NUTRITION KNOWLEDGE AND INTEREST OF COLLEGIATE ATHLETES AT A DIVISION I UNIVERSITY

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ABSTRACT

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Statement of Problem: The major objectives of this study were to determine the difference in nutrition-related knowledge between sport, gender, and academic year; how nutrition interest varied between sport and gender; and how perceived nutrition-related knowledge correlated with actual nutrition-related knowledge in a collegiate athlete population.

Methods and Procedures: Data was collected using a survey, which was created new for the purposes of this study and was administered to student-athletes in a face-to-face setting. The survey instrument covered a variety of topic areas, including nutrition-related knowledge, perceived nutrition-related knowledge, and nutrition topics of interest. Data was analyzed after all 17 intercollegiate athletic teams, 319 subjects (approximately 75% of the student-athlete population), were surveyed. Descriptive statistics, inferential statistics, Pearson correlation, two-sample t-tests, and ANOVA tests were conducted.

Results: The women’s gymnastics team scored significantly higher with regard to nutrition-related knowledge than any other team surveyed, scoring an average of 9.9 out of 14 (p = 0.000). The men’s football and men’s basketball teams scored significantly lower with regard to nutrition-related knowledge than all other teams, scoring, on average, 7.5 and 6.6 out of 14, respectively (p = 0.000). Female athletes, scoring an 8.8 out of 14, scored significantly higher on average than male athletes, scoring a 7.8 out of 14 (p = 0.000). There was no significant difference in nutrition-related knowledge between academic years. Nutrition topics of interest varied between sport, with pre- and post-workout meals, healthier fast food alternatives, and
energy requirements being the topics of highest interest. Females, overall, were most interested in the topics of cheap, healthy meals and safe, healthy weight loss, while males were found to be most interested in the topics of sports drinks and muscle building. Lastly, there was no significant correlation found between perceived and actual nutrition-related knowledge ($r = 0.093$).

**Conclusions:** Future nutrition education interventions at the university under review should be tailored to fit the interests and education levels of the sport or gender being educated. This will assist in the optimization of retained information, providing a greater opportunity for improvements in athletic performance and overall quality of life.
“To eat is a necessity, but to eat intelligently is an art.” - La Rochefoucauld
I wish to dedicate this thesis to my parents, Paul and Angie Gilis, who have not only been incredibly and unconditionally supportive of me throughout my life but were also the inspiration for my interest in and passion for nutrition. Thank you very much for all of your past and continued love and understanding throughout the years.
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CHAPTER I

INTRODUCTION

It is well-documented that the majority of collegiate athletes lack the nutritional knowledge required to optimize athletic performance (1-10). Furthermore, athletes in the National Collegiate Athletic Association (NCAA) have been reported to have deleterious attitudes and behaviors with regard to proper nutrition (2-6, 8, 11, 12). Few studies, however, have determined what nutritional information collegiate athletes would be most interested in learning. Collegiate athletic programs could potentially benefit greatly through the incorporation of adequate nutrition in the athletes’ diets, but without first understanding what the athletes want, and more importantly, need to know, valuable education is unattainable. In addition, Rockwell, Nickols-Richardson, and Thye concluded that further nutrition education requirements might be necessary for coaches and athletic trainers (13). With coaches being an integral part in the collegiate athlete’s athletic career, discovering the nutrition knowledge of these “coaches and trainers” may be crucial in assisting the development of nutritionally-sound dietary behaviors.

Due to the increased physical demand of collegiate athletic programs, collegiate athletes have greater, specific nutritional requirements. The American College of Sports Medicine (ACSM) recommends that, as a result of high-intensity exercise, athletes should consume 150% more water than what was lost in sweat to reduce the risk of dehydration (14). Additionally, in order to ensure proper nutrition for those participating in a weight training regimen, consuming protein before a bout of anaerobic training, specifically weight lifting, can assist in muscle
recovery and consequently increase overall athletic performance (14). Women, in particular, may need improved nutrition, such as an increased consumption of iron-containing foods or even iron supplementation, due to their risk for developing iron-deficiency anemia as a result of menses, as well as because of their risk for developing osteoporosis later in life from insufficient calcium consumption (14, 15). Furthermore, Gabel suggested that female athletes commonly seen with amenorrhea, such as runners and other endurance athletes, might have a predisposition to the development of heart disease (15). These considerations only begin to discuss the nutritional needs of collegiate athletics and the importance of tailored nutrition education in collegiate athletic programs.

Bowling Green State University, the university under review, has recently created a Sport Performance Team, with the following message:

The role of the Sport Performance Team is to coordinate and provide athletic services in the areas of sports medicine, strength and conditioning, sports nutrition and body composition, sport psychology and mental health support (16).

The sports nutrition component of this is listed as follows:

Sports nutrition is a vital ingredient to the success of our student-athletes. Our Nutrition Coaches (Registered Dietitians and support staff) will help separate facts from fads and will translate science into information you can use. As part of the Sport Performance Team, our nutrition specialists will provide services to coaches, individual student-athletes and teams (16).

It is because of the Sport Performance Team that the study described below was created, in an effort to assist in the enhancement and optimization of collegiate athletic performance.
Statement of the Problem

In order for collegiate student-athletes to receive accurate and beneficial information on nutrition and nutrition-related practices, it is essential to first understand what the athletes need and want to know. In addition, there is no data available to determine what form of nutrition education is most relevant to individual collegiate athletic teams. Without first determining collegiate athlete interest with regard to nutrition-related topics and those methods that they would prefer to be informed about these topics, future nutrition education interventions are without guidance. Furthermore, a study to ensure the successful education of collegiate athletes, by determining their current and desired levels of nutritional knowledge, is critical.

Significance of the Problem

A review of 11 Big Ten Conference athletic departments found that only four individuals had “dietitian” or “nutritionist” in their job titles, and two of these individuals were at the University of Wisconsin (8). The clear lack of nutritional support in athletic programs provides athletes with no other option than to resort to alternative means for their information. As collegiate athletics grow, student-athletes will continue to pursue the next level of performance through any means necessary, without regard for individual well-being. Improper nutritional advice can often provide athletes with what they believe to be necessary to succeed and surpass their competition. Without valid education on this crucial aspect required to achieve optimal performance, collegiate athletic programs run the risk of practicing unhealthy behaviors that have the potential to cause serious complications for the athletes and their futures in athletics. By understanding what NCAA student-athletes need and want to know, an apposite nutrition education program can build athletic prominence, while also maintaining overall health.
Objectives of the Study

The major objectives of this study with regard to student athletes were to determine:

1. How nutritional knowledge of athletes vary between sport, gender, and academic year.

2. How nutritional interest of athletes vary between sport and gender.

3. How perceived nutritional knowledge correlates with actual nutritional knowledge.
CHAPTER II

REVIEW OF LITERATURE

Overview

The knowledge, attitudes, and behaviors of collegiate athletes toward nutrition have been shown through numerous reports to be deficient (1-8, 10, 11, 17, 18). By incorporating nutrition education into athletic advancement opportunities, such as training regimens, the knowledge and attitude of athletes regarding nutrition for athletic performance can significantly increase (4, 7, 18). If readily available, Registered Dietitians have been shown to be the number one source for nutrition information by collegiate athletes and coaches (5, 13). Without this foundation for nutrition education, athletes and coaches resort to alternative sources for information that may be unreliable and invalid (5, 13, 18). As misinformation progresses through an athletic program, deleterious behaviors may result, hindering athletic performance and, possibly, quality of life and health.

Nichols, Jonnalagadda, and Rosenbloom examined collegiate athletes at a southeast Division I NCAA institution for proper knowledge, attitudes, and behaviors regarding hydration and fluid replacement (3). This study concluded, after a two-part survey of 139 athletes participating in eight different sports, that there is a definite need for education on “proper hydration and fluid replacement practices” among collegiate athletes, and that regular monitoring should take place to ensure and emphasize positive attitudes and behaviors with regard to hydration (3). This conclusion is reinforced by the finding that one-fourth of the collegiate athletes surveyed in this study believed that thirst alone was a reliable indicator of dehydration.
and that, even though readily available, sports drinks were not used properly to maintain adequate hydration (3). As a preventative measure, understanding one’s sweat rate can be the first step in understanding fluid losses and adequate fluid replenishment (19). It was also discovered that certain athletes, such as those partaking in endurance sports, might have better knowledge on hydration than those in skill sports (3). This evidence suggests that, although the need for further nutrition education with regard to hydration is evident, the degree of education may vary among sports, creating the necessity for individualized, or tailored, nutrition education intervention programs.

In a report on the effectiveness of nutrition intervention for female collegiate athletes, Abood, Black, and Dirnbaum summarized that nutrition education interventions are needed and effective in order to increase self-efficacy and knowledge in female athletes (1). For those female athletes that received a nutrition education intervention, a significant increase in nutrition knowledge was noted, along with increases in self-efficacy and confidence towards making healthier food choices (1). Another study determined that male and female collegiate athletes alike reported consuming inadequate amounts of carbohydrate and protein, with male athletes consuming less energy from carbohydrate than females and, consequently, having a higher risk for falling below the recommended dietary range (2). This coincides with the finding by Dunn, Turner, and Denny that “most athletes incorrectly believe that carbohydrates should be decreased in the diet” (4). It was additionally suggested that athletes with higher energy requirements might have difficulty consuming sufficient energy (2). This denotes the need for nutrition education on high-kilocalorie foods for those requiring a greater supply of energy. In another study surveying 190 student-athletes at a Bowl Championship Series (BCS) school, only one athlete correctly identified diseases of the teeth as the most immediate health risk for sugar intake (8). These
findings suggest that nutrition education, overall, is lacking in collegiate athletics, and without intervention, a resolution to the issue is unattainable.

Nutrition for Athletes

Not only are there increased energy needs for athletes, but there are also varying macro- and micronutrient requirements associated with increased physical activity and achieving optimal athletic performance. Strategies for nutritional needs can differ between pre-training, post-training, pre-game, competition, post-game, off-season, and the transitions between these periods (20). Furthermore, adolescent athletes, collegiate athletes, and professional athletes may each require specific levels of nutritional support that are appropriate for their age, sport, and competition level. Houtkooper, Abbot, and Nimmo stated the following with regard to throwers, jumpers, and combined events athletes, although highly relevant to all athletes:

Nutritional recommendations for training and competition periods include: (1) meeting energy needs; (2) timing consumption of adequate fluid and electrolyte intakes before, during, and after exercise to promote adequate hydration; (3) timing consumption of carbohydrate intake to provide adequate fuel for energy demands and to spare protein for muscle repair, growth, and maintenance; (4) timing consumption of adequate protein intake to meet protein synthesis and turnover needs; and (5) consuming effective nutritional and dietary supplements (20).

Overall, while carbohydrate is the main source of energy, protein, providing some energy, should be consumed in an amount that meets amino acid requirements for the formation and turnover of body protein, leaving fat to provide the remainder of the energy needs (20). Although alcohol
provides energy, it is not an essential nutrient and may have harmful effects on athletic performance if consumed in excess (20).

*Carbohydrate*

Depletion of carbohydrate stores is a major underlying factor in the contribution of fatigue and decreased athletic performance (20-22). Burke, Loucks, and Broad noted that it requires at least 24-48 hours before a game to super-compensate, or even replenish, muscle glycogen stores (23). Fully replenished glycogen stores allow an athlete to have an enhanced capacity to undertake repeated bouts of exercise and increase their overall amount of performed work (23). In soccer players, high-carbohydrate diets have been linked with increases in muscle glycogen content by 38%, as well as a 33% higher intensity performance during games (23). Coinciding with this finding, elite ice hockey players on a high-carbohydrate diet [8.4 grams per kilogram of body weight per day (g/kg/d)] were found to be able to skate longer distances at higher intensities than when consuming their normal diet (6.2 g/kg/d) (23-25). Specifically, distance skated, amount of time skated within shifts, and skating speed were all increased in these elite ice hockey athletes that were consuming a high-carbohydrate diet (23-25). Moreover, the athletes following this diet regimen were able to restore their muscle glycogen concentrations before their next game 45% more efficiently, further enhancing overall recovery (23-25). Burke, Loucks, and Broad stated with regard to post-exercise refueling, “as long as total energy intake is adequate, increasing amounts of dietary carbohydrate promotes increased muscle glycogen storage until the upper limit for glycogen synthesis is reached at intakes of about 10 g/kg/d” (23, 25, 26).
Specific carbohydrate requirements have been listed as 3-5 g/kg/d for athletes with very light training and low-intensity exercise or skill-based exercises (20, 27). For those athletes that have less mobile roles, moderate training schedules, or desire periods of energy restriction for fat loss, a recommendation of 5-7 g/kg/d is appropriate (20, 23, 25, 27, 28). Subsequently, an increased recommendation of 7-12 g/kg/d was set for those athletes that have more mobile roles, wish to maximize muscle glycogen refueling, or have heavy training schedules (20, 23, 25).

Furthermore, for those athletes that may be uneducated or misinformed about pre-event nutritional recommendations, athletic performance may be improved through proper education with regard to this material. Pre-exercise training meals should be consumed between 1-4 hours prior to exercise and are recommended to contain around 1-4 g/kg/d of carbohydrate (20, 22, 27). For those that have early morning events, the pre-competition meal should be consumed one hour prior to the event and focus mainly on carbohydrates and familiar, well-tolerated foods (20, 22, 29). During training sessions lasting longer than one hour, athletes should consume 0.5-1.0 g/kg of body weight per hour, or about 30-60 grams per hour throughout each hour of actual exercise training, by eating or drinking every 10-30 minutes (20, 27, 30). This will allow for greater levels of glycogen replenishment, while also maintaining the high level of energy necessary for the activity (20, 21, 29). Additionally, because of enhanced glucose delivery and enzyme activity within the muscle, the highest rate for muscle glycogen storage is within the first hour after exercise (20, 23, 25). Thus, it is proposed that, following exercise, an athlete consume 1.0-1.2 g/kg of body weight of carbohydrate immediately after, and then again two hours after, exercise (20, 25). Therefore, athletes need not only be aware of their increased dietary needs, but also the timing with which they choose to refuel, as it can have marked effects on their athletic performance.
Protein

Physiologically, humans require 24 kilocalories of energy for the synthesis of one gram of protein (31). This energy should be from carbohydrates and fats; otherwise, energy will be taken from amino acids, reducing the amount available for protein synthesis (31). For this reason, athletes participating in strength training to increase muscle mass and power-to-mass ratio require adequate carbohydrate intake to provide energy to fuel training and meet total energy needs, sparing protein for muscle growth and turnover (20, 32). The two main factors that are important for making individualized recommendations on protein intake are as follows: (1) Overall energy needs must be met to make the ingested protein available for muscle repair, maintenance, and growth; and (2) the timing of protein intake is significant because of its influence on the anabolic response of muscle in relation to exercise (20, 32, 33). Advancements in muscle hypertrophy and the power-to-mass ratio require that an athlete focus on an adequate consumption of energy, consuming protein close to the start and/or end of the exercise, and maintaining appropriate protein and energy intakes during rest days (20, 32).

The Academy of Nutrition and Dietetics (AND), International Olympic Committee (IOC), Dietitians of Canada (DC), and the American College of Sports Medicine (ACSM) have set protein requirements for strength and speed athletes of 1.2-1.7 g/kg/d and 1.2-1.4 g/kg/d for endurance athletes (26, 32). However, during the off-season and transition periods when intensity is reduced, protein needs become closer to that of recreational athletes, falling within the 0.8-1.0 g/kg/d range (20, 27, 34). Houtkooper, Abbot, and Nimmo concluded that protein from food sources provides all of the amino acids necessary to meet protein requirements and that protein supplements, although convenient, “do not provide protein that is superior to protein in food” (20, 35).
Fat

Fat, having several roles in the body, assists with insulation, absorption of certain vitamins, and serves as a source for energy. Fat is considered an essential nutrient and is required to thrive; however, because of the physical demands placed on collegiate athletes, carbohydrate and protein intake are of greater concern when there is a desire to optimize athletic performance. Consequently, there is limited research regarding fat recommendations in the collegiate athlete population and sparse information available for review.

Vitamins/Minerals

“In general, the Dietary Reference Intakes (DRIs) for micronutrients should be met for athletes, as long as the athletes are meeting their energy needs from a variety of recommended food groups” (20, 36). For athletes that have diets restricting total energy, limiting food variety, or severely restricting or eliminating specific food groups, low-dose vitamin/mineral supplements, that do not exceed the DRIs, may be reasonable to assist them in meeting their nutrient needs (20, 37). Antioxidants have previously received attention due to the high level of oxidative stress that exercise can cause; however, there is limited data suggesting that athletes require greater amounts of antioxidants or that dietary antioxidant supplementation improves performance (20, 32, 38-42). Athletes need to be cautious about dietary antioxidant levels as it is dependent on the individual, but if supplementation is chosen, it is recommended that antioxidants be consumed within multi-nutrient preparations instead of as mega-doses of individual nutrients (20, 38). Since an ample supply of antioxidants are acquired through a nutrient-dense diet including whole grains, fruits, vegetables, nuts, and seeds, supplementation should be considered a last resort (20).
Due to the amount of stress placed on the joints in some athletic events, particular athletes may take interest in those nutrients deemed as joint-health supportive: protein, calcium, phosphorus, zinc, vitamin C, vitamin D, vitamin E, and omega-3 fatty acids (20, 43). Since further research is needed to determine appropriate recommendations for these nutrients with regard to joint health, athletes should focus on obtaining them, as with any other nutrient, from foods (20). If supplementation is chosen as a means to achieve adequate nutrient status, athletes need to remain cautious about the potential for contamination of vitamin, mineral, and other dietary supplements with banned substances, as it may cause inadvertent doping and be grounds for disqualification (20).

*Hydration*

Current guidelines from the ACSM state that around four hours before exercise, athletes should drink about 5-7 ml/kg of body weight of water, and if there is no, or dark, urine produced, then 3-5 ml/kg of body weight of water should also be consumed two hours prior to exercise (20, 44). An important goal for any athlete is to limit fluid loss to less than 2% body mass since this amount does not adversely affect exercise performance (20, 30, 45-47). For sprinters, body mass reductions of 2-3% have been shown to have no significant effect on sprint performance because of the relatively short durations of high-intensity work (45). However, prolonged moderate dehydration has been associated with increased tiredness and reduced alertness, notably reducing athletic performance (45). Timing, as with other nutrients, is also important for achieving an adequate hydration status, with recommendations for fluid consumption being four hours before and two hours before warm-ups and events (20, 44, 48). In addition, full advantage should be taken of any downtime that an athlete may have to rehydrate, particularly in hot, outdoor environments (20). Conversely, though, over-consumption of fluids during downtime can cause
hyperhydration, also negatively affecting performance (20, 45). Therefore, although athletes are highly encouraged to maintain an adequate hydration status to optimize athletic performance, caution should be taken to not over-consume fluid before, during, or after an event, as it may negatively influence performance.

In general, for those activities that are strenuous, performed in high temperatures and/or humidity, and/or last longer than 60-90 minutes, a carbohydrate- and electrolyte-containing sports beverage is encouraged (20). The addition of electrolytes, mainly sodium and potassium, assist in the absorption of fluid, while the carbohydrates provide a source of additional energy, reducing glycogen depletion and improving performance (20, 48). The general recommendations for athlete rehydration are to consume 1.5 L/kg of body weight lost throughout competition and/or training, while also replacing the electrolytes, specifically sodium, that are lost through the sweat (20, 44, 48). For those events that are short- to middle-duration, hydration during the event is unrealistic and unnecessary because by the time gastric emptying and intestinal absorption of any drink takes place, the event would be finished (45, 49). Concurrently, drinks that are consumed before an event for the purpose of influencing hydration during the event should be emptied from the stomach and absorbed in the intestine relatively quickly; the drink should not have a high energy density or osmolality (45).

One study found that oral replacement of even 50% of a 4% body-mass loss during a twenty-minute break was effective in restoring exercise capacity (50, 51). Furthermore, even when there is not a positive effect noticed, ingesting fluid does not hurt performance unless the fluid is consumed in excess or the composition is inappropriate (50). “The general consensus is that it is better to drink water than to drink nothing during prolonged exercise in a warm environment, but drinks with carbohydrate and electrolytes might promote better performance”
This statement has been supported through various exercise modes, intensities, and durations in differing environmental conditions with both male and female subjects of varying levels of fitness (50). In addition, the consumption of water and sodium, not water alone, has been shown to reduce the frequency and intensity of muscle cramps seen from prolonged exposures to hard physical work in hot environments (50, 52, 53).

The development of individualized hydration strategies is necessary to protect health and preserve performance because there is no single recommendation best for all individuals in every situation (46, 50). Pre-exercise hydration status should be monitored in order to assist athletes in determining their hydration requirements. In those situations where high precision is not required, urine color has been shown to have a linear relationship to both specific gravity and osmolality of the urine, proving beneficial to athletes (50, 54). Due to the health and performance risk associated with dehydration, athletes need to take responsibility for monitoring urine frequency, volume, and color to keep the body in the state of euhydration (50). Sweat loss is also a common marker for hydration status; therefore, it is important for athletes to understand that sweat loss can be influenced by exercise intensity, exercise duration, environmental conditions, the amount of clothing worn, and the aerobic fitness and acclimation of the individual (50).

Overall recommendations to be made to athletes include weighing themselves before and after training to ensure that there is not a greater than 1-2% loss of body mass (20, 30, 45-47, 50). If there has been a greater loss of body mass than these values, it is likely that there was inadequate hydration throughout the activity and steps should be taken to prevent any future occurrences (50). Next, if there is a noticeable decrease in urine volume with an overall darker color than normal, fluid intake should be increased (50). Another recommendation is for athletes to observe when and why they drink, while relating these findings to their observed sweat and
urine losses (50). This strategy may shed light on possible defects of the thirst stimulus or imperceptions of the hunger mechanism for thirst (50). If an individual has a higher amount of salt in their sweat, sodium-containing drinks or salty foods may need to be increased in the diet to account for these losses (50). A rather crude form of self-assessment for high-salt sweat is to wear a black T-shirt throughout a typical training session and, after drying, examine the shirt for salt stains (50). Another method is to use absorbent patches to collect sweat, which could then be analyzed to determine electrolyte content (46). Lastly, athletes need to account for carbohydrate and energy requirements when consuming fluids for rehydration, taking care to not exceed carbohydrate or energy intake for what is necessary (50). This may be a particular problem when considering sports drinks, so it is important to understand that diluting the sports drink may not be a solution because the electrolyte content would be diluted as well (50).

Nutrition for Vegetarian/Vegan Athletes

A vegetarian is defined as an individual who does not consume animal flesh, including meat, fowl, fish, and seafood, while a vegan has a stricter diet/lifestyle, excluding animal flesh and any products derived from an animal, such as eggs, milk, or any by-products of these foods. “According to the American Dietetic Association (ADA), vegetarian diets are nutritionally adequate for all stages of life and for athletes” (55, 56). Several studies on vegetarian athletes have even shown increases in athletic performance compared to those athletes that consume animal flesh (55). This observation of improved athletic performance may result from the protective effects of vegetables against coronary heart disease, which is known to involve oxidative damage, possibly promoting vegetarianism as a means towards enhancing athletic capacity (55, 57).
With regard to protein needs, vegetarian/vegan athletes have increased requirements because of the low biological value of plant protein compared to animal protein (31). Therefore, those that consume a vegetarian/vegan diet should be aware of consuming protein-rich and complimentary foods in adequate amounts, such as rice and beans. Carefully designed and well-supplemented vegan diets can not only promote outstanding health, but also meet energy and protein needs without excess (55). Overall, increasing intake of beans, greens, seeds, nuts, whole grains, and other colorful plant products can maximize performance, recovery, endurance, and resistance to illness, which is applicable to, and recommended for, all athletes (55).

Micronutrients identified by the AND for special attention among vegetarian/vegan athletes are omega-3 fatty acids, iron, zinc, iodine, calcium, vitamin D, and vitamin B₁₂ (55). Because calcium and iron are readily obtained in a vegetarian/vegan diet, there is not a high level of concern for the deficiency of either of these nutrients (55). Although zinc is provided in ample quantities through a vegetarian diet, it is not readily absorbed from plant foods (55). Therefore, zinc requirements for vegans are 50% higher than the U.S. Recommended Dietary Allowance (RDA), being 12 mg per day for females and 16.5 mg per day for males (55). Zinc is available through supplementation or pumpkin seeds and hemp seeds, if supplementation is not favorable (55). Another nutrient that is commonly found to be deficient in vegetarians/vegans is iodine (55). Iodine, similar to zinc, can be obtained through supplementation; however, if the athlete does not wish to consume a daily supplement, iodine is readily found in kelp and other seaweeds (55).

Supplementation of vitamin B₁₂, 6 µg per day minimum, is required for vegans, especially because it is much more abundant in animal foods than in plant foods (55). Omega-3 fatty acids are also commonly found to be inadequate in vegan diets; therefore, an algae-based
omega-3 fatty acid supplement is recommended for vegan athletes, which has also been shown to attenuate exercise-induced inflammation and oxidative stress (55, 58). Due to the widespread occurrence of vitamin D deficiencies, vegetarians/vegans should be aware of their vitamin D intake as it may be especially important to athletes due to its role with skeletal muscle (55). Taurine has also been shown to offer benefits to athletic performance and because of its low availability in vegetarian/vegan diets, is recommended for consumption at 500 mg twice daily for serious vegan athletes (55).

Nutrition for Young Athletes

A level of understanding with regard to the nutritional status of young athletes should be attained to better comprehend the current nutritional status of collegiate athletes. This is especially true for those youth that are exposed to diet or training regimens that are too rigorous for their age, level of maturation, or individual limits, where the benefits of sports participation are minimal or even deleterious (59, 60). In some situations, chronic inadequate energy intake can result in short stature, delayed puberty, menstrual irregularities, poor bone health, and increased risk for injuries (59, 61). Since children are less metabolically efficient than adults are, energy requirements per kilogram of body mass during walking or running can be as much as 30% higher (59, 62-64).

With regard to hydration status, even though children have lower sweat rates than adults, studies have shown that children can dehydrate as much as adults if no fluid is ingested (59, 65). Additionally, one study investigating teenage athlete hydration showed that “16- to 18-year-old soccer players do not differ significantly from adult male players in terms of their sweat volume and sodium losses during training sessions” (46). For this reason, it is recommended that young
athletes drink periodically during physical activity, adding in a sodium- and carbohydrate-containing beverage for activities lasting over one hour (59). Lastly, it is even possible that young athletes have increased risks for energy deficiency, disordered eating, menstrual irregularities, and reduced bone density as a result of children’s requirements for energy expenditure, fuel utilization, and thermoregulation during exercise (59). Therefore, an emphasis should be placed on proper nutritional practices at an early age to reduce the likelihood of causing potential detrimental behaviors and possibly hampering a collegiate athletic career.

**Supplement Use**

Supplement use has become a large topic of interest for collegiate athletics in recent years, with a notable increase in the use of purported ergogenic aids to improve performance (5). The self-reported uses of these supplements by athletes are for improved strength and power, increased energy, muscle or weight gain, or overall improved health (5). Specifically, female athletes have been found to have a greater likelihood of taking supplements for the purposes of boosting immunity when compared to male athletes (66). Sixty-two percent of ultraendurance athletes were found to regularly consume a dietary supplement, according to Knez and Peake (67). For these individuals, it was discovered that appropriate dietary intakes of most nutrients was diligently attained, with supplementation being present as a result of unreliable reports rather than strong scientific evidence (67). These reports confirm that collegiate athletes regularly take one or more dietary supplements, even though supplementation, which is present through misinformation, is not necessary.

Fifty-six percent of collegiate athletes in one study by Rash, Malinauskas, Duffrin, Barber-Heidal, and Overton were under the belief that a multivitamin/mineral supplement
supplied energy, while 67% thought athletes needed to take this form of supplement daily (11). Interestingly, however, 71% of the same subjects strongly agreed with the statement, “Eating healthy foods will improve my athletic performance,” suggesting that collegiate athletes understand the importance of proper nutritional practices, but do not actively adopt them into their lifestyle (11). This suggestion is confirmed through the conclusion that neither nutrition knowledge nor attitude correlated with dietary intake, with knowledge being less than 1% predictive of dietary intake (11). Athletes are undeniably in need of further education to understand that exercise does not increase the need for vitamins, and that adequate amounts of vitamins can be attained from a balanced diet (7). Over half of the collegiate hockey athletes in one hockey conference reported using a stimulant to “enhance athletic performance,” with just under half of the athletes using ephedrine, a product banned by the NCAA and U.S. Food and Drug Administration (FDA), at some point in their athletic careers (6). Although 80% of collegiate hockey athletes in this study indicated they were aware of the NCAA ban on ephedrine, only 59% felt that the national ban makes them less likely to use the product (6). Since the use of this product is grounds for immediate disqualification, it is crucial that collegiate athletes and coaches understand not only the athletic ramifications placed upon the athlete and the team, but also the negative consequences associated with personal health as a result of taking ephedra or ephedra-containing products.

It is important to note, however, that although some supplements can have deleterious effects on an athlete’s health, some forms may be necessary, such as iron supplements for vegetarian, female athletes, to ensure ample iron stores (12, 68). As discussed in the “Vegetarian/Vegan Athlete Nutrition” section above, this demographic may warrant the need for other supplementation as well due to the presence of a restrictive diet. Similarly, those that may
have food allergies/intolerances may have a diet/lifestyle that is also nutritionally restrictive, also creating the need for supplementation, depending on the condition and whether any deficiencies may be present as a result. The presence of a condition, such as an allergy/intolerance, may produce an individualized interest for particular athletes, creating an opportunity for nutrition education. With regard to other areas of interest, collegiate athletes were found to take particular interest in supplementation and dietary manipulation to boost immunity and reduce gastrointestinal distress (66). These may be areas for further exploration in relation to the nutrition education of collegiate athletes and coaches to optimize athletic performance.

Even though collegiate athletes have been shown to use supplements in order to improve performance, the NCAA has provisions on nutritional supplements, with only four categories of nutritional supplements considered permissible by the NCAA: vitamins and minerals; energy bars; calorie replacement drinks, such as Ensure® and Boost®; and electrolyte replacement drinks, such as Gatorade® and Powerade® (69). The last three categories were chosen because they do not create a competitive advantage and only provide hydration and energy replacement (69). The first category, vitamins and minerals, is considered permissible because of their general acceptance by the public, as well as their widespread inclusion in foods (69). Impermissible products include amino acids, creatine, ginkgo biloba, ginseng, glycerol, green tea, HMB (Hydroxymethylbutyrate), protein powders, and St. John’s Wort, as well as several others (69). It is unclear if collegiate athletes are aware of the ban on these products; therefore, discovering their level of knowledge on the topic could provide a basis for nutrition education intervention.

An important message to convey to athletes is that supplements cannot make up for deficient eating patterns (70). The most common supplements seen in the athletic community are as follows: multivitamin-multimineral supplements, creatine, protein powders, amino acid
supplements, energy boosters, caffeine, anabolic ergogenic aids, nitric oxide stimulators, fat burners (thermogenics), and supplements for bone and joint health (70). First, one of the most common supplements consumed are multivitamin-multimineral supplements. These supplements are not to be used as a replacement for breakfast and are not to exceed 500% of the daily value for vitamins and 100% of the daily value for minerals (70, 71).

Next, creatine, which is produced naturally in the kidneys, liver, and pancreas, is used to increase muscle fiber hypertrophy and cell volume (70, 71). The largest issue associated with creatine, aside from being banned by the NCAA, is not safety, but rather that it does not work the same for everyone (70). Some individuals may see results, where others will not. Furthermore, since creatine levels take approximately six weeks to return to baseline after supplementation, continuous intake is unnecessary (70). In addition, if the goal were weight gain, a protein-containing food would provide more calories than a creatine supplement and have a much better chance of showing improvements (70).

With regard to protein powders, athletes need to understand that the goal is to consume protein from protein-containing foods at the appropriate time in order to see results (70). Furthermore, the addition of carbohydrate to protein-containing meals is necessary to allow the protein to synthesize and repair muscle instead of being converted to glucose for energy (70). Amino acid supplements are also not recommended since the human body is better able to utilize dipeptides and tripeptides from protein-containing foods than from simple amino acids in supplements (70).

Energy boosters are commonly consumed because of the perception of increased energy; however, the only way to energize the body is through the consumption of kilocalories (70). Any
references to increases in energy is merely perceived and a result of central nervous system stimulants, such as caffeine (70). It also may be of particular interest to many athletes to learn that B-vitamins do not provide energy, further emphasizing the point that the body is energized by energy-containing nutrients: carbohydrate, protein, and fat (70). Addressing the topic of caffeine, improved reaction time and increased speed and/or power output are possible with its consumption, but to a specific degree (70). Ergogenic benefits are only seen in doses between one and three milligrams per kilogram of body weight before and during exercise, with no improvements seen with increased intakes (70, 72). In fact, over consumption of caffeine can lead to a myriad of side effects including, but not limited to, tremors, arrhythmia, anxiety, tachycardia, increased blood pressure, irritability, dependence, and insomnia (70). Anabolic ergogenic aids tend to contain ingredients that are banned by the NCAA, United States Olympic Committee (USOC), and professional sporting organizations, and, therefore, are highly ill advised (70). If the desire is to increase mass, strength training, optimizing protein intake, and eating pre- and post-lifts are more advantageous than these supplements (70, 73).

Although minimal side effects have been seen with nitric oxide stimulators, no effect has been seen on performance, and supplementation does not influence nitric oxide levels in the muscle (70). Fat burners, also known as thermogenics, are mostly useless; however, some may even be harmful, such as ephedrine, a central nervous system stimulant banned by the FDA since 2004 (70). It is highly recommended that athletes become aware of what is considered an ephedra-containing product, while also making note of similar substances on the market, such as synephrine (70). Both of these products are banned by the NCAA, USOC, and professional sporting organizations (70). If improvements in bone and joint health are desired, some beneficial supplements include ginger, omega-3 supplements, pycnogenol, turmeric,
glucosamine/chondroitin, tart cherry juice, and digestive enzymes (70). Optimal bone nutrition
demands adequate protein intake, vitamins D, K, and C, fluoride, iron, magnesium, calcium,
manganese, and boron (70). Overall, athletes need to be aware that supplements are to be used as
additions to the diet, not replacements, and that products that are banned by an athletic
organization may still be readily available for purchase (70). All athletes need to remain cautious
when considering supplementation and understand that a well-balanced nutritional diet is the best
option for achieving optimal athletic performance (70).

Nutrition Education

Nutrition education theory and practice are documented in numerous research studies,
providing suggested improvements to current nutrition education programs (74-84). These
suggestions are of particular interest to collegiate athletes and coaches because of the
consequences that they can have on the improvement and optimization of the athletes’
performance. Kicklighter, Koonce, Rosenbloom, and Commander noted that the use of a
graduate nutrition student in the nutrition education of college freshmen was highly effective and
provided an informal and comfortable atmosphere for the students to learn (76). This may be
useful in the education of collegiate athletes by providing them with a more inviting environment
to ask questions and better understand the information presented to them. Other proposed
methods to increasing retention of nutrition information include the following: on-line journaling
of dietary behavior (78), mini-cases and resource sessions provided to students (79), service-
learning (80), nutritional comparisons to business applications (83), and the use of dietary
analysis software (84). Potentially the most fundamental aspect of nutrition education, though, is
the incorporation of several educational theories and practices, such as the transtheoretical
model, the theory of planned behavior, and the social cognitive theory, in order to provide a
well-rounded form of instruction. Although some theories may be better than others, none are sufficient by themselves (81).

In order for these theories to be put into practice, however, it is important to understand what information collegiate athletes are interested in learning with regard to nutrition. First, Cousineau, Goldstein, and Franko discovered that there are similar interests in nutrition education between nutrition experts and students, with the only major difference being that students ranked “basic nutrition facts” as substantially more important than the experts (74). Overall, this study found that experts and students ranked the relative importance of six areas of nutrition education in the same order, including agreement on the most important aspect of nutrition education for college students, “healthy eating on a budget” (74). This finding may have important implications towards collegiate athletes and coaches, as they often find themselves under financial constraints, making nutrition education on this topic of high relevance. Weight loss for athletes may also be a large area of interest, with one study stating that sport dietitians are essential in determining accurate weight loss goals for collegiate athletes (77).

*Adolescent Nutrition Education*

To better understand the basis for collegiate athlete nutrition education, it is essential to evaluate the nutrition education of the high school athlete. One survey of 328 female gymnasts, ages 7 to 17, found that the majority of the gymnasts received their nutritional information from their parents, suggesting that there is a fair chance of these students receiving inaccurate nutrition information (9). Bartee, Grandjean, Dunn, Perko, Eddy, and Wang suggested that, throughout their high school career, adolescent athletes’ odds of using supplements increase irrespective of
their attitudes and beliefs towards the use of supplements (85). Through this understanding, it is easier to recognize why supplements seem to play such a major role in the collegiate athlete’s life. In addition, since adolescent athletes have been described as the target market for the dietary supplement industry, the misinformation collected in these years can easily be carried over into college, possibly causing unhealthy nutritional behaviors throughout their collegiate career (86-90).

Furthermore, coaches have been found to be a major source of information for adolescent athletes, while also having poor nutrition knowledge themselves (86, 91). With the potential for high school coaches providing erroneous nutrition education to adolescent athletes, collegiate athletes should be evaluated at the beginning of their Freshman year to determine their current level of nutrition education. This will allow tailored nutrition information to be provided to the athlete, and concurrently assist in optimizing athletic performance. By undertaking such a strategy, there is a better chance of reducing college freshmen’s struggle with nutrition that is experienced as a result of transitioning into a more independent lifestyle (92). This may be especially significant when considering the college environment, specifically, hours of operation of cafeterias, cost and variety of food choices, and increased snacking as a coping mechanism for stress (92, 93).

**Barriers to Adequate Nutrition**

In order to provide an effective delivery of information, it is tremendously beneficial to first understand the barriers to appropriate nutrition for athletes and coaches.

College athletes encounter numerous barriers that can hinder healthy eating, including lack of time to prepare healthy foods (due to rigorous academic and training schedules),
insufficient financial resources to purchase healthy foods, limited meal planning and preparation skills, and travel schedules necessitating “eating on the road” (11).

In one study, athletes, coaches, and sports dietitians all considered an insufficient amount of time to prepare food as being as a significant barrier to achieving adequate nutrition (91). Other barriers determined in this study included financial limitations, difficulty with living arrangements, inadequate cooking skills, perceptions of an idealistic physique, and nutrition knowledge (91). Since lack of time for the preparation of an appropriate diet is strongly linked with food access and cost, as well as being the most consistent barrier found in the just-mentioned study, appropriate time management skills should be a major focus of nutrition education programs (91). Furthermore, for those transitioning from late adolescence to adulthood, while living on their own for the first time, there may be more difficulties financially (91). One collegiate athlete was quoted as saying, “Funds, what funds? There are no funds.” (91). In addition, while on the road, teams noted problems with planning ahead, resulting in unhealthier meal choices (91).

While coaches have been reported as being more concerned with excess body weight and fat levels in relation to sports performance, athletes noted a concern with physique because of societal pressures (91). “Despite recognizing the need for strength and energy for performance, the perception of physique for some female athletes was not related to their sport, but to their shape, size, and physical appearance or attractiveness in general” (91). Sports dietitians reported that athletes considered an “ideal” physique have greater opportunities for sponsorship and advancement in their sport, regardless of athletic performance (91). If these barriers are not addressed in a nutrition education intervention, it is possible that any nutritional information
provided could be readily ignored or not taken seriously, as current societal positions would be considered more pressing.

Summary

It has been shown that collegiate athletes are less interested in eating for health, but rather seek improved performance. Therefore, the most important message to convey to athletes is that eating well will help you to achieve optimal sports performance now (8, 94). Furthermore, when nutrition becomes a featured component of an athletic program, collegiate athletes’ attitudes toward healthy eating rapidly improve (95). A clear need for continued and detailed nutrition education is apparent for collegiate athletes in order to improve performance, but more importantly, health. Lastly, Rockwell, Nickols-Richardson, and Thye concluded, “an active collaboration between a university’s athletic staff/athletics and the Nutrition and/or Exercise academic departments could be a low cost alternative” to providing effective and economical nutrition education (13). Considering that the collaboration of the athletic department and nutrition department is the proposed plan for the university under review, it is without hesitation that this study was performed to ensure the successful education of collegiate athletes and coaches, particularly with regard to their athletes’ nutrition knowledge and interest.
CHAPTER III

METHODS

For the purposes of this study, student-athletes of 17 intercollegiate teams were surveyed at Bowling Green State University (BGSU). The athletes were provided with a paper survey containing several multiple-choice questions regarding nutrition-related topics. After compiling the collected data, a statistical analysis, using several different tests, was conducted to evaluate the results.

Approval

The study was approved through the Human and Subjects Review Board (HSRB) (Appendix A), Project H11T240GE7, at BGSU. Initial approval through BGSU ICA Research Subcommittee was attained (Appendix B) to permit the study of all student-athletes at BGSU.

Subjects

The 17 intercollegiate athletic teams at BGSU were evaluated using a survey to determine the nutritional knowledge of the collegiate athletes. There were seven men’s teams (basketball, football, baseball, ice hockey, golf, soccer, and cross country) and ten women’s teams (basketball, gymnastics, volleyball, golf, soccer, cross country/track and field, softball, swimming, and tennis) that participated, totaling 319 student-athletes surveyed (approximately 75% of the student-athlete population), ranging in gender and academic year. All subjects were 18 years of age or older. Out of the 319 subjects surveyed in this study, 98 (31%) were in their first year, 98 (31%) were in their second year, 78 (24%) were in their third year, 40 (13%) were
in their fourth year, and three (1%) were in their fifth year or greater of study. Approximately 57% of the subjects were male, while approximately 43% were female.

Recruitment

The student-athletes of any particular team were surveyed after first receiving the permission of their head coach, which was attained through email communication. If a particular team was unable to be reached through their head coach, the team was surveyed before or after a team lift during a prescheduled strength and conditioning session. Once in person, the participants then received an informational letter (Appendix C) containing information on the following topics: purpose, procedure, voluntary nature, confidentiality, and contact information. Those that chose to complete the survey did not require submission of a signed informed consent form due to the nature of the research being no more than minimal risk and involving no procedures requiring written consent.

Incentive

In order to provide incentive to the athletes for completion of the survey, all the athletes that choose to participate were entered into a raffle to receive one of seventeen $10 gift cards to Kroger®. Each individual that completed a survey was issued a numbered ticket that corresponded to a matching ticket, which was drawn at random from a hat. The individual that was able to provide the matching number to the ticket drawn received the $10 gift card. For football, due to the high subject number, two $10 gift cards were provided.
Survey Instrument

The paper survey for the collegiate athletes (Appendix D) consisted of 18 multiple-choice/ranking questions that required the participant to either indicate their choice with an “X” to the left of their selection or circle their level of interest for the topic provided on a scale from one to five. The question content covered nutrition-related coursework, perceived nutrition-related knowledge, nutrition knowledge, nutrition topics of interest, nutrition education preferences, projected Registered Dietitian use, participating sport, gender, and academic year. Specifically for the nutrition knowledge portion, if more than one answer was chosen for a question that had only one correct choice, the question was marked as incorrect.

All survey questions were created new for the purpose of this study and were developed to cover a range of nutrition knowledge levels (e.g. general, advanced, sports nutrition). Other topics included in the survey were incorporated after analysis of desired outcomes from the study. Two Food and Nutrition faculty members, one that is a Registered Dietitian, and a Human Movement, Sport, and Leisure Studies professor measured face and content validity through the review of the instrument.

The collegiate athlete survey was administered to the athletes at individual team meetings per sport throughout the Fall 2011 and Spring 2012 semesters, from August to March. The survey was collected in person, providing the student-athletes with ample time to complete all questions, approximately 5-10 minutes.

Statistical Analysis

The data collected was analyzed using Minitab 16® using several descriptive statistics. These statistics included: Pearson correlation to test the correlation between perceived and actual
nutrition knowledge, two-sample t-test to measure coursework effect on overall nutrition knowledge, frequency in the determination of percentage of subjects that chose a particular option for question eight (Appendix D), mean to measure the average level of interest for nutrition topics, and ANOVA tests to compare the differences between sports for nutrition knowledge, Registered Dietitian use, nutrition coursework, and several others. With regard to the ANOVA tests, specifically, Tukey post-hoc analysis was used to determine statistical significance between groups. Raw data from the paper surveys was entered by hand into Microsoft Excel\textsuperscript{®} before being uploaded into Minitab 16\textsuperscript{®} for statistical analysis.
CHAPTER IV

RESULTS/DISCUSSION

Collegiate Athlete Nutrition Knowledge

Although the nutrition knowledge of collegiate athletes has been shown repeatedly to be deficient through numerous studies (1-10), a baseline of current nutrition knowledge was desired for the population under review for the purposes of assisting in the development of future nutrition education interventions. Remaining consistent with previous research (1-10), this study found that nutrition knowledge was frequently deficient regardless of sport, gender, or academic year. Although deficiency with regard to nutrition-related knowledge was present, it was not universal. Out of the 14 nutrition knowledge questions posed to the student-athletes, the highest values scored by any athlete was 12, which was seen in seven of the 17 teams surveyed. However, when considering statistical significance, women’s gymnastics had statistically significant higher nutrition knowledge than any other team surveyed, scoring, on average, a 9.9 out of 14 possible points (p = 0.000) (Table 1). Conversely, men’s football and men’s basketball showed statistically significant lower scores than the other 15 intercollegiate athletic teams surveyed, indicating that these teams may need greater nutrition education than the other teams (p = 0.000) (Table 1). Furthermore, the female student-athletes tested significantly higher with regard to nutrition knowledge, scoring an average of 8.8 ± 1.8 total correct, than male student-athletes, scoring an average of 7.8 ± 2.0 total correct (p = 0.000). There was no significant difference in nutrition knowledge noted between academic years, indicating that greater levels of education do not significantly affect nutrition knowledge.
### Table 1

**Average Total Nutrition Knowledge Score per Sport**

<table>
<thead>
<tr>
<th>Sport</th>
<th>Nutrition Knowledge Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball (M) (n = 14)</td>
<td>6.6 ± 2.0^b</td>
</tr>
<tr>
<td>Basketball (W) (n = 15)</td>
<td>8.7 ± 1.8^a</td>
</tr>
<tr>
<td>Football (M) (n = 84)</td>
<td>7.5 ± 2.1^b</td>
</tr>
<tr>
<td>Baseball (M) (n = 25)</td>
<td>7.9 ± 1.9^ab</td>
</tr>
<tr>
<td>Ice Hockey (M) (n = 25)</td>
<td>9.1 ± 1.6^ab</td>
</tr>
<tr>
<td>Gymnastics (W) (n = 13)</td>
<td>9.9 ± 1.4^a</td>
</tr>
<tr>
<td>Volleyball (W) (n = 11)</td>
<td>8.1 ± 2.1^ab</td>
</tr>
<tr>
<td>Golf (M) (n = 8)</td>
<td>7.6 ± 2.1^ab</td>
</tr>
<tr>
<td>Golf (W) (n = 7)</td>
<td>9.1 ± 1.9^a</td>
</tr>
<tr>
<td>Soccer (M) (n = 17)</td>
<td>7.9 ± 1.6^ab</td>
</tr>
<tr>
<td>Soccer (W) (n = 29)</td>
<td>8.7 ± 1.2^a</td>
</tr>
<tr>
<td>Cross Country (M) (n = 11)</td>
<td>9.2 ± 1.9^a</td>
</tr>
<tr>
<td>CC/Track &amp; Field (W) (n = 26)</td>
<td>9.2 ± 1.8^a</td>
</tr>
<tr>
<td>Softball (W) (n = 11)</td>
<td>7.6 ± 2.0^ab</td>
</tr>
<tr>
<td>Swimming (W) (n = 16)</td>
<td>8.4 ± 1.9^ab</td>
</tr>
<tr>
<td>Tennis (W) (n = 7)</td>
<td>9.4 ± 1.4^ab</td>
</tr>
</tbody>
</table>

Means that do not share a letter are significantly different (p < 0.05). Maximum score was 14.

When considering only the nine “general nutrition knowledge” questions that were posed to the student-athletes, nutrition-related knowledge scores were still the highest among the gymnastics team, averaging 7.9 out of 9 questions correctly answered. Remaining consistent with the overall nutrition-related knowledge scores, the men’s football team scored significantly lower than the other teams surveyed, along with women’s softball, which had the lowest general nutrition knowledge score of 5.6 out of 9. This finding is likely affected by the number of subjects surveyed from the women’s softball team, 11, compared to the men’s football team, 84; however, an opportunity for nutrition education intervention may still be relevant. Regarding gender, females still scored significantly higher on the general nutrition knowledge questions than males (p = 0.000), while academic year continued to show no relationship towards nutrition-
related knowledge. Within the nutrition knowledge questions, three “advanced nutrition knowledge” questions were posed. All teams surveyed scored poorly on these questions, illustrating that nutrition-related knowledge is not more advanced in any one particular sport, gender, or academic year. An interesting phenomenon did occur, however, with the administration of these questions, with regard to one question, which asked, “Which of the following provides the most carbohydrate?” [Appendix D (Question 8)]. The correct answer was “One cup of regular ice cream,” providing 30 grams of carbohydrate; however, 92% of the student-athletes, 294 out of 319, incorrectly chose “One cup pasta,” which contains one-third fewer grams of carbohydrate. Only 1.6% of the student-athletes, 5 out of the 319 surveyed, correctly answered this question. This finding suggests that the vast majority of student-athletes may not fully understand sources of carbohydrates, possibly negatively affecting their diet, and consequent athletic performance.

**Nutrition-Related Coursework**

When considering correlations between nutrition coursework and nutrition-related knowledge, it was noted that, although the majority of student-athletes, 84%, did not take an “Introduction to Human Nutrition course at the collegiate level,” there was a significant difference in nutrition-related knowledge in those that had completed this coursework (p = 0.000). However, although statistically significant, practically, the completion of this course showed an increase in score by only one question, suggesting that an Introduction to Human Nutrition course would only allow for a 7% increase in total nutrition-related knowledge. Even though an increase in nutrition-related knowledge is present, it is unclear how practically significant a course such as this would be when taking into account the potential affect on athletic performance. Furthermore, there was no significant difference in nutrition-related
knowledge when considering the total number of courses taken at the collegiate level, which had discussed the topic of nutrition. Therefore, those that even had four or more classes discussing nutrition still did not score significantly higher on the nutrition knowledge questions than those that had one or less courses discussing the topic. For this reason, encouragement towards greater collegiate nutrition education through coursework may be ineffective at increasing nutrition-related knowledge, therefore reducing the probability of optimizing athletic performance in collegiate student-athletes.

**Registered Dietitian Projected Use**

For the population at study, Registered Dietitians have become more available over the previous two semesters, from August 2011 to May 2012; however, information regarding the likelihood of any particular athlete utilizing this resource was unknown. Therefore, included in the student-athlete survey was a question that addressed this issue. After statistical analysis, it was discovered that male athletes were significantly more likely to use a Registered Dietitian more frequently than female athletes ($p = 0.000$). This finding was reinforced when the use of a Registered Dietitian was compared to sport, discovering that the most likely sports to use the Registered Dietitian on a more frequent basis included football and baseball, male sports, while tennis and softball, female sports, were least likely. However, it is to be noted that there was no statistically significant difference in utilization of a Registered Dietitian between any sports, regardless of gender, it was only through comparison to gender alone that statistical significance was found ($p = 0.000$). This has high practical significance particularly because the male athletes were found to have lower nutrition-related knowledge compared to females, while also being more willing to visit a Registered Dietitian. It may be assumed, therefore, that males, due to their personal understanding towards a lack of nutrition-related knowledge, would be compensating
by utilizing a Registered Dietitian more frequently; however, since males did not have any significant difference in perceived nutrition knowledge from females, this is unlikely. Overall, 56% of the student-athletes stated that they would utilize a Registered Dietitian once a week or greater if one was made available to them (Figure 1).

Figure 1

*Projected Use of Registered Dietitian by Collegiate Athletes*

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>3+ times per week</td>
<td>1.3%</td>
</tr>
<tr>
<td>2-3 times per week</td>
<td>6.3%</td>
</tr>
<tr>
<td>Once a week</td>
<td>10.3%</td>
</tr>
<tr>
<td>Once every other week</td>
<td>16.3%</td>
</tr>
<tr>
<td>Once a month</td>
<td>16.3%</td>
</tr>
<tr>
<td>Once a semester</td>
<td>29.2%</td>
</tr>
<tr>
<td>Never</td>
<td>16.9%</td>
</tr>
<tr>
<td>Unanswered</td>
<td>16.3%</td>
</tr>
</tbody>
</table>

Perceived vs. Actual Nutrition Knowledge

Through the analysis of perceived nutrition knowledge per individual, it was discovered that there was no significant difference in perceived nutrition knowledge when compared to actual nutrition knowledge, sport, gender, or academic year. It was hypothesized that student-athletes, particularly at the collegiate level, would be able to accurately assess their own
knowledge level related to nutrition, however, there was no significant correlation found between perceived and actual nutrition knowledge in the athletes surveyed ($r = 0.093$) (Figure 2).

Figure 2

*Comparison of Perceived and Actual Nutrition Knowledge in Collegiate Athletes*

Perceived Nutrition Knowledge value (1 = Not knowledgeable at all, 10 = Very knowledgeable, and * = unanswered). Actual Nutrition Knowledge value is shown as the percentage of nutrition knowledge questions answered correctly.

Between sports, the average ranking that collegiate athletes chose with regard to their perceived “level of nutrition knowledge” ranged from 5.6 to 6.5, with “1” correlating with “Not knowledgeable” and “10” correlating with “Very knowledgeable.” When considering gender, females rated themselves as having, on average, a 6.1 level of nutrition knowledge, while males rated themselves with a 5.8 level of nutrition knowledge. As a result of collegiate athletes’ unfounded beliefs towards their level of nutrition knowledge, educators are encouraged to
overlook perceived nutrition knowledge when developing nutrition education interventions for this population.

**Collegiate Athlete Interests**

A major objective of this study was to determine the level of interest within each sport or gender with regard to nutrition-related topics in an effort to individualize nutrition education interventions for a given subpopulation. The topics of interest that were proposed to the subjects within this study were the following: sports drinks; energy drinks; protein supplements; pre- and post-workout meals; energy requirements; general nutrition; cheap, healthy meals; healthier fast food alternatives; muscle building; and safe, healthy weight loss [Appendix D (Question 13)]. Concerning gender specifically, varying levels of interest were noted between males and females. Females were found to have higher levels of interest in the topics of pre- and post-workout meals; cheap, healthy meals; and safe, healthy weight loss (Table 2). Alternatively, males ranked sports drinks, pre- and post-workout meals, and muscle building as the most appealing subjects (Table 2). Both genders were equally as interested in learning more about pre- and post-workout meals, energy requirements, and healthier fast food alternatives, while neither group showed much interest towards the topic of energy drinks. Pre- and post-workout meals and energy requirements are topics of interest that are crucial for all athletes to understand in an effort to optimize athletic performance and gain a competitive edge; therefore, it is beneficial that both genders stated an equal level of interest in these topics. An equal interest in healthier fast food alternatives was also predictable due to the social environment of the division I university under review. Due to the high prevalence of fast food establishments in the area, as well as the low income of most collegiate athletes, the inclusion of this topic in future nutrition education interventions may prove to be highly advantageous. It is unclear why the student-
athletes did not find as much interest in “energy drinks” as the other categories. It is a possibility that these athletes already understand the negative effects that many energy drinks can have on physical performance, causing them to rank it lower, or it is equally as possible that they are misinformed on the subject and do not desire additional information on the topic. Further investigation into the area may be warranted. Males did find protein supplements to be substantially more appealing than females; however, this topic was not rated as being one of their top interests.

Table 2

Nutrition Topics of Interest per Gender by Mean

<table>
<thead>
<tr>
<th>Topic of Interest</th>
<th>Male (n = 184)</th>
<th>Female (n = 135)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports Drinks</td>
<td>3.9 ± 1.1</td>
<td>3.5 ± 1.2</td>
</tr>
<tr>
<td>Energy Drinks</td>
<td>2.8 ± 1.4</td>
<td>2.6 ± 1.5</td>
</tr>
<tr>
<td>Protein Supplements</td>
<td>3.7 ± 1.4</td>
<td>2.8 ± 1.4</td>
</tr>
<tr>
<td>Pre-Post Workout Meals</td>
<td>4.2 ± 0.9</td>
<td>4.3 ± 1.0</td>
</tr>
<tr>
<td>Energy Requirements</td>
<td>3.8 ± 1.0</td>
<td>4.0 ± 1.0</td>
</tr>
<tr>
<td>General Nutrition</td>
<td>3.7 ± 1.0</td>
<td>4.2 ± 0.9</td>
</tr>
<tr>
<td>Cheap, Healthy Meals</td>
<td>3.7 ± 1.1</td>
<td>4.3 ± 1.0</td>
</tr>
<tr>
<td>Healthier Fast Food Alternatives</td>
<td>3.7 ± 1.2</td>
<td>3.9 ± 1.3</td>
</tr>
<tr>
<td>Muscle Building</td>
<td>4.3 ± 0.9</td>
<td>3.6 ± 1.2</td>
</tr>
<tr>
<td>Safe, Healthy Weight Loss</td>
<td>3.1 ± 1.5</td>
<td>4.1 ± 1.3</td>
</tr>
</tbody>
</table>

All values are shown as Mean (1 = Low Interest and 5 = High Interest) ± Standard Deviation.

Interest differences by sport were also analyzed for assistance in the development of nutrition education interventions per team. Men’s soccer, for instance, expressed large amounts of interest in several categories, but four of them, energy requirements, general nutrition, pre- and post-workout meals, and muscle building, were rated higher than the others (Table 3). Comparatively, women’s soccer stated higher levels of interest towards the topics of safe,
healthy weight loss and cheap, healthy meals (Table 3). When considering golf, the women’s
1 team showed significant interest in pre- and post-workout meals; general nutrition; healthier fast
food alternatives; and safe, healthy weight loss (Table 3). While men’s golf also shared interest
in pre- and post-workout meals, there was also a noted level of interest towards muscle building,
which is consistent with male athletes in general (Table 3). Since golf is not as commonly
associated with pre- and post-workout or pre- and post-game/match nutrition tips as other sports,
the universal appeal towards this subject within the golf teams may provide improvements in
athletic performance. The men’s and women’s basketball teams’ results depicted that the men’s
team stated interest mostly in muscle building, but also with healthier fast food alternatives
(Table 3). The women’s team, on the contrary, showed significant interest in pre- and post-
workout meals; cheap, healthy meals; healthier fast food alternatives; and safe, healthy weight
loss (Table 3). The last collegiate team present at the university under review with both men’s
and women’s teams is cross country/track and field, with only a men’s cross country team and
both cross country and track and field for women’s. After surveying these teams, the main
nutrition topics of interest for the men’s cross country team included pre- and post-workout
meals, energy requirements, and muscle building (Table 3). The women’s cross country/track
and field teams stated very high interest in cheap, healthy meals, while also showing significant
attention toward pre- and post-workout meals and general nutrition topics (Table 3).

For the purposes of this analysis, men’s baseball and women’s softball will also be
compared to determine notable differences. Although these sports are not fully congruent, the
level of dissimilarity between the two is minimal. First, men’s baseball noted higher levels of
interest within the following topics: protein supplements, pre- and post-workout meals, and
muscle building, which is mostly consistent with overall male interests (Table 3). Women’s
softball, however, ranked cheap, healthy meals and safe, healthy weight loss substantially higher than the other interests provided within the survey (Table 3). These findings are also consistent with overall female interests in the athletic teams under study.

The remaining six sports were gender dependent and, therefore, will be analyzed as such. Women’s tennis, although consisting of only seven members, provided unanimously high interest in the topic of healthier fast food alternatives (Table 3). These women additionally found pre- and post-workout meals, energy requirements, general nutrition, and cheap, healthy meals to be of significant interest (Table 3). Women’s swimming rated pre- and post-workout meals, general nutrition, and cheap, healthy meals as the three most appealing topics of interest (Table 3). The women’s volleyball team also found the topics of pre- and post-workout meals and general nutrition to be of high interest, while also showing significant interest in healthier fast food alternatives (Table 3). The last women’s team, gymnastics, showed the most significant interest in safe, healthy weight loss, with energy requirements, general nutrition, and pre- and post-workout meals also being topics of substantial interest (Table 3). Men’s hockey stated considerable levels of interest towards pre- and post-workout meals and muscle building, while showing inconsistent or lower levels of interest in the remaining topics (Table 3). Lastly, men’s football, containing the largest number of subjects, showed the most consistent levels of interest with sports drinks, pre- and post-workout meals, and muscle building (Table 3). Overall, “Pre- and post-workout meals” was shown to be of high interest to 13 out of 16 collegiate athletic teams; therefore, signifying it as a topic that is to be addressed in future education interventions.
Table 3

*Nutrition Topics of Interest per Sport by Mean*

<table>
<thead>
<tr>
<th>Topic of Interest</th>
<th>Basketball (M) (n = 14)</th>
<th>Basketball (W) (n = 15)</th>
<th>Football (M) (n = 84)</th>
<th>Baseball (M) (n = 25)</th>
<th>Ice Hockey (M) (n = 25)</th>
<th>Gymnastics (W) (n = 13)</th>
<th>Volleyball (W) (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports Drinks</td>
<td>3.1 ± 1.0</td>
<td>3.4 ± 1.1</td>
<td>4.1 ± 1.1</td>
<td>4.0 ± 1.1</td>
<td>3.4 ± 1.2</td>
<td>2.9 ± 1.5</td>
<td>3.0 ± 1.3</td>
</tr>
<tr>
<td>Energy Drinks</td>
<td>3.2 ± 1.3</td>
<td>2.4 ± 1.4</td>
<td>2.9 ± 1.3</td>
<td>3.0 ± 1.4</td>
<td>2.1 ± 1.2</td>
<td>2.5 ± 1.7</td>
<td>2.0 ± 1.4</td>
</tr>
<tr>
<td>Protein Suppl.</td>
<td>2.9 ± 1.2</td>
<td>2.3 ± 1.4</td>
<td>3.7 ± 1.4</td>
<td>4.1 ± 1.1</td>
<td>3.5 ± 1.2</td>
<td>2.6 ± 1.6</td>
<td>3.4 ± 1.0</td>
</tr>
<tr>
<td>Pre-Post Meal</td>
<td>3.4 ± 0.7</td>
<td>4.2 ± 1.2</td>
<td>4.3 ± 0.9</td>
<td>4.4 ± 0.8</td>
<td>4.1 ± 0.8</td>
<td>4.2 ± 1.0</td>
<td>4.4 ± 1.3</td>
</tr>
<tr>
<td>Energy Req.</td>
<td>3.3 ± 0.7</td>
<td>3.7 ± 0.9</td>
<td>3.9 ± 1.0</td>
<td>3.8 ± 1.0</td>
<td>3.3 ± 1.1</td>
<td>4.2 ± 0.9</td>
<td>3.9 ± 1.5</td>
</tr>
<tr>
<td>Gen. Nutr.</td>
<td>3.3 ± 0.9</td>
<td>3.6 ± 1.1</td>
<td>3.8 ± 1.0</td>
<td>3.7 ± 0.9</td>
<td>3.4 ± 0.9</td>
<td>4.4 ± 0.8</td>
<td>4.3 ± 0.9</td>
</tr>
<tr>
<td>Cheap/Healthy Meal</td>
<td>3.4 ± 1.1</td>
<td>4.4 ± 0.6</td>
<td>3.7 ± 1.2</td>
<td>3.6 ± 1.1</td>
<td>3.5 ± 1.0</td>
<td>4.2 ± 0.9</td>
<td>4.0 ± 1.2</td>
</tr>
<tr>
<td>Fast Food Alt.</td>
<td>3.7 ± 1.2</td>
<td>4.1 ± 0.9</td>
<td>3.8 ± 1.1</td>
<td>3.7 ± 1.2</td>
<td>3.3 ± 1.1</td>
<td>3.9 ± 1.2</td>
<td>4.3 ± 0.8</td>
</tr>
<tr>
<td>Muscle Build.</td>
<td>3.9 ± 1.0</td>
<td>3.5 ± 1.4</td>
<td>4.4 ± 0.9</td>
<td>4.5 ± 0.8</td>
<td>4.1 ± 0.7</td>
<td>3.9 ± 1.0</td>
<td>4.2 ± 0.9</td>
</tr>
<tr>
<td>Safe Wt. Loss</td>
<td>2.9 ± 1.2</td>
<td>4.4 ± 0.9</td>
<td>3.2 ± 1.5</td>
<td>3.2 ± 1.5</td>
<td>2.5 ± 1.3</td>
<td>4.7 ± 0.5</td>
<td>4.1 ± 1.3</td>
</tr>
</tbody>
</table>

All values are shown as Mean (1 = Lowest Interest and 5 = Highest Interest) ± Standard Deviation. (M) = Men’s (W) = Women’s.
Table 3

*Nutrition Topics of Interest per Sport by Mean, cont.*

<table>
<thead>
<tr>
<th>Topic of Interest</th>
<th>Golf (M) (n = 8)</th>
<th>Golf (W) (n = 7)</th>
<th>Soccer (M) (n = 17)</th>
<th>Soccer (W) (n = 29)</th>
<th>Cross Country (M) (n = 11)</th>
<th>CC/Track &amp; Field (W) (n = 26)</th>
<th>Softball (W) (n = 11)</th>
<th>Swimming (W) (n = 16)</th>
<th>Tennis (W) (n = 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports Drinks</td>
<td>3.6 ± 0.9</td>
<td>3.4 ± 1.0</td>
<td>3.9 ± 1.1</td>
<td>3.9 ± 1.0</td>
<td>4.1 ± 0.8</td>
<td>4.0 ± 0.9</td>
<td>2.9 ± 1.3</td>
<td>3.4 ± 1.9</td>
<td>3.3 ± 1.4</td>
</tr>
<tr>
<td>Energy Drinks</td>
<td>2.8 ± 0.7</td>
<td>2.4 ± 1.3</td>
<td>3.2 ± 1.5</td>
<td>2.9 ± 1.4</td>
<td>2.3 ± 1.6</td>
<td>2.9 ± 1.6</td>
<td>2.1 ± 1.5</td>
<td>2.6 ± 1.4</td>
<td>2.6 ± 1.5</td>
</tr>
<tr>
<td>Protein Suppl.</td>
<td>3.4 ± 1.2</td>
<td>2.7 ± 1.7</td>
<td>3.8 ± 1.3</td>
<td>2.5 ± 1.5</td>
<td>3.1 ± 1.8</td>
<td>3.1 ± 1.5</td>
<td>2.4 ± 1.4</td>
<td>3.2 ± 1.1</td>
<td>2.4 ± 1.0</td>
</tr>
<tr>
<td>Pre-Post Meal</td>
<td>4.3 ± 0.7</td>
<td>4.7 ± 0.5</td>
<td>4.2 ± 0.8</td>
<td>3.9 ± 1.0</td>
<td>4.3 ± 0.9</td>
<td>4.6 ± 0.7</td>
<td>3.7 ± 1.0</td>
<td>4.6 ± 0.6</td>
<td>4.7 ± 0.5</td>
</tr>
<tr>
<td>Energy Req.</td>
<td>3.6 ± 0.9</td>
<td>3.7 ± 1.0</td>
<td>4.2 ± 0.9</td>
<td>3.9 ± 0.8</td>
<td>4.2 ± 0.9</td>
<td>4.2 ± 1.0</td>
<td>3.4 ± 1.3</td>
<td>3.9 ± 1.2</td>
<td>4.6 ± 0.5</td>
</tr>
<tr>
<td>Gen. Nutr.</td>
<td>3.8 ± 1.0</td>
<td>4.7 ± 0.5</td>
<td>4.2 ± 0.7</td>
<td>4.1 ± 0.8</td>
<td>3.6 ± 1.2</td>
<td>4.5 ± 0.8</td>
<td>3.6 ± 1.1</td>
<td>4.1 ± 0.9</td>
<td>4.7 ± 0.5</td>
</tr>
<tr>
<td>Cheap/Healthy Meal</td>
<td>3.9 ± 1.1</td>
<td>4.6 ± 0.8</td>
<td>3.9 ± 1.3</td>
<td>4.4 ± 0.9</td>
<td>4.1 ± 0.7</td>
<td>4.5 ± 1.0</td>
<td>3.8 ± 1.3</td>
<td>4.1 ± 1.1</td>
<td>4.4 ± 0.5</td>
</tr>
<tr>
<td>Fast Food Alt.</td>
<td>3.5 ± 1.3</td>
<td>4.3 ± 1.1</td>
<td>3.5 ± 1.6</td>
<td>4.0 ± 1.2</td>
<td>3.7 ± 1.4</td>
<td>3.7 ± 1.3</td>
<td>3.1 ± 1.5</td>
<td>3.1 ± 1.4</td>
<td>5.0 ± 0.0</td>
</tr>
<tr>
<td>Muscle Build.</td>
<td>4.0 ± 0.9</td>
<td>3.9 ± 0.7</td>
<td>4.4 ± 0.9</td>
<td>3.2 ± 1.2</td>
<td>4.4 ± 0.9</td>
<td>3.9 ± 1.3</td>
<td>3.5 ± 1.7</td>
<td>3.2 ± 1.3</td>
<td>3.6 ± 1.1</td>
</tr>
<tr>
<td>Safe Wt. Loss</td>
<td>3.6 ± 1.4</td>
<td>4.6 ± 1.1</td>
<td>3.7 ± 1.3</td>
<td>4.2 ± 1.1</td>
<td>2.5 ± 1.6</td>
<td>3.5 ± 1.7</td>
<td>4.4 ± 1.3</td>
<td>3.6 ± 1.3</td>
<td>4.3 ± 1.0</td>
</tr>
</tbody>
</table>

All values are shown as Mean (1 = Lowest Interest and 5 = Highest Interest) ± Standard Deviation. (M) = Men’s (W) = Women’s.
Collegiate Athlete Education Preferences

As potentially significant as understanding collegiate athletes’ interests, is determining the methods within which they are most interested in learning about these topics. When preferred methods for nutrition education interventions were analyzed by gender, it was found that female athletes found group sessions and individual counseling as slightly more appealing methods for receiving nutrition education, while male athletes ranked individual counseling as the most interesting method (Table 4). It is interesting to note that individual counseling seemed to standout as vastly more preferable between males and females, suggesting that collegiate athletes have preference with regard to the means within which they are educated on nutrition-related topics. This proposal, congruently, was consistent when the data was analyzed for each athletic team.

Table 4

Nutrition Education Preferences per Gender by Mean

<table>
<thead>
<tr>
<th>Education Preferences</th>
<th>Male (n = 184)</th>
<th>Female (n = 135)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Sessions</td>
<td>2.9 ± 1.3</td>
<td>3.2 ± 1.3</td>
</tr>
<tr>
<td>Individual Counseling</td>
<td>3.1 ± 1.4</td>
<td>3.2 ± 1.4</td>
</tr>
<tr>
<td>Newsletters</td>
<td>2.5 ± 1.3</td>
<td>3.1 ± 1.3</td>
</tr>
<tr>
<td>Independent Study Modules</td>
<td>2.5 ± 1.2</td>
<td>2.4 ± 1.2</td>
</tr>
<tr>
<td>Computer Training</td>
<td>2.5 ± 1.3</td>
<td>2.4 ± 1.2</td>
</tr>
<tr>
<td>Conferences</td>
<td>2.5 ± 1.1</td>
<td>2.5 ± 1.2</td>
</tr>
<tr>
<td>Academic Courses</td>
<td>2.8 ± 1.2</td>
<td>3.1 ± 1.3</td>
</tr>
<tr>
<td>Nutrition Graduate Student</td>
<td>2.9 ± 1.2</td>
<td>3.1 ± 1.2</td>
</tr>
</tbody>
</table>

All values are shown as Mean (1 = Low Interest and 5 = High Interest) ± Standard Deviation.
Men’s and women’s basketball showed higher rankings with the “Nutrition graduate student” category than any of the other choices when asked about their preferred method for receiving nutrition education (Table 5). Similarly, men’s golf stated that having a nutrition graduate student provide nutrition information would be the most preferable form of nutrition education, while women’s golf stated that individual counseling would be more favorable (Table 5). When considering soccer, the men’s team ranked individual counseling as the most interesting method for nutrition education, with the women’s team ranking newsletters and academic courses the highest (Table 5). Women’s cross country/track and field was found to exhibit higher levels of interest in individual counseling, although men’s cross country rated group sessions and nutrition graduate student equally as their most appealing preferences (Table 5).

Again comparing men’s baseball with women’s softball, men’s baseball preferred that a nutrition graduate student or academic courses provide an education of nutrition information and women’s softball preferred group sessions (Table 5). Women’s swimming stated greater interest in individual counseling, women’s tennis leaned towards group sessions, women’s volleyball showed interest in group sessions and a nutrition graduate student, and women’s gymnastics favored a nutrition graduate student (Table 5). Individual counseling was again chosen to be a favorite by men’s football, with men’s hockey showing limited interest in all of the proposed methods for nutrition education while leaning slightly towards academic courses as the more preferred means (Table 5). The two highest selected categories were “Individual counseling” and “Nutrition graduate student,” the former being chosen five times and the latter being chosen seven times, providing that 12 out of 20 favored choices, or almost two-thirds of the selections,
Table 5

*Nutrition Education Preferences per Sport by Mean*

<table>
<thead>
<tr>
<th>Education Preference</th>
<th>Basketball (M) (n = 14)</th>
<th>Basketball (W) (n = 15)</th>
<th>Football (M) (n = 84)</th>
<th>Baseball (M) (n = 25)</th>
<th>Ice Hockey (M) (n = 25)</th>
<th>Gymnastics (W) (n = 13)</th>
<th>Volleyball (W) (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Sessions</td>
<td>2.9 ± 1.1</td>
<td>3.2 ± 1.2</td>
<td>2.8 ± 1.4</td>
<td>3.0 ± 1.4</td>
<td>2.6 ± 1.1</td>
<td>3.0 ± 1.6</td>
<td>3.6 ± 1.2</td>
</tr>
<tr>
<td>Ind. Counseling</td>
<td>3.2 ± 1.4</td>
<td>3.1 ± 1.3</td>
<td>3.4 ± 1.4</td>
<td>3.0 ± 1.2</td>
<td>2.5 ± 1.1</td>
<td>3.0 ± 1.5</td>
<td>3.5 ± 1.7</td>
</tr>
<tr>
<td>Newsletters</td>
<td>3.2 ± 1.1</td>
<td>2.5 ± 1.1</td>
<td>2.3 ± 1.2</td>
<td>3.0 ± 1.3</td>
<td>1.9 ± 1.1</td>
<td>3.3 ± 1.2</td>
<td>3.3 ± 1.4</td>
</tr>
<tr>
<td>Study Modules</td>
<td>3.1 ± 1.2</td>
<td>2.0 ± 1.0</td>
<td>2.4 ± 1.2</td>
<td>2.9 ± 1.1</td>
<td>1.9 ± 0.9</td>
<td>2.7 ± 1.1</td>
<td>2.7 ± 1.3</td>
</tr>
<tr>
<td>Comp. Training</td>
<td>2.8 ± 1.4</td>
<td>2.1 ± 1.1</td>
<td>2.5 ± 1.3</td>
<td>3.1 ± 1.2</td>
<td>2.0 ± 1.1</td>
<td>2.5 ± 1.3</td>
<td>2.2 ± 1.0</td>
</tr>
<tr>
<td>Conferences</td>
<td>2.8 ± 1.3</td>
<td>2.3 ± 1.2</td>
<td>2.5 ± 1.1</td>
<td>3.0 ± 1.1</td>
<td>2.0 ± 0.9</td>
<td>2.6 ± 0.8</td>
<td>2.6 ± 1.5</td>
</tr>
<tr>
<td>Academic Courses</td>
<td>3.2 ± 1.3</td>
<td>2.6 ± 1.2</td>
<td>2.7 ± 1.3</td>
<td>3.4 ± 1.0</td>
<td>2.7 ± 0.9</td>
<td>2.9 ± 1.4</td>
<td>3.1 ± 1.7</td>
</tr>
<tr>
<td>Nutr. Grad. Student</td>
<td>3.4 ± 1.2</td>
<td>3.3 ± 1.0</td>
<td>2.7 ± 1.3</td>
<td>3.4 ± 1.1</td>
<td>2.3 ± 1.1</td>
<td>3.6 ± 1.2</td>
<td>3.7 ± 1.4</td>
</tr>
</tbody>
</table>

All values are shown as Mean (1 = Lowest Interest and 5 = Highest Interest) ± Standard Deviation. (M) = Men’s (W) = Women’s.
Table 5

*Nutrition Education Preferences per Sport by Mean, cont.*

<table>
<thead>
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<th>Education Preference</th>
<th>Golf (M) (n = 8)</th>
<th>Golf (W) (n = 7)</th>
<th>Soccer (M) (n = 17)</th>
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<th>Cross Country (M) (n = 11)</th>
<th>CC/Track &amp; Field (W) (n = 26)</th>
<th>Softball (W) (n = 11)</th>
<th>Swimming (W) (n = 16)</th>
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<td>2.5 ± 1.4</td>
<td>3.1 ± 1.6</td>
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<td>3.6 ± 1.5</td>
<td>2.3 ± 1.1</td>
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<td>2.9 ± 1.1</td>
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<td>2.8 ± 1.2</td>
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<td>Comp. Training</td>
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<td>2.6 ± 1.2</td>
<td>3.2 ± 0.8</td>
<td>3.3 ± 0.8</td>
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</tbody>
</table>

All values are shown as Mean (1 = Lowest Interest and 5 = Highest Interest) ± Standard Deviation. (M) = Men’s (W) = Women’s.
included these two methods for nutrition education interventions. The effectiveness of a nutrition graduate student has already been shown to be useful through previous research on the area (76), thus, with the addition of collegiate athlete interest, this method may prove to be highly effective for the university under review. Therefore, future nutrition education interventions aimed toward the collegiate athlete population should focus on these two modalities in an effort to maximize athlete interest and consequent information retention.

Collegiate Athlete Comments

The final statement within the survey instrument asked the athletes to provide any additional comments regarding sports nutrition if they desired. This was only done by six of the 319 student-athletes surveyed, but it still may provide further insight into the interest of this population. One athlete wrote that if they were made more aware of a Registered Dietitian, they would have utilized this service sooner and more often. This statement illustrates that if a Registered Dietitian (RD) is made available to student-athletes at the university under review, action must be taken to inform these athletes of the RD’s availability and the means within which to contact this individual. Another collegiate athlete wrote that he/she would be highly interested in individual counseling related to sports nutrition and wishes to begin a nutritional program to determine if there was a positive effect on his or her athletic performance. This statement correlates with the previously determined high level of interest towards individual counseling, while also displaying that some athletes may seek specified nutritional programming in an effort to gain a competitive advantage. Also regarding the delivery of nutrition information, one athlete stated that they were very interested in the topic of sports nutrition and would enjoy a class on the subject. The university under review recently developed a sports nutrition course, so it is likely that this student had yet to be made aware of its implementation, which should be a topic
that is addressed when discussing sports nutrition with these athletes in the future. Another comment related to the desire to learn more about balanced meals, which was a topic not specifically mentioned within the survey and may be an opportunity for education. The next collegiate athlete simply restated their interest in healthy, cheap meals, but also desired for them to be “fast,” which continues to show that collegiate athletes are interested in health and cost, as well as convenience. This finding is consistent with previous research on the area of common barriers collegiate athletes experience towards proper nutrition (91). Lastly, “more access to nutrition facts” was written, possibly implying that this individual may need something as simple as education on how to interpret nutrition facts or that they wish to have nutrition facts provided to them at on- and off-campus locations. Specifically with regard to the latter, initiative should be taken to provide this information on a regular basis throughout the city to educate the public on their nutrition-related decisions.
CHAPTER V

CONCLUSIONS

The overall aim of this study was to provide the nutrition faculty, who are members of the Sport Performance Team of the university under review, with a foundation for the development and execution of nutrition education interventions for the athletic teams studied. Due to nutrition’s role in the enhancement and optimization of athletic performance, an understanding of a population’s current nutrition knowledge, as well as their interests related to the topic, is essential. After collection of extensive data through survey of 17 intercollegiate athletic teams, student-athlete nutrition knowledge, interest related to sports nutrition topics, and interest related to delivery of sports nutrition information was successfully collected and analyzed, greatly aiding planning for future nutrition education interventions within this target population.

When considering gender, male athletes were shown to have lower nutrition-related knowledge than female athletes, with men’s football and men’s basketball having statistically significant lower scores and women’s gymnastics having statistically significant higher scores than the other athletic teams ($p = 0.000$). Nutrition knowledge was shown to have a negative correlation with projected Registered Dietitian use; however, some athletes may be relatively unaware of this service’s availability and are likely in need of contact information. Each team also had individualized topics of interest that may be significant when considering future nutrition education interventions. Overall, female athlete nutrition education may benefit from focusing on cheap, healthy meals and safe, healthy weight loss, while male athlete nutrition
education may benefit from focusing on sports drinks and muscle building. Since both genders found equal interest in pre- and post-workout meals, energy requirements, and healthier fast food alternatives, these topics may be covered equally between male and female athletic teams. Although energy drinks were not rated as very interesting by any sport, this topic may require further exploration to determine why student-athletes found it to be of relatively low interest.

Future nutrition education interventions may benefit from utilizing nutrition graduate students as well as individual counseling, as these methods were rated as being the most interesting by the collegiate athletes surveyed in this study. Those providing these interventions may also wish to consider, particularly during individual counseling, that perceived nutrition knowledge is not significantly correlated with actual nutrition knowledge. Even though the completion of an Introduction to Human Nutrition course showed statistically significant higher scores related to nutrition knowledge, it is uncertain how practically significant this is and may require further research before inclusion into recommendations.

Limitations of the Study

It is important to note that a major limitation of this study is that only one Midwestern university was surveyed. The implications of any data gathered may not be applicable to other universities throughout the nation. In addition, some of the athletic teams do not have a large quantity of student-athletes. This factor may provide data that is not universal to the sport or other universities. Likewise, the population under review is limited to the student-athletes at the division I university studied. It is unclear whether this population size will provide a useful data pool to safely generalize the information to other universities across the nation.
With regard to the survey instrument itself, after the administration of the survey, it became apparent that some of the questions were misunderstood to a greater degree than anticipated. Many of the student-athletes marked several choices for answers when there was only one correction selection. If “Check only one” was specified for each question, the results may have differed slightly, possibly allowing student-athletes to correctly answer more of the nutrition knowledge questions. In addition, the first question with regard to the completion of an Introduction to Human Nutrition course only asked whether the individual had completed a course and not whether they were in the process of completing the course. If this was listed as a third choice, a more varied analysis could have been conducted.

Recommendations for Future Research

In order to assist the nutrition department of the university under review with future nutrition education interventions, clarification on some of the findings within this study should be sought. One of these findings is the lack of interest noted in the topic of energy drinks. Future research on this should aim to determine what the motivations of student-athletes are for their lack of interest in the subject. In addition, due to the confines of this study’s survey instrument, the completion of an Introduction to Human Nutrition course was found to only produce a 7% increase in nutrition knowledge. Further investigation on the area should utilize a more extensive measure of nutrition knowledge than this study’s 14-question knowledge survey, while also acknowledging those student-athletes currently completing the course. Lastly, this study, as originally designed, intended to survey collegiate coaches as well to determine their level of nutrition knowledge and interest; however, due to lack of response from these coaches, that portion of the study was removed. Further studies may benefit from determining collegiate
coaches’ interests with regard to nutrition-related topics and methods for receiving nutrition education interventions.
REFERENCES


APPENDIX A:

HSRB APPROVAL
May 11, 2011

TO: Jeffrey Gilis
FCS

FROM: Hillary Harms, Ph.D.
HSRB Administrator

RE: HSRB Project No.: H11T240GE7

TITLE: Nutrition Knowledge and Interest of Collegiate Athletes and Coaches at a Division I University

You have met the conditions for approval for your project involving human subjects. As of May 9, 2011, your project has been granted final approval by the Human Subjects Review Board (HSRB). This approval expires on April 20, 2012. You may proceed with subject recruitment and data collection.

The final approved version of the consent document(s) is attached. Consistent with federal OHRP guidance to IRBs, the consent document(s) bearing the HSRB approval/expiration date stamp is the only valid version and you must use copies of the date-stamped document(s) in obtaining consent from research subjects.

You are responsible to conduct the study as approved by the HSRB and to use only approved forms. If you seek to make any changes in your project activities or procedures, send a request for modifications to the HSRB via this office. Those changes must be approved by the HSRB prior to their implementation.

You have been approved to enroll 400 participants. If you want to enroll additional participants you must seek approval from the HSRB.

Good luck with your work. Let me know if this office or the HSRB can be of assistance as your project proceeds.

Comments/Modifications: Stamped original consent forms are coming to you via campus mail.

c: Dr. Dawn Anderson

Research Category: EXPEDITED #7
APPENDIX B

ICA RESEARCH SUBCOMMITTEE APPROVAL
April 19, 2011

MEMORANDUM

To: Jeffrey Gilis
Graduate Student

From: Lee A. Meserve
For the ICA Research Subcommittee

Re: Your Proposal to Do Research Using Student-Athletes
Project title: Nutrition knowledge and interest of collegiate athletes and coaches at a Division I university.
The Intercollegiate Athletics Committee Research Subcommittee has reviewed your proposal to use BGSU student-athletes and coaches as subjects for the survey research project for your master’s degree, the title of which is mentioned above. The ICA Research Subcommittee approves your use of student-athletes to collect data by means of your survey instrument for this project. Best wishes for successful collection of data and information. The Intercollegiate Athletics Committee Research Subcommittee would be interested in your findings, and would request that you provide us with a summary of the findings of this study at its completion.

cc: Dawn Anderson, Advisor
    Hillary Harris, Compliance Office
    ICA Committee Research Subcommittee
    Greg Christopher, Director of intercollegiate Athletics
APPENDIX C:

INFORMED CONSENT FOR COLLEGIATE ATHLETES
Informed Consent for Collegiate Athletes

Introduction: My name is Jeffrey Gilis, and I am in the Master’s of Food and Nutrition program at Bowling Green State University. I am researching the nutrition education and interests of all the collegiate athletes and coaches at Bowling Green State University. This research is being conducted under the supervision of Dr. Dawn Anderson, Associate Professor and Graduate Coordinator for the School of Family and Consumer Sciences.

Purpose: By learning what collegiate student-athletes and coaches know and want to know about nutrition, programs and educational materials can be prepared accordingly. Once a high level of tailored nutrition education is then provided to the athletes and coaches, optimal sports performance is attainable. Not only will the Bowling Green State University athletic programs benefit, but also the individual athletes will have a higher sense of knowledge on the subject of sports nutrition and be able to advance their level of performance to the maximum level.

Procedure: Each collegiate athletic program will be evaluated through a paper survey at a team meeting. The survey will consist of several multiple choice and rating questions, as well as demographic type questions. The evaluation will be in written form and take place only once. Involvement in this study will take approximately 30 minutes of your time. In addition, the athletes and coaches from each collegiate team will be entered into a drawing to win one of fifteen $10 gift cards to Kroger®. Participants assume no risk when completing this survey.

Voluntary Nature: Your participation is completely voluntary. You are free to withdraw at any time. You may decide to skip questions or discontinue participation at any time without penalty. Deciding to participate or not will not affect your grades, class standing, or your relationship with Bowling Green State University, your team, or your coach.

Confidentiality Protection: The data will be stored in a locked file cabinet with only the researcher having access. The data will be stored for a period of six months and then destroyed to maintain confidentiality. Individual responses will not be shared with coaches, athletic department, or any other athletic personnel. The survey will not consist of names or any other identifying variables. The responses will be confidential and participant names will not be disclosed when reporting the data.

Contact Information: I, Jeffrey Gilis, can be contacted at 419-372-8528 or jgilis@bgsu.edu. My advisor, Dr. Dawn Anderson, can be contacted at 419-372-8030 or dawna@bgsu.edu. Please contact my advisor, Dr. Dawn Anderson, or me if you have any questions about the research or your participation in the research. You may also contact the Chair, Human Subjects Review Board at 419-372-7716 or hsrb@bgsu.edu, if you have any questions about your rights as a participant in this research. Thank you very much for your time!

By completing the corresponding survey, you are acknowledging the following statement as true: I am at least 18 years of age. I have been informed of the purposes, procedures, risks, and benefits of this study. I have had the opportunity to have all my questions answered and I have been informed that my participation is completely voluntary. I agree to participate in this research.
APPENDIX D:

SURVEY INSTRUMENT
Collegiate Athletes

Please complete the following questions to the best of your ability. You must be at least 18 years of age to participate. It is important for you to answer these questions honestly, so that the results will be as valid as possible to ensure the development of an optimal sports nutrition education program. For those questions with a line provided, please mark an “X” on the line next to your answer. Some questions may have more than one choice, so please read all questions carefully. Thank you very much for your time.

1) Have you completed an Introduction to Human Nutrition course at the collegiate level?
   ___ Yes
   ___ No

2) Out of all the courses you have taken in college thus far, how many of them have discussed the topic of nutrition?
   ___ More than four
   ___ Four
   ___ Three
   ___ Two
   ___ One
   ___ None

3) How would you rank your level of nutrition knowledge on a scale from 1 to 10, 1 = Not knowledgeable at all and 10 = Very knowledgeable. ___

4) Which of the following items are energy-producing nutrients? (Check all that apply)
   ___ Carbohydrate
   ___ Protein
   ___ Fat
   ___ Vitamins
   ___ Minerals
   ___ Water

5) What is the body’s main source of energy?
   ___ Carbohydrate
   ___ Protein
   ___ Fat
   ___ Vitamins

6) What does the body use for muscle repair?
   ___ Carbohydrate
   ___ Protein
   ___ Fat
   ___ Water

7) For athletes, which nutrient is required in the greatest quantity for energy?
   ___ Carbohydrate
   ___ Protein
   ___ Fat
   ___ Minerals
8) Which of the following provides the most carbohydrate?

- One cup of skim milk
- One-half cup of applesauce
- One cup pasta
- One cup of regular ice cream

9) Which of the following provides the most protein?

- Two egg whites
- One cup of whole milk
- Three-ounce chicken breast
- One tablespoon of peanut butter

10) Which of the following provides the most fat?

- Twelve almonds
- One tablespoon olive oil
- One slice of bacon
- One ounce cheddar cheese

11) Which of the following nutrients should be limited immediately following exercise?

- Carbohydrate
- Protein
- Fat
- Water

12) Within which time frame is it essential for athletes to eat post-exercise?

- Less than 30 minutes
- 30 minutes – 2 hours
- 2 – 3 hours
- More than 3 hours

13) For EACH of the following topics, circle your level of interest with regard to nutrition knowledge. 1 = Not Interested and 5 = Very Interested.

<table>
<thead>
<tr>
<th>Topic</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
<td>Sports drinks</td>
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<td>Protein supplements</td>
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<td>Pre- and post-workout meals</td>
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<td>General nutrition</td>
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<td>Cheap, healthy meals</td>
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<td>Healthier fast food alternatives</td>
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<tr>
<td>Muscle building</td>
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<tr>
<td>Safe, healthy weight loss</td>
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</table>
14) For EACH of the following, circle your level of interest in how you would prefer to receive nutrition information, 1 = Not Interested and 5 = Very Interested.

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<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
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<td>Nutrition graduate student</td>
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15) If a Registered Dietitian were available to you, how often would you utilize this service?

- 3+ times per week
- 2-3 times per week
- Once a week
- Once every other week
- Once a month
- Once a semester
- Never

16) In which sport do you participate?

- Basketball
- Football
- Baseball
- Ice Hockey
- Gymnastics
- Volleyball
- Golf
- Soccer
- Cross Country/Track and Field
- Softball
- Swimming
- Tennis

17) Gender?

- Male
- Female

18) Class rank?

- 1st year
- 2nd year
- 3rd year
- 4th year
- 5th year +

If you have any additional comments regarding sports nutrition, please write in the space below.