fiber (g)	13.4 (8.1)	2.3 - 34.7	25(F) 31(M)
Calcium (mg)	885.1 (682.4)	54.4 - 2453.3	1300
Iron (mg)	13.3 (8.0)	1.3 – 33.2	15(F) 11(M)
Magnesium (mg)	217.2 (119.8)	35.8 – 477.1	360(F) 410(M)
Phosphorous (mg)	1178.6 (718.4)	79.7 – 2662.2	1250
Potassium (mg)	2017.7 (1313.2)	265.5 – 5214.2	2300(F) 3000(M)
Sodium (mg)	2839.8 (1367.8)	212.7 – 5040.4	2300
Zinc (mg)	10.7 (7.7)	0.6 – 33.5	9(F) 11(M)
Copper (mg)	0.8 (0.4)	0.2 – 1.7	0.9
Selenium (mcg)	97.1 (58.3)	10.4 – 237.4	55
Vitamin C (mg)	63.7 (105.0)	0.8 – 355.3	65(F) 75(F)
Vitamin A (mcg_RAE)	579.7 (489.4)	3.0 – 1555.1	700(F) 900(M)
Vitamin E (mg)	5.9 (3.2)	0.2 – 12.5	15
EPA[3] (mg)	30.0 (100.0)	0 – 500.0	250-500 mg combined EPA & DHA
DPA (mg)	20.0 (30.0)	0 – 100.0	n/a
DHA[3] (mg)	100.0 (200.0)	0 – 1000.0	250-500 mg combined EPA & DHA
Vitamin D (mcg)	6.2 (8.2)	0 – 32.2	15
Food groups[4]			
Fruit total (cups)	0.7 (1.5)	0 – 6.0	2.5 - 3
Vegetable total (cups)	1.1 (1.1)	0 – 3.6	3 - 4
Dark green Veg (cups)	0.2 (0.4)	0 – 1.2	n/a

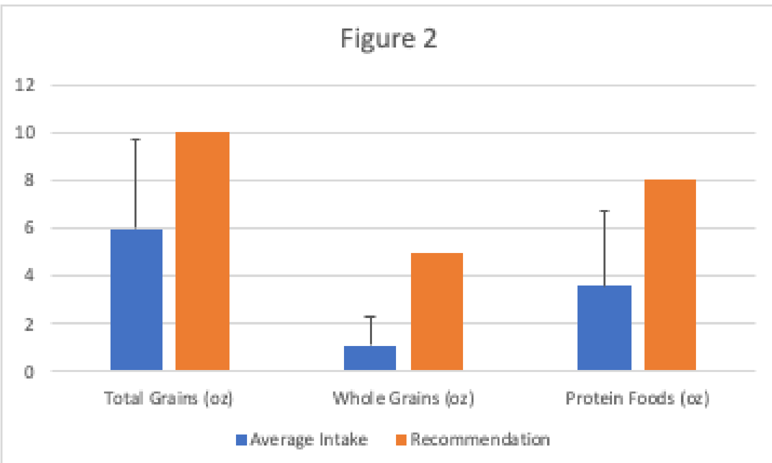
Starchy Veg (cups)	0.3 (0.6)	0 – 2.1	n/a
Legumes (cups)	0.1 (0.3)	0 – 0.9	n/a
Total grains (oz)	6.0 (3.7)	0 – 14.4	8 - 10
Whole grains (oz)	1.1 (1.2)	0 – 4.1	4 - 5
Protein foods (oz)	3.6 (3.1)	0 – 13.6	7.5 - 8
PF Legumes (oz)	0.5 (1.0)	0 – 3.4	n/a
Dairy total (cups)	1.8 (2.2)	0 – 7.6	2.5

[1] RDAs for general population of adolescent age group
[2] Kcals general range for active adolescents
[3] No RDA established for EPA and DHA
[4] Food group recommendations for given kcal ranges

Self-reported intakes for all food groups with determined RDAs fell below recommendations (Table 4). The mean total intake of fruit was 0.7 cups ± 1.5 cups compared to the recommended 2.5-3 cup (dependent on kcal intake), the mean vegetable intake was 1.1 cups ± 1.1 cups compared to the 3-4 cup recommendation, and the mean dairy intake was 1.8 cups ± 2.2 cups compared to the 2.5 cup recommendation. A bar graph comparing the daily recommendations to actual intakes of fruits (including standard deviations), vegetables, and dairy by participants can be seen in Figure 1. The average daily intakes of total grains, whole grains, and protein foods by participants also fell under recommendations with a mean of 6 oz ± 3.7 oz for total grains compared to the 8-10 oz recommendation, a mean of 1.1 oz ± 1.2 oz for whole grains compared to the 4-5 oz recommendation, and a mean of 3.6 oz ± 3.1 oz for protein foods compared to the 7.5-8 oz recommendation. Figure 2 compares the actual intakes of athletes (with standard deviations) compared to the recommended intakes of total grains, whole grains, and protein foods. All nutrients examined from the ASA24 recall system along with mean intakes and standard deviations, ranges, and RDAs are shown in Table 4.

Food Group Intakes of Participants Compared to USDA Recommendations





*Figures 1 & 2 compare the recommended targets for food groups (orange) such as fruits, vegetables, and dairy (Figure 1), and total grains, whole grains, and protein foods (Figure 2) with the actual intakes (blue) of participants (n=18) at baseline.
**Recommendations for each food group in the bar graph are set at the higher end of recommendation range.

Part 2: Intervention

A total of 10 student athletes participated in all three nutrition education sessions and completed the Sports Nutrition Knowledge Instrument, the Nutrition Self-efficacy Scale, and the ASA24 dietary recall at baseline and conclusion of the study. As seen in Table 5, when comparing scores of the 10 participants that completed the knowledge questionnaire, mean scores from all categories increased, with four out of six categories showing a significant increase after the intervention. The average score on protein related questions increased significantly (p=0.02) from 42% to 72%, with a mean total of 2.1 ± 1.7 out of 5 questions answered correctly at baseline increasing to 3.6 ± 2.0 post intervention. Questions related to fat intake and physical performance also showed a significant increase (p=0.003) with the average score of 50% at baseline increasing to 72% post intervention; the mean total for questions answered correctly increased from 2.5 ± 1.4 out of 5 to 3.6 ± 1.3 out of 5 after the intervention in this category. The categories with the most significant increase were hydration and weight management (p<0.001). Hydration related questions improved with the average score of 43% increasing to 88%, the mean of correct answers in this category was 1.7 ± 1.2 out of 4 at baseline compared to 3.5 ± 0.7 post intervention. The weight management questions also showed great improvement with the mean total of questions being answered correctly increasing from 1.0 ± 0.7 out of 3 at baseline to 2.3 ± 0.8 at conclusion of the study with the average score improving from 33% to 77%.

Means between participants that did not complete the education intervention (14) versus participants that completed all three interactive education sessions (10) were compared using independent t-tests to measure the difference in baseline sports related knowledge between groups. Five out of the six categories showed there was no significant difference in knowledge between the two groups, with only the micronutrient category showing any significance (p=0.005). Due to the similarity in scores between groups at baseline, it is safe to assume that the whole group would have seen an improvement in sport related nutrition knowledge had they finished the study, and that the outcome data is all accurate and likely valid for this population.

Table 5: Changes in Sport Nutrition Knowledge from Pre- to Post-intervention (n=10)

Sports Nutrition Related Knowledge Categories	% Average Pre-intervention	% Average Post-intervention	Mean (SD) Pre-intervention	Mean (SD) Post-intervention	p-values
Carbohydrate related questions (out of 9)	53%	70%	4.8 (2.7)	6.3 (1.4)	p=0.129
Protein related questions (out of 5)	42%	72%	2.1 (1.7)	3.6 (2.0)	*p=0.022
Fat related questions (out of 5)	50%	72%	2.5 (1.4)	3.6 (1.3)	*p=0.003
Hydration related questions (out of 4)	43%	88%	1.7 (1.2)	3.5 (0.7)	*p<0.001
Micronutrient related questions (out of 4)	55%	73%	2.2 (1.4)	2.9 (1.2)	p=0.173
Weight management related questions (out of 3)	33%	77%	1.0 (0.7)	2.3 (0.8)	*p<0.001

* A p-value of less than 0.05 ($p < 0.05$) indicates a significant difference in mean test scores between participants at baseline versus at the end of the study using paired *t*-test to compare means.

When results from the Self-efficacy scale were compared pre and post intervention for the 10 students, there were no significant changes in answers, as shown in Table 6. The means for a couple questions did have a clinically relevant yet statistically insignificant improvement; for instance the answers to "I find it difficult to choose healthy meals/snacks when I am eating out with my friends" improved from 3.8 ± 1.3 (slightly agree) to 2.8 ± 0.8 (slightly disagree) and answers to "Healthy eating can help me improve my concentration at school" improved from 4.9 ± 1.0 (agree) to 5.6 ± 0.5 (strongly agree) after the intervention. Since distribution of the data were not normal, non-parametric testing (Wilcoxon) was used to compare means. There was no noted significant improvement in nutrition self-efficacy for the participants, however, the mean scores for most statements were already high at baseline, leaving little room for improvement post intervention.

Table 6: Changes in Self-efficacy from Pre- to Post-intervention (n=10)

Nutrition Self-efficacy Statements	Mean (SD) Pre-Intervention	Mean (SD) Post-Intervention	p-values
I find it difficult to choose low-fat foods (e.g. fruit or "light" milk rather than "full cream" milk).	2.9 (1.1) slightly disagree	2.5 (1.0) slightly disagree	p=0.157
I find it easy to choose a healthy snack when I eat in between meals (e.g. fruit or reduced-fat yogurt).	4.1 (1.5) slightly agree	4.3 (1.5) slightly agree	p=0.564
I believe I have the knowledge and ability to choose/prepare healthy snacks.	5.1 (1.2) agree	5.4 (0.7) agree	p=0.180
I find it difficult to choose healthy meals/snacks when I am eating out with my friends.	3.8 (1.3) slightly agree	2.8 (0.8) slightly disagree	p=0.103
I find it easy to eat at least 3 servings of fruit each day.	4.0 (1.2) slightly agree	4.4 (1.4) slightly agree	p=0.271
I find it easy to eat at least 4 servings of vegetables/salad each day.	4.1 (1.3) slightly agree	4.3 (1.3) slightly agree	p=0.414
I find it easy to have healthy portion sizes during meals (e.g. not eating till I feel full).	4.6 (1.2) agree	4.2 (1.6) slightly agree	p=0.492
Healthy eating can reduce my risk for some illnesses and diseases (e.g. heart disease, diabetes, some cancers etc.).	5.9 (0.3) strongly agree	5.6 (1.0) strongly agree	p=0.414
Healthy eating can help me to feel better physically.	5.8 (0.4) strongly agree	5.5 (1.1) strongly agree	p=0.461
Healthy eating (e.g. not skipping meals) can help to	4.9 (1.0) agree	5.6 (0.5) strongly agree	p=0.084

improve my concentration at school.			
Healthy eating can help me to feel more energetic throughout the day.	5.5 (1.0) strongly agree	5.4 (0.8) agree	p=0.785

* A p-value of less than 0.05 ($p < 0.05$) indicates a significant difference in mean test scores between participants at baseline versus at the end of the study using paired *t*-test to compare means.
**On a scale from 1-6 with 1= strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree, and 6 = strongly agree

When comparing mean intakes of total energy and macronutrients for the 10 athletes pre and post intervention, there was an increase in total energy from 1578 ± 605 kcals to 2043 ± 1155 kcals and in protein from 67 ± 33 g to 95 ± 65 g. However, due to the small sample size and large variance in dietary intake among athletes, these changes were not statistically significant. While a small change was also observed in some antioxidants like selenium and vitamin E with intakes increasing from 96.3 ± 47.0 mcg to 139.1 ± 70.3 mcg for selenium and 7.0 ± 3.2 mg to 11.1 ± 9.1 mg for vitamin E, the changes were not statistically significant. For most food group categories, mean intakes for total amounts consumed didn't change except for in protein foods with intakes increasing from 4.4 ± 3.6 oz to 9.0 ± 8.2 oz, however these changes weren't found to be statistically significant. All results from the ASA24 dietary recall pre and post intervention can be found in Table 7.

Table 7: Changes in Dietary Intake from Pre- to Post-intervention (n=10)

Variable	Mean (SD) Pre intervention	Mean (SD) Post intervention	p-values
Total energy, water, and macronutrients			
Calories (kcals)	1578 (605)	2043 (1155)	p=0.346
Protein (g)	67 (33)	95 (65)	p=0.305
Carbohydrates (g)	188 (97)	200 (109)	p=0.794
Fat (g)	64 (26)	97 (72)	p=0.189

Water (g)	1687 (787)	1644 (1182)	p=0.929
Micronutrients			
Fiber (g)	14.5 (9.1)	13.8 (8.1)	p=0.861
Calcium (mg)	762.6 (572.4)	698.7 (399.4)	p=0.785
Iron (mg)	13.2 (6.4)	14.1 (8.2)	p=0.796
Magnesium (mg)	239.5 (120.2)	239.0 (163.3)	p=0.996
Phosphorous (mg)	1170.2 (607.3)	1340.8 (721.2)	p=0.645
Potassium (mg)	2389.3 (1508.9)	2346.7 (1757.9)	p=0.958
Sodium (mg)	2973.6 (1098.5)	4358.8 (2242.5)	p=0.136
Zinc (mg)	9.9 (5.4)	11.4 (10.0)	p=0.721
Copper (mg)	0.862 (0.368)	1.0 (0.574)	p=0.576
Selenium (mcg)	96.3 (47.0)	139.1 (70.3)	p=0.165
Vitamin C (mg)	97.2 (133.3)	52.7 (59.1)	p=0.415
Vitamin A (mcg RAE)	531.9 (367.5)	568.8 (344.4)	p=0.829
Vitamin E (mg)	7.0 (3.2)	11.1 (9.1)	p=0.210
EPA (mg)	59.0 (165.0)	6.0 (6.0)	p=0.340
DPA (mg)	28.0 (41.0)	20.0 (17.0)	p=0.583
DHA (mg)	118.0 (300.0)	54.0 (46.0)	p=0.530
Vitamin D (mcg)	7.1 (9.7)	4.6 (2.4)	p=0.487
Food groups			
Fruit total (cups)	1.0 (2.0)	0.6 (0.8)	p=0.542
Vegetable total (cups)	1.4 (1.3)	1.2 (1.2)	p=0.768
Dark green Veg (cups)	0.1 (0.3)	0.1 (0.2)	p=0.366
Starchy Veg (cups)	0.5 (0.8)	0.4 (1.0)	p=0.761
Legumes (cups)	0.1 (0.3)	0.1 (0.3)	p=0.691
Total grains (oz)	5.6 (3.2)	6.2 (3.5)	p=0.626

Whole grains (oz)	0.7 (0.7)	0.6 (0.9)	p=0.682
Protein foods (oz)	4.4 (3.6)	9.0 (8.2)	p=0.157
PF Legumes (oz)	0.5 (1.1)	0.4 (1.1)	p=0.706
Dairy total (cups)	1.4 (1.9)	0.9 (0.0)	p=0.509

* A p-value of less than 0.05 ($p < 0.05$) indicates a significant difference in mean test scores between participants at baseline versus at the end of the study using paired *t*-test to compare means.

Chapter 4: Discussion

Summary

Nutrition Knowledge

On average students scored below 50% in all categories of the sport related nutrition knowledge questionnaire at baseline, indicating a need for performance related nutrition education in this population After the nutrition education mini-series, there was an increase in average scores in all categories, with the scores related to protein, fat, hydration, and weight management all having a significant increase ($p < 0.05$). These findings indicate that even athletes who have interests in enhancing athletic performance may possess little nutrition knowledge and can benefit from hands-on nutrition education that focuses on improving performance. The low baseline nutrition knowledge we found in this age group doesn't differ from previous findings. In a similar study exploring sport nutrition knowledge and dietary behaviors, at baseline student athletes had low sport nutrition knowledge scores (< 60%) which significantly improved after an education intervention.[7] These commonly observed findings of limited nutrition knowledge at baseline in adolescents along with the significant increases seen in nutrition knowledge scores post educational interventions reveal the importance of improving efforts made to educate this age group on proper nutrition and provide them with the skills necessary to make healthy food choices.

While sport related nutrition knowledge certainly increased for the participants that completed our intervention, that increase was not observed in every desired outcome. We anticipated seeing some enrichment in dietary behaviors, however, the changes in dietary intake were insignificant despite the significant increases in knowledge. Similar results were reported for another intervention that included nutrition education and food skill building where students experienced a significant knowledge increase with limited improvement in food behaviors.[14] Participants in the other study reported less sugar sweetened beverage intake and a higher likelihood of eating pre-exercise after the educational intervention, however, these changes were not significant and they occurred over a timespan of two years.[14] Implementing nutrition education programs that address knowledge deficits and teach food-based skills show benefit by increasing nutrition knowledge in young athletes, but one of the aims of this study was that improvements in nutrition knowledge would be reflected in participants' eating habits. Further research that investigates diet related behavior change in this population is needed to more fully determine the barriers to translation of knowledge into dietary choices.

Dietary Intake

Participant intake data gathered from the ASA24 dietary recall system on the first day of the study prior to the education intervention revealed that on average the athlete's self-reported intakes of protein foods, vegetables, fruits, dairy, and whole grains all fell below the recommended intake ranges for this age group.[22] Along with food groups, the student athlete's average total energy intake was low compared to recommendations; the overall mean energy intake for the student athletes that completed the recall was 1602, which is roughly 800 kcals below the lower range of recommended kcals for active adolescents in this age group.[22] Several micronutrients, even those of key importance for athletes and/or individuals in this age group fell below the RDAs. These included calcium and vitamin D which are both essential for building bone density at this age, essential fatty acids EPA and DHA, which are anti-inflammatory and critical for brain development, and antioxidants vitamins like C, A, and E which are of concern for athletes due to the increased oxidative stress related to intense exercise.[1,6,24] These results pose concern for the immediate and long term health of young athletes who undergo more physical stress related to their sport and are at higher risk for injury than adolescents who are not involved in athletics. Other nutrients with means below recommendations included fiber, magnesium, and potassium. The overall low intakes of fiber and antioxidants revealed by the ASA24 data were consistent with the low reported intakes of fruits, vegetables, and grains which are major sources of these nutrients.

These findings are not dissimilar to findings from other studies examining sport nutrition knowledge and dietary behaviors in adolescents. A similar study where student athlete's reported dietary intake data at baseline revealed poor dietary patterns with intakes of most major food groups falling below recommendations.[7] Regardless of involvement in athletics, in general individuals in this age group who are typically gaining more independence in food choices, do not demonstrate optimal eating habits. Adolescents often report low intakes of fruits and vegetables, whole grains, proteins, and dairy products and higher intakes of convenience foods while exceeding the recommended limits on sodium, saturated fat, and sugar. [4,22] The intake data collected from the high school athletes in this study showed little difference when compared to NHANES data looking at dietary intake in this age group; in general, whether involved in athletics or not, teenagers are not meeting the DGAs.[23]

When comparing mean intakes of total energy and macronutrients pre and post intervention for the 10 athletes that completed the study, there was a slight increase in total energy from 1578 ± 605 kcals to 2043 ± 1155 kcals and in protein from 67 ± 33 g to 95 ± 65 g. This suggests there may have been small improvements in some of the participants' food choices, however, these changes were not statistically significant; there was also no significant difference in micronutrient intake when comparing dietary data pre and post intervention. With a notable increase in nutrition knowledge, it is surprising that there was no notable change in eating habits. However, as observed in previous studies, knowing better does not always equate to doing better and adolescents (active or not) have shown that possessing knowledge of proper nutrition and its importance doesn't necessarily influence their food choices.[7,12] While this study incorporated food related skill building such as meal planning and snack preparation into the education intervention to assist in improving the athletes' eating habits, the 10 participants that completed a 24-hour recall both pre and post intervention didn't seem to make any significant changes to their dietary habits. This leads to question whether it was the small number of participants, the number of education sessions, or the six-week timespan of the intervention that may have limited the possibility of seeing meaningful changes in diet behaviors.

Nutrition Self-Efficacy

Overall, the participants scored high on nutrition self-efficacy at baseline indicating that they already knew how to eat healthy and felt they followed a healthy diet. This aligned with what students reported on the athlete history form where only 12% (three students) stated they believed they had poor eating habits. However, while only three students reported having poor eating habits, eight reported only eating two meals or less most days, and nine reported skipping meals, suggesting adolescents perceive their diet behaviors to be healthy despite reporting poor intakes for most nutrients. There were no significant changes when comparing answers to the self-efficacy questionnaire pre and post intervention, which isn't surprising considering the majority of participants already considered their diet behaviors to be healthy. The reported nutrition self-efficacy levels of participants in this study are similar to what has been revealed in other studies investigating perceptions of diet behaviors in adolescents; while participants overall claimed to know what constitutes a healthy diet and the importance of nutrition and health, they still failed to meet recommended intakes for healthy foods like fruits, vegetables, whole grains, low-fat dairy products, and lean proteins.[12] This only further demonstrates the importance of focusing on guiding behavior change in future nutrition interventions for adolescents.

When investigating possible barriers to healthy eating, we observed a commonality among our participants and those in other studies aiming to understand and influence adolescent diet behaviors. While some studies have identified food cost as a barrier to healthy eating, this has not been acknowledged as the primary obstacle.[12,25] Similarly, participants in our study did not indicate access to healthy foods as an issue and scored high on self-efficacy questions regarding the availability of healthy foods at home. Studies that have utilized focus groups to better understand food habits in adolescents have instead revealed time, family food preferences, and cooking confidence as greater barriers to improving eating behaviors.[3,12,25] To address these barriers, incorporating more food-based skills into nutrition interventions like cooking and meal planning should be considered, as well as more involvement with parents to enforce better eating behaviors at home.

Limitations

One limitation to our study was the small initial sample size of only 25 students, which could be attributed to a short recruitment period and limited availability in athlete's schedules. It also doesn't allow for the participants in this study to be considered a representative sample of the greater population of adolescent athletes. Another limitation was that only 40% of the athletes completed all study requirements. Due to the already small sample size and large variance in energy and nutrient intake among participants, this resulted in any changes in dietary intake having little significance. Since nutrition knowledge scores between participants that did not complete the study and participants that did complete the study were similar at baseline, it is potentially likely that there would have been an observable increase in nutrition knowledge for the whole group had they finished the study, giving the intervention greater reach. Hosting the education sessions during school hours or practice time was not possible, which led to the sessions being hosted on Sundays. Finding a time to meet all family needs is difficult and this day may have decreased participation as the students weren't already in attendance as they would be during practice or school hours.

Future Research

Future research should consider allowing longer time periods for recruitment and focusing on methods of increasing participant engagement by reducing the time burden and increasing the program's accessibility to student athletes. Incorporating the nutrition education mini-series into a health or physical education curriculum could eliminate the time commitment for athletes with busy schedules and possibly increase student interest in the program as it wouldn't take away from the little free time that they have for outside activities. Modifying the intervention to include online modules and activities by adopting a more hybrid model could be another way to increase accessibility and student engagement in future studies. This would allow the opportunity to extend the length of the program and increase the likelihood of reinforcing better dietary habits without also increasing participant burden as modules and activities could be spread out over time. Involving technology to allow for less in person lecture time may be perceived as a benefit by this population, and if the online activities included a practical component focused on food skill building, it may help reinforce better dietary behaviors among adolescent athletes.

Conclusions

The student athletes that participated in this study possessed little nutrition knowledge at baseline and self-reported dietary intakes displayed poor eating habits. Despite this, students reported high self-efficacy, indicating that they believed they knew how to eat healthy, even though their reported nutrition knowledge and behaviors did not support this belief. While there was a significant knowledge increase among participants after the interactive nutrition education series, there was no significant change in dietary behaviors. This study expands upon the literature of nutrition knowledge and behaviors of adolescent athletes and reveals that a combination of educational lectures and skill building activities help to increase nutrition knowledge in this population. More research is needed to explore methods of improving dietary behaviors among active adolescents, including methods for intervention delivery that increase accessibility and reach.

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Appendices

Appendix A

ASA24 Module Descriptions

1. **Location-**

This module asks the respondent where they ate each meal or snack. The choices are:

Home
Fast food Restaurant
Other Restaurant
Cafeteria
Bar or Tavern
Work (not in Cafeteria)
Car
Sports or entertainment venue
Someplace else
School, cafeteria
School, not in cafeteria
Other

2. **Ate with-**

This module asks the respondent if anyone was present at each meal and snack, and if so, was it a family member or someone else.

3. **TV/Computer use-**

This module asks the respondent if they were watching TV, using a computer, and/or using a mobile device during meals and snacks.

4. **Supplements-**

All Respondents can report supplements such as vitamins and minerals. Selecting the Supplement Module modifies several of the ASA24 system prompts to remind Respondents to report supplements. For example, the instruction 'Type a food or drink' becomes 'Type a food, drink or supplement'. In addition, the word, 'Supplements' is included in the list of Forgotten Foods.

5. **Respondent nutrition report-**

This module allows for a nutrition profile report to be generated for respondents.

Generation of the Respondent Nutrition Report works differently for a recall versus a record. After completing a recall or record, respondents are asked to provide their age and sex, and, for women, whether they are pregnant and/or lactating. Respondents completing a recall can immediately view the report. Respondents completing a record must obtain their Respondent Nutrition Report directly from the researcher, who is able to access the report from the Researcher website.

The Respondent Nutrition Report includes:

Calories, carbohydrate, protein, fats, saturated fats, cholesterol, total fiber

Vitamins: A, B6, B12, C, D, E, K, folate, riboflavin, niacin, thiamin

Minerals: calcium, chlorine, copper, iron, magnesium, phosphorus, potassium, selenium, sodium, zinc

Food groups: added sugars, grains, dairy, vegetables, fruits, protein foods

Appendix B

<u>Date:</u>
<u>ID Number:</u>

<u>Food Security Survey</u>

These 6 questions are based on food eaten in your household within the last 12 months and whether you were able to afford the food you need. Please select the appropriate option from the choices depending on the number of people in the household.

1. "The food that we bought just didn't last, and we didn't have money to get more." Was this often, sometimes, or never true for you and your household in the last 12 months?

   a. Often true (1)
   b. Sometimes true (1)
   c. Never true (0)
   d. Don't know (0)

2. "We could not afford to eat balanced meals." Was that often, sometimes, or never true for your household in the last 12 months?

   a. Often true (1)
   b. Sometimes true (1)
   c. Never true (0)
   d. Don't know (0)

3. In the last 12 months, did you or others in your household ever cut the size of your meals down or skip meals because there was not enough money for food?

   a. Yes (1)
   b. No (0)
   c. Don't know (0)

4. If you answered YES to question 3, how often did this happen? Almost every month, some months but not every month, or only 1 or 2 times?

   a. Almost every month (1)

b. Some months but not every month (1)
c. Only 1 or 2 times (0)
d. Don't know (0)

5. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?

    a. Yes (1)
    b. No (0)
    c. Don't know (0)

6. In the last 12 months, were you ever hungry but didn't eat because there wasn't enough money for food?

    a. Yes (1)
    b. No (0)
    c. Don't know (0)

Appendix C

Date:
ID Number:

Sports Nutrition Knowledge Instrument

Please respond to each question below with the answer of true or false. If you do not know the answer, a column is also provided that states "don't know".

	True	False	Don't Know
Carbohydrate			
1. Eating a low carbohydrate diet will reduce muscle carbohydrate stores (glycogen) which can cause early fatigue	x		
2. A high carbohydrate diet helps athletes reduce muscle protein breakdown in the body.	x		
3. An athlete's plate should consist of more carbohydrate-rich foods than protein foods.	x		
4. Carbohydrates are the main fuel source for muscles during weightlifting.	x		
5. An endurance athlete such as a marathon runner, distance cyclist or Ironman distance triathlete should consume 60-90 grams of carbohydrate hourly during training/competition.	x		
6. Both carbohydrate and protein foods should be consumed after exercise to enhance recovery.	x		
7. The best time to eat carbohydrate to restore glycogen (carbohydrate) muscle stores is within 4 hours after exercise.		x	
8. An endurance athlete does not need to eat a high carbohydrate diet during training as long as they load up on carbohydrate prior to competition.		x	
9. Glycogen (carbohydrate stores) is the muscle's main fuel for high intensity exercise such as sprinting.	x		
Protein			
10. Protein is the primary source of energy used by muscles during strength training.		x	
11. Protein supplements are necessary for building muscle mass.		x	
12. It is less important to eat protein at every meal when a protein supplement is consumed after a workout.		x	
13. A whey protein supplement will enhance muscle growth more effectively than milk or eggs.		x	

14. Consuming protein and amino acid supplements decreases the amount of training needed to increase muscle mass.		x	
Fat			
15. Most athletes should eat as little fat as possible.		x	
16. An athlete who eats very little fat may have difficulty absorbing certain vitamins.	x		
17. Most athletes should avoid high fat foods such as bacon or nuts in the few hours before competing.	x		
18. Fat is a major fuel source for high-intensity exercise, such as sprinting.		x	
19. Eating a high fat, low carbohydrate diet for several days prior to a long race is an effective way to make carbohydrate stores last longer.		x	
Hydration			
20. Sports drinks are always the best way to replace body fluids regardless of exercise duration.		x	
21. Drinking too much water during endurance exercise can lead to hyponatremia (low levels of sodium in the blood).	x		
22. The best drink to consume during an intense 2-hour workout is water with protein.		x	
23. Drinking fluids during exercise helps to decrease the body's core temperature.	x		
Micronutrients			
24. Athletes should routinely take an iron supplement as iron deficiency is common in athletes.		x	
25. Eating foods high in antioxidants is more effective at enhancing training adaptations than taking antioxidant supplements.	x		
26. Vitamin D is only important for athletes because of its role in maintaining bone health.		x	
27. Athletes should not add salt to their food because it causes fluid retention.		x	
Weight Management			
28. An athlete trying to lose weight should avoid breads and starchy foods.		x	
29. To increase muscle mass, it is recommended to increase resistance training and eat more protein but not carbohydrate.		x	
30. An athlete who increases the duration and intensity of their workouts must also increase calories to prevent a breakdown of muscle.	x		

Appendix D

Date:
ID Number:

Nutrition Self-Efficacy Scale

On a scale from 1-6 with 1 being strongly disagree and 6 being strongly agree, please indicate how much you agree or disagree with each of the following statements.

Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree

Whenever I have a choice of the food I eat….

1.) I find it difficult to choose low-fat foods (e.g. fruit or "light" milk rather than "full cream" milk).

1 2 3 4 5 6

2.) I find it easy to choose a healthy snack when I eat in between meals (e.g. fruit or reduced-fat yogurt).

1 2 3 4 6 6

3.) I believe I have the knowledge and ability to choose/prepare healthy snacks.

1 2 3 4 5 6

4.) I find it difficult to choose healthy meals/snacks when I am eating out with my friends.

1 2 3 4 5 6

5.) I find it easy to eat at least 3 servings of fruit each day.

1 2 3 4 5 6

6.) I find it easy to eat at least 4 servings of vegetables/salad each day.

1 2 3 4 5 6

7.) I find it easy to have healthy portion sizes during meals (e.g. not eating till I feel full).

1 2 3 4 5 6

On a scale from 1-6 with 1 being strongly disagree and 6 being strongly agree, please indicate how much you agree or disagree with each of the following statements.

Strongly Disagree	**Disagree**	**Slightly Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**

8.) At home there are healthy snacks available to eat.

1 2 3 4 5 6

9.) At home there are healthy drinks available (e.g. cold water, sugar-free drinks, reduced-fat milk).

1 2 3 4 5 6

10.) At home fruit is always available to eat (including fresh, frozen, canned, or dried).

1 2 3 4 5 6

11.) At home vegetables are always available to eat (including fresh, frozen, or canned).

1 2 3 4 5 6

12.) Healthy eating can reduce my risk for some illnesses and diseases (e.g. heart disease, diabetes, some cancers etc.).

1 2 3 4 5 6

13.) Healthy eating can help me to feel better physically.

1 2 3 4 5 6

14.) Healthy eating (e.g. not skipping meals) can help to improve my concentration at school.

1 2 3 4 5 6

15.) Healthy eating can help me to feel more energetic throughout the day.

1 2 3 4 5 6

Vita

Faith M. Wright was born in St. Louis, Missouri, to Mary and Scott Horner. She graduated from Union High School in 2009, after which, she later attended Appalachian State University where she received a Bachelor of Science in Dietetics in the Spring of 2021. She then continued her studies at Appalachian State University in the Fall of 2021, where she worked as a Graduate Assistant at the Institute for Health and Human Services Interprofessional Clinic. The following year, she completed her Dietetic Internship in Winston Salem, NC. She was awarded the Master of Science degree in Nutrition and Dietetics in May of 2023 from Appalachian State University.