Improving Sports Nutrition Knowledge and Behavior in High School Student-Athletes

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High school student-athletes often contend with intense pressure to excel academically and athletically, yet frequently lack adequate support in nutrition education and guidance. This absence is particularly concerning given the critical growth and development phase these athletes undergo, coupled with the strenuous physical demands they face. This study addresses the lack of sports nutrition knowledge (SNK) and habits among student-athletes at Carlisle High School, focusing on the girls' basketball team. Through a three-session nutrition education intervention conducted between October and December 2024, the study aimed to assess the impact on student-athletes' nutrition knowledge, food selection for pre-activity fueling, and coaches' perceptions of the intervention's effects. Measures included pre/post nutrition knowledge surveys, pre-activity fueling forms, and a coach interview. Results revealed a 38.1% increase in student-athletes' sports nutrition knowledge, with an average 36.2% growth observed among students and coaches combined. Notably, student-athletes showed the most significant growth in understanding pre-activity fueling, with a 57.1% increase. No notable improvements were observed in student-athlete behavior through pre-activity fueling forms. This study demonstrates the efficacy of three nutrition education sessions in enhancing student-athletes' knowledge and highlights the need for continued research with this population. Suggestions for future studies include refining measures to track behavior changes and exploring additional interventions to bolster sports nutrition practices among high school student-athletes. Despite the small sample size, this research contributes to existing
literature, demonstrating the feasibility of improving nutrition knowledge in student-athletes through tailored nutrition education sessions.
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Preface

I am forever grateful to have worked and learned from my advisor, Dr. Sharon E. Ross. Her support, encouragement, and help during this process were invaluable and helped me achieve this lifelong dream of mine.

I am also thankful for the support of my friends and friends, but most importantly my husband. He has read this document almost as much as I have, and I could not be more appreciative of his support, motivation, and partnership over these past three years. Completing this program was a huge undertaking and I hope my daughters, Everleigh and Amelia, know the sky is the limit and that achieving their dreams is always possible. All this hard work and dedication is not only for me but also to be a role model for them as they get older and will someday have dreams and passions of their own.
1.0 Naming and Framing the Problem of Practice

1.1 Broader Problem Area

High school student-athletes face high pressure to perform and do well for their school; however, when looking at what is available to support these athletes, nutrition education and guidance are usually absent. This is problematic to student-athletes because they are in a critical period of growth and development, pushing their physical demands to the limit without understanding how to best support their physical performance and recovery. Nutrition knowledge (NK) or sports nutrition knowledge (SNK) among adolescent athletes is lacking (Bird & Rushton, 2020; Patton-Lopez et al., 2018; Partida et al., 2018).

Sports nutrition knowledge can be defined as the understanding of nutrition as it relates to training, performing, or recovering from an athletic event (Klein et al., 2021). Previous studies have estimated that only 26-35% of high school athletes believe that their diet meets their nutritional needs (Manore et al., 2017; Patton-Lopez et al. 2018; Partida et al. 2018). Athletes’ lack of awareness of viable nutritional practices and the demands of athletics can negatively impact their well-being and sports performance (Stoll, 2018). This reinforces the importance of including nutrition education in high school athletic programs.

Through the literature, empathy interviews, and my practitioner knowledge and experience as a health and physical educator, I have attributed five significant contributors to this problem: 1) lack of SNK in the student-athletes themselves, 2) the lack of SNK in the student-athletes sphere of influence (i.e., concerned parties), 3) confusion around nutrition topics, 4) rules, regulations, and policies (or lack thereof) around nutrition in schools and high school athletic programs, and
5) limited nutrition resources for this age group. These contributors to the overall problem both pose barriers to nutrition education in high school student-athletes and within interscholastic athletic programs.

Student-athletes are negatively impacted by their lack of nutrition knowledge because it can lead them to seek quick solutions, especially when the athletic program is also not supporting their nutritional needs. Athletes deserve nutrition education throughout their high school career to help establish healthy habits, increase energy, and consume enough food to support growth and development as well as performance. While it has been well-established that knowledge and education alone do not change behavior, not being given nutritional support in their high school athletic program is also negatively impacting athletes in the moment and in the future.

The student-athletes’ sphere of influence also lacks SNK, which leads to factors that disrupt the follow-through between nutrition knowledge and food intake. Specifically, factors such as convenience, peer pressure, lack of good decision-making, values, and motivation can impact nutrition habits (Patton-Lopez et al. 2018). On their own, adolescents are not able to develop nutrition habits to support their goals as an athlete or into adulthood. After speaking with coaches, athletes, and parents/caregivers through empathy interviews, all parties see the value in including SNK in their athletic programs; however, value alone is not moving nutrition efforts forward for student-athletes.

When considering a student-athlete's sphere of influence, parents/caregivers and school play a huge role in sharing knowledge. If nutrition is not a topic emphasized by either of these groups, then the student’s foundation for nutrition knowledge is limited. Through the literature and my conversations with athletes, coaches, and parents/caregivers, concerned parties that support the athletes often have little to no nutrition knowledge (Partida et al., 2018; Heikkilä et al., 2019). As
adolescents gain more independence and freedom, such as having a cell phone and hanging out with other peers without supervision, knowledge is also gained through these experiences. Comparing this experience with high school programs, all high schools require a credit of health and physical education to graduate in the Commonwealth of Pennsylvania; however, how a district implements this credit varies greatly. Because nutrition is only one unit that needs to be covered the curriculum often just skims the surface. The foundation for supporting high school student-athletes and their SNK is lacking in their sphere of influence.

The third contributor to the problem is the confusion around nutrition. Nutrition science is ever-changing or updating as more studies and research are being completed which can lead to confusion or misconceptions when it comes to what information is correct or not (Stoll, 2018). Many individuals have trouble understanding the research related to nutrition, as it is complex and can be highly individualized. The adolescent population is impacted by the media and societal pressures with the nutrition information they receive. Fad diets, health coaches, celebrities, and other unqualified individuals can spread false information that student-athletes may try or be exposed to. Social media may be harmfully filling in gaps in nutrition knowledge. This confusion further highlights the need for a credible voice to give dietary advice to student-athletes to maximize performance and benefit long-term health (Stoll, 2018).

When looking at what current policies and guidelines are in place, oftentimes athletes are an overlooked population. According to the Centers for Disease Control and Prevention (CDC), for effective behavior change, students should receive 40-50 hours of nutrition education; however, most students receive less than eight hours in a school year (Centers for Disease Control and Prevention [CDC], 2021). Much of the focus of school nutrition and wellness is geared toward obesity prevention, which is needed, but I believe athletic programs can use this policy to build a
robust nutrition program to support the nutritional needs of their athletes. Health and physical educators are limited in the time they can spend educating on one topic. Nutrition may be a topic that is rushed through or glanced over, so students may not have enough time to engage with this topic during the school year.

There are also limitations surrounding nutrition rules, guidelines, or expectations from the state level for athletes from the Pennsylvania Interscholastic Athletic Association (PIAA). Nutrition policies or regulations are nonexistent, causing unclear expectations for how best to support the student-athlete. Athletic directors oversee coaches and athletes and can be informed of ways to support the nutritional needs and knowledge of coaches, parents/caregivers, and players. Athletic directors could use school policies to create a more comprehensive athletic program that includes nutrition. However, this omission on the state level does not hold the athletic directors accountable in any tangible way, further contributing to the problem.

The final contributing factor to the problem is the lack of nutrition resources for this age group within the school and athletic environment. Some of the barriers to moving such a program forward include finances, staffing, time, and other required supports/resources. Investing in a registered dietitian, having fueling stations, and providing nutrition training for coaches, parents/caregivers, and athletes costs money (Cruz, 2016). All of this also requires time; time to plan out meals, plan and organize training, and support the needs of all concerned parties. Much of the focus surrounding high school athletic programs is on the physical demands of practice and training and not equally on the nutritional demands of the players.

To reiterate again, student-athletes want the edge to get them to the top. Many athletic programs will respond with more training sessions or better coaches; however, nutrition is missing from this standard approach. To better inform high school athletes of how to perform while
properly supporting their growth and development, nutrition education needs to be more at the forefront. Student-athletes have limited SNK, concerned parties have limited SNK, there is pervasive confusion around nutrition topics, and an overall lack of policy/guidelines and resources to support the nutrition goals, knowledge, and habits of student-athletes. By providing a greater focus on nutrition in Carlisle High School athletic programs, an overall improvement in student-athlete nutrition knowledge, behavior, and performance is likely.

1.2 Organizational System

Carlisle High School is a public high school in south-central Pennsylvania. Educating roughly 1,500 students, this school encompasses students from multiple socioeconomic statuses, a variety of ethnicities, and families stationed in the communities as well as the Army War College (Carlisle Area High School (2022-23 ranking), n.d.). Carlisle High School currently has 400-500 students who participate in athletic or band programs (Sentinel, J. C. T., 2021).

Carlisle High School has 20 athletic programs available for students to participate in that are spread over fall, winter, and spring. There is one athletic director, three athletic trainers, and a minimum of one coach per team (Athletics, n.d.). The same athletic director has been in the position for at least 17 years. There is no athletic program-specific mission statement or goal statement on the website, beyond a code of conduct (Athletics, n.d.). The focus of this code of conduct is discussing a student’s eligibility status for participating in athletics. This omission is magnified because neighboring school districts have posted mission statements for their athletic programs on their websites. There is an opportunity to create an athletic program mission statement
that encompasses supporting the whole athlete, from training to nutrition information and sports psychology.

During the current administration’s tenure, nutrition has not been a focal point in a student-athlete's high school athletic career. After speaking with one of the coaches at Carlisle, many of the coaches are not equipped with nutrition knowledge or support from their athletic program (Coach G, 2022). Currently, there are no specific rules, guidelines, policies, or resources for educating coaches or athletes on nutrition. As such, if athletes receive any nutrition education from their athletic program, this is at the discretion of their coach.

The Pennsylvania Department of Education and the State Board of Education do not state a required amount of time per week that health or physical education must be provided, so it is up to the school districts to determine the appropriate amount per grade level within the Pennsylvania School Code (Health and physical education, n.d.). Students at Carlisle High School are required to take two health courses in ninth and eleventh or twelfth grade, which includes one unit on nutrition. The Pennsylvania State Standards outline what students should learn in each subject area by a certain grade level. These standards guide curriculum choices and what should be taught in various classes. The Standards Aligned System (SAS), created by the Pennsylvania Department of Education, is a research-based tool aimed at enhancing student performance (Commonwealth of Pennsylvania, 2024). It delineates six key components crucial for improving student achievement: Standards, Assessments, Curriculum Framework, Instruction, Materials & Resources, and Safe and Supportive Schools (Commonwealth of Pennsylvania, 2024).

For high school students, nutrition standards are seen for ninth and twelfth grades through the health, safety, and physical education standards as well as Family and Consumer Science. Table 1 shows what standards are covered by these grade levels and what is expected to be
understood by students by the end of these grade levels. Students at Carlisle are required to take health, but they can also learn about nutrition through elective courses such as family and consumer science, and culinary classes (Course selection information, n.d.). There is no course solely dedicated to nutrition or sports nutrition/performance nutrition at Carlisle High School.

Table 1 Pennsylvania State Standards that cover nutrition topics in high school

<table>
<thead>
<tr>
<th>Health, Safety, and Physical Education standards</th>
<th>Ninth Grade</th>
<th>Twelfth Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Analyze factors that impact growth and development between adolescence and adulthood. Risk factors (e.g., physical inactivity, substance abuse, intentional/unintentional injuries, dietary pattern)</td>
<td>• Evaluate factors that impact the body systems and apply protective/preventative strategies. Nutrition</td>
</tr>
<tr>
<td></td>
<td>• Analyze factors that impact nutritional choices of adolescents. Body image</td>
<td>• Analyze factors that impact nutritional choices of adults. Cost</td>
</tr>
<tr>
<td></td>
<td>Advertising</td>
<td>Food preparation</td>
</tr>
<tr>
<td></td>
<td>Dietary guidelines</td>
<td>(e.g., time, skills)</td>
</tr>
<tr>
<td></td>
<td>Eating disorders</td>
<td>Consumer skills (e.g. understanding food labels, evaluating fads)</td>
</tr>
<tr>
<td></td>
<td>Peer influence</td>
<td>Nutrition knowledge</td>
</tr>
<tr>
<td></td>
<td>Athletic goals</td>
<td>Changes in nutritional requirements (e.g., age, physical activity level)</td>
</tr>
</tbody>
</table>
Some coaches at Carlisle High School have taken it upon themselves to support the nutrition of their athletes. For example, one coach I spoke with shared that when the players ask her, “Is this healthy or not” she provides them with a brief explanation of if it is or not. She also shared she encourages her athletes to eat something if she overhears them talking about eating before a practice or game. Over 35% of the student population at Carlisle School District receive free and reduced lunch (Carlisle Area High School (2022-23 ranking), n.d.). While not everyone involved in that statistic are student-athletes, the correlation shows some of the financial hurdles
that coaches may face when attempting to provide healthy food options for their athletes. In speaking with one of Carlisle’s coaches, she shared that her team orders pre-game meals when they have away games. For example, the team will order subs from a local restaurant. However, this coach also acknowledged that not every student-athlete is able to participate due to financial reasons. Restricting access to proper nutrition for certain athletes based on financial circumstances is a primary example of inequity as it pertains to scholastic athletics.

1.3 Positionality

While I do not currently work within Carlisle High School, I am an educator in the K-12 setting with 10 years of experience educating adolescents about health and physical education. My master’s degree is in nutrition education, so I am very passionate about this topic and apply components to my physical education class as well as go beyond the minimum requirements in the health classroom. As an experienced practitioner, I recognize that nutrition information can be confusing to many concerned parties and hard to apply in practice. I want to make SNK more accessible to high school athletes and coaches who are training at more intense levels than the general high school student population, helping them understand the value nutrition for performance and growth.
1.4 User/Concerned Parties Description

1.4.1 Student Athletes

When high school student-athletes pursue athletics at the collegiate level, they have little knowledge of proper nutrition practices to support their performance (Weeden et. al, 2014). In my empathy interviews with two high school athletes, they shared that they really do not receive much support from school and turn to their parents/caregivers, and maybe occasionally ask their coach a question related to nutrition. They also shared how they utilize the internet for nutrition information.

Adolescence is a critical period of growth and development that requires proper nutrition, along with an adequate amount of sleep and physical activity (Lassi et al., 2017). In terms of sports nutrition, high school athletes risk under-hydrating and not getting enough nutrients to fuel their bodies (Manore et al., 2017). By not focusing on nutrition education, even in the slightest, high school athletic programs are failing to meet the demands athletes require. Investing in nutrition programs, support, and resources at the high school level can help adolescent athletes develop stronger nutrition habits while giving them support to better understand how to make healthy decisions to benefit them for their entire lives.

1.4.2 Peers, social media, and societal pressure

Peers and social media can also influence the SNK of athletes. What adolescents are watching and being exposed to can shape or influence their habits (Rocka et al., 2022). Peers can support one another, keep accountability, or provide some knowledge related to nutrition; they can
also model nutrition habits, for better or for worse. Social media and influencers are often popular with this age group and become a major influence for this population. Trends, fad diets, and supplement use can be harmful to all adolescents; however, student-athletes may be particularly at risk, as they have higher caloric needs than the general high school student population. For example, many female athletes are concerned with having an “ideal” body composition which may lead them to under-fuel to look slimmer. This under-fueling impacts how the athlete feels, performs, and supports their daily function (Jagim et al., 2022).

1.4.3 Athletic Director

Athletic directors oversee the sports organization of a school. At Carlisle High School, there is one individual who is the athletic director, which is typical for a district. The role of the athletic director includes ensuring transportation for athletes, making sure there are officials assigned to activities, scheduling current and future games, connecting with coaches about problems and issues they are experiencing, answering parents/caregivers’ concerns, and much more.

Speaking with a high school athletic director, who is also an assistant principal from another school, provided me with a better insight into his world and how to navigate athletic programs. When asked about nutrition-related goals, he sees the value; however, there is nothing offered to support students unless they take on the initiative themselves. This thought is oftentimes a common one for athletic directors. There must be a major push from other concerned parties (i.e., athletes, parents/caregivers, coaches, or administration) for standard rules or regulations to change.
1.4.4 Coaches

Coaches play an influential role in an athlete’s life. They can motivate and inspire or induce stress and anxiety in an athlete. Many high school coaches are educators themselves or community volunteers who get a small stipend for coaching. Their passion is what drives them to coach; however, they may not have a background or training in sports psychology, strength and conditioning, or nutrition.

When it comes to sharing nutrition knowledge with athletes, both coaches that I interviewed shared that they have very little nutrition education or knowledge. Much of the nutrition information they share with athletes come from the internet or their own past experiences. One coach I spoke with discussed how hydration was a huge concern when she was an athlete and how her team was required to have frequent water breaks, so she instilled that in her team. Nutrition information that is shared with athletes by coaches can be surface-level and lacks a meaningful reason behind why the athlete needs to care for their nutritional needs. Since there are little to no resources provided to the coaches at Carlisle High School, it is up to the coach’s discretion in how they want to discuss nutrition with their athletes.

1.4.5 Parents/Caregivers

Another influential group in a student-athlete’s life is their parents/caregivers. Parents/caregivers can influence what foods are available at home, model healthy eating behaviors, and support their athletes in navigating confusion around nutrition. The division of responsibility of feeding, according to Ellyn Satter, highlights for adolescents the parents are responsible for the what, when, and where of food while the child is responsible for how much and whether (Ellyn
Healthy habits can start in the home and with adolescents, you must trust the healthy habits you instill will translate into nutritious food choices in and outside of the home.

Along with coaches, parents/caregivers have been identified as the students’ go-to for nutrition education questions and information (Heikkilä et al., 2019, Partida et al., 2018). Taking it a step further, the responsibility may fall on parents/caregivers to support and educate their students on proper nutritional habits. However, problems can arise if the parent is not well educated or lacks an understanding of nutrition knowledge. From the individuals I spoke with, there are no organizational supports for parents/caregivers to better understand nutrition. They are on their own to get the answers they need for their nutritional concerns or guidance. If parents/caregivers assume the school and their coaches/athletic programs are providing nutrition education, but very little is being taught, then the gap in a student’s nutrition knowledge can become more glaring.

When speaking with two parents/caregivers of student-athletes, one mother shared that she tries to provide healthy snacks and reminders to eat something before practice or a game. What sometimes ends up happening though is what she thinks is healthy has caused her daughter to feel sick during the practice. She also encourages her daughter to drink plenty of water. The other mom shared that her daughter is self-motivated and does not ask too many questions; however, the mother will remind her daughter about drinking plenty of water and having something to eat when she gets home from school. This basic idea is a start; however, I think the biggest takeaway is that parents/caregivers are not equipped to provide quality nutrition education for their students.

1.4.6 Health and Physical Education teachers and other teachers

Within the school building, curriculum, and school wellness policies can provide nutrition education to all students, not just athletes. Carlisle has a School Wellness Policy (School Board
Policy #246) that highlights nutrition education will be seen in Health, Safety and Physical education classes as well as Family and Consumer Science courses (Carlisle Area School District, 2018). The district will also promote healthy eating for students and teach, “behavior-focused skills, such as meal planning, reading a food label, and media awareness” (Carlisle Area School District, 2018). Part of the policy also focuses on nutrition promotion stating they will use evidence-based techniques and messages to promote healthy eating for students and their parents/guardians (Carlisle Area School District, 2018).

As a health and physical educator, I know what the nutrition scope is through our curriculum. A lot of the education in health classes is dictated by state standards as well as curriculum guidelines set by the school district. At the teacher level, excitement and time spent on that topic can vary by individual preference. Some schools offer a sports nutrition class for high school students; however, this elective is not offered at Carlisle. According to the curriculum maps at Carlisle High School, students are required to take 2 health classes. Health 1, taken freshman year, is a year-long course meeting two days a week, covering a nutrition unit that spans seventeen classes (Carlisle Area School District, 2017). Topics in this unit are nutrients and antioxidant-rich foods, menu planning, portion size, food labels, and more. Health 2, taken junior or senior year, is a yearlong course meeting one a week and covers a nutrition unit that spans seven days (Carlisle Area School District, 2017). Many of the topics are similar to the Health 1 course.

Family and Consumer Science elective courses may cover nutrition topics, but students are not required to take these classes. Courses offered by the Family and Consumer Science electives that cover topics of nutrition, as stated in the course selection guide, are Skills for Success and Foods and Nutrition (“Course selection information”, n.d.). Carlisle High School also has a culinary arts program that students can elect to take and learn more about food and nutrition.
Food service can also provide and label sport-performing meals, and this can be integrated into the school wellness policy. Carlisle follows the National School Lunch and Breakfast programs, which require them to provide nutritious foods to students while meeting guidelines. Finding a way to operate within the national requirements while helping student-athletes could be something the wellness committee could review.

### 1.5 Statement of the Problem of Practice

When it comes to training in interscholastic sports, many high school programs offer pre-season practices, weight training, and year-long support for athletes to grow in their athletic performance. What is currently lacking in Carlisle High School’s athletic program is a focus on sports nutrition, which is a key component in supporting the whole athlete. The girls’ basketball team at Carlisle is starting their fourth season under new coach staff who are focused on changing the culture around the sport. The coach’s focus for the past three years has been fostering a positive environment for girls and instilling good character in players. This year they are focusing on leadership skills and getting stronger through strength and conditioning in the gym. The coach agrees that a missing piece remains-- nutrition education and support for her players. This is a problem because this lack of information prevents student-athletes from having a full understanding of how much food they need to consume compared to the general high school student population, how to fuel pre- and post-activity, the importance of hydration, and understanding the why behind it so they can make more informed choices. As such, the problem of practice this dissertation seeks to address is that *Carlisle High School is not fostering adequate sports nutrition knowledge and nutritional habits to support performance in their student-athletes.*
There is no accountability for nutrition in adolescent athletes in the same way that student-athletes are held accountable for being on time or attending regular practices (Noonan, 2021). For example, no one checks if players are fueling their bodies in the same way that they are checked for being on time or at practice. This accountability falls on the student-athlete, and when student-athletes are not equipped with this skill set, the ball is dropped. It is insufficient to rely on the school curriculum or parent nutrition knowledge shared with the athletes. When high school student-athletes pursue athletics at the collegiate level, they have little knowledge of proper nutrition practices to support their performance (Weeden et. al, 2014). According to the CDC, for effective behavior change, students should have 40-50 hours of required nutrition education, but most students receive less than eight hours in a school year (CDC, 2021). This is not happening in most school settings.

Nutrition information is critical in helping athletes improve their energy levels, hydration status, and perform their best during their activity. Beginning with what information student-athletes currently know, and building on that, can drive nutrition education programs to be successful. Student-athletes deserve to learn about what nutrients they need to consume to support their performance and how they differ from the general high school student population. While nutrition knowledge is not enough to change behaviors, finding ways to meet student-athletes where they are and provide the tools to make small, meaningful changes can be beneficial in supporting overall behavior change.
1.6 Review of Supporting Scholarship

The purpose of this literature review is to explore interscholastic athletic programs’ failure to implement a nutrition education program and how it is impacting their student-athletes. I begin by reviewing school wellness policies and how this model can impact students’ health as well as their nutrition knowledge. Next, I discuss student-athlete nutrition knowledge, lifestyle, and nutrition-related behavior. Finally, I summarize the literature regarding best practices for improving nutrition knowledge in student-athletes.

1.6.1 How schools influence nutrition knowledge in student-athletes

1.6.1.1 School-wellness policy for all students

The CDC (2021) established a framework for schools when addressing the health and well-being of students known as The Whole School, Whole Community, Whole Child (WSCC) Model. This framework was established in 2014 and is student-centered with an emphasis on the supporting role of the community and its influence between health and academia through evidence-based school policies and practices. In the WSCC model, nutrition education falls in line with the classroom, cafeteria, school nurses, and other influential adults. The WSCC model can help establish a plan for addressing the nutritional needs of student-athletes.

While the primary focus of WSCC is aimed at helping the child in various aspects to decrease or help lower their body mass index (BMI) and prevent diet-related disease, the importance of education on health topics that go beyond the sphere of school is setting the foundation for a healthy lifestyle. Childhood obesity and health-related diseases have increased, especially during the COVID-19 pandemic (Robert Wood Johnson Foundation, 2022). The
national rate of obesity among children ages 2 to 19 increased to 22.4% in 2020, up from 19.3% in 2019 (Robert Wood Johnson Foundation, 2022). Schools play an important role in the nutrition and access to food for students because many children consume up to half of their daily calories at school. One of the biggest missing links is the lack of nutrition education provided to students so they can create lifelong healthy eating habits from an early age.

More funding, support, and resources should be provided to schools to meet the goals outlined by WSCC for all students. Nutrition education should also be at the forefront from kindergarten through twelfth grade to help understand the importance of nutrition for growth and development, disease prevention, and fueling your body efficiently. The incorporation of nutrition content in the elementary school curriculum is a great start to help build nutrition knowledge at a younger age. The demands on teachers to meet their requirements are high; however, if the curriculum can incorporate effective nutrition education in their math, reading, and/or science lessons, it would help teachers provide nutrition-related content in a manner that also supports their curriculum goals (Vlieger et al., 2018). Starting at primary age may lead to a stronger foundation in nutrition knowledge so students have a basic understanding upon reaching middle and high school when it comes to meal-time choices, nutrient-dense food selection, and fueling their bodies daily for their needs.

In Pennsylvania, all students are required to take health and physical education throughout their schooling career (K-12). Since this is a requirement, nutrition education falls into one area of health education and is not given its own dedicated space. If the curriculum from primary school through high school could incorporate nutrition themes, nutrition education goals could be seamless (Vlieger et al., 2019). An option for student-athletes could be taking an introduction to nutrition course and/or sports nutrition course to help them understand the basics around nutrition
and its importance to their diet during activity. Having students in high school who are athletes or active individuals having the option to enroll in a class specifically related to nutrition education for performance can be a way to support the nutritional needs in an effective manner while meeting the goals of a school wellness program. Leaving it solely up to health and physical education classes is not enough. The whole school community needs to be on board in helping with these health and physical education requirements and school policy agreements from the wellness program.

1.6.1.2 School wellness policy for student-athletes

Interscholastic activities and sports provide an option for students to achieve many of the goals of the WSCC model. The WSCC helps identify high BMI numbers and disease markers; however, athletes are a unique category that may be overlooked because they are not identified as at-risk. BMI is not the best marker of health, as it does not consider muscle mass. It is a quick and inexpensive measure used to calculate body composition but should not be the only measure, especially for athletes; for example, considering their physical activity levels and dietary intake as indicated by the AHA Essential 8 (Lloyd-Jones et al., 2022). This does not take away from the importance of their health and well-being in performance because nutrition is significantly lacking in current practices. The athletes who want to have a competitive edge or increase their SNK are not being properly supported (Bird & Rushton, 2020). The Pennsylvania Interscholastic Athletic Association (PIAA) does not include guidelines or resources that promote proper nutrition for high school student-athletes or for coaches to support their players. So much of an athlete's focus is on their sport’s physical demands and not on proper fueling requirements to be successful, sustain those physical demands, or reap the performance benefits.
Nutrition education can see positive improvements in nutrition knowledge, but that does not mean this translates to healthy nutrition behavior (Kyere et al., 2020). The environment where kids are learning nutrition education in class needs to be reinforced in school cafeterias, school events, and with their use of the school’s vending machines. There is a disconnect between sports nutrition information and proper meals for student-athletes in the cafeteria (Fitzpatrick, 2018). Athletic programs can work with food service directors to create a fueling menu that helps meet the requirements of the student-athletes for their performance (Fitzpatrick, 2018), while operating within the government’s nutrition guidelines for the school lunch program. Making an effort like this can help student-athletes apply what they are learning into actionable steps in the cafeteria.

Another way schools are making changes to help foster a healthier nutrition environment is through vending machine options. There are time restrictions, food and beverage costs, and even the elimination of vending machines in schools that make it challenging for athletes to grab a fueling option in a quick and convenient way. Schools may think they are following the guidelines under their school wellness policy with these “natural experiments” in changing vending machine items to align with their physical activity and nutrition policies; however, the success rate or effectiveness is either not strong enough or not proven (Ramanathan et al., 2008). Education with appropriate options laid out for student selection in vending machines may help with the follow-through of nutrition education ideas in middle and high school students (Chriqui et al., 2020). Some student-athletes may rely on these convenient foods to fuel themselves after school for their activity or sport. It is important for student-athletes to know how to navigate their food selections when options are limited or convenient.
1.6.1.3 Role of the concerned parties

Student-athletes rely on coaches and their parents/caregivers for nutrition education information (Partida et al., 2018). When examining the WSCC model, the concerned parties that impact the student-athlete are teachers, specifically the health and physical education teachers, school nurses, coaches, and parents/caregivers. In the previous section, I explored how teachers and school services can implement changes to best support the student-athletes above, but it is vital to highlight the role of coaches and parents/caregivers.

Nutrition education is something both middle and high school students have identified that they would like to learn more about (Partida et al., 2018). When it comes to nutrition education, many students and athletes identify that they receive their nutrition information from parents/caregivers, coaches, and school, as well as social media, the internet, and other athletes (Bird & Rushton, 2020; Partida et al., 2018). Oftentimes coaches do not understand nutrition for performance (Partida et al., 2018; Heikkilä et al., 2019, Jacobs et al., 2016). Many coaches are volunteers who may have played the sport they are coaching. Student-athletes rely on their coaches for nutrition information; however, most high school coaches are not properly trained or informed on proper sports nutrition information (Manore et al., 2017). In one study, the average score for nutrition knowledge among the coaches was 68.4%, with less than 30% answering general nutrition questions correctly, explicitly relating to carbohydrates and lipids (Couture et al., 2015). Over half of the coaches reported that they received their nutrition information from the internet. This data highlights that if the coaches are not well informed, the players likely will not be either. Involving key stakeholders, such as coaches, in nutrition knowledge training or education should be considered.
Kehm, Davey, and Nanney (2015) looked at the role of family and community involvement in developing and implementing school nutrition and physical activity policies. Since parents/caregivers and community members play a vital role in the delivery of nutrition education for student-athletes, getting buy-in and engagement from those groups can foster a stronger program. Family and community involvement can yield positive benefits in healthy eating strategies, healthier food options, support for physical education, and intramural sports opportunities (Kehm et al., 2015). When parents/caregivers participate in the nutrition education sessions, adherence to the protocols suggested were higher than those parents/caregivers who do not participate (Philippou et al., 2017). Involving parents/caregivers in nutrition education is critical since they are largely the ones completing the grocery shopping and cooking meals and can help support their student-athletes with nutrient-dense choices and advice.

Schools play an important role in aiding all children, but there is a gap in helping student-athletes develop successful nutrition knowledge and habits for their interscholastic activities. Nutrition education alone is not the answer. Schools can find success by cultivating an environment from kindergarten through twelfth grade with nutrition education linked in all curricula, providing education for key stakeholders to support student-athletes, while also ensuring that food choices provided at mealtimes are conducive to what they need. In the Commonwealth of Pennsylvania, the best practice is to follow the state standards and wellness policies to ensure all students are receiving adequate nutrition education.

1.6.2 Student-athlete’s nutrition knowledge and nutrition behavior

Student-athletes, particularly those who are in high school, are gaining a new sense of independence and influence from the world around them. In the world of sports, information
related to nutrition can be confusing and overwhelming. Understanding what student-athletes know about nutrition can be a powerful tool to meet athletes where they are, improve or expand their nutrition knowledge, and encourage behavior changes in their eating habits.

Athletes have additional caloric needs to keep up with their performance, but also to support a critical period of growth and development. Previous research estimates that only 26-35% of high-school athletes reported that their diet met their nutritional needs (Manore et al., 2017; Partida et al. 2018; Patton-Lopez et al. 2018). All three studies highlighted that student-athletes know it is imperative for their performance that they consume more than the general high school student population (Manore et al., 2017; Partida et al. 2018; Patton-Lopez et al. 2018).

1.6.2.1 Middle and high school student-athletes nutrition knowledge

Nutrition knowledge or SNK is lacking among adolescent athletes (Bird & Rushton, 2020; Patton-Lopez et al., 2018; Partida et al., 2018). Previous studies have shown that student-athletes specifically lacked an understanding of protein and carbohydrates as they relate to exercise (Partida et al., 2018), macronutrient recommendations (Bird & Rushton 2020), and the underconsumption of carbohydrates (Steffl et al., 2019; Heikkilä et al., 2019). Confusion around these macronutrients is problematic since they are the main fuel and recovery sources for athletes. If student-athletes do not know the basics surrounding what to eat to support their activity level, this could have an adverse impact on their performance. This information can guide nutrition education programs in understanding the importance of these essential nutrients and what adequate consumption needs are.

Many studies have looked at both male and female athletes across various sports. Previous nutrition interventions with athletes report that nutrition knowledge or SNK showed greater improvements among females than male athletes following intervention (Bird & Rushton, 2020;
Manore et al. 2017; Patton-Lopez et al., 2018). This may be because initial or pre-scores were lower so there was more room for growth (Patton-Lopez et al. 2018). This data supports that females could benefit more from nutrition education sessions since there is an initial lack of understanding (Manore et al. 2017). However, males should not be excluded from nutrition education because there are gaps in their knowledge as well.

Peers, curiosity, and misinformation related to nutrition supplements can also be primary influences on student-athletes’ knowledge and behaviors. One study reported that nearly half of youth believe supplements are necessary to support training (Manore et al. 2017). Another study reported 22.5% of high-school students and 44.3% of middle-school students believed supplements are necessary (Partida et al., 2018). Male athletes tend to use nutrition supplements more than females, despite knowing the health risks (Jovanov et al., 2019). While this information is not surprising since much of the supplement use is marketed towards males, debunking the need for supplements is important. Student-athletes are likely unaware or not properly educated on the long-term effects of supplement use and how it can significantly impact their body.

1.6.2.2 Collegiate student-athletes’ nutrition knowledge

When high school student-athletes pursue athletics at the collegiate level, they have little knowledge of proper nutrition practices to support their performance (Weeden et. al, 2014). Previous studies have estimated the mean nutrition knowledge scores for collegiate athletes were around 50-56% (Boumoseleh et al., 2021; Kimmel et al. 2020; Weeden et al., 2014). Forty-two percent of athletes had concerns related to what and how to eat healthy (Weeden et al., 2014). With more independence than high school students, college athletes can rely on food services to prepare meals but are also living in a place where they have access to a kitchen and will be preparing some or all their meals. They typically have no guidance in the grocery store from parent/caregiver, so
navigating this concern can be overwhelming when they do not understand what they should be eating along with other constrictions like budget and availability. Food insecurity on college campuses is an under-discussed reality of many college students (Peterson et al., 2022). This may limit access to healthy foods outside the dining halls.

Only sixty-seven percent of Division 1 universities currently have board-certified specialists in sports dietetics (CSSD) on staff (Kimmel et al. 2020). Considering this, not all collegiate athletes have the experience of working with a registered dietitian or one with this certification. While having a CSSD is ideal, it is not required if working with a registered dietitian. Males have been reported to be hard to reach in this category and are not accessing nutrition services as frequently as females as the misconception related to nutrition in thinking “learning about nutrition is not important for athletes because they eat so much food that they always get the nutrients their bodies need” and that “nutritional counseling would be important only to the athlete who is trying to change his or her weight” (Boumoseleh et al., 2021; Manore et al., 2017). Nutrition information is lacking as student-athletes come from high school but may plateau if there is no access to a registered dietitian or no value is seen in nutrition education at the collegiate level.

If student-athletes enroll in a college nutrition course, they may improve their nutrition knowledge (Weeden et al., 2014). High nutrition knowledge scores were associated with individuals who took a nutrition class or were in a health-related field (Kimmel et al. 2020). Enrolling in or providing a nutrition education course may be especially beneficial for athletes who do not have a registered dietitian available to them (Weeden et. al, 2014). Collegiate athletes, like middle and high school athletes, want to learn proper nutrition and tend to have more specialists to support them than younger athletes. Filling in the gaps when high school athletes graduate to collegiate programs can be lessened with proper nutrition education earlier on.
1.6.2.3 Lifestyle or behavior changes that may influence eating.

Another factor related to nutrition in adolescence is understanding how nutrition knowledge can influence lifestyle or behavior changes with food. It is not enough to just inform student-athletes about proper nutrition. Finding ways to make impactful behavior changes that are realistic against the pressures of peers, social settings, media, and trends need to be considered to translate nutrition knowledge into practice.

Just over 50% of high school student-athletes consume breakfast (Manore et al., 2017; Patton-Lopez et al., 2018; Partida et al., 2018). Middle-school students had the highest percentage of breakfast consumption at 68.8%, highlighting that a shift occurs with breakfast consumption once student-athletes hit high school (Partida et al. 2018). Breakfast can be an important way to kick-start student-athletes’ nutrition requirements because many vitamins and minerals, along with macronutrients, can be consumed to meet the nutritional demands of student-athletes. With breakfast being skipped by around half of the high school student-athletes, this impacts their window of opportunity to properly fuel themselves for activity. This information shows that breakfast intervention may be beneficial to informing student-athletes of the importance of eating breakfast and outlining meal suggestions to make eating at this mealtime attainable. More research is needed to analyze lunchtime consumption to see what student-athletes are consuming to make up for the gaps in their morning dietary intake.

Considering that student-athletes need to consume more food than the general high school student population, the literature shows conflicting information about SNK or nutrition knowledge and its predictor of dietary behavior change. Nutrition education increased the consumption of some vitamins and minerals and increased the understanding of what makes a balanced meal in high school baseball players (Ueda et al. 2021). In Singapore, collegiate netball players also
improved their dietary behaviors with increased nutrition knowledge (Teo et al., 2022). However another study showed no significant improvements in dietary intake in endurance athletes aged 16–20 years, and continued underconsumption of nutrients was seen regardless of increased nutrition knowledge (Heikkilä et al., 2019). While education is not the only factor in dietary change, motivation, attitude, and beliefs should be considered when reflecting upon this age group.

General nutrition information can be shared among these groups; however, when it comes to athletes, their nutritional needs are more specific and require more thought compared to the general high school student population (Manore et al., 2017; Patton-Lopez et al. 2018). Most adolescents know this information but need to spend more time focusing on their nutritional needs. Considering the literature, factors that can disrupt the follow-through of nutrition knowledge are convenience, peer pressure, lack of good decision-making, values, and motivation (Patton-Lopez et al. 2018). In a post-survey following a nutrition education program, 46% of students in the intervention group stated their mindset towards meals has changed and meals can be related to body composition and performance (Ueda et al., 2020). Exploring what student-athletes already know can help tailor nutrition education programming in interscholastic programs.

1.6.3 Successful interventions with student-athletes

The two previous themes highlighted the gaps in a student’s education in relation to nutrition knowledge, their lifestyle patterns in relation to nutritious eating, and how concerned parties play a role in nutrition education for performance. Considering this information, it is important to see what interventions have worked with athletes to better fill in the gaps and be successful in increasing nutrition knowledge and positively impacting nutrition behaviors. Some
of the intervention settings have been in health class, on sports teams, and within summer camps, with a few incorporating concerned parties such as parents/caregivers and coaches.

1.6.3.1 Lecture-based interventions

Lecture sessions have been shown to be an effective way of presenting nutritional information to athletes Heikkilä et al., 2019; Partida et al., 2018; Uede et al., 2020). Lecture sessions allow for face-to-face discussion, hands-on practice with an instructor and facilitate a conversation with someone who is knowledgeable on the topic. Some studies began with a nutrition knowledge or SNK baseline questionnaire, followed by multiple lecture sessions, and concluded with a post-nutrition knowledge or SNK questionnaire to measure growth in knowledge (Partida et al., 2018; Foo et al., 2021). This pre/post evaluation approach is helpful to see the growth in the participants following the intervention.

Nutrition education interventions, on average, have a minimum of three lectures and have demonstrated an increase in high school athletes’ nutrition knowledge during this short period of time (Heikkilä et al., 2019; Partida et al., 2018; Uede et al., 2020). These lecture sessions were delivered by a registered dietitian/team of dietitians or a nutritionist over three weeks to several months. This information is helpful when creating an intervention program to show that the minimum should be three lecture sessions to see a change in nutrition knowledge. Ideally, more time would be great; however, with time or budget constraints, three sessions is a strong starting point.

When looking at intervention tools to support the lecture or face-to-face meetings, social media has not been the most effective method in nutrition knowledge or nutrition changes (Partida et al., 2018; Heikkilä et al., 2019). While it can be a tool for student-athletes to reference, it was not shown to be an effective way to significantly increase nutrition knowledge or behavior change.
This may be surprising since this age group is usually absorbed in their phones; however, social media is viewed more for pleasure and fun and less for education at this age (Schaeffer, 2019). Flyers or posters in the bathroom or common areas also are not as effective in changing behavior or raising awareness (Kavouras et al., 2012; Partida et al., 2018). Hydration charts are an easy tool to show students in common places and in the bathroom, but most of the time it is not going to translate into behavior change.

1.6.3.2 Team-based interventions

Nutrition education interventions that are delivered in a group-setting or team-based have been identified as successful approaches for student-athletes (Foo et al., 2021; Patton-Lopez et al., 2018). These approaches help motivate student-athletes to improve dietary behaviors (Patton-Lopez et al., 2018) and enhance their nutrition knowledge (Foo et al., 2021). Focusing on a team-based or group setting can create a sense of accountability for athletes. Follow-through of the intervention was greater with a team that received nutrition support compared to the control group (Ueda et al., 2021). One of the benefits of focusing on a team approach is that there is typically a common thread throughout the group. General interventions that combine athletes from various sports may not be able to tailor to the unique athletes’ needs. For example, when athletes participate primarily in high cardiovascular activities, such as soccer or basketball, their general nutritional needs will include carbohydrates, whereas wrestlers may need to focus on proteins to build and repair muscles.

In a longitudinal study looked at increasing nutrition knowledge and behavior in high school soccer players over a two-year period (Patton-Lopez et al., 2018), they saw growth in the player's SNK and understanding that athletes are not currently meeting their nutrient needs and differ from the general high school student population (Patton-Lopez et al., 2018). This team-based
approach pulled in elements of Family and Consumer Science with cooking and grocery shopping tours with nutrition education sessions. While this may not be feasible for every school or sport, the foundation in nutrition education and application for setting up these athletes for success in adulthood is huge.

1.6.3.3 Interventions with concerned parties

The previously mentioned studies show that intervention sessions or education should consider coach and parent involvement to support student-athletes since they play a vital role in motivating, implementing, and supporting their student-athlete's goals. While very few studies incorporated the coaches or parents/caregivers into these interventions, almost all mentioned including coaches could be beneficial with follow-through from the interventions (Bird and Rushton, 2020; Kimmel et al., 2020; Kudret Saribay and Kirbas, 2019; Torres-McGehee et al., 2012).

When parents/caregivers were included in the intervention, student-athletes' compliance and understanding of the Mediterranean diet increased compared to a lack of parental participation (Philippou et al., 2016). Parents/caregivers can also play a vital role in supporting their student-athletes needs by taking a more deliberate approach to grocery shopping or prepping meals for their student-athletes. What is modeled at home can help establish positive attitudes and motivation in eating behaviors in athletes.

When coaches are not included in the intervention or education session, follow-through from the athletes may be negatively impacted because the goals or the objectives that the athletes are focused on may be missed. Hydration tends to be the focus for many coaches, especially in the summer months; however, there is evidence that not enough water breaks are provided for the athletes (Cleary et al., 2012; Decher et al., 2008). Many athletes arrive to practice dehydrated and
leave practice more dehydrated (Kavouras et al., 2012; Decher et al., 2008). With coaches' awareness, offering more water breaks can help student-athletes increase their hydration levels.

Including the coach in the education sessions, as well as providing coaches with a cheat sheet or follow-up, may be beneficial for the follow-through of nutrition education (Jacob et al., 2016). Giving coaches the knowledge to support their athletes and providing a summary highlight of recommendations may be helpful in helping student-athletes when they have questions; however, presenting the nutrition information alone and giving handouts related to the nutrition content is not enough to contribute to the success or follow-through of the coach and parents/caregivers (Cleary et al., 2012). If the coaches are not included in the intervention, they may lack the understanding of following through with a program and will impact the student-athlete.

Many collegiate athletes look to strength and conditioning specialists, athletic trainers, and their coaches for nutrition advice (Kimmel et al. 2020; Torres-McGehee et al., 2012; Boumoseleh et al., 2021). When these concerned parties have limited nutrition knowledge, student-athletes are hindered (Kimmel et al. 2020; Torres-McGehee et al., 2012; Boumoseleh et al., 2021). Athletic trainers and strength and conditioning coaches were seen to have higher nutrition knowledge scores compared to coaches (Torres-McGehee et al. 2012). This is important as Kimmel et al. (2020) found that student-athletes are getting SNK first from strength and conditioning specialists (48%) followed by coaches (41%) and athletic trainers (39.4%). All these stakeholders who are available to most collegiate athletes play an important role in supporting the student-athlete's nutrition knowledge and need to be trained to best support the player. If each school has a registered dietitian with a board-certified specialist in sports dietetics would be ideal, but funding may not be available for all schools.
Interventions for the high school age group are limited; however, the literature provided shows that education is needed, and lecture-based interventions help improve some of the nutritional gaps seen in adolescent athletes. Investing in nutritional services for high-school athletes will only reap positive benefits for players. Team-based and lecture styles are most beneficial and can help establish camaraderie and accountability around nutrition goals. Involving the concerned parties, such as parents/caregivers and coaches, in the intervention should be considered as well, as they can help with the maintenance, support, and follow-through of nutritional information.

1.6.4 Conclusion

There are gaps in the literature and limited research on the topic specifically in high school athletes and nutrition education to help boost nutrition knowledge and behaviors for performance. With the current literature, there are clear indicators that nutrition education is lacking in this population as well as the concerned parties in a student-athlete’s life. When heat exhaustion and deaths were occurring during the summer training months, mandates were created to ensure athletes were staying properly hydrated in the high temperatures. While the case of nutrition education is not life or death, it is still as important to help student-athletes fuel efficiently, understand what their bodies need during critical periods of development as well as performance, and be encouraged to make mindful food selections before and after activity.

The literature shows many student-athletes see the value and want to learn more; however, few schools are implementing these interventions at the high school. Student-athletes need support for their physical demands that go beyond training, practicing, and games. The value of incorporating nutrition education into athletic programs outweighs the negatives for student-
athletes. School is about investing in a child’s future. That investment should include nutrition education for all students, but also amplify nutrition education and support for student-athletes because this group is often overlooked.
2.0 Theory of Improvement and Implementation Plan

2.1 Theory of Improvement and the Change

The problem of practice I address with this current dissertation in practice is *Carlisle High School is not fostering adequate sports nutrition knowledge and nutritional habits to support the performance of their student-athletes*. The theory of improvement considers ideas from observations, interviews, drivers, and hypothesized actions that may lead to the improvement of a problem (Bryk et al., 2015). My theory of improvement focuses on ways high schools, specifically Carlisle High School, can implement programs and supports to help high school student-athletes better understand the role of nutrition in performance. Currently, there is no nutritional education or guidance for student-athletes from their athletic program or athletic director and minimal guidance from coaches. The current basketball coach shared she knows the basics when it comes to nutrition information; however, not enough to really speak impactfully to her players. The organizational system supporting these players is failing to impart adequate knowledge and skills to these student-athletes on how to best fuel for performance and recovery as well as fuel for their critical period of growth and development.

Nutrition education is currently missing from Carlisle High School’s athletic program. One of the first steps in creating change would be targeting and impacting the concerned parties that are responsible for change, including athletic director, coaches, student-athletes and parents/caregivers. Furthermore, improving the school environment, including policies, practices, curriculum, and community partnerships can foster support for the athlete's nutritional knowledge and skills on an organizational level. Through these changes, student-athletes may value nutrition
as a vital part of their athletic experience and will have access to support through their athletic program and school system. These changes will be instituted over multiple Plan, Do, Study, Act cycles (Perry et al., 2020). The Driver Diagram (Appendix A) is a visual representation that outlines my theory of improvement and includes my aim, primary and secondary drivers, and change ideas, which I discuss in more detail below.

2.1.1 Aim Statement

An aim statement helps clearly define what you are trying to accomplish and how you plan on measuring and evaluating the progress of the goal within a certain timeframe (Bryk, et al., 2015). My aim is by the end of the 2026 school year, the Carlisle High School athletic programs will incorporate a nutritional component to support the knowledge and nutritional habits of student-athletes.

2.1.2 Primary Drivers

Primary drivers are ideas or people who can make the most change or contribution to the problem (Bryk, et al., 2015). When looking at my aim, one of the most important concerned parties to drive change in the system is the athletic director. Under their directive, they decide and advocate for all student-athletes and express what their athletes need. The athletic director advocates for the best interest of athletes to the school board, other administrators, and the community. They also are responsible for supporting their coaches in providing the best athletic experience to the athletes. With the support from the athletic director, making nutrition education
a focus would be the biggest driver for change for not only their athletic program but for the athletes.

The second primary driver would be coaches. Coaches play a vital role in the day-to-day aspect of the student-athlete. Many coaches answer questions related to nutrition, diet, and exercise. In my experience as a Health and Physical Education teacher and former athlete, I believe a good coach not only improves a player's knowledge and ability in the sport but also supports the well-roundedness that makes up an athlete. Equipping coaches with some training, background, or personnel who can help answer some common nutrition concerns can strengthen their program. When athletes have issues with injuries, they are directed to the athletic trainer but what about nutritional questions? These questions can typically go unanswered.

The last primary driver would be the student-athletes themselves. This program is being created to support them and their nutritional needs. Through a preliminary survey I conducted in 2023 with n=42 student-athletes, I found that while the majority (98%) believed nutrition to be very or extremely important for performance, about 60% said they believed their high school athletic program prepares them with nutrition knowledge not well at all or slightly well (see Figures 1 and 2 below). It will be critical to get the buy-in from the student-athletes and make them aware of the nutrition education offered to them to achieve my overall aim.
Secondary drivers are ones that can support or push the primary drivers to make actionable steps towards the aim (Bryk et al., 2015). Considering secondary drivers, school approval is one of the most important factors in supporting the athletic director. For the athletic director to change his program or hire someone, the school board must approve this addition of nutritional services to the athletic programs. Since there are currently no nutrition education or a registered dietitian (RD), it will be important to establish a plan of how to best utilize an RD and cultivate a nutrition program and present this to the board. With this change, another secondary driver that can impact this primary driver is using health and wellness policy to establish new nutrition policies to
support athletes. This approval will also help the players receive the nutrition education they deserve.

Community partnerships are another secondary driver that can help support the sports nutrition environment in high-school athletic programs via the athletic director and coaches. Carlisle High School can work with local colleges and organizations to help the athletic director fill the nutritional needs of multiple sports in a season. This is a cost-effective measure that is also beneficial to dietetic students who need training as they can practice their educating skills in a community setting. These partnerships could pull in supplies, funding, or food from local organizations. Another great opportunity could be working with local colleges and universities where dietetic majors can help with community nutrition and support of fueling stations. This is beneficial for dietetic students to gain experience but also helpful to the athletic director and coaches who can rely on someone who has proper training and background knowledge in nutrition and can support the nutritional goals and questions student-athletes may have. Since many schools appreciate and rely on community help and support, community influence can help meet the goal of supporting all high-school athletes.

Two other secondary drivers that work together to support the coaches and student-athletes are supporting/improving their SNK and the sports nutrition environment. Looking at what nutrition education is provided to student-athletes from classes such as health, physical education, and Family and Consumer Science can help fill in basic nutrition knowledge gaps. Another area to consider is opportunities during mealtimes, such as school breakfast and lunch, and helping students connect what they are learning to best identify foods to support their performance and growth in the school building.
The last secondary driver would be **parent/caregiver support** of the student-athletes (primary driver). These individuals play a vital role in supporting their athletes with purchasing foods for the family, educating their players on what to eat and influencing their children to be healthy. Getting parents/caregivers involved in nutritional changes in athletic programs could be beneficial to supporting the student-athletes and nutritional goals of the athletic program. When parents/caregivers were included in the nutrition intervention, student-athletes' compliance and understanding of the Mediterranean diet increased compared to a lack of parent participation (Philippou et al., 2016).

### 2.1.4 Change Ideas

A change idea is an “alteration to a system or process that is to be tested through a Plan-Do-Study-Act (PDSA) cycle, to examine its efficacy in improving some driver in the working theory of improvement” (Bryk, et al., 2015). **Hiring a registered dietitian** would be the ultimate change idea that would impact all secondary drivers. By hiring a registered dietitian, support for all student-athletes will be available and a program can be developed to support the nutritional goals of teams and individuals. Having a registered dietitian will be so valuable to student-athletes to better understand sports nutrition principles and receive support and counseling on how to properly fuel for performance, especially during growth and development. This idea would be ideal but relies on the school board's approval and support from the athletic director. Buy-in would be needed and student-athletes, along with coaches and parent/caregiver or guardians, would have to buy in as well as see the benefit of this addition to their athletic program.

Another change idea could be offering a **sports nutrition course** for student-athletes or all students at the high school level to participate in. This idea can help deliver sports nutrition
content and provide support from an educator to help increase SNK. Some school districts have been offering a class like this as an elective but oftentimes will be delivered on an online platform. There are some pros and cons to this delivery method; however, this change idea would be a step in the right direction. This option would also need buy-in and approval from the school board and would help create a better sports nutrition environment at school. Elective courses oftentimes are taught by teachers, so having a qualified health and physical education teacher or Family and Consumer Science teacher would be ideal for this position. Most student-athletes from my survey identified they feel slightly prepared by their school with nutrition knowledge and this may be a solution to help.

A final change idea that could help build community partnerships identified in the secondary drivers could be **working with local colleges/universities and professionals for workshops** can help strengthen the sports nutrition environment, support community partnerships, and help impact nutritional services for athletes, coaches, and parent/caregiver. Workshops can be tailored for individual student-athletes or entire sports teams, as well as coaches and parent/caregiver. The benefits of community partnerships with local college students providing nutritional support, workshops or education sessions can benefit the primary drivers to help strengthen the nutritional component for student-athletes. Colleges could also offer select nutrition courses. Through my empathy interviews and the literature, parent/caregiver and coaches have been identified as the main groups of student-athletes who receive their nutrition information from. It has also been found that these groups may or may not have a good understanding of nutrition information and often are unsure how to best support their athlete. By equipping these concerned parties with workshops and resources, they can better support their student-athletes which could help improve the athlete’s SNK.
2.2 System Measures

2.2.1 Process Measures

Since there are multiple change ideas, the process measures for each will vary. One of the most important process measures would be student-athlete participation and engagement. The registered dietitian or individual leading the lectures or sports nutrition class should track participation during the lecture/course, what questions are arising, and ask probing questions to see if the follow-through is occurring outside of class. Attendance will also be important to measure to see how many student-athletes participate in either a sports nutrition class or an information session. Considering these measures will help understand buy-in from student-athletes.

Looking at concerned parties such as athletic directors, coaches, and parents/caregivers, it will be important to establish a check-in or survey to see what improvements they see in their own NK/SNK and their student-athletes. Checking in halfway through and at the end of the season may be beneficial as well as taking note of what questions, comments or concerns arise throughout the season. Noting these factors may help establish clear expectations, objectives, or re-working informational documents. Hiring a registered dietitian, working with outside agencies (i.e., local colleges and their dietetic students).

2.2.2 Outcome Measures

It will take time to meet my aim of improving the sports nutrition environment of Carlisle High School’s athletic program. Currently, there is no baseline information on student-athletes
NK/SNK. Analyzing and evaluating the data from student-athletes SNK before, during, and after the intervention or course will show how much was learned. I could also monitor the dietary behavior patterns of players; what they are consuming before/after activity and their hydration during practice. This could be an indicator of behavior change due to increased SNK. Ideal outcomes would be improving their NK/SNK and nutrition habits for their performance through these education sessions. If this is not seen, then I will know I will need to revise my Theory of Improvement or try more change ideas.

2.2.3 Driver Measures

Driver measures, like school approval and policy creation, can be obstacles in the K-12 setting, but having an athletic director who sees the value of nutrition for their program will help improve the sports nutrition environment of their program. Creating an environment to include nutrition will help with supporting SNK, parent/guardian support, and increase a positive sports nutrition environment. Important measures will include conversations with the athletic director and what improvements he is making to establish this change. Gathering the perceptions of coaches, players, and parents/caregivers may also be beneficial to better understand how the sports nutrition environment is changing in the athletic program. Outlining new objectives for the athletic program will show progress has occurred for the outcome measures. All of these will help to better understand the impact on student-athletes and create a well-rounded program to support their needs.
2.2.4 Balance Measures

When looking at the big picture of my aim, there are a lot of moving parts, and I am proposing to incorporate and test changes to create a program that is not yet established. This comes with financial costs as well as additional responsibilities for the athletic director, coaches, and parent/caregiver. While the aim is important to me, it is also important to be cognizant of others’ responsibilities as well. It would be important to establish a coalition of concerned parties (e.g., the athletic directors, trainers, registered dietitians, and some coaches) to drive change, discuss challenges and barriers to maintain balance in the system. I also hope that while my program would create additional financial constraints, the impact would be minimal and be met with long-term positive gains for the entire program, coaches, and most importantly, the student-athletes.

2.3 Methods and Measures

2.3.1 Inquiry Questions

1. How does participating in pre-season nutrition education sessions impact student-athlete’s nutrition knowledge?

2. How does participating in the pre-season nutrition education session impact student-athletes food selection for pre-activity?

3. What are the coaches’ perceptions of the impact of the nutrition education sessions on student-athletes’ knowledge and habits?
My hypothesis was that students would demonstrate growth/improvement in SNK, along with behavior changes via pre-activity snack selection, following participation in the nutrition intervention. These three brief education sessions, incorporating three broad topics in sports nutrition basics, were grounded in the literature stating as little as three education sessions can demonstrate improvement (Heikkilä et al., 2019; Partida et al., 2018; Uede et al., 2020). With coaches’ involvement, I wanted to see growth in their understanding and knowledge in the content as well be a resource for student-athletes to continue the conversation post-intervention. The implications of the findings could better support the need of nutrition education being included in high school athletic programs and how beneficial education sessions can impact SNK and/or behaviors.

2.3.2 Intervention Description

Three, thirty-minute education sessions were completed in-person before or after basketball practices. These sessions took place at Carlisle High School on October 23, 2023, November 6, 2023, and November 30, 2023. The first two sessions took place prior to tryouts and the final session was conducted during the basketball season. The education sessions were a mixture of lectures, hands-on activities, and discussions. At the end of each session, the girls and the coach were given a handout with the slides (Appendix B). These sessions were completed in the team room using a projector and athletes sat on benches or the floor during instruction.

The first session focused on the six essential nutrients, building a fueling foundation and performance plate, and pre-activity fueling. The second session emphasized hydration and electrolytes. I spent time discussing what is proper hydration, how to assess hydration through

44
urine color, what are hydrating foods, and the benefits of electrolytes and electrolyte products. The final session focused on recovery nutrition. I reviewed what nutrients they should be focusing on after the activity, the timing of their fuel, and how to plan to eat around later practice and game times (i.e. 7pm game when to eat dinner and snack). This was a common game time for basketball players, so providing strategies that would be helpful to them during the season was important. I used the preliminary data from the pre-survey to support the information taught in the last two lecture sessions. While I had the themes of the lessons outlined, the information from the survey helped me focus more on certain areas within each lesson or prompt certain discussions/questions.

2.3.3 Participants

The participants for my intervention were girls from the Carlisle girls’ basketball program and the coaches. Participation was open to anyone who wanted to join. Because the intervention began during the pre-season (before tryouts), I invited every student from 9th-12th grade to participate. Prior to the start of the education sessions, student-athletes were given an opt-out form; however, none of the students completed the form.

2.3.4 Measures

2.3.4.1 Pre/Post Sports Nutrition Knowledge Survey

For the intervention, Qualtrics was used for pre- and post-SNK survey (Appendix C). This survey gathered data on general and SNK on the players and coaches. Questions were draw and adapted from previous surveys (Vázquez-Espino et al., 2020; Calella et al., 2017) and selected based on core content, such as the six essential nutrients and other content emphasized in the three
lessons. A total of twenty-two questions were asked. Table 2 highlights the subcategory breakdown of the survey questions asked. Another piece of the survey, asked in both the pre- and post-survey, included rating their current SNK level. The scale ranged from not knowledgeable at all, slightly knowledgeable, moderately knowledgeable, very knowledgeable, and extremely knowledgeable. The post-survey included additional open-ended questions to solicit student and coach feedback on the nutrition education sessions.

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition Basics</td>
<td>7</td>
</tr>
<tr>
<td>Pre-activity Fueling</td>
<td>4</td>
</tr>
<tr>
<td>Hydration</td>
<td>7</td>
</tr>
<tr>
<td>Post-activity Fueling</td>
<td>4</td>
</tr>
<tr>
<td>Total number of questions</td>
<td>22</td>
</tr>
</tbody>
</table>

**Table 2 Survey question numbers by category**

2.3.4.2 Pre-activity fueling behavior

I collected four separate pre-activity fueling forms, through Google Forms, tracking what athletes consumed (food and beverage) throughout the intervention (*Appendix D*). This measure looked at what and how much student-athletes were consuming 30-60 minutes before activity. In the form, there was a section for students to explain why they chose the food/beverage they consumed and any additional comments they would like to share. If they did not consume anything, they were able to report that as well. Students had the option to upload a picture of what they
consumed or write a description if they were not able to upload a picture. This data was collected to understand how much they consumed (i.e., the whole item/half/a little/none), why they selected what they did before the activity, and if improvements or changes were made from pre- to post-intervention. Figure 3 shows the criteria for the pre-activity fueling form.

<table>
<thead>
<tr>
<th>Yes</th>
<th>• Met the criteria of pre-activity fueling snack (30-60 grams of carbs, 30-60 minutes before activity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>• Did not meet the criteria of pre-activity fueling snack</td>
</tr>
<tr>
<td></td>
<td>• Did not complete or did not eat anything</td>
</tr>
</tbody>
</table>

Figure 3. Criteria Measure for the Pre-Activity Fueling Form

2.3.4.3 Semi-structured Interview with the coach

The semi-structured interview guide was broken down into four categories: a) observation and conversations with players post-intervention, b) comparing pre-/post-intervention SNK and habits of her athletes, c) changes you’ve experienced as a coach from intervention, and d) recommendations for the future or what next steps you have for supporting your athlete’s nutritional goals (Appendix E). This was beneficial in understanding her perceptions of the impact of the intervention and the benefits and drawbacks of the change idea.

2.3.4.4 Field Notes

At the conclusion of each session, handwritten field notes were taken to highlight and retain information, impressions, and takeaways from the intervention. After each education session, I wrote down field notes from the session highlighting what questions were asked or topics we spent a lot of time discussing, how the activities went, student engagement level, and overall takeaways from the session. Student-athlete names remained anonymous on these notes. These notes were
used as secondary analysis to provide a better picture of the setting, participants, and reflection as supported by Phillippi and Lauderdale (2017).

2.3.5 Data Collection Plan

A link to the pre-survey to the coach who shared it via text with her athletes one week before the intervention. The survey link was also posted on the screen in the beginning of the first lecture session to allow student-athletes to complete it if they had not previously. The first pre-activity fueling form was sent to athletes, via a group text from the coach, two days before the first intervention session. Two days after each education session, the coach sent another form for students to share what they consumed prior to their activity that day. The post-survey was shared with the coach who text it to her athletes one week after the intervention was completed. The survey link was left open for one month to increase participation. Students and coaches used their first and last name initial (i.e. KH for Katie Hanford) as identification on all surveys and fueling forms to match their responses. Two ten-dollar gift cards were raffled off as incentives for completing both the pre- and post-intervention survey.

Just under two months following the intervention, I had a phone interview with the head basketball coach to discuss the ongoing effects of the intervention. The interview was completed over the phone and lasted just under ten minutes due to the coach being on the bus for an away basketball game.
2.3.6 Analysis Plan

Descriptive statistics were calculated for the survey data. The average number and percent correct on the pre/post survey were calculated by for the total score and four subcategories: nutrition basics, pre-activity fueling, hydration, and post-activity fueling. Total scores from the pretest were compared with those from the posttest to determine growth in nutrition knowledge after participating in the education sessions. Growth of at least 20% was the cutoff I used to determine whether the intervention was successful. Figure 4. Highlights the calculation used to measure percent growth for the survey (Oklahoma Christian University, n.d.), Two student-athletes answered the posttest twice, so I used data from their first submission.

![Figure 4. Learning Gain Scores](image)

For the pre-activity fueling food/beverage description responses were categorized into yes/no categories of meeting 30-60 grams of carbohydrates before activity. Since only one individual included a photo, I primarily focused on the text narratives from student-athletes. For
something to be categorized as a yes, it had to be low in fiber and protein and focused on simple carbohydrates. Water or electrolyte beverages, such as Gatorade, were also valued in the categorization. There is no one correct response when looking at the data, as simple carbohydrates can vary depending on the individual's taste preferences and dietary limitations or restrictions. However, consuming nothing pre-activity was flagged as a negative response since it does not support their nutrition needs or overall performance. Responses were charted using the yes/no criteria. A qualitative narrative was gathered summarizing what the student-athletes ate, how much they ate, and why they ate what they did. Student-athletes also were given the option to share any additional information and these responses were summarized as well.

Lastly, to complete the qualitative analysis I applied content analysis methods (Erlingsson & Brysiewicz, 2017). Specifically, the semi-structured interview transcript and field notes were coded for themes or patterns in the data. First, I read and re-read the transcript and field notes to get a better understanding of the conversation. Then, I organized the text into meaning units and shorter condensations. I applied codes to capture the main idea of the meaning unit condensations. From there, codes were organized into categories and themes.
3.0 PDSA Cycle Results

3.1 Education Session Reflection

Session 1 focused on nutrition basics and pre-activity fueling. Ten student-athletes and one coach participated in the session. This session took place on October 23, 2023, prior to tryouts and the season starting and occurred before that day’s practice. The session was a combination of lectures and activities. The session was well received due to the conversations we had, the questions there were asked, and the level of engagement. There was a nice flow of teaching, activities, and questions/conversations. In the nutrient definition matching activity, students were divided into partners; pairs got one to three correct answers out of six, which was somewhat of a surprise to me because I assumed their knowledge would have been higher for this activity.

A big portion of our conversation focused on breakfast and their consumption patterns and barriers. Less than half of the students attending this session agreed that they eat breakfast regularly. Student-athletes shared barriers to consuming breakfast regularly included being “not hungry”, “no time in the morning” and “nothing sounds appealing.” We also covered pre-activity fueling and many student-athletes asked what foods were okay to eat before activity. The student-athletes asked the coach if they could have a snack basket in the locker room to help promote pre-activity fueling. She thought it was a great idea but told the girls they would have to provide their own snacks to share. We also had a conversation about keeping accountability with one another since they are a team. The session ended by talking about the pre-activity fueling form, which some of them had completed before the first session.
As the session went on, I could tell the student-athletes were getting more comfortable with me and the conversations by their engagement and participation. Two girls were knowledgeable and answered most of the questions; however, the rest of the student-athletes participated and were also engaged during the entire session.

**Session 2** occurred two weeks later on November 6, 2023, with fourteen student-athletes participating and one coach. This session started with lots of energy and engagement. The girls and coach also shared right away with me that they started a breakfast club group chat via text. This was something they spearheaded on their own and was not something we had previously discussed during session 1. This had the coach and I excited and happy to see the follow-through of the information we had discussed during the last session. Someone was also eating their pre-activity fuel while walking in and asked me if it was a good food choice before practice or not.

This second session focused on hydration and again occurred before that day’s practice. For my opening activity, I had a picture of raw meat and jerky and asked how this related to hydration. Only one person knew and understood the picture and how it related to hydration; stating the beef jerky were dehydrated muscles while the piece of meat was hydrated muscles. We then got into a discussion of the barriers to proper hydration. Student-athletes’ responses included, “I don’t want to pee so much”, “I’m not thirsty”, “I don’t have access to ‘good’ water” (not liking the school’s water), and “forgetting my water bottle”.

The activities helped capture more attention, but it also had some student-athletes be a little goofier or get off task. The activities helped break up the conversation because some of the girls were on their phones, distracted by others, or having side conversations compared to the first session. It was a whirlwind session, and we ran a few minutes longer; however, based on the wrap-up conversation and the questions asked throughout the session, I felt like the student-athletes were
considering this information and thinking about applying it or that they were thinking about it more than before.

**Session 3** took place a little over three weeks from the second session due to the timing of basketball team tryouts and Thanksgiving break. For this session, only six girls participated and none of the coaches. This was the first session during the season and occurred right after practice. The girls who attended were tired and lacked focus. This made me feel like I needed to rush through the material because they were not as engaged, demonstrated by being on their phones during the session or not asking questions.

This session focused on post-activity fueling, and we had some good conversations. Some of the athletes genuinely wanted to know more about this topic. No barriers to post-activity fueling were shared by the athletes since most of them typically eat something after practice or a game. We had a conversation about pre-activity fueling barriers again, prompted by the girls, now that they are in season. The two common responses were, “*not enough time*” and “*not allowed to eat in my last period class.*” We discussed packing pre- and post-activity fuel in their bags to help stay prepared and to help address the barriers they shared. I also encouraged them to have a conversation with their teachers; however, they shared they did not think that would work.

The activity of building a meal was engaging to the girls and prompted a lot of questions and conversation. Since it was a smaller group, I was able to check-in with each of them and provide feedback or brainstorm different food options for their meal building. I concluded the lesson by asking them for some feedback about the sessions. and they stated knowing more examples of what food to eat would have been helpful. I encouraged them to reference the slides I shared with them from each session since all the information was included there.
3.2 Nutrition Knowledge Pre- and Post- Survey

3.2.1 Pre-survey Data

Twelve student-athletes and two coaches (n=14) completed the pre-survey. When asked about their current SNK, 75% (n=9) student-athletes stated they were ‘slightly knowledgeable’ and 25% (n=3) stated they were ‘moderately knowledgeable.’ Similarly, one coach stated they were ‘slightly knowledgeable’ and the other ‘moderately knowledgeable.’ No student or coach rated their current nutrition knowledge as ‘extremely knowledgeable’ or ‘very knowledgeable’ on the pre-survey.

Of the n=12 student-athletes, the average number correct for the pre-survey score was 10.67 out of 22 questions (48.5% correct), with nutrition basics (3.83/7) and hydration (3.67/7) being their strongest areas of knowledge. Two coaches also participated in the pre-survey with an average of 13 out of 22 questions (59% correct), with nutrition basics (5/7) and hydration (5.5/7) being their strongest areas of knowledge.

3.2.2 Post-survey Data

Four student-athletes and two coaches (n=6) completed the post-survey after the education sessions. Of the n=4 student-athletes that participated in the post-survey, each of them identified they were ‘moderately knowledgeable’ an improvement from their responses of ‘slightly knowledgeable’ on the pre-survey. The responses from the n=2 coaches stayed the same; one stated they were ‘slightly knowledgeable’ and the other ‘moderately knowledgeable.’
Tables 3 and 4 highlight the percent growth from the pre-survey results to the post-survey results and by each survey subsection. Of the n=4 student-athletes, the average number correct on the post-survey was 15 out of 22 questions (68% correct) (Table 3). This is an average of 38.1% percent growth from the pre-survey. Students also demonstrated growth in each subsection of the survey (Table 4). The average for the nutrition basics section was 3.83/7 for the pre-survey and increased to an average of 5/7 post-survey, resulting in 36.9% growth. For the pre-activity fueling section, the pre-survey average was 1.6/4 and increased to 3/4, resulting in 57.1% growth. The hydration average pre-survey was 3.67/7 and increased to 4.25/7 post-survey, resulting in 17.4% growth. The final section was post-activity fueling with an average response of 1.5/4 on the pre-survey to 2.5/4 on the post-survey, resulting in 40% growth.

Both coaches completed the post-survey. The average score remained the same from their pre-survey results of 13 out of 22 questions (Table 3). One of the coaches participated in two of the three education sessions and her individual growth was 24.8% from pre-survey to post-survey. She had marked improvements in two categories (nutrition basics and pre-activity fueling), while two slightly dropped (hydration and post-activity fueling) compared to her pre-survey results (Table 4). The second coach did not attend any sessions and just completed the pre- and post-survey form, so we would not expect any changes in the scores. However, one area she improved from was nutrition basics with a score of 4/7 on the pre-test to a 5/7 on the post-test. Pre-activity fuel also stayed the same with 1/4 for both pre- and post-test. Hydration and post-activity fuel saw a decline by one or two questions.
Table 3. Pre- vs. post-survey total nutrition knowledge (# and % correct) and % growth for student-athletes and coaches

<table>
<thead>
<tr>
<th></th>
<th>Pre-Survey</th>
<th>Post-Survey</th>
<th>% Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#Correct</td>
<td># Correct</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(% correct)</td>
<td>(% correct)</td>
<td></td>
</tr>
<tr>
<td>Athlete 1</td>
<td>12 (54.5%)</td>
<td>17 (77.2%)</td>
<td>49.9%</td>
</tr>
<tr>
<td>Athlete 2</td>
<td>11 (50%)</td>
<td>15 (68.1%)</td>
<td>36.2%</td>
</tr>
<tr>
<td>Athlete 3</td>
<td>14 (63.6%)</td>
<td>12 (54.5)</td>
<td>-25.3%</td>
</tr>
<tr>
<td>Athlete 4</td>
<td>8 (36.3%)</td>
<td>16 (72.7%)</td>
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<tr>
<td>Coach 1</td>
<td>12 (54.5)</td>
<td>10 (45.4%)</td>
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<tr>
<td>Coach 2</td>
<td>14 (63.6%)</td>
<td>16 (72.7%)</td>
<td>25.0%</td>
</tr>
<tr>
<td>All Athletes</td>
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<td>15 (68.1%)</td>
<td>38.1%</td>
</tr>
<tr>
<td>Athletes + Coaches</td>
<td>11 (50%)</td>
<td>15 (68.1%)</td>
<td>36.2%</td>
</tr>
</tbody>
</table>

NOTE: Max number of correct is 22 on both the pre- and post-survey; percent growth was calculated based on the pre- and post-survey percent correct.
Table 4. Pre- vs. post-survey subsection nutrition knowledge (# [%] correct) and % growth for student-athletes and coaches

<table>
<thead>
<tr>
<th></th>
<th>NB Pre</th>
<th>NB Post</th>
<th>% Growth</th>
<th>PRAF Pre</th>
<th>PRAF Post</th>
<th>% Growth</th>
<th>HYD Pre</th>
<th>HYD Post</th>
<th>% Growth</th>
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<th>POAF Post</th>
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<td>(71.4%)</td>
<td>(85.7%)</td>
<td>(25%)</td>
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<td>(71.4%)</td>
<td>(71.4%)</td>
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<td>(25%)</td>
<td>(50%)</td>
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<td>(25%)</td>
<td>(50%)</td>
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<td>(57.1%)</td>
<td>(42.9%)</td>
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<td>(25%)</td>
<td>(100%)</td>
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<td>(85.7%)</td>
<td>(71.4%)</td>
<td>(75%)</td>
<td>(50%)</td>
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<td>(57.1%)</td>
<td>(57.1%)</td>
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<td>(25%)</td>
<td>(25%)</td>
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</tr>
<tr>
<td>Athlete 4</td>
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<td>(57.1%)</td>
<td>(25%)</td>
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<td>(28.6%)</td>
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<td>(75%)</td>
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<tr>
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<td>(71.4%)</td>
<td>(25%)</td>
<td>(25%)</td>
<td></td>
<td>(71.4%)</td>
<td>(57.1%)</td>
<td></td>
<td>(50%)</td>
<td>(0%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coach 2</td>
<td>6</td>
<td>6</td>
<td>0%</td>
<td>1</td>
<td>2</td>
<td>33.3%</td>
<td>6</td>
<td>6</td>
<td>0%</td>
<td>1</td>
<td>2</td>
<td>33.3%</td>
</tr>
<tr>
<td></td>
<td>(85.7%)</td>
<td>(85.7%)</td>
<td>(25%)</td>
<td>(50%)</td>
<td></td>
<td>(85.7%)</td>
<td>(85.7%)</td>
<td></td>
<td>(25%)</td>
<td>(50%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Athletes</td>
<td>3.83</td>
<td>5</td>
<td>36.9%</td>
<td>1.67</td>
<td>3</td>
<td>46.2%</td>
<td>3.67</td>
<td>4.25</td>
<td>17.4%</td>
<td>1.5</td>
<td>2.5</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>(54.7%)</td>
<td>(71.4%)</td>
<td>(41.8%)</td>
<td>(75%)</td>
<td></td>
<td>(52.4%)</td>
<td>(60.7%)</td>
<td></td>
<td>(37.5%)</td>
<td>(62.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Athletes + Coaches</td>
<td>4</td>
<td>5.17</td>
<td>39.2%</td>
<td>1.57</td>
<td>2.5</td>
<td>38.2%</td>
<td>3.93</td>
<td>4.5</td>
<td>18.7%</td>
<td>1.5</td>
<td>2</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>(57.1%)</td>
<td>(73.9%)</td>
<td>(39.3%)</td>
<td>(62.5%)</td>
<td></td>
<td>(56.1%)</td>
<td>(64.3%)</td>
<td></td>
<td>(37.5%)</td>
<td>(50%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: NB= Nutrition Basics (7 questions), PRAF= Pre-activity fueling (4 questions), HYD= Hydration (7 questions), POAF= Post-activity fueling (4 questions)
3.2.3 Feedback on the Intervention Sessions

The participants were asked to respond to four open-ended questions in the post-survey to provide feedback on the intervention sessions. Seven participants responded to the question, “What did you enjoy the most about the sessions?”. Five of the responses highlighted enjoying the interactive activities, while others stated, “the small cool little facts I learned. Stuff I didn’t know before.” and “How you got to write stuff done [down] during it.”. Two participants responded to the second question, “What did you least enjoy about the sessions?”, including “Timing-wish we had longer than 30min!” and “I think everything was good.”. When asked, “What could be improved for next time?”, 5 participants responded. Three of the responses stated they thought everything was good or great, with one responding “get more girls to participate” and the other asking for “more examples of food you can eat after workouts”. Finally, one participant replied when asked “What questions do you still have or what other topics would you like to see incorporated in the future?”, saying “I don’t have any questions, but I’m glad you did these sessions for the girls. Thank you!”. 

3.3 Pre-Activity Fueling Form

Criteria for the pre-activity fueling form was looking for 30-60 grams of carbohydrates 30-60 minutes prior to activity. The first form had nine responses, with six (66.67%) meeting the criteria of a pre-activity fueling snack. The second form, which was sent after the first education session, had eleven responses with three (27.3%) meeting the criteria of a pre-activity fueling
snack. Two athletes stated they did not eat or drink anything prior to the activity. The third form, which was sent after the second education session, had seven responses with four (57%) meeting the criteria of a pre-activity fueling snack. The last form, which was sent after the last education session, had six responses with three (50%) meeting the criteria of a pre-activity fueling snack.

When asked to share how much they ate or what they ate by uploading a picture and/or typing a response, only one student uploaded a picture. Instead, most students preferred to submit text responses. A lot of common answers that would meet the criteria were granola bars, applesauce pouches, water, Gatorade, fruit, and fruit snacks. Answers that were not appropriate for the criteria include full meals, smoothie bowls, yogurt parfaits, and protein shakes. Table 5 includes the responses to the pre-activity fueling form, detailing their responses for what each student-athlete ate and how much.

<table>
<thead>
<tr>
<th>Table 5. Responses to the Pre-Activity Fueling Form</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What they ate (How much was consumed?)</strong></td>
</tr>
<tr>
<td><strong>Form 1</strong></td>
</tr>
<tr>
<td>Water, Granola bar and apple slices <em>(Ate it all)</em></td>
</tr>
<tr>
<td>Chicken, potatoes, green beans and water <em>(1 drumstick, scoop of green beans and 5 cut up potatoes)</em></td>
</tr>
<tr>
<td>Gogo squeeze and granola <em>(Whole thing)</em></td>
</tr>
<tr>
<td>Fig bar, applesauce pouch and blue Gatorade <em>(All the food and 3/4 of the Gatorade)</em></td>
</tr>
<tr>
<td>English muffin with peanut butter and Nutella. Blueberries and strawberries on the side. 20fl Glacier Freeze Gatorade <em>(Whole thing)</em></td>
</tr>
<tr>
<td>1 medium banana and half a glass of water <em>(Whole thing)</em></td>
</tr>
<tr>
<td>One peanut butter granola bar and few sips of water <em>(Whole thing)</em></td>
</tr>
<tr>
<td>Granola bar, Gatorade and Strawberry parfit <em>(Whole thing)</em></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Strawberry banana Smoothie and cashews (picture of a Tumbler but cannot see the smoothie) (<em>Whole thing</em>)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Fruit Bowl (picture of a smoothie bowl from a local restaurant) (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>Apples, carrots, and banana parfit (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>Few sips of water and a granola bar (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>Smoothie bowl with fruit and Nutella (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>Bowl of cherries and a banana (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>Cliff bar and Core Power Vanilla Shake (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>One small mac and cheese and juice box (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>Granola bar (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>12 Totinos pizza rolls (<em>All of them</em>)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Picture uploaded of Welches fruit snack pack (<em>Two Packs</em>)</td>
</tr>
<tr>
<td>Apple (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>Banana, pretzels, apples, fruit snacks, and chocolate chip cliff bar (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>Gatorade and 2 orange cups (<em>Whole thing</em>)</td>
</tr>
<tr>
<td>Pizza, apple slices and Gatorade (<em>1 slide of pizza and 5 apple slices</em>)</td>
</tr>
<tr>
<td>Banana and PB&amp;J (<em>Half the PB&amp;J and entire banana</em>)</td>
</tr>
<tr>
<td>1 banana, handful of granola and half a glass of water (<em>Whole thing</em>)</td>
</tr>
</tbody>
</table>
Table 5 Responses to the Pre-Activity Fueling Form (continued)

<table>
<thead>
<tr>
<th>Form 4</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Few sips of water and a Rice Krispie Treat <em>(Whole thing)</em></td>
<td>Yes</td>
</tr>
<tr>
<td>Gatorade, peanut butter crackers and fruit snacks <em>(Whole thing)</em></td>
<td>Yes</td>
</tr>
<tr>
<td>2 scrambled eggs, some fruit and water <em>(Whole thing)</em></td>
<td>No</td>
</tr>
<tr>
<td>Chicken, rice, and corn (N/A)</td>
<td>No</td>
</tr>
<tr>
<td>5 pepperoni bagel bites and some water <em>(Whole thing)</em></td>
<td>No</td>
</tr>
<tr>
<td>1 banana, handful of granola and cup of water <em>(Whole thing)</em></td>
<td>Yes</td>
</tr>
</tbody>
</table>

NOTE: Yes= met the criteria of pre-activity fueling snack (30-60 grams of carbohydrates), No= did not meet the criteria of pre-activity fueling snack (more than 30-60 grams of carbohydrates).

Along with sharing what they ate, they were asked “Why did you pick this food and/or beverage?” and “Anything else you would like me to know?”. These were optional questions asked; however, almost every participant responded to the first question and a few to the last. Table 6 presents the common responses and direct quotes. Many of the responses to “Why did you pick this food and/or beverage?” included taste preference, convenience, and that the student-athletes thought was healthy/nutritious. A few student-athletes responded to the question “Anything else you would like me to know?” and included more context to their selection as well as changes they have made in their fueling. On the final form, two athletes shared positive feedback on the intervention.
<table>
<thead>
<tr>
<th>Why did you pick this food and/or beverage?</th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“Gives me energy”</td>
<td>Gives good protein/nutrition/energy (n=2).</td>
<td>“Convenient”</td>
<td>Quick, accessible, easy, quick energy (n=3)</td>
</tr>
<tr>
<td></td>
<td>“Made for dinner”</td>
<td>Quick, easy to eat/write (n=2).</td>
<td>“Energy be good for practice “</td>
<td>Made for dinner.</td>
</tr>
<tr>
<td></td>
<td>“What we had at home”</td>
<td>“To go with a friend”</td>
<td>“What I got for lunch”</td>
<td>“Potassium and hydration”</td>
</tr>
<tr>
<td></td>
<td>“Taste good” (n=2)</td>
<td>“It’s good” (n=2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“I think it is healthy?”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Easy to grab</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“I love the food and it gives me great protein”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“I like it”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anything else you would like me to know?</td>
<td>“Sometimes I eat more like a granola bar but I small snack these</td>
<td>“I started to eat breakfast everyday”</td>
<td>“That I’m still eating breakfast”</td>
<td>“These sessions helped me a lot! I definitely think about what I eat</td>
</tr>
<tr>
<td></td>
<td>throughout the day so it’s not necessarily right before my activity.</td>
<td></td>
<td></td>
<td>before and after exercise now.”</td>
</tr>
<tr>
<td></td>
<td>I try to eat at least 45 minutes before I work out to give time for</td>
<td></td>
<td></td>
<td>“I loved the nutrition sessions !!!”</td>
</tr>
<tr>
<td></td>
<td>my stomach to not hurt while I’m playing”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“Only thing to know is that I really love basketball and I want to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>get my diet right “</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: A mixture of direct quotes and codes are included in the table.
3.4 Coach Interview

3.4.1 Observation and conversations with players post-intervention

Surrounding this question, the coach really reflected on the fact that she was not sure what conversations were happening beyond practice and if their breakfast club chat was still occurring. She did say the snacks in the team room were still available all season to help with grabbing something before or after practice. She would hear them talk about it getting low or empty but beyond that, not too much.

The coach shared there were a few questions from athletes about what to eat when the athletes were not feeling well. She prompted them by asking what they ate or drank for the day. She felt that the girls were more aware of the foods they were eating but conversations about nutrition did not increase following the intervention.

The coach did not find herself reinforcing any of the topics or conversations from the sessions after the intervention. She felt like she did not always know what to say. She stated it would have been helpful to have conversation starters, resource documents, or check-in prompts to use with the girls concluding the intervention. She felt this could have helped her text out messages or have the support to ask the right types of questions.

3.4.2 Comparing pre/post-intervention sports nutrition knowledge and habits of your athletes

Again, the coach mentioned she was unsure if the breakfast club chat was occurring because they did not talk about it or bring it up to her anymore. This was consistent in the beginning
of the season, but now being over halfway through, it is not so much a conversation or accountability piece she is hearing about. There are not as many questions, but she did have someone ask if eating pasta on the bus before a game was a good choice.

The biggest change she has observed with nutrition behaviors was the addition of snacks in the team room. This was beneficial to players and helped when someone was hungry. She also mentioned she felt like hydration was something they focused more on but could not provide me with concrete examples.

3.4.3 Changes you experienced as a coach from the intervention.

The coach shared she feels confident in her program and what she has created thus far with focusing on leadership development. Nutrition is still something the coach shared she is not confident enough to speak on. She felt like this intervention was a great addition to the program and was well received from the girls, but it has not changed much of her area of coaching. She shared that she is more comfortable outsourcing this type of education and intervention to someone rather than being the person speaking to it. The coach again highlighted how beneficial a document, or prompts would be to her as a coach to help support the themes from the intervention.

3.4.4 Recommendations for the future or what next steps you have for supporting your athlete’s nutrition goals.

The coach expressed how this topic is important for her athletes to know and would love to continue moving forward with it in future years. She shared she has ideas on how she wants to change the program timing, accountability of players attendance for the future, and collaborating
on ideas or topics for the girls; however, she was not able to elaborate during this interview given the time constraints. She also mentioned how the team room was not the ideal environment for holding the sessions. She suggested a classroom setting may have helped with the girls’ focus and could have provided a space for the girls to complete the activities and have better conversations.
4.0 Learning and Actions

The following section details the main findings from the current inquiry project, organized by the inquiry questions that guided my dissertation in practice.

4.1 Findings from inquiry questions

4.1.1 Findings from inquiry question 1

*How does participating in pre-season nutrition education sessions impact student-athlete nutrition knowledge?*

Eleven girls completed the pre-intervention survey while four girls completed the post-intervention survey. While there was a small sample of participants who completed both assessments, the overall average SNK score increased from the pre-survey. This provides preliminary evidence that participating in these education sessions positively impacted overall SNK in this sample of high school student-athletes. The design of this intervention aligned with Partida et al. (2018) and Foo et al. (2021) studies by measuring NK growth via survey pre/post-intervention and completing multiple education sessions to support this growth. It is unclear whether this finding would hold true for all participants or other groups of high school student-athletes. In the current study, a larger post-intervention sample would have been better to get a more rounded result. There was also an increase in student-athlete attendance in the second education session, with the lowest attendance in the third session. Perhaps more consistent
attendance, or word of mouth from player to player, could have improved attendance in the education sessions which could have improved SNK in athletes.

These findings support the need for nutrition education in high school athletics and the fact that many high school athletes want to learn more about nutrition (Partida et al., 2018). The lack of knowledge in various nutrition topics in the current sample was consistent with findings in the published literature. When looking at nutrition knowledge or SNK scores, student-athletes specifically lacked an understanding of protein and carbohydrates as they relate to exercise (Partida et al., 2018), macronutrient recommendations (Bird & Rushton 2020), and underconsumption of carbohydrates (Steffl et al., 2019; Heikkilä et al., 2019). The athletes who want to have a competitive edge or increase their SNK are not being properly supported (Bird & Rushton, 2020) and a few students throughout the intervention shared they wanted to eat better to be a better athlete.

Another area of growth seen in the pre- and post-intervention data was that perceived knowledge grew from ‘slightly knowledgeable’ in some athletes to ‘moderately knowledgeable’ in all participating athletes. While it is hard to interpret what this improvement means practically for their actual nutrition knowledge, and whether any threshold was met for basic nutrition knowledge encouraged in this age group through state standards, this finding aligns with the previous finding the benefits of three lecture sessions over time to increase nutrition knowledge in high school athletes (Heikkilä et al., 2019; Partida et al., 2018; Uede et al., 2020). This also corroborates the finding that most of the student-athletes who completed the post-intervention survey increased and demonstrated >20% growth in their SNK. Taken in tandem, these findings highlight how improved SNK can impact self-perceived knowledge. This study also contributes to the literature, since there is limited research on this age group. Having student-athletes feel more
confident or stay consistent in their initial rating of their nutrition understanding is a positive of this intervention.

The literature supports the inclusion of coaches in interventions because they could be beneficial in the follow-through of nutrition information for athletes (Bird and Rushton, 2020; Kimmel et al., 2020; Kudret Saribay and Kirbas, 2019; Torres-McGehee et al., 2012). Considering the influential people in these athletes’ lives, the coaches were also invited to the education sessions and encouraged to complete the pre- and post-survey. The varsity coach attended two out of the three education sessions while the junior varsity coach did not attend any sessions. Both coaches completed the pre-and post-intervention surveys. While the overall average number of correct answers increased from the pre-survey, the coach who attended the education sessions was the only one who increased her overall SNK. Again, this provides additional preliminary evidence that participating in the education sessions not only improved student-athlete SNK but could increase SNK in coaches as well. Two studies from Belski et al. (2018) and Jacob et al. (2016) showed that nutrition knowledge scores did improve in coaches after interventions. Both interventions were over a short period of time and growth was still observed, supporting that coaches should be included in trainings or education sessions to improve their overall nutrition knowledge.

4.1.2 Findings from inquiry question 2

*How does participating in the pre-season nutrition education session impact student-athletes food selection for pre-activity?*

When looking at the pre-activity fueling forms, there were no noticeable improvements in consumption of 30-60 grams of carbohydrates pre-activity across the four submissions. Student-
athletes seemed to understand they needed quick carbohydrates for their pre-activity fueling in our education session through our conversations or questions asked, even in the first intervention session. A systematic review by Sanchez-Diaz et al. (2020) noted that there was evidence to support nutrition education in improving eating habits in athletes who participate in team sports. While we didn’t see this in the fueling forms, some student-athletes were making the connection based on our conversations during the sessions. Limited participation in the pre-activity fueling forms and inconsistencies of eating patterns could have played a role in the inconsistencies observed.

Lacking details in the form could have been the downfall of a better understanding of the food sections from the student-athletes. One of the most influential parts of this data point was hoping student-athletes would include a picture of their food and drinks consumed. In a study by Ueda et al. (2021), pictures of meals helped researchers better understand what nutrients were being consumed. In the current study, focusing on simple carbohydrates before activity, around 30-60 grams of carbohydrates about 30-60 minutes before activity, was discussed during the education sessions. Only one player was consistent in sharing their items consumed with a picture, while everyone else relied on the text feature to type out what they consumed. Another limitation was what time they were consuming their food and beverage. Some athletes stated that they consumed a full meal while others had snack foods. With focusing on 30-60 grams of carbohydrates before activity, this amount is focusing on topping off glycogen stores in the muscles. In a study by Kerkcick et al. (2017), eating carbohydrates 30 minutes before activity “led to greater increases in exercise capacity.” Knowing what time students ate their meal or snack in relation to what time practice was, could have given a better picture of what is most appropriate with the time constraints they had. If student-athletes were not able to eat in their last period or
had to rush to practice, barriers that the student-athletes verbally shared during the intervention, this could have limited them from consuming anything or relying on their lunch as their last fueling source.

After our first education session, students reported that their breakfast habits changed, and this was a big topic of discussion during all three sessions. Without prompting from myself or the coaches, the student-athletes created an accountability group chat to increase breakfast-eating behavior. Some student-athletes stated in the pre-activity fueling form they were still eating breakfast or noticing a change in their energy when they ate breakfast. This is impactful since data from the Youth Risk Behavior Survey highlight in 2021, 75% of teens were not eating breakfast (Michael et al., 2023). The lack of breakfast consumption was consistent with the literature and how it can be difficult to meet their nutritional needs in a day (Patton-Lopez et al., 2018; Partida et al., 2018). When teens are not consuming breakfast, they struggle to consume enough calories throughout the rest of the day to meet their nutritional needs and this can impact student-athletes since they need to consume more than the general high school student population (Manore et al., 2017; Patton-Lopez et al. 2018).

4.1.3 Findings from inquiry question 3

What is the coaches’ perception of the impact of the nutrition education sessions on student-athletes’ knowledge and habits?

In reflecting with the head coach post-intervention, she stated that she saw some benefit in her players from the intervention. One of the biggest notes she made was the breakfast club chat as well as snacks made available in the team room. Both were student-led initiatives, and she was happy to see the impact on the girls after just one session. Snacks in the team room were a new
concept and the coach did not provide these snacks but encouraged the girls to bring them in and share. A locker in their locker room was dedicated to supporting their pre-fueling.

The head coach shared she did not see an increase in conversation or questions in the following weeks after the intervention. She knows some of the athletes were doing the breakfast club chat; however, she did not know if that was ongoing at the time of our conversation. A few nutrition-related questions were asked over the season, but the coach stated that this is typical in past years. Torres et al. (2012) found that athletes need to feel comfortable to ask questions to their coaches; however, not all coaches are confident or knowledgeable in nutrition so this could limit the amount of information shared. Kimmel et al. (2020) also discussed how coaches can debunk false information online, but they too need nutrition education to understand the information. The head coach attended two out of the three sessions and enjoyed hearing the session’s topics. It would have been nice to have the Junior Varsity (JV) coach in attendance, since some of the JV players participated in the education sessions. If all coaches attended, I may have received a more complete picture of the impact on all the players and the coaches themselves.

4.2 Impact of the change idea on the system

While this intervention only focused on one team during one season, it was one step closer to influencing the overall aim of the Carlisle High School athletic program incorporating a nutritional component to support the knowledge and nutritional habits of student-athletes by 2026. My change idea of implementing three nutrition education sessions to athletes and coaches focused on changing the secondary drivers of improving the sports nutrition environment in the program and supporting the nutrition knowledge (or lack thereof) of student-athletes. Something as simple
as a few education sessions can help improve the nutrition knowledge of athletes (Heikkilä et al., 2019; Partida et al., 2018; Uede et al., 2020) and help them to have meaningful conversations and discussions about nutrition, fueling, and voice barriers to hopefully strategize ways to overcome these obstacles.

This initial PDSA cycle provides preliminary evidence that three brief nutrition education sessions were beneficial and improved overall SNK in students and coaches. The intervention sparked conversations and was well-received by students and the head coach. Having these education sessions could be a starting point for Carlisle before integrating and testing bigger changes, such as creating a sports nutrition course or hiring a registered dietitian. Another option would be considering nutrition education courses for all students to participate in. Some colleges offer College in High School (CHS) programs and introductory nutrition courses that would be beneficial to high school students and help with this gap in nutrition knowledge. This could be beneficial for all students but especially for athletes as they transition to college and help limit the gap in their knowledge and support performance goals.

This intervention also showed that there was an interest and a need for something like this to be implemented at Carlisle to help raise awareness of how to properly fuel student-athletes’ bodies and increase overall nutrition knowledge. The head coach was excited about our collaboration and had ideas for how to improve future sessions and delivery. The current and future change ideas directly impact the primary drivers of coaches and student-athletes. Testing this change with additional teams, measuring their changes in knowledge and behavior, and considering the nutrition climate, would support the overall goal of adding a nutritional component and tie in many of the secondary drivers.
4.3 Strengths/Limitations

The primary strength of this short intervention showed that SNK improved in 9th-12th grade girls’ basketball players. Even with a low completion rate in the post-intervention survey, improvements were made in each category and overall knowledge for the student-athletes. Overall improvements were also seen with the two coaches who participated. These sessions were well received by the coaches and players with positive feedback and praises for activities during the sessions. There was a lot of great discussion and question-asking as well. Engagement was strong until the season started. While having more time with the team would have been ideal (either longer time frames or more sessions), this intervention nutrition education can successfully improve SNK in just three sessions.

The primary limitation of this initial PDSA cycle was the small sample size and low participation rate in the pre- and post-intervention survey. It would have been ideal to have a larger sample and higher completion rates for all the activities and assessment pieces. Part of this could also be a limitation of not working in the place of practice and relying on the coach to text the student-athletes or remind them face-to-face. Another limitation was with the pre-activity fueling form. One thing that was not asked was what time they consumed the food and what time practice took place. This information would have helped clarify how to code the submissions. For example, if a student-athlete ate a meal after school, that may have been the best option for them if the practice was later and a small snack was not necessarily needed. Another limitation within the pre-activity fueling form was only one person included pictures of what they ate, everyone else just used descriptions for their form. This did not always provide me with enough context as to how much or what specifically was being eaten before the activity.
In the follow-up conversation with the coach, she shared that she wished we were in an actual classroom for the education sessions as opposed to the team room. This space limited comfortable seating and had everyone in tight quarters and thus did not provide the best space to complete some of the activities during the education sessions. We both agreed a classroom setting or the cafeteria would have been ideal and may have increased the number of participants.

4.4 Next steps and implications

4.4.1 Implications for research

A primary next step for research would be completing another PDSA cycle with students and coaches playing other sports. Comparing the results from this initial PDSA cycle to other winter sports, other female sports, or all sports would be beneficial to confirm the impact on nutrition knowledge. I think it would still be beneficial to complete pre- and post-intervention knowledge through a survey to check for understanding, in addition to some qualitative data collection. I would expand on the perceived knowledge rating scores, since every athlete identified as moderately knowledgeable post-intervention, by asking specific questions in an interview or focus group about what it looks like to them or what ideas or concepts have they incorporated from the intervention into their daily lives. By doing this, it would provide a clear picture of why students feel more confident in nutrition information. This type of mixed methods data approach would yield more detailed and nuanced findings.

Another next step would be to modify and pilot the revised pre-activity fueling form. I would revise the specific wording and prompts and consider different recall methods. While I
thought it may have been convenient for high school athletes to upload a picture of their pre-activity fuel/food, and thus made it optional, this method proved to not be successful. In my literature review, social media has not been the most effective method in nutrition knowledge or nutrition changes (Partida et al., 2018; Heikkilä et al., 2019), but I thought picture-taking may have been. In the future, I would want to consider other beneficial and accurate measures for recall. In a systematic review by Sanchez-Diaz et al. (2020), looking at interventions focusing on eating habits in team sports, seven out of the ten studies completed a three-day food recall. The other three completed questionnaires. While recalls have their limitations, this method could give a better picture of what the athletes are consuming throughout the entire day, and not just a snapshot of their pre-activity fueling.

Lastly, I would consider collecting more data from the coaches, both pre-and post-intervention. Having a focus group with all the coaches to get a better understanding of what they are seeing and having their input for supporting the nutritional goals around student-athletes would be ideal to informing the development of the intervention and finalization of the intervention topics. Also, it is important to have their attendance in the education session to have a better sense of what is being discussed and the potential follow-through of the program information. This was something lacking from this current intervention as only one coach attended two out of the three education sessions.

4.4.2 Implications for practice

The exciting part of this intervention is that great implications for practice came out and could benefit the student-athletes as well as the coaches. The biggest feedback from the coach was wanting to have a document that she could reference for nutrition information. She could reference
this information for conversation starters or check-in prompts for texting her athletes or face-to-face interactions. She felt this could have helped her feel more confident in what to ask or say to her athletes. The coach would have liked to continue the conversations after our education sessions, but she was not sure what prompts would encourage or support the ‘right types of questions.’

Providing a cheat sheet or follow-up document may be beneficial for coaches with the follow-through of nutrition education (Jacob et al., 2016). When coaches had nutrition education it improved their self-confidence in nutrition information as well as confidence in making recommendations for athletes (Belski et al., 2018). While for some, having a handout may not contribute to the follow-through on nutrition advice, as seen in Cleary et al. (2012), it could be worth exploring more of beneficial strategies to help coaches beyond the intervention.

Another implication for practice was in the intervention, copies of the slides were provided for all student-athletes after each session. One feedback I received was student-athletes would have liked more specific examples, perhaps in a handout, for pre- and post-fueling options. It is perhaps because the slide handouts were not as easily considered to be a handout. Having a single-page document compared to a multiple-page presentation could have been more helpful in supporting the nutritional habits around fueling or hydrating.

Collaborating with local colleges could help high school students, as well as educators, benefit from already-made nutrition courses. Looking at College in High School programs, like offered by the University of Pittsburgh, offers an Introduction to Human Nutrition that students and schools can take advantage of (CHS Courses, 2024). High schools can also create their own electives. If high schools offered an introductory to nutrition course and/or a sports nutrition course, this could allow students to get a better understanding of nutrition and could help with their
nutrition knowledge levels. Since there is a knowledge gap seen between high school and collegiate athletes, this partnership can help lessen the gap for not just athletes but any high school students who participate in the nutrition course(s).

To conclude, although this initial PDSA cycle was brief and had limitations, there were clear implications that education sessions at the high school level increase SNK in student-athletes. There is also a desire from high school student-athletes to learn this information. These sessions also showed to maintain or improve self-reported confidence in nutrition knowledge. Identifying better methods for gathering data for behavior change would be an implication for research, as well as more studies, are needed on this age group as research is limited. Including coaches and providing them with resources may also be beneficial in confidence and follow-through of nutrition information as coaches play an important role in dispersing nutrition information.
5.0 Reflection

Reflecting on my experience in the EdD program at The University of Pittsburgh, I have grown so much in my knowledge as well as the knowledge surrounding the world of research and education. The emphasis on looking at systems, what systems have been created, and who they benefit has given me a more critical eye in my understanding. I’m more aware of non-performatives and how many people or organizations may create blanket statements thinking they are addressing the root of the problem but are not. The reading specifically from Ahmed (2012), had me thinking more critically about how “performativity must be understood not as a singular or deliberate act but rather as the reiterative and citational practice by which discourse produces the effects that it names.” (Ahmed, 2012, p117). I think about this often and how change is not a one-and-done deal, it is ever-evolving and requires deliberate check-ins. I try and keep myself accountable with what I say to students and how I follow through with it because of this.

As a middle school Health and Physical education teacher, this doctoral program has made me a better educator and practitioner. I am so grateful for my experience at the University of Pittsburgh and the guidance I received from all the professors. Information I have learned throughout this program informs my current teaching practices as well as inspires me to continue to ‘push the needle’ further in helping establish change in education. Small change, I have learned, still makes an impact, and can help continue to move toward a better system.

The EdD program at the University of Pittsburgh has also provided me with incredible experiences in new career options I never considered. One of the most rewarding parts of this program was completing an internship with the University of Pittsburgh sports nutrition program. I was given the opportunity to create infographics educating athletes on various nutrition topics. I
also worked a week with the football team during their pre-season camp collaborating with other nutrition majors. During this week-long experience, I got a better understanding of the world of sports nutrition since it is not my place of practice. From stocking shelves, taking inventory, hydrating, and fueling players during practice, encouraging healthy eating during mealtimes, educating the athletic training staff on the benefits and whys behind collagen use, and creating education resources in the fitness center, these experiences made me fall in love with this career. I do not think I would have fully understood the world of sports nutrition without this experience, and it strengthened and informed my research by having this opportunity.

The internship also put me in connection with Auburn Paulone (Weisensale) and Allison Maurer, two dietitians who are working in the careers I hope to one day impact. As an educator working with grade-school children, seeing what Allison has created at her school and the benefits it has on student-athletes in the high school setting is changing the game for sports nutrition. All students can benefit from more nutrition education, empowering students to make more nutrient-dense choices and fuel their bodies efficiently. This is why I hope my research contributes to supporting the inclusion of nutrition in all high school sports programs.

Nutrition has always been a passion of mine and being able to explore this topic further and use the theory of improvement to help address problems of practice has been rewarding. Nutrition falls through a lot of cracks and loopholes and does not receive the proper focus it deserves in education with students and athletes. I feel this is largely due to budget issues, confusion from the media, people thinking they know nutrition but not understanding the nuance of sports, and not prioritizing it in various programs (i.e., school and sports). This program has provided me with more tools and support to help establish change in my system and hopefully, one day see the rippling effect in the larger system. By focusing on a specific problem of practice,
asking the five whys, using literature to support what is or is not contributing to the problem, considering policy and who it is written for and by, and understanding the layers of impact that can drive change, this program encourages me to continue the push forward in establishing change.
Appendix A Driver Diagram

Figure 5. Driver Diagram
Appendix B Sports Nutrition Slides and Materials

Materials:

Google slides
(https://docs.google.com/presentation/d/1ujD4LF25UGFe14eOx7URPTMis9WMofT2xn7KlpCjMpU/edit?usp=sharing)

- Projector and computer
- WIFI
- Printed Handouts

**Nutrition education session outline**

NOTE: 30-minute sessions

**Lesson 1: Six Essential Nutrients and Fueling**

- Review expectations and objectives for the intervention and lesson for today
  
  o Matching game in small groups to review the six essential nutrients; functions and examples. We will check answers with the information in the Google slides.

  o Discuss the importance of building a fueling foundation

  o Defining and showing examples of what a performance plate look like

  o Talk through scenarios and snow ideal pre-activity fuel; 2-3 hours before activity and 3-60 minutes prior to activity
Lesson 2: Hydration

- Review expectations and objectives for the lesson
- Look at the two pictures (raw meat and dehydrated meat). How do these pictures relate to hydration? Discussion with a partner then share as a group.
- What does hydration look like and feel like in your body?
- Hydration assessment tools; urine color chart
- Hydrating foods and consumption strategies- interactive worksheet where student-athletes can guess the % of water in different foods
- Defining electrolytes, discussing their importance for performance and examples of a few beverages.
- Goal setting with hydration
- Any additional time, answer questions

Lesson 3: Recovery nutrition

- True/false activity based on recovery nutrition information.
- Understanding the purpose of a recovery food/beverage
- Nutrients to focus on and examples
- Recovery nutrition fueling performance plates examples for dinner and snacks based on different scenarios
Appendix C Pre/Post-Survey SNK Questions and scoring

Questions were entered into a form using Qualtrics.

Page 1:

Hello! I am Katie Hanford, a doctoral student at the University of Pittsburgh as well as a nutrition educator and health and physical education teacher. This survey is designed to better understand your knowledge as it relates to general nutrition information and sports nutrition. Please try to answer these questions as best as you can. I plan to tailor my sessions according to your current knowledge. You are welcome to skip any questions that make you feel uncomfortable. If you do not know the answer, it’s okay to guess. This survey should take no more than fifteen minutes. Responses are anonymous. Results will be analyzed and interpreted by me and used in my dissertation. If you complete all the surveys/forms (pre- and post-intervention), two people will be randomly selected to win a $10 gift card. Thank you for taking the time to complete this survey!

Page 2:

First Name and Last Name Initials (e.g., Name: Katie Hanford, Initials: KH):

Are you a student or a coach?  StudentCoach

What grade are you in?  9 101112N/A

How would you rate your current nutrition knowledge?

a. Not knowledgeable at all
b. Slightly knowledgeable

c. Moderately knowledgeable

d. Very knowledgeable

e. Extremely knowledgeable

Page 3:

Nutrition Basics

1. Are carbohydrates stored in the muscle as glycogen?

   a. Yes

   b. No

   c. I’m not sure

2. Carbohydrates are beneficial before, during and after activity.

   a. Yes

   b. No

   c. I’m not sure

3. Does the muscle use protein as the main source of energy during exercise?

   a. Yes

   b. No

   c. I’m not sure

4. Athletes need to consume more protein than non-athletic peers.
a. Yes
b. No
c. I’m not sure

5. Fats are essential in your diet.
   a. Yes
   b. No
   c. I’m not sure

6. Are vitamins and minerals a good source of energy?
   a. Yes
   b. No
   c. I’m not sure

7. Breakfast is an important meal for athletes.
   a. Yes
   b. No
   c. I’m not sure

Page 4

Pre-activity fueling (Please select only one response per question)

8. The purpose of a pre-activity snack is to:
   a. Help with muscle growth and repair
b. Top off glycogen stores in the muscles

c. Help you feel full so you are not hungry during your activity.

9. Two to three hours before activity, should you consume:

a. A balanced meal high in carbohydrates, moderate protein, and low in fat

b. A balanced meal low in carbohydrates, high in protein, and low in fat

c. A high carbohydrate snack

d. A high-protein snack

10. What should you consume 30-60 minutes before activity?

a. Simple carbohydrate

b. Simple carbohydrate + protein

c. Complex carbohydrate + protein

d. Nothing

11. Consuming liquid energy (i.e., juice, sports drinks, apple sauce) 30-60 minutes pre-activity is an effective way to meet pre-activity fueling goals.

a. Agree

b. Disagree

c. I’m not sure
Page 5:

Hydration

12. To be well hydrated during sports training, you should wait until you are thirsty to drink.
   a. True
   b. False
   c. I’m not sure

13. Drinking fluids before, during, and after a competition is needed.
   a. True
   b. False
   c. I’m not sure

14. For every one-pound loss during a game or practice, you need to replenish with about 24 fluid ounces within six hours.
   a. True
   b. False
   c. I’m not sure

15. Sports drinks are most beneficial after an hour of activity.
   a. True
   b. False
   c. I’m not sure
16. What do you think is the most suitable urine color before starting to train?

a. Clear

b. Pale yellow (like lemon juice)

c. Rich yellow (like apple juice)

d. I’m not sure

17. During intense or prolonged exercise, what is the best way to replace the water that is lost in the form of sweat?

a. Water alone

b. Water and salt

c. Water and carbohydrates

18. Sports drinks should have what kind of balance to them?

a. Carbohydrate + Sodium

b. Carbohydrate + Protein

c. Protein + Sodium

Page 6

Post-activity fueling

19. What is the optimum time to eat and drink something to kick-start recovery after exercise or competition?

a. As soon as possible, within an hour after the activity
b. Between 2-3 hours after activity

c. When you are hungry

20. What should you consume post-activity/training?

a. Water

b. Water + Carbohydrate

c. Water + Carbohydrate + Protein

d. Water + Carbohydrate + Protein + Fat

21. Consuming liquid energy (i.e., juice, sports drinks, apple sauce) post-activity is an effective way to meet post-activity fueling goals.

a. Agree

b. Disagree

c. I’m not sure

22. If you have a late game or practice, you should not consume a meal afterward.

a. Agree

b. Disagree

c. I’m not sure

Page 7- only for the post-intervention survey

Intervention reflection, open-ended questions

23. What did you enjoy most about the sessions?
24. What did you least enjoy about the sessions?

25. What could be improved for next time?

26. What questions do you still have or what other topics would you like to see incorporated in future sessions?

**Scoring**

Possible of 22 points.

<table>
<thead>
<tr>
<th>Points Assigned</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Incorrect Response</td>
</tr>
<tr>
<td>0</td>
<td>Not Answered/I’m not sure</td>
</tr>
<tr>
<td>1</td>
<td>Correct Response</td>
</tr>
</tbody>
</table>
Appendix D Pre-Activity Fueling Form and Directions

Pre-activity Fueling Form (Google Form)

Pre-activity Fueling Form (directions)

Please complete the form below about your pre-activity food and/or beverage that you consumed today 30-60 minutes before practice today.

By submitting this form, you will be entered in the drawing to win a $10 gift card.

First Name and Last Name Initials (e.g., Name: Katie Hanford, Initials: KH): (Short answer response)

Did you consume a food/beverage prior to your activity today?

If no, once you respond you can submit this form.

If yes, please continue.

Yes

No

If yes, please upload a picture of what you consumed. (Upload option included)

If you are unable to upload a picture, please describe in detail what you consumed.

For example: I ate 1 medium apple and a few sips of water. (Long answer response)

How much did you consume (i.e. the whole thing, half, a little bit, none)? (Short answer response)

Why did you pick this food and/or beverage? (Long answer response)

Anything else you would like me to know? (Long answer response)
Figure 6 Google Form Example
Appendix E Semi-Structured Interview Guide

Thank you for taking the time to have this follow-up discussion with me. The goal of our conversation today is to provide a space for you to share your feedback and perceptions about the three nutrition education sessions and the impact of the sessions on your player’s knowledge, habits, or performance, if any. Our talk will last approximately 45 min-1 hour and I encourage you to share your thoughts openly and freely so I can better understand this topic to inform my future research and practice. Feel free to skip any questions that make you feel uncomfortable or top the conversation if you wish.

I am hoping to record our meeting today so that I can go back and review the transcript of our conversation. However, if you prefer, you can turn off your video so it would be only an audio recording. If you want to avoid this interview being audio/video-recorded, please let me know before we start the recording and I can just take notes. After the interview today, I will delete the audio file and save the de-identified transcript so that your and your players’ identities will be protected.

Do you have any questions for me? Do I have your consent to have this interview audio and video recorded?

1. I would like to start by hearing more about your experience with sports nutrition
   a. What was your exposure prior to this intervention? (Prompts: training, education)
   b. Where do you typically go to for support and information?
   c. Do you have any examples of how you have previously tried to include a focus on sports nutrition on your team?
2. **Next, I would like to talk a bit about the sports nutrition knowledge and habits of your players**
   a. In the past 4 years as coach, what have you noticed about their knowledge or behavior related to nutrition and diet?
      i. (Prompts: pre-activity snacking, consuming electrolytes, any confusion, etc.)
   b. Can you share about a time in the past when a player came to you asking for advice or having nutrition-related questions?

3. **I was hoping you could share more about your perceptions of the nutrition education sessions.**
   a. What do you remember about that experience and the three sessions?
   b. What do you think went well?
   c. What do you think could have been improved?

4. **I’m interested in understanding your perception of the impact of the sessions on your players and team. Can you talk a little about your observations and conversations with players after the nutrition education sessions?**
   a. Conversations (questions, information recall), reinforcement of concepts/topics when coaching, behaviors (hydration, fueling), performance (energy), etc.

5. **Lastly, I would love to hear your thoughts about any recommendations for the future support your athletes’ nutrition goals at Carlisle High School.**
   a. What would be most helpful to you and your players moving forward?
   b. What barriers prevent you and athletes from getting the nutrition information you need?
   c. What recommendations do you have for me, or what things should I keep in mind, as I continue moving forward with this work?

Thank you for your time. I truly appreciate the information you shared and your participation.

Please feel free to reach out if you have any questions or additional thoughts.


Coach G (lacrosse coach) in discussion with the author, October 2022.


