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The Measurement of College Athletes' Knowledge and Behavior on Pre- And Post-Workout Nutrition Utilizing a Text-Message Intervention

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HANNAH CHRISTINE YOUNG

63 Pages

The purpose of this study was to measure athlete's knowledge on pre- and post-workout nutrition, specifically assessing their macronutrient intake. Nutrition education for collegiate athletes has been a popular topic of discussion for years. Illinois State University athletes participated in the study by completing a pre- and post- sports nutrition survey which consisted of 29 questions. This survey regarding nutrition knowledge specifically included questions based off their pre-workout intake, recovery, as well as behavior-related questions based off a 1-7 Likert Scale (one being disagree and seven being agree).

A total of 40 participants completed both the pre- and post-assessment surveys. A total of 12 text messages were sent during the 4-week intervention phase, with 3 text messages sent per week. This was administered via Microsoft Teams app utilizing a third party. The text messages included educational information regarding: sources of carbohydrates; importance of carbohydrate consumption before training; sources of protein; and the importance of a carbohydrate-protein mixture consumption for recovery.

The test revealed that the nutrition-knowledge scores numerically increased from a mean of 17.49 (SD = 2.106) on the pre-test to a mean of 18.03 (SD = 2.189) on the post-test. The difference between the two means was not statistically significant at the .05 level (p = .156). A dependent t-test was also completed for the nutrition behavior questionnaire between the pre-

and post-assessment survey. The test revealed that the nutrition-behavior scores numerically increased from a mean of 69.54 (SD = 8.410) on the pre-test to a mean of 71.74 (SD = 9.214) on the post-test. The difference between the two means was not statistically significant *(p* = .177).

This study revealed an increase in nutrition knowledge and nutrition behavior due to the text-message based intervention, although the increase from the pre-assessment survey to the post-assessment was not significant. Future research should focus on the effectiveness of the length and frequency of the text message intervention, as well as investigate the athletes' willingness to change dietary behaviors based on various time increments.

KEYWORDS: Nutrition, Knowledge, Carbohydrates, Protein, Performance, Recovery, Behavior, Athlete, Text Intervention

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CHAPTER I: THE MEASUREMENT OF COLLEGE ATHLETES' KNOWLEDGE AND BEHAVIOR ON PRE- AND POST-WORKOUT NUTRITION UTILIZING A TEXT-MESSAGE INTERVENTION

Introduction

Nutrition Education in Collegiate Athletes

Nutrition composition plays a crucial role in athletic performance, specifically, the type and amount of macronutrients, as well as the timing of consumption before and after workouts. Not all athletes optimally consume macronutrients. Throughout research, it is evident that the problem in changing athlete behavior, at least in part, stems from lack of education on nutrition (Werner, et al., 2020). There is an apparent gap between nutrition education and college athletic performance. As stated by Werner, Guadgni, and Pivarnik (2020), college sports nutrition research is important because an athlete with poor knowledge cannot be expected to make optimal dietary choices. Therefore, it is significant to note that an adequate foundation of nutrition knowledge may allow a college athlete to effectively follow nutrition practices that will optimize performance and decrease risk of injury.

Function of Macronutrients

The three macronutrients, carbohydrates, protein, and fat, all perform different roles in the body, whether it is for energy, recovery, or to maintain body functions. Two specific macronutrients, carbohydrates and protein, were investigated throughout this study. Carbohydrates are sugars, starches, and fiber in food that are a source of energy for the body. Starches and sugar provide glucose, the main energy source for the brain, central nervous system, and red blood cells (Slavin and Carlson, 2014). This glucose is stored in the body as glycogen. The role of carbohydrates is to provide energy to all cells in the body, and they are the

primary energy source for active people. Proteins are polymers of amino acids linked through peptide bonds that perform to help the body build and repair cells and tissues (Watford and Wu, 2018). Together, they function to increase athletic performance. Carbohydrates serve to provide energy to an athlete before and during a workout, and mixed carbohydrate-protein meals have shown to increase recovery post-workout, including increased glycogen synthesis (Ormsbee, Bach, and Baur, 2014). It is important that college athletes understand this information.

Nutrition Behavior in Collegiate Athletes

Nutrition knowledge is accompanied by nutrition behavior. The Theory of Planned Behavior (TPB) is a model utilized in this study to evaluate the outcome of changes in dietary intake. The TPB is used to predict and individual's intention to engage in a behavior at a specific time and place (LaMorte, 2019). The key component to this model is behavioral intent because behavioral intentions are influenced by the attitude about the likelihood that the behavior will have the expected outcomes. Ogden (2016) studied the feasibility of behavior changes and mentioned that it is important to realize that individuals will behave uniquely in response to intrapersonal, interpersonal, and external factors. It can be concluded that without intention to change, an athlete's dietary intakes will not improve because athletes need both nutrition knowledge and have intentions to change their behaviors. These behaviors are individualized to the specific athletes.

Goals of the Study

As research has shown, college athletes appear to have low nutrition knowledge, which puts them at risk for inappropriate dietary choices that could decrease ability to optimally perform and increase risk of injury (Werner, et al., 2020). The goal of this study was to provide nutrition education to college athletes to promote appropriate dietary choices before and after

workouts to increase sports performance. A study conducted in Division I baseball players discovered that sports nutrition education intervention increased nutritional knowledge and nutritional status (Rossi, Landreth, Beam, Jones, Norton, and Cholewa, 2017). Another study conducted by Bill (2015) studied the effects of nutrition education messages delivered by text messages on self-efficacy, dietary intake, and body composition of college athletes, which produced insights for future studies. The purpose of this current study was to assess college athlete's knowledge and behavior regarding pre- and post-workout nutrition, specifically carbohydrate intake before training and a carbohydrate-protein mixture after training, before and after a text-message based educational intervention.

The current study sought to address the gap between nutrition knowledge and college athletes by evaluating if a text-based educational intervention improves carbohydrate and protein knowledge before and after training. From previous literature, text-based educational interventions related to the maintenance of healthy behaviors have been found to be feasible (Gerber et al., 2009). This study also sought to evaluate changes in dietary intake after providing this nutritional education. This intervention provided athletes with nutrition information about the importance carbohydrates before training and the importance of a carbohydrate-protein mixture after training.

Hypothesis 1: A text-based education intervention will be effective at increasing nutrition knowledge in collegiate athletes before and after their training sessions.

Hypothesis 2: A text-based education intervention will be effective at improving dietary intake both pre- and post-training amongst collegiate athletes.

Methodology

Sample Selection

The sample selection of this study included Division I athletes at Illinois State University who fell under the NCAA and were above the age of 18-years old. Participants for this study were recruited via Microsoft Teams application. Demographic information was collected during the pre-assessment survey, which included their age, biological sex, ethnicity, year in school, height, and weight.

Study Procedure

All student athletes were invited to participate in the study via a Microsoft Teams message. There are approximately 550 athletes at Illinois State University and the response rate was 62. The invitational message provided them with insight on the time commitment, expectations, and the goals of this study. This message included a link to the informed consent. Consenting participants completed a pre-intervention nutrition knowledge and behavior survey. A baseline survey was distributed via the Microsoft Teams application. There was a pre-assessment survey and post-assessment survey, which included questions regarding nutrient knowledge, pre-workout nutrition, recovery (post-workout consumption), and nutrition behavior. A text-based intervention was provided, and then the outcomes were assessed in the post-assessment survey.

Instruments

Demographics. Participants were asked to report on their age, biological sex, ethnicity, year in school, height, and weight. They were then asked more specific questions including: the sport they played and if they had access to the dining hall during the school year and/or summer and if so, which meal plan they were enrolled in.

Nutrition Knowledge Questionnaire. The athletes completed a pre-assessment survey, which consisted of questions adopted from Zinn, et al., (2005) and newly created questions. This questionnaire included: nutrient-based questions such as carbohydrate-composed foods and protein-composed foods; pre-workout questions such as the type of food they consumed before their training and the timing of this consumption; and recovery questions such as the type of food they consumed after their training and the timing of this consumption. New questions were reviewed by Registered Dietitian Nutritionists. The athletes then completed the same questionnaire for the post-assessment survey following the intervention.

Nutrition Behavior Questionnaire. The athletes completed a pre- and post-assessment survey on nutrition behavior. These questions were related to their: attitude about carbohydrate consumption before training and carbohydrate-protein consumption after training; past-behavior about their fueling and recovery; and intention to change their fueling and recovery strategies. These questions were self-created and adopted from Ajzen's "Theory of Planned Behaviour Questionnaire" (2013). Questions were then reviewed by Registered Dietitian Nutritionists. The needs of nutrition vary depending on the sport; therefore, athletes in nutrition-focused sports may have been more willing to change their dietary behaviors.

Intervention

Microsoft Teams communication app was used as the intervention mode in this study. Microsoft Teams allowed interaction throughout all athletes, or specific team types. This study targeted all athletes, but the data was utilized to compare amongst the sports teams. Week 1 included the pre-intervention, which was the knowledge and behavior pre-assessment questionnaire. Weeks 2-5 was the intervention. This text-based education intervention lasted four weeks and provided education through single-sentence factual nutrition information three times

per week for four weeks, for a total of twelve messages. These messages provided information on carbohydrate sources, protein sources, the importance of carbohydrate intake prior to training, and the importance of a carbohydrate-protein mixture intake after training. The text messages were reviewed by Registered Dietitian Nutritionists. Week 6 consisted of a post-assessment survey, which was the same survey administered in the beginning.

Data Analysis

To examine the effectiveness of the intervention on nutrition knowledge and nutrition behavior in collegiate athletes, a dependent sample *t*-test was conducted to assess if differences exist in knowledge adherence and dietary intake from the pre-assessment survey to the post-assessment survey. This was conducted in IBM SPSS 25.The *t*-test was a two-tailed statistical significance set at $p < 0.05$. This ensured a 95% certainty that the differences did not occur by chance.

Demographics were expressed in percentages or means, and standard deviations. These demographics consisted of their age, biological sex, ethnicity, year in school, height and weight, which were used to calculate body mass index (BMI). The independent variable was the education intervention via the Microsoft Teams communications application, whereas the dependent variables were the knowledge and dietary intake of pre- and post-workout nutrition.

Results

Demographics

Participants were asked to report on their age, biological sex, ethnicity, year in school, height, and weight (Table 1). The sample of this prospective cohort study included both male and female participants from various Division I collegiate sports at a Midwest university. For the pre-assessment questionnaire, 15 males and 47 females completed the survey. Out of these

individuals, there were 55 White/Caucasians, 2 African-Americans, 1 Hispanic-American, 1 Pacific Islander, and 3 individuals that selected "Other." There were 12 freshman, 15 sophomores, 9 juniors, 22 seniors, and 4 graduate/doctorate program students. Height and weight varied amongst the group for males and BMI was calculated for these individuals (M = 28.96, SD = 2.72). Height and weight also varied amongst the females and expressed through BMI (M = 23.67, SD = 2.75) (Table 1).

For the post-assessment survey, the number of participants decreased to 9 males and 31 females. There were 37 White/Caucasians, 1 Hispanic-American, 1 Pacific Islanders, and 1 "Other." Out of these 40 participants, there were 7 freshman, 10 sophomores, 3 juniors, 15 seniors, and 5 graduate/doctorate program students. Height and weight varied amongst the group for males and was expressed in means of BMI (M = 28.62, SD = 3.64). Height and weight also varied amongst the females and expressed in means of BMI (M = 24.01, SD = 2.28) (Table 1).

Sports and Dining Center Access

Aside from demographics, the participants were asked questions regarding their sport and if they had dining center access. It was important to distinguish if specific sports need more nutrition-related education because different teams have different coaches, which may give them an advantage. Dining center access was also important to measure because these students would have access to eat healthy foods, if selected (Table 2).

The pre-assessment questionnaire showed that out of the 62 responses, there were student athletes from twelve different teams, which included: 4 baseball; 6 softball; 1 women's basketball, 1 women's cross country; 5 football; 4 women's golf; 2 women's tennis; 6 men's track and field; 13 women's track and field; 3 gymnastics; 12 soccer; and 5 swimming and diving. Their access to the dining center during the school year expressed that 34 did not have

access, 18 had access but only a limited amount of swipes, and 10 had access and unlimited amount of swipes. Their access to the dining center during the summer expressed that 60 did not have access, 1 had access but only a limited amount of swipes, and 1 had access and unlimited amount of swipes (Table 2).

The post-assessment questionnaire expressed that out of the 40 responses, there were student athletes from nine different teams. Teams that no longer had representation were women's basketball, women's cross country, and women's tennis. The breakdown of participants for the nine teams included: 2 baseball; 4 softball; 3 football; 3 women's golf; 4 men's track and field; 6 women's track and field; 3 gymnastics; 11 soccer; and 4 swimming and diving. Their access to the dining center during the school year expressed that 26 did not have access, 9 had access but only a limited amount of swipes, and 5 had access and unlimited amount of swipes. Their access to the dining center during the summer expressed that all 40 participants did not have access (Table 2).

Nutrition Knowledge Questionnaire

Pre-Assessment Survey. The percentage correct for each question was calculated. The results demonstrated fairly high comprehension on nutrition knowledge for the participants. Question 19 yielded the lowest percentage correct at 33.8%, which was "After practice, how long did you consume this/these macronutrients?" in reference to the anabolic window. Question 7 received the highest percentage rate at 100% which was, "Do you think chicken is high or low in protein?" with the answer being high. Aside from these percentages, the range was between 53.8% and 96.9% (Table 4).

Pre-Assessment vs. Post-Assessment Surveys. A dependent *t*-test was completed for the nutrition knowledge questionnaire portion between the pre- and post-assessment survey. These surveys were completed before and after the text-message based intervention. A dependent t-test was used to compare the same individuals ($N = 35$) on the same measure. The test revealed that the nutrition-knowledge scores numerically increased from a mean of 17.49 (SD = 2.106) on the pre-test to a mean of 18.03 (SD = 2.189) on the post-test. The difference between the two means was not statistically significant at the .05 level ($p = .156$) (Table 5). Another dependent *t*-test was conducted for each specific question. The main findings showed that there was an increase in nine questions, decrease in five questions, and eight remained unchanged (Table 4).

Nutrition Behavior Questionnaire

Pre-Assessment Survey. The results of the nutrition-behavior questionnaire demonstrated fairly high intention to change nutrition behavior for the participants. Answer choices were on a 1-7 Likert Scale (one being disagree with the statement and seven being agree with the statement). Question 2 yielded the lowest average of 5.14, which stated, "Most of my teammates consume carbohydrates before training." Question 4 yielded the highest average of 6.47 which stated, "My carbohydrate consumption before training is up to me." Aside from these means, the remainder ranged from 5.44-6.36, which demonstrated a high intention to change nutrition behavior (Table 7).

Pre-Assessment vs. Post-Assessment Surveys. A dependent *t*-test was also completed for the nutrition behavior questionnaire between the pre- and post-assessment survey. The test revealed that the nutrition-behavior scores numerically increased from a mean of 69.54 (SD = 8.410) on the pre-test to a mean of 71.74 (SD = 9.214) on the post-test. The difference between the two means was not statistically significant at the .05 level ($p = .177$). Another dependent *t*-test was

conducted for each specific question. The main findings showed that there was an increase in nine questions, decrease in two questions, and one question remained unchanged. The statements the participants rated were based on carbohydrate consumption before training and a carbohydrate-protein mixture after training regarding their own intentions to change and their teammates likelihood to change (Table 7). Two questions regarding carbohydrate consumption before training and a carbohydrate/protein mixture following training were significant at the .05 level, as their behavior change increased following the intervention. These questions were Question 1 and 7 (Table 8). Question 12, regarding the intention of consuming a carbohydrate/protein mixture after training, was approaching statistical significance $p = .096$ (Table 8).

Discussion

Proper nutrition is an important variable in athletic performance, as well as recovery time. Inconsistent nutrition habits may occur in athletes, at least in part, due to the gap in knowledge, which is caused by lack of access to nutrition information and limited time due to academic and practice demands. In this study, both the nutrition knowledge and nutrition behavior questionnaires showed a numerically positive change, which could be attributed to the intervention of text message reminders about nutrition. However, this numerical increase was not statistically significant.

Multiple research studies have conducted similar interventions to assess nutrition knowledge and behavior in athletes by completing a pre- and post-survey associated with an educational intervention. In a study conducted by Rossi et al. (2017), there was a 46 question questionnaire (1 point was given per correct answer, and 0 was given for incorrect or "unsure" responses). The percentages of total questions increased from a 56.7% (pre-intervention survey)

to a 70% (post-intervention survey). Similarly, the Illinois State athletes increased their average from 77.36% (pre-intervention survey) to an 81.95% (post-intervention survey), which is shown in Table 5.

Significant Findings

The behavior questionnaire is the most significant finding from the study. It is possible that the athletes already knew most of the information based on the knowledge tests, but the text-message based intervention may have changed their perceptions and made them more likely to turn their knowledge into behavior change. Their behavior test revealed that there was an overall numerical increase in their mean nutrition-behavior scores, suggesting that the athletes were more likely to change dietary behaviors and patterns that could benefit their own and their teammates' sports performance. Overall, they had more accountability to their dietary intake after the text-message based intervention. As previously stated, two questions regarding carbohydrate consumption before training and a carbohydrate/protein mixture following training were significant at the .05 level, while other questions were approaching significance at the .05 level (Table 8). This suggests that the athletes were more likely to consume carbohydrates prior to training, as well as a carbohydrate-protein mixture following training due to the text-message based intervention. It is noted that there was a trend with the questions approaching significance, which is important for future directions.

The findings of this study revealed a numerical increase in nutrition knowledge and nutrition behavior after a text-message based intervention. These text messages educated the participants about the importance of carbohydrates and protein, especially the relationship of their effects on the body and sports performance, relative to their consumption time. Although there was a numerical increase in nutrition knowledge and nutrition behavior, the findings were

not statistically significant. Similarly, the purpose of Bill's (2015) study was to assess the effect of nutrition educational text messages on the body composition, dietary intake, and self-efficacy of college athletes. The measurements did not show an improvement among the time points, but the study revealed the data is still valuable with authors suggesting the lack of significance stemmed from the short timeframe, which can provide direction for future research (Bill, 2015).

It can be postulated that there was not a significant difference between the pre- and post-surveys due to: the significant drop out rate; the athletes' prior nutrition knowledge; the small total of twelve text messages; and the length of the study. There were 62 athletes who completed the pre-assessment survey but only 40 who completed the post-assessment survey. The sample size decreased by one-third, which could have contributed to the lack of significant findings in this study. There was not much diversity in ethnicity, which could have influenced the results. These athletes also have nutrition resources, as there is a registered dietitian on staff as well as a sports nutrition graduate assistant. Many of the ISU athletics coaches are aware of the importance of nutrition on sports performance, and encourage them to intake adequate nutrition during their seasons, which is based off verbal statements from the athletes and coaches. Despite these contributions, athletes are individuals and will behave uniquely in response to intrapersonal, interpersonal, and external factors (Ogden, 2016).

A study conducted by Gerber et al. (2009) investigated newer strategies pertaining to the maintenance of healthy behaviors and weight, which included the use of a text-message based intervention. This study demonstrated early feasibility and acceptability of text messaging as a method for promoting healthy behaviors for weight maintenance. Unlike our study, this software transmitted over 4500 total text messages when multiplied by the number of participants, and the intervention period lasted four months long. Another study conducted by Noonan et al. (2019)

reviewed the feasibility of a text-based intervention in adults to encourage behavior change, and these results also revealed that using cell phones are a feasible and acceptable way to deliver interventions. This study intervention also lasted four weeks, similar to our study; however, there were 2-3 text messages sent per day whereas our study sent text messages only three times per week. Research shows that the use of an intervention via cell phones is effective, but the duration and frequency of these messages is something to consider for future direction.

Limitations

There were several limitations within this study. The first limitation would include the directions for the surveys. In order to make it anonymous, the participants were directed to create a 4-digit code based off various personal information. However, several participants that completed both the pre- and post-surveys used two different 4-digit codes, which made it difficult to match their results.

Another limitation included the lack of text messaging control for the intervention. Despite attempting to control all elements of the study, researchers needed to rely on third parties to send text messages, which may have impacted the results of the study. Lack of control for sending out the survey could have also impacted the sample size of the study.

The last limitation would involve the percentage of athletes who participated in the study already being educated in this field through previous nutrition courses or meeting with nutrition professionals; therefore, yielding no significant changes in their scores. Some coaches at ISU take the time to educate their athletes in nutrition to enhance their performance. There is also a Director of Sports Nutrition, who is a registered dietitian on staff, with a Sports Nutrition graduate assistant, available to answer any questions the athletes may have. In this study, there were multiple individuals that received full points in the nutrition knowledge section in the pre-

assessment survey due to prior nutrition knowledge, and therefore did not show an increase in nutrition knowledge in the post-assessment survey.

Strengths

Aside from the limitations, there were also several strengths within this study. The first strength would include the diversity of the athletic sports teams. There were nine of out the seventeen different sports represented in both the pre- and post-survey, which included baseball, softball, football, women's golf, men's track and field, women's track and field, gymnastics, soccer, and swimming and diving. This text-message intervention was able to reach various athletes throughout the ISU athletics department. Research has shown that nutrition composition plays a crucial role in athletic performance (Dunford & Doyle, 2019), which provides evidence that this study could positively impact sports performance across the Illinois State athletic department.

Another strength included the athletes' willingness to change. The behavior knowledge questionnaire demonstrated high intention to change, and the overall mean from the pre-assessment survey to the post-assessment survey did increase amongst the athletes. This text-message based intervention provided the athletes with information about the importance of carbohydrates before training and the importance of a carbohydrate-protein mixture after training. These messages were based solely off research, which gave the athletes insight to the importance of proper nutrition, thus encouraging them to change their behavior. Not only did this study evaluate nutrition knowledge amongst the athletes at ISU, but it also evaluated dietary behavior changes. The means for both nutrition knowledge and dietary behavior changes increased from the pre-assessment to post-assessment surveys, which enhances the strengths of

this study. Future directions to improve nutrition behavior could be researching various ways to change their motivation to actions.

Changes for Future Studies

Although there were strengths within this study, there are also variables that could have been conducted differently to make the study stronger. There was not a control group in this study, as one of the goals was to benefit all athletes with the informative and educational text messages. Something that could have been altered would be the incorporation of a control group to assess if there was a statistical significance in the pre- and post-survey between the two groups. Along with this, another option could have been to split the participants into three groups: a control group; the text message group (conducted similarly to this current study); and an additional group that received an in-person educational seminar or handout that discussed the benefits of nutrition and its effects on sports performance. The ability to separate the various groups would have been beneficial to evaluate any significant differences in the nutrition-knowledge and nutrition-behavior questionnaires amongst these three groups.

Microsoft Teams was the communication application of choice; however, the researchers could have considered creating our own Microsoft Teams account or utilizing a different communication application to avoid the use of a third party. Leon et al. (2021) conducted a study which also utilized a third-party to deliver messages, and they found that the electronic information system was not feasible. This specific study did not ask detailed questions on the barriers they may face when attempting to make dietary changes, which could have been helpful knowledge for future research. Similarly, Bill (2015) evaluated the effects of nutrition education messages on dietary intake and body composition of college athletes and mentioned future investigations should consider ways to personalize messages to increase the likelihood that

participants will change their dietary behavior. The challenges and barriers in this study is perhaps something to investigate further.

Conclusions

Overall, the Illinois State athletes did show an increase in nutrition knowledge and nutrition behavior due to the text-message based intervention, although the increase from the pre-assessment survey to the post-assessment was not significant. While this study did not produce significant results, it does provide insight to future studies.

Although athletes received this information from a third party source, it may be beneficial to investigate who may be the best individual to share this information. Athletes may be more willing to trust their head coaches, strength coaches, or athletic trainers, or making it more clear that a dietitian is providing this information to the athletes may be beneficial. These are all variables to consider for future studies.

Additional information that can be pulled from this study to investigate further would be sport-specific differences in nutrition knowledge and behavior. Different sports require different fueling, recovery, and training strategies. Due to the importance of nutrition in certain sports (i.e. football, basketball, cross country, etc.), the results from this study may have been influenced by the athlete's intensity of training. Some athletes may be more willing to change their dietary behaviors if it will allow them to perform optimally and prevent injuries, but this is very dependent on the specific sport.

Future directions for this study would be to conduct the intervention over a longer period of time. There was only a total of twelve text messages, which were sent over the course of four weeks. Other studies have shown a statistical significance in behavior change with text-message based interventions that were conducted over a longer period of time (Gerber et al., 2009;

Noonan et al., 2019). More information regarding the importance of nutrition consumption and its effects on sports performance may have given the athletes a better insight to the nutrition education; therefore, yielding a higher numerical increase in both the nutrition knowledge section and dietary behavior section. Knowledge is not the only way to facilitate behavior change, so providing the athletes with a higher reward for this change by evaluating their intrinsic reasons to change (continuation/maintenance of body composition and/or performance) could be something to further investigate.

In addition to the option of a longitudinal text-message based intervention, another future direction would also include the extension of the behavior portion of the study. There was a numerical increase in the behavior questionnaire from the pre- to post-assessment, which only lasted four weeks. If the timeframe of this study would have been longer, it would have produced helpful data to see if the athletes' behaviors aligned with their original answers. All things considered, future research should evaluate the effectiveness of the length and frequency of the text message intervention, as well as investigate the athletes' willingness to change dietary behaviors based on various time increments.

Individuals who may find this study to be helpful would include coaches and sports nutrition directors. This study provides insight to the various areas of nutrition athletes may be lacking in. Some questions were easily answered by the athletes such as foods high in protein, whereas other questions were answered incorrectly such as the importance of timing in nutrient intake. Some sports teams scored higher than others, which can be helpful for coaches or nutrition directors to focus in on these various sports teams. Behavior questions were another piece that may provide insight to coaches or nutrition directors because these athletes may need

support in specific areas for their motivation to change. Overall, this can be useful information for leaders in the sports nutrition world.

Table 1. Survey Demographics

	Pre-Assessment Survey (N = 62)		Post-Assessment Survey (N = 40)	
	Number	Percentage	Number	Percentage
Biological Sex				
Male	15	24.2%	9	22.5%
Female	47	75.8%	31	77.5%
Ethnicity				
White/Caucasian	55	88.7%	37	92.5%
African-American	2	3.2%	0	0%
Hispanic-American	1	1.6%	1	2.5%
Native-American	0	0%	0	0%
Pacific Islander	1	1.6%	1	2.5%
Other	3	4.8%	1	2.5%
Year in School				
Freshman	12	19.4%	7	17.5%
Sophomore	15	24.2%	10	25%
Junior	9	14.5%	3	7.5%
Senior	22	35.5%	15	37.5%
Graduate/Doctoral	4	6.4%	5	12.5%
	Means (Standard Deviation)	Range	Means (Standard Deviation)	Range
BMI				
Male	28.96 (2.72)	25.77 – 34.99	28.62 (3.64)	22.72 – 34.70
Female	23.67 (2.75)	18.30 – 32.52	24.01 (2.28)	20.50 – 28.31

Table 2. Survey Sports and Dining Center Access

	Pre-Assessment Survey (N = 62)		Post-Assessment Survey (N = 40)	
	Number	Percentage	Number	Percentage
Sport				
Baseball	4	6.5%	2	5%
Softball	6	9.6%	4	10%
Men's Basketball	0	0%	0	0%
Women's Basketball	1	1.6%	0	0%
Men's Cross Country	0	0%	0	0%
Women's Cross Country	1	1.6%	0	0%
Football	5	8.1%	3	7.5%
Men's Golf	0	0%	0	0%
Women's Golf	4	6.5%	3	7.5%
Men's Tennis	0	0%	0	0%
Women's Tennis	2	3.2%	0	0%
Men's Track and Field	6	9.6%	4	10%
Women's Track and Field	13	21.0%	6	15%
Gymnastics	3	4.8%	3	7.5%
Soccer	12	19.4%	11	27.5%
Swimming and Diving	5	8.1%	4	10%
Volleyball	0	0%	0	0%
Dining Center Access (School Year)				
I do not have access	34	54.8%	26	65%
I have access BUT a limited amount of swipes	18	29.1%	9	22.5%
I have access AND an unlimited amount of swipes	10	16.1%	5	12.5%
Dining Center Access (Summer)				
I do not have access	60	96.8%	40	100%
I have access BUT a limited amount of swipes	1	1.6%	0	0%
I have access AND an unlimited amount of swipes	1	1.6%	0	0%

Table 3. Nutrition Knowledge Pre-Intervention Scores

	N	Mean % Correct	Std. Deviation	Std. Error Mean
Total Correct Nutrition Answers	66	77.36%	2.765	.340

Table 4. Survey Percentage Correct & Dependent *t*-test Results – Nutrition Knowledge

Questions N = 35	Question Description	Pre- % Correct	Post- % Correct	*p*
1	Do you think chicken is high or low in carbohydrates?	83%	89%	.487
2	Do you think baked beans are high or low in carbohydrates?	83%	69%	.096
3	Do you think white bread is high or low in carbohydrates?	89%	91%	.661
4	Do you think butter is high or low in carbohydrates?	57%	54%	.661
5	Do you think cornflakes cereal is high or low in carbohydrates?	77%	89%	.160
6	Do you think cream of rice pudding is high or low in carbohydrates?	69%	83%	.134
7	Do you think chicken is high or low in protein?	100%	100%	---
8	Do you think baked beans are high or low in protein?	74%	66%	.373
9	Do you think fruit is high or low in protein?	100%	100%	---
10	Do you think margarine is high or low in protein?	94%	97%	.571
11	Do you think cornflakes cereal is high or low in protein?	97%	89%	.083
12	Do you think peanuts are high or low in protein?	89%	89%	1.000
13	Did you consume a carbohydrate source before your workout today?	80%	80%	1.000
14	If yes, how long did you consume this carbohydrate before your workout? (Options: 1 hour, 2 hours, 3+ hours) **1 hour being the ideal answer	52%	72%	.096
15	Agree/Disagree. Carbohydrates prior to exercise appear to be beneficial to performance to provide energy and delay time to exhaustion.	97%	100%	.324

(Table Continues)

(Table 4, Continued)

16	Does the type of food consumed before practice effect training?	97%	100%	.324
17	Did you consume carbohydrates after your workout today?	100%	100%	---
18	Did you consume protein after your workout today?	100%	100%	---
19	After practice, how soon did you consume this/these macronutrient(s)?	37%	31%	.535
20	Agree/Disagree. Carbohydrates are an important nutrient to replace after training.	100%	100%	---
21	Agree/Disagree. Protein is an important nutrient to replace after training.	100%	100%	---
22	Does the type of macronutrient consumed after your workout make a difference in sports performance?	89%	94%	.324

Table 5. Dependent *t*-Test Results – Nutrition Knowledge Pre vs. Post-Intervention

Paired Samples Statistics

	Mean % Correct	N	Std. Deviation	*p*-Value
Pre-Assessment Nutrition Score	79.50%	35	2.106	.156
Post-Assessment Nutrition Score	81.95%	35	2.198	

Table 6. Nutrition Behavior Pre-Intervention Scores

	N	Mean	Std. Deviation
Total Nutrition Behavior Points	62	5.8 (Range 1-7)	9.241

Table 7. Survey Average out of 7 & Dependent *t*-test Results – Nutrition Behavior Pre vs. Post-Intervention

Questions	Question Description	Mean + SD		*p*
		Pre-Survey	Post-Survey	
1	Consuming carbohydrates before training would be: good/bad. Good = 7 points. Bad = 1 point.	6.29 + 0.86	6.63 + 0.73	.026
2	Most of my teammates consume carbohydrates before training: agree/disagree. Agree = 7 points. Disagree = 1 point.	5.14 + 0.92	5.38 + 0.98	.270
3	I am confident that I can consume carbohydrates before training: true/false. True = 7 points. False = 1 point.	6.15 + 0.75	6.36 + 0.74	.165
4	My carbohydrate consumption before training is up to me: agree/disagree. Agree = 7 points. Disagree = 1 point.	6.47 + 0.71	6.41 + 0.78	.711
5	In the past three months, I have consumed carbohydrates before training: true/false. True = 7 points. False = 1 point.	6.10 + 0.79	6.00 + 0.89	.540
6	I intend to consume carbohydrates before training: likely/unlikely. Likely = 7 points. Unlikely = 1 point.	6.06 + 0.89	6.16 + 0.97	.557
7	Consuming a carbohydrate-protein mixture after training would be: good/bad. Good = 7 points. Bad = 1 point.	6.29 + 0.83	6.63 + 0.69	.016
8	Most of my teammates consume a carbohydrate-protein mixture after training: agree/disagree. Agree = 7 points. Disagree = 1 point.	5.44 + 0.95	5.50 + 0.95	.804
9	I am confident that I can consume a carbohydrate-protein mixture after training: true/false. True = 7 points. False = 1 point.	6.06 + 0.84	6.23 + 0.81	.373
10	My carbohydrate-protein mixture consumption after training is up to me: agree/disagree. Agree = 7 points. Disagree = 1 point.	6.36 + 0.78	6.36 + 0.86	1.000
11	In the past three months, I have consumed a carbohydrate-protein mixture after training: true/false. True = 7 points. False = 1 point.	5.97 + 0.77	6.03 + 0.85	.721

(Table Continues)

(Table 7, Continued)

12	I intend to consume a carbohydrate-protein mixture after training: likely/unlikely. Likely = 7 points. Unlikely = 1 point.	6.06 + 0.91	6.34 + 0.80	.096

Table 8. Dependent *t*-Test Results – Nutrition Behavior

Paired Samples Statistics

	Mean	N	Std. Deviation	*p*-Value
Pre-Assessment Behavior Score	69.54	35	8.410	0.177
Post-Assessment Behavior Score	71.74	35	9.214	

CHAPTER II: LITERATURE REVIEW

Review of Literature

Nutrition and College Athletes

The importance of nutrition education for collegiate athletes has been a very popular topic. Many research studies have been conducted to examine nutrition knowledge and college athletes, some of which found significant results through the deliverance of various forms of educational information. In the book *Nutrition for Sport and Exercise*, it provides reasons why nutrition is so important for training, recovery, and performance. Nutrition improves specific components of fitness, helps avoid injury and overtraining, supports achievement in top performance for selected events, provides fuel to activity and fuel to recover, promotes health, and appropriate weight and body composition (Dunford & Doyle, 2019). Although gaining this information can greatly benefit an athlete, there is a substantial gap between this nutrition knowledge and collegiate athletes.

This gap is prevalent for several reasons. If an athlete does not have access to nutrition information, this athlete cannot be expected to make optimal dietary choices. In a study conducted by Werner, et al. (2020), their conclusions demonstrated high stress of being both a full-time student and college athlete, coupled with low nutrition knowledge, could lead to poor dietary choices, thus inhibiting proper fueling for and recovery from a specific sport. Another study that supports poor nutrition knowledge due to lack of time and lack of nutrition education was completed by Rossi, et al. (2017). The researchers found that NCAA athletes have limited time due to academic and practice demands; however, the subjects in this study believed that good nutrition would improve their performance if they were provided with an educational intervention.

Function of Macronutrients

Carbohydrates, fats, and proteins all serve important responsibilities in the human body. They each have a unique set of properties that influence health, but they are all sources of energy. Macronutrients play a significant role in metabolism, energy production, hemoglobin synthesis, lean mass and bone mass maintenance, immunity, health, and protection against oxidative damage (Papadopoulou, 2020). In a study that investigated the role of macronutrient intake for athletes, the researcher found that adequate intakes of macronutrients support athletes' anabolism, which is the growth of molecules within the body. Dietary protocols should consider doses, timing, and type and quality of nutrients.

Athletes should be able to meet their dietary needs through eating a wide variety of food sources, including the three macronutrients. This will help capitalize on their performance for training and competition. Nutrient timing is an important factor in the consumption of macronutrients; however, the timing of nutrients depends on many variables, including the type of training (practice, strength, conditioning, or recovery), schedule, and the individual athlete's dietary preferences (Bytomski, 2017). In this specific study, the researcher emphasized the importance of macronutrient goals depending on the athlete's sport, timing of exercise, and season status. It is evident that all macronutrients are essential to providing adequate nutrition to an individual; however, there is an emphasis on carbohydrates and protein in the sports nutrition realm.

Importance of Carbohydrates

Carbohydrate Usage. Carbohydrate usage will increase mitochondrial adaptations when coupled with training. According to a study that involved carbohydrate availability and physical performance, the researchers found that there are adaptations within the body during endurance

exercise through stimulating mitochondria biogenesis and improving oxidative capacity (Mata, et al., 2019). This study focused on the concept of the increase of mitochondria allowing someone to produce more ATP (an energy-containing molecule). Since an athlete will be utilizing an abundant amount of ATP during their exercises, carbohydrate usage will have a positive effect on their training.

During carbohydrate usage, there will also be an increase in oxidative enzyme activity. A study conducted by Hargreaves and Spriet (2020) found that during training, not only is there enhanced skeletal muscle mitochondrial density, but also increased capacity for muscle carbohydrate oxidation. This same study found that increasing dietary carbohydrate intake before exercise will increase muscle glycogen availability and endurance exercise capacity (Hargreaves and Spriet, 2020). There is significance in the findings of this study because carbohydrate usage will provide an increase in stored muscle glycogen, which will allow an athlete to perform in events longer than 60-90 minutes. Because of this, they will be able to compete at higher intensities for longer time intervals.

Carbohydrate Recommendations for Athletes. Carbohydrate recommendations for athletes vary depending on the sport. General athlete recommendations are 5-10 grams per kilogram of body weight, the minimum being 5 grams per kilogram of body weight. In expression of total calories, an athlete should be consuming 50-65% of total kilocalories as carbohydrates and can vary up to 70% carbohydrates as their daily average for endurance athletes (Hassapidou, 2011). The Recommended Dietary Allowance (RDA) is the average amount of a nutrient a healthy person should consume each day. RDAs are developed by the Food and Nutrition Board at the Institute of Medicine of the National Academies (National Institutes of Health, 2020). In Dunford's book (2019) the athlete's recommendations are far above the RDA because athletes need more

carbohydrates than the average person. They are higher for athletes because increased carbohydrate availability enhances endurance and performance during a single exercise session (Burke, Cox, Cummings, & Desbrow, 2012). These recommendations vary depending on the timing of consumption, such as pre-workout versus post-workout.

Effects of Timing. Timing of carbohydrate intake will influence its metabolic effect. According to Kerksick, et al. (2017), carbohydrate timing can influence exercise performance (prior to exercise), and it can influence rates of glycogen resynthesis (post-exercise). If there is not proper timing of carbohydrate consumption, it may be disadvantageous to sports performance. These considerations include: gastrointestinal tolerance and if the carbohydrate is easily digested; glycemic index, since higher glycemic index food is beneficial due to the spike in insulin; but also trial and error, which refers to the strategies that work for a specific athlete (Mata, et al., 2019). Timing and amount of carbohydrates prior to exercise should be: 3-4.5 grams/kilogram body weight 3-4 hours before training; 2 grams/kilogram body weight 2 hours before training; or 1 gram/kilogram body weight 1 hour before training. Timing and amount of carbohydrate after exercise should be 1.5 grams/kilogram body weight during the first hour after exercise and 0.75-1.5 grams/kilogram each subsequent hour for four hours (Mata, et al., 2019).

Carbohydrates Prior to Exercise. Carbohydrates prior to exercise appear to be beneficial to performance to provide energy and reduce time to exhaustion. Carbohydrates provide glucose, the main energy source, and exercise stimulates the uptake of glucose. As exercise intensity increases, more ATP will be coming from carbohydrates because carbohydrates improve performance by preventing hypoglycemia and maintaining high levels of carbohydrate oxidation (Beck, Thomson, Swift, & Hurst, 2015). Therefore, the consumption of carbohydrates prior to exercise will provide energy to the body and prevent the body from fatiguing. In a study

conducted by Ormsbee, et al. (2014), their results stated that consuming carbohydrate-rich meals in the hours prior to endurance exercise appears to benefit performance. Carbohydrates were beneficial to their performance because this glucose maximized glycogen stores and contributed to rapid glycogen resynthesis, and it also increased time to exhaustion.

Carbohydrates After Exercise. Carbohydrates after exercise are just as important for sports performance. Consuming carbohydrates immediately after exercise increases the rate of muscle glycogen synthesis and also results in greater endurance capacity during subsequent exercise (Williams, 2004). If an athlete waits as little as two hours to consume these carbohydrates, it will slow the rate of glycogen synthesis. Studies show a supercompensation of glycogen stores when carbohydrate is consumed immediately post-exercise. Since exercise enhances insulin-stimulated glucose uptake following a workout with a strong correlation between the amount of uptake and the magnitude of glycogen utilization, there is a rapid uptake of glucose following an exercise bout, allowing glycogen to be replenished at an accelerated rate (Richter, Derave, & Wojtaszewski, 2001).

A recovery diet of carbohydrates should consist of roughly 10 grams/kilogram body mass per day. To restate, specific recommendations for carbohydrates immediately *following* training should be 1.0-1.5 grams/kilogram body weight during the first half hour after exercise and again every two hours for four-six hours in order to replace liver and muscle glycogen stores (Hassapidou, 2011). Smaller and more frequent meals will improve tolerance to nutrition, and it will create a steady insulin response. The goal is to obtain a long and stable insulin level as soon as possible. Consuming carbohydrates immediately post-exercise to coincide with the initial rapid phase of glycogen synthesis has been used as a strategy to maximize rates of muscle

glycogen synthesis, which ultimately improve recovery in the athlete by attenuating muscle damage and soreness (Beck, et al, 2015).

Importance of Protein

Protein Intake. Protein intake will induce a significant rise in muscle protein synthesis. Protein functions to provide energy, form glucose, transport nutrients, maintain fluid balance, and many other body functions. Proper consumption of protein for an athlete can improve strength, hypertrophy, body composition, and performance (Cintineo, Arent, Antonio, & Arent, 2018). In this study, the authors found that athletes should consume protein post-training and post-competition in order to see optimal results. There are many factors that affect the utility of post-workout feedings on training status such as the type of athlete, duration of exercise, the number of training sessions per day, or the number of competitive events per day.

Protein Recommendations for Athletes. Protein recommendations for athletes depend on the type of athlete. The Recommended Dietary Allowance for protein is 0.8 grams of protein per kilogram body weight; however, athletes require higher protein intake for their bodies. Protein recommendations for athletes can vary from 0.8 grams/kilogram body weight up to 2.0 grams/kilogram body weight. A recreational athlete will need between 0.8-1.0g/kg/day; a middle distance runner will need between 1.2-1.5 g/kg/day to reflect an increase in volume and intensity of training; an athlete in an active muscle-building phase will need 2.0 g/kg/day to support an increase in skeletal muscle mass; an athlete retuning to a muscle-maintaining phase after an increase in skeletal muscle mass will need to decrease their intake to 1.5 g/kg/day for muscle maintenance; and an ultra-endurance athlete will need between 1.2-2.0 g/kg/day for an adjustment of protein intake to reflect rest, low volume, and high volume endurance training phases (Kanter, 2018). According to a study conducted by Cintineo, et al. (2019), it is more

appropriate for active individuals attempting to optimizing training adaptations to follow a protein intake of at least 1.4-1.6 grams/kilogram body weight per day.

Effects of Timing. Timing of protein intake will influence the metabolic effects of muscle protein synthesis. There is an anabolic window after exercise where the body is in a building state. This window is most potent within the first two hours following training, but the prime time frame would be within the first 15 minutes. Following exercise, there is a transition from a catabolic to an anabolic state. Because of this, it is important for athletes to consume protein as soon as possible in order to capitalize on greater muscle mass gain and greater gains in oxidative capacity, since the goal is to undergo muscle protein synthesis (Stark, Lukaszuk, Prawitz, & Salacinski, 2012). Protein use for athletes is a popular topic; however, the effects of timing plays a very important role into attaining the benefits. Though protein-containing meals result in an increase of muscle protein synthesis, the timing of ingestion of protein around exercise further enhances this increase of muscle protein synthesis (Cintineo, et al., 2019).

Protein After Exercise. Protein after exercise is crucial to an athlete's recovery. The goal for protein consumption is 15-25 grams of protein following training. In terms of grams per kilogram of body weight, the recommendation is 0.25-0.30 g/kg. Although it is important to consume a protein source, the quality of protein is also important. The ingestion of whole foods, which contain a food matrix rich in dietary protein, vitamins, minerals, and other macronutrients to stimulate post-exercise muscle protein remodeling may also provide additional benefits such as improvements in overall diet quality (Van Vilet, Beals, Matrinez, Skinner, & Burd, 2018). The purpose of this specific study was to investigate how to achieve optimal post-exercise muscle protein remodeling in physically active individuals through whole food consumption. Therefore, the quality of protein and nutrition in general does affect sports performance improvement. Some

athletes may struggle with achieving optimal nutrition due to availability, cost, and preference. Due to this, Van Vilet et al. (2018) state that protein supplements remain a convenient complementary nutritional strategy for physically active individuals to meet protein recommendations, which will provide dietary amino acids to stimulate skeletal muscle protein remodeling and repair. The quality of protein for an athlete plays an important role in their performance and recovery; however, if an athlete can manage to consume a protein source following exercise, it will still provide them with the proper nutrients that will provide their body with proper fuels for recovery.

Carbohydrates and Protein

Recovery for an Athlete. Recovery for an athlete involves the consumption of both carbohydrates and protein. A recovery diet that is high in carbohydrate will allow athletes to restore their exercise capacity on the following day (Williams, 2004). Incorporating protein into a recovery diet will help with muscle protein synthesis. Consuming a carbohydrate-protein mixture during recovery from exercise increases the insulin response and glycogen synthesis rate (Williams, 2004). As stated, consuming these macronutrients at the most beneficial time will positively impact sports performance. Kerksick, et al. (2017) found that the timing of energy intake and the ratio of certain ingested macronutrients may enhance recovery and tissue repair, augment muscle protein synthesis, and improve mood states following high-volume or intense exercise.

The Carbohydrate-Protein Mixture. The carbohydrate-protein mixture will restore glycogen in the body and the insulin from the carbohydrate source will stimulate amino acid uptake. These sources should be those of high quality in order to receive optimal results. Although whole foods are the preferred option and an athlete should be encouraged to consume high-quality sources, an

athlete may struggle with time, cost, and preferences. Therefore, the educational information should capitalize on the importance of consuming a carbohydrate-protein mixture, which can be convenient yet effective. There is evidence supporting that glycogen availability will mediate muscle protein breakdown; therefore, carbohydrates and protein usage should be consumed together for optimal results. Berardi et al. (2006) discovered that adding protein to a post-workout carbohydrate meal can enhance glycogen re-synthesis.

Nutrient Timing. Nutrient timing is a popular nutritional strategy that involves the consumption of combinations of carbohydrate and protein in and around exercise session (Aragon & Schoenfeld, 2013). The purpose of this study was to review existing literature on the effects of nutrient timing with respect to post-exercise muscular adaptations and to draw relevant conclusions that allow practical, evidence-based nutritional recommendations to be made for maximizing the anabolic response to exercise. They found that expediting glycogen resynthesis is important for a narrow subset of endurance sports where the duration between glycogen depleting is limited. With the supporting evidence that there are benefits of quick repletion of glycogen stores, it has also been found that another purported benefit of post-workout nutrient timing is an attenuation of muscle protein breakdown (Aragon & Schoenfeld, 2013).

Theory of Planned Behaviors

Definition. The Theory of Planned Behavior (TPB) is a model utilized in this study to evaluate the outcome of changes in dietary intake. The TPB is used to predict an individual's intention to engage in a behavior at a specific time and place and it was intended to explain all behaviors over which people have the ability to exert self-control (LaMorte, 2019). The key component to this model is behavioral intent because behavioral intentions are influenced by the attitude about the likelihood that the behavior will have the expected outcomes.

Constructs. There are six constructs that collectively represent a person's actual control over the behavior. These six constructs include: attitudes; behavioral intention; subjective norms; social norms; perceived power; and perceived behavioral control. These constructs have been used to successfully predict and explain a wide range of health behaviors (LaMorte, 2019). Ogden (2016) studied the feasibility of behavior changes and mentioned that it is important to realize that individuals will behave uniquely in response to intrapersonal, interpersonal, and external factors. It can be concluded that without intention to change, an athlete's dietary intakes will not improve because athletes need both nutrition knowledge and have intentions to change their behaviors.

Dietary Interventions

Athletes often have significant gaps in their nutrition knowledge. In order to measure if nutrition knowledge and dietary intake can be improved through an education intervention, Heikkila et al. (2019) collected data on 79 endurance athletes in a randomized controlled intervention. This intervention incorporated education sessions with lectures, discussions, exercises, and individual and group work that lasted 90 minutes each. The nutrition knowledge topics covered included: the importance of nutrition for athlete performance, energy requirements; fluids; carbohydrate, protein, and fat intakes; minerals and vitamins; and supplements and challenges. Their findings revealed significant and long-term improvement in nutrition knowledge amongst the athletes; however, the nutrition education intervention alone was not enough to change dietary intake.

Delivering a successful dietary intervention is essential to the role of sports nutrition. Previous research suggests that dietary interventions are more successful when changed behavior strategies are incorporated into the intervention. An athlete is able to obtain nutrition information

but not be willing to change their dietary habits. Atkins and Michie (2015) studied the changed behaviors in 20,000 United Kingdom adults, and they found that effective interventions (such as education seminars or handouts) are needed to encourage changed behaviors. Intervention designers are encouraged to identify and address barriers in order to support the implementation. Ogden (2016) studied the feasibility of behavior changes and mentioned that it is important to realize that individuals will behave uniquely in response to intrapersonal, interpersonal, and external factors.

Behavior Change

Environmental Interventions. To properly assess sports nutrition knowledge and comprehension, the changes in dietary attitudes/beliefs relevant to sport performance are often analyzed to see if behavior change is associated with an increase in nutrition knowledge. Coutts (2017) stated that high-performance sports are time-pressured environments where the necessity for immediate results can often supersede pursuit of the most effective evidence-based practice. Since athletes experience high-stress environments, it is often challenging to change dietary behaviors in athletes. Patton-Lopez et al. (2018) found that sports nutrition education interventions should be paired with environmental interventions to increase healthy food options. This study initiated a general nutrition and sports nutrition knowledge questionnaire as a part of the intervention. This study also had a similar approach to pre- and post-workout consumption in which they encouraged athletes to eat prior to physical activity and to initiate a recovery meal soon after this activity. Their findings found a significant increase in athletes reporting to eat for performance, which includes pre- and post-workout (Patton-Lopez et al., 2018); therefore, it is believed that the encouragement of a nutrition intervention can be effective at improving dietary intake both pre- and post-training.

Athletic Performance. Another study conducted by Dunn and colleagues (2008) investigated dietary behaviors and how they may affect health status and athletic performance. Similar to the results from Patton-Lopez et al. (2018), the majority of student athletes had healthy attitudes about eating behaviors. Behavioral traits are an important factor to monitor when assessing nutrition knowledge. Dunn et al. (2008) utilized a survey to compare nutrition knowledge and attitudes of college athletes. The results of the survey revealed a lack of nutrition knowledge among university athletes. The authors stated that more research is needed regarding the effects of nutrition interventions on knowledge, attitudes, and food behavior (Dunn, et al., 2008). As mentioned, lack of nutrition knowledge is a prominent problem within the sports nutrition world; therefore, our study is being conducted to provide nutrition information to educate collegiate athletes and to also positively change their dietary behaviors.

Microsoft Teams

The effectiveness of this Teams app has been used in other studies. It has been found that this app allows for stable communication factors such as goals and roles (Benishek & Lazzara, 2019). In this specific study, there was an intervention completed on its effectiveness. This intervention revealed that team-based interventions such as systemic activity aimed at strengthening team competencies and dynamics improved team performance (Benishek & Lazzara, 2019). Microsoft Teams has shown to be an effective tool to implement within a study design to communicate with a specific population. Microsoft Team is defined as unpacking five important characteristics of teams, including membership, interdependence, shared goals, dynamics, and an organizationally bounded context (Benishek & Lazzara, 2019). Microsoft Teams has shown to be an effective collaboration and communication platform.

It is essential to have a functional and sustainable communication tool when studying the effectiveness of an intervention. Buchal and Songsore (2019) utilized Microsoft Teams as a collaborative knowledge building platform. This study found that this communication application was effective in developing the ability to build upon knowledge. Microsoft Teams was not only effective with knowledge enhancement but that it was also a sustainable messaging/communication, sharing, and collaborating tool (Buchal & Songsore, 2019). Microsoft Teams can be accessed via a web browser through a computer or via mobile phone by downloading the application. Many interventions utilizing Microsoft Teams are accessed via a mobile phone. From previous literature, it has been shown that mobile phones have become the most accessible form of mediated communication in world history, and text messaging has become one of the most frequently used forms of mobile communication (Hall, Cole-Lewis, & Bernhardt, 2015).

Text-Message Based Interventions

Mobile devices are used frequently and their short message services (SMS) are used by an enormous amount of individuals. Text-messaging interventions may be well-suited for public health interventions. Several strengths this approach include the relatively low cost and ability to reach large groups of people (Hall, Cole-Lewis, & Bernhardt, 2015). Although there have been many text-message based interventions conducted, there is still room for improvement. Fjeldsoe et al. (2009) suggested that text message interventions have positive short-term behavioral outcomes but that further research is required to evaluate interventions for health behaviors. Monitoring behavior change over a longer period of time is something that should be investigated. Other limitations include the lack of interaction with experts or the absence of

tailoring content to individuals (Sabin et al., 2017). Future direction might consider enhancements to foster this communication.

Perhaps tailoring and personalizing messages may result in an increased efficacy to promote health behaviors. Head et al. (2013) investigated the efficacy of text-messaging based health promotion interventions. They found that message tailoring and personalization were significantly associated with greater intervention efficacy. It is a known concept that student athletes have many obligations and are often faced with time-management obstacles. Many of these individuals have specific barriers to applying knowledge to behavior change. Ludwig and colleagues (2018) investigated the efficacy of a text message intervention for health improvement as well. The authors propose incorporating the following elements in future studies: specific focus on desired health behavior; include long-term follow-up; include self-monitoring, goal setting, and feedback; combine SMS with a mobile app; and send three or more SMS text messages per week.

Conclusion

There are many elements to consider when investigating the feasibility of a text-message based intervention on nutrition knowledge and nutrition behavior. Through previous research, there is an evident gap between nutrition knowledge and collegiate athletes, which can be related to various factors: lack of resources, increased stress, lack of time, or willingness to change their current dietary habits. Macronutrients have specific functions in athletic performance and recovery, which consist of their doses, timing of ingestion, and type of macronutrient. Carbohydrate consumption before training and a carbohydrate-protein mixture following training are the key macronutrients that aid in athletic performance and recovery. Mobile devices are very prominent in today's society, and this cements the reason to utilize a text-message based

intervention. Microsoft Teams is an effective app for stable communication and goal-setting, which can be used to educate collegiate athletes on nutrition, as well as encourage them to change their current dietary behaviors.

REFERENCES

Ajzen, I. (2013). Theory of Planned Behavior Questionnaire. Measurement Instrument Database for the Social Science. Retrieved from www.midss.ie

Aragon, A. & Schoenfeld, B. (2013). Nutrient timing revisited: is there a post-exercise anabolic window? *Journal of the International Society of Sports Nutrition 10*: 5. Doi: 10.1186/1550-2783-10-5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3577439/#B26

Atkins, L., & Michie, S. (2015). Designing interventions to change eating behaviors. *Proceedings of the Nutrition Society 74*(2): 164-170. https://doi.org/10.1017/S0029665115000075

Beck, K., Thomson, J., Swift, R., & von Hurst, P. (2015). Role of nutrition in performance enhancement and post-exercise recovery. *Journal of Sports Medicine 6*: 259-267. Doi: 10.2147/OAJSM.S33605. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4540168/

Benishek, L. & Lazzara, E. (2019). Teams in a new era: some considerations and implications. *Frontiers in Psychology 10*: 1006. Doi: 10.3389/fpsyg.2019.01006. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6520615/

Berardi, J., Price, T., Noreen, E., & Lemon, P. (2006). Post-exercise muscle glycogen recovery enhanced with a carbohydrate-protein supplement. *Medicine and Science in Sports and Exercise 38*(6): 1106-1113.

Bill, H. (2015). Effects of nutrition education messages delivered by SMS/text message on self-efficacy, dietary intake, and body composition of college athletes. [Masters dissertation, California State Polytechnic University]. California State Polytechnic University Research Repository. https://scholarworks.calstate.edu/downloads/sn00b0918?locale=en

Buchal, R. & Songsore, E. (2019). Using Microsoft Teams to support collaborative knowledge building in the context of sustainability assessment. *Engineering.* https://doi.org/10.24908/pceea.vi0.13806

Burke, L., Cox, G., Cummings, N., & Desbrow, B. (2012). Guidelines for daily carbohydrate intake. *Sports Medicine 31*: 267-299. https://link.springer.com/article/10.2165/00007256-200131040-00003

Bytomski, J. (2017). Fueling for performance. *Sports Health 10*(1): 47-53. https://doi.org/10.1177/1941738117743913

Cintineo, H., Arent, M., Antonio, J., & Arent, S. (2018). Effects of protein supplementation on performance and recovery in resistance and endurance training. *Frontiers in Nutrition 5*: 83. https://doi.org/10.3389/fnut.2018.00083

Coutts, A.J. (2017). Challenges in developing evidence-based practice in high-performance sport. *International Journal of Sports Physiology and Performance 12*: 717-718. https://doi.org/10.1123/IJSPP/2017-0455

Dunford, M. & Doyle, J.A. (2019). *Nutrition for Sport and Exercise*. Fourth edition. Boston, MA: Cengage.

Dunn, D., Turner, L., & Denny, G. (2008). Nutrition knowledge and attitudes of college athletes. *The Sport Journal 22*.

Fjeldsoe, B., Marshall, A., & Miller, Y. (2009). Behavior change interventions delivered by mobile telephone short-message service. *American Journal of Preventative Medicine 36*(2): 165-173. https://doi.org/10.1016/j.amepre.2008.09.040

Gerber, B.S., Stolley, M.R., Thompson, A.L., Sharp, L.K., & Fitzgibbon, M.L. (2009). Mobile phone text messaging to promote healthy behaviors and weight loss maintenance: A feasibility study. *Health Informatics Journal 15*(1), 17-25.

Hall, A., Cole-Lewis, H., and Bernhardt, J. (2015). Mobile text messaging for health: a systematic review of reviews. *Annual Review of Public Health 36*: 393-415. Doi: 10.1146/annurev-publhealth-031914-122855. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4406229/

Hargreaves, M. and Spriet, L. (2020). Skeletal muscle energy metabolism during exercise. *Nature Metabolism 2*, 817-828.

Hassapidou, M. (2011). Carbohydrate requirements of elite athletes. *Sports Medicine 45*(2). https://dx.doi.org/10.1136/bjsm.2010.081570.23

Head, K., Noar, S., Iannarino, N., & Harrington, N. Efficacy of text messaging-based interventions for health promotion: A meta-analysis. *Social Science & Medicine 97*: 41-48. https://doi.org/10.1016/j.socscimed.2013.08.003

Heikkila, M., Lehtovirta, M., Autio, O., Fodelholm, M., & Valve, R. (2019). The impact of nutrition education intervention with and without a mobile phone application on nutrition knowledge among young endurance athletes. *Nutrients 11*(9): 2249. https://doi.org/10.3390/nu11092249

Kanter, M. (2018). High-quality carbohydrates and physical performance. *Nutrition Today 53*(1): 35-39. https://doi.org/10.1097/NT.0000000000000238

Kerksick, C., Arent, S., Schoenfeld, B., Stout, J., Campbell, B., Wilborn, C., Taylor, L., Kalman, D., Smith-Ryan, A., Kreider, R., Willoughby, D., Arciero, P., VanDusseldorp, T., Ormsbee, M., Wildman, R., Greenwood, M., Ziegenfuss, T., Aragon, A., & Antonio, J. (2017). International society of sports nutrition position stand: nutrient timing. *Journal of the International Society of Sports Nutrition 14*: 33. Doi: 10.1186/s12970-017-0189-4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5596471/

LaMorte, W. (2019). The Theory of Planned Behavior. *Boston University School of Public Health*. Retrieved from https://sphweb.bumc.bu.edu/otlt/mph-modules/sb/behavioralchangetheories/BehavioralChangeTheories3.html

Leon, N., Namadingo, H., Bobrow, K., Cooper, S., Crampin, A., Pauly, B., Levitt, N., & Farmer, A. (2021). Intervention development of a brief messaging intervention for a randomized controlled trial to improve diabetes treatment adherence in sub-Saharan Africa. *BMC Public Health 21*(147). https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-020-10089-6

Ludwig, K., Arthur, R., Sculthorpe, N., Fountain, H., & Buchan, D. (2018). Text messaging interventions for improvement in physical activity and sedentary behavior in youth: Systemic review. *Journal of Medical Internet Research 6*(9): e10799. https://doi.org/10.2196/10799

Mata, F., Valenzuela, P., Gimenez, J., Tur, C., Ferreria, D., Dominguez, R., Sanchez-Oliver, A., Sanz, J., (2019). Carbohydrate availability and Physical performance: Physiological overview and practical recommendations. *Nutrients 11*(5): 1084.

National Institutes of Health (2020). *Nutrient Recommendations: Dietary Reference Intakes (DRIs).* Office of Dietary Supplements. https://ods.od.nih.gov/HealthInformation/Dietary_References_Intakes.aspx

Noonan, D., Silva, S., Njuru, J., Bishop, T., Fish, L., Simmons, L., Choi, S., & Pollak, K. (2018). Feasibility of a text-based smoking cessation intervention in rural older adults. *Health Education Research 33*(1): 81-88. http://doi.org/10.1093/her/cyx080

Ogden, J. (2016). Celebrating variability and a call to limit systematization: The example of the behavior change technique taxonomy and the behavior change wheel. *Health Psychology Review*, 10: 245-250. https://doi.org/10.1080/17437199.2016.1190291

Ormsbee, M., Bach, C., and Baur, D. (2014). Pre-exercise nutrition: the role of macronutrients, modified starches and supplements on metabolism and endurance performance. *Nutrients 6*(5): 1782-1808. Doi: 10.3390/nu6051782. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4042570/

Papadopoulou, S. (2020). Rehabilitation nutrition for injury recovery of athletes: the role of macronutrient intake. *Nutrients 12*(8): 2449. Doi: 10.3390/nu12082449. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7468744/

Patton-Lopez, M., Manore, M., Branscum, A., Meng, Y., and Wong, S. (2018). Changes in sports nutrition knowledge, attitudes/beliefs and behaviors following a two-year sports nutrition education and life-style intervention among high school soccer players. *Nutrients 10*(11): 1636. Doi: 10.3390/nu10111636. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6266993/

Richter, E., Derave, W., & Wojtaszewski, J. (2001). Glucose, exercise and insulin: emerging concepts. *The Journal of Physiology 535*: 313-322.

Rossi, F., Landreth, A., Beam, S., Jones, T., Norton, L., & Cholewa, J. (2017). The effects of a sports nutrition education intervention on nutritional status, sport nutrition knowledge, body composition, and performance during off season training in NCAA division I baseball players. *Journal of Sports Science & Medicine 16*(1): 60-68. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5358033/#ref25

Sabin, L. L, Larson Williams, A., Le, B. N., Herman, A. R., Viet Nguyen, H., Albanese, R. R., Xiong, W., Shobiye, H. O., Halim, N., Tran, L., McNabb, M., Hoang, H., Falconer, A., Nguyen, T., & Gill, C. J. (2017). Benefits and limitations of text messages to stimulate higher learning among community providers: Participants' views of an mHealth intervention to support continuing medical education in Vietnam. *Global Health, Science and Practice*, *5*(2), 261–273. https://doi.org/10.9745/GHSP-D-16-00348

Slavin, J., and Carlson, J. (2014). Carbohydrates. *Advances in Nutrition 5*(6): 760-761. Doi: 10.3945/an.114.006163. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4224210/

Stark, M., Lukaszuk, J., Prawitz, & Salacinski, A. (2012). Protein timing and its effects on muscular hypertrophy and strength in individuals engaged in weight-training. *Journal of the International Society of Sports Nutrition 9*: 54. https://doi.org/10.1186/1550-2783-9-54

Van Vilet, S., Beals, J., Martinez, I., Skinner, S., & Burd, N. (2018). Achieving optimal post-exercise muscle protein remodeling in physically active adults through whole food consumption. *Nutrients 10*(2): 224. Doi: 10.3390/nu10020224. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5852800/

Watford, M., and Wu, G. (2018). Protein. *Advances in Nutrition 9*(5): 651-653. Doi: 10.1093/advances/nmy027. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6140426/#:~:text=Abstract,linked%20via%20%CE%B1%2Dpeptide%20bonds.

Werner, E., Guadgni, A., & Pivarnik, J. (2020). Assessment of nutrition knowledge in division I college athletes. *Journal of American College Health*: 1-8.

Williams, C. (2004). Carbohydrate intake and recovery from exercise. *Science & Sport 19*(5): 239-244. Doi: 10/1016/j.scrispo.2004.05.005. https://www.sciencedirect.com/science/article/abs/pii/S076515970400053X

Zinn, C., Schofield, G., and Wall, C. (2005). Development of a psychometrically valid and reliable sports nutrition knowledge questionnaire. *Journal of Sports Science & Medicine 8*(3): 346-351. Doi: 10.1016/s1440-2440(05)80045-3. https://pubmed.ncbi.nlm.nih.gov/16248475/

APPENDIX A: ELIGIBILITY

Q1 Are you at least 18 years of age?

- ○ Yes (1)
- ○ No (2)

Q2 Are you currently a student-athlete at Illinois State University?

- ○ Yes (1)
- ○ No (2)

APPENDIX B: DEMOGRAPHIC QUESTIONS

Q3 What is your biological sex?

- ○ Male (1)
- ○ Female (2)
- ○ Prefer not to answer (3)

Q4 What is your ethnicity?

- ○ White/Caucasian (1)
- ○ African-American (2)
- ○ Hispanic-American (3)
- ○ Native-American (4)
- ○ Pacific Islander (5)
- ○ Other (6)
- ○ Prefer not to answer (7)

Q5 What year in school are you?

- ○ Freshman (1)
- ○ Sophomore (2)
- ○ Junior (3)
- ○ Senior (4)
- ○ Graduate School (Master's/Doctoral Program) (5)

Q6 What is your height in feet and inches?

	0 1 2 3 4 6 7 8 9 10 11
Feet ()	
Inches ()	

Q7 What is your weight in pounds?

_____

Q8 Which sport do you play?

- ○ Baseball (1)
- ○ Softball (2)
- ○ Men's Basketball (3)
- ○ Women's Basketball (4)
- ○ Men's Cross Country (5)
- ○ Women's Cross Country (6)
- ○ Football (7)
- ○ Men's Golf (8)
- ○ Women's Golf (9)
- ○ Men's Tennis (10)
- ○ Women's Tennis (11)
- ○ Men's Track and Field (12)
- ○ Women's Track and Field (13)
- ○ Gymnastics (14)
- ○ Soccer (15)
- ○ Swimming and Diving (16)
- ○ Volleyball (17)

Q9 Do you have access to the dining hall during the school year and/or summer? If so, what plan are you enrolled in?

	I have access BUT only a limited number of swipes (1)	I have access AND an unlimited number of swipes (2)	I do not have access (3)
During the school year (1)	○	○	○
During the summer (2)	○	○	○

APPENDIX C: SURVEY QUESTIONS

Nutrition Knowledge Questionnaire

Nutrients

Q10 Do you think these foods are high or low in carbohydrate (Check one box per food).

	High (1)	Low (2)	Unsure (3)
Chicken (1)	○	○	○
Baked beans (2)	○	○	○
White bread (3)	○	○	○
Butter (4)	○	○	○
Cornflakes cereal (5)	○	○	○
Cream of rice pudding (6)	○	○	○

Q11 Do you think these foods are high or low in protein (Check one box per food).

	High (1)	Low (2)	Unsure (3)
Chicken (1)	○	○	○
Baked beans (2)	○	○	○
Fruit (3)	○	○	○
Margarine (4)	○	○	○
Cornflakes cereal (5)	○	○	○
Peanuts (6)	○	○	○

Pre-Workout

Q12 Did you consume a carbohydrate source before your workout/practice today? (Check one box).

- ○ Yes (1)
- ○ No (2)

If yes, how long before your workout?

- ○ 1 hour (1)
- ○ 2 hours (2)
- ○ 3+ hours (3)

If yes, what did you have?

_____

Q13 Do you agree or disagree with this statement? Carbohydrates prior to exercise appear to be beneficial to performance to provide energy and delay time to exhaustion. (Check one box).

- ○ Agree (1)
- ○ Disagree (2)
- ○ Unsure (3)

Q14 Does the type of food consumed before practice effect training? (Check one box).

- ○ Yes (1)
- ○ No (2)
- ○ Unsure (3)

Recovery

Q15 What did you consume after your workout/practice today? (Check all that apply).

- ○ Carbohydrate (1)
- ○ Protein (2)
- ○ Fat (3)
- ○ Unsure (4)

Please list the specific food(s) you had:

_____

After practice, how soon did you consume this/these macronutrient(s)? (Check one box).

- ○ ASAP (5-15 minutes) (1)
- ○ 1 hour (2)
- ○ 2 hours (3)
- ○ 3+ hours (4)

Q16 The most important nutrient(s) to replace after training is/are: (Check all boxes that apply).

- ○ Carbohydrate (1)
- ○ Protein (2)
- ○ Fat (3)
- ○ Unsure (4)

Q17 Does the type of macronutrient consumed after your workout make a difference in sports performance? (Check one box).

- ○ Yes (1)
- ○ No (2)
- ○ Unsure (3)

Nutrition Behavior Questionnaire

Carbohydrates Before Training

Q18 Consuming carbohydrates before training would be:

- Good : _1_, _2_,_3_, _4_,_5_,_6_,_7_: Bad

Q19 Most of my teammates consume carbohydrates before training:

- Agree : _1_, _2_,_3_, _4_,_5_,_6_,_7_: Disagree

Q20 I am confident that I can consume carbohydrates before training:

- True : _1_, _2_,_3_, _4_,_5_,_6_,_7_: False

Q21 My carbohydrate consumption before training is up to me:

- Agree : _1_, _2_,_3_, _4_,_5_,_6_,_7_: Disagree

Q22 In the past three months, I have consumed carbohydrates before training:

- True : _1_, _2_,_3_, _4_,_5_,_6_,_7_: False

Q23 I intend to consume carbohydrates before training:

- Likely : _1_, _2_,_3_, _4_,_5_,_6_,_7_: Unlikely

Carbohydrate-Protein Mixture After Training

Q24 Consuming a carbohydrate-protein mixture after training would be:

- Good : _1_, _2_,_3_, _4_,_5_,_6_,_7_: Bad

Q25 Most of my teammates consume a carbohydrate-protein mixture after training:

- Agree : _1_, _2_,_3_, _4_,_5_,_6_,_7_: Disagree

Q26 I am confident that I can consume a carbohydrate-protein mixture after training:

- True : _1_, _2_,_3_, _4_,_5_,_6_,_7_: False

Q27 My carbohydrate-protein mixture consumption after training is up to me:

- Agree : _1_, _2_,_3_, _4_,_5_,_6_,_7_: Disagree

Q28 In the past three months, I have consumed a carbohydrate-protein mixture after training:

- True : _1_, _2_,_3_, _4_,_5_,_6_,_7_: False

Q29 I intend to consume a carbohydrate-protein mixture after training:

- Likely : _1_, _2_,_3_, _4_,_5_,_6_,_7_: Unlikely

APPENDIX D: INTERVENTION TEXT MESSAGES

Intervention Text Messages:

Week 1: Carbohydrates

1. Carbohydrates are sugars, starches, and fiber in food that are a source of energy for the body, and these sugars and starches provide glucose.
2. Glucose is the main energy source for the body and it is stored in the body as glycogen, and glycogen is used during exercise; and insulin takes up glucose during and after exercise.
3. Healthy sources of carbohydrates include: grains such as quinoa, brown rice, oats, cereal; starchy vegetables such as sweet potatoes, corn, squash, and peas; beans and lentils; and fruit such as bananas, oranges, and berries.

Week 2: Proteins

1. Proteins help the body build and repair cells and tissues by inducing a significant rise in muscle protein synthesis.
2. Proper consumption of protein for an athlete can improve strength, muscle size, body composition, and performance.
3. Healthy sources of protein include: animal-based sources such as chicken, beef, salmon, cod, egg whites, pork, whey, and milk; and plant-based sources such as tofu, tempeh, nut butter, seeds, almonds and cashews, chickpeas, and edamame.

Week 3: Carbohydrates Prior to Exercise & Timing

1. Increasing dietary carbohydrate intake before exercise will provide energy to an athlete before their workouts and increase their muscle glycogen availability.
2. Carbohydrate usage will increase endurance and delay time to exhaustion, so athletes can compete at higher intensities for longer periods of time.
3. As exercise intensity increases, more energy will be coming from carbohydrates because carbohydrates prevent fatigue and help maintain proper energy.

Week 4: Carbohydrate-Protein Mixture After Exercise & Timing

1. Consuming carbohydrates immediately after exercise (most potent in the first hour) increases the rate of muscle glycogen synthesis and results in greater endurance capacity during subsequent exercise.
2. It is important for athletes to consume protein within the first hour after training to capitalize on greater gains in muscle mass and strength, since the goal is to undergo muscle protein synthesis.
3. Consuming a carbohydrate-protein mixture during recovery from exercise increases the insulin response and glycogen synthesis rate, which will enhance recovery and tissue repair, increase muscle protein synthesis, and improve mood states following high-volume or intense exercise.