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UNDERSTANDING NUTRITION KNOWLEDGE AND BEHAVIORS OF COLLEGIATE ATHLETES

A Thesis in

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ABSTRACT

Background: Collegiate athletes often have inadequate diets due to lack appropriate nutrition knowledge (NK) and subsequently poor nutrition behavior (NB). Poor diet may compromise athletic performance, delay recovery from physical activity, and increase vulnerability to injury and illness. The purpose of the this study was to examine the relationship between gender, prior nutrition-related coursework, international vs. domestic student status, living situation, sport played, race/ethnicity, and year in school with NK and NB.

Methods: Collegiate athletes from Fairleigh Dickinson University, an NCAA Division I institution, voluntarily participated in the cross-sectional study. An online questionnaire distributed to the athletes via members of the coaching staff collected anthropometric and demographic information in addition to information on nutrition knowledge and behaviors. Descriptive data were calculated as frequencies (%). A Pearson correlation (r) was used to examine the relationship between NK and NB. An independent samples t-test (t) was used to determine differences between male and female gender, whether or not an athlete had previous nutrition-related coursework, and NK and NB. A one-way ANOVA (F) was used to determine differences between living situation, sport played, race/ethnicity, year in school and NK and NB.

Results: The final sample (n=140) consisted of 42.5% male and 57.5% female athletes. The study found no significant relationship between NK and NB. No significant difference was found between genders for NK and NB. Athletes who had previous nutrition-related coursework were found to have significantly greater NK (p=.025). However, there was no difference between NB and those who had previous nutrition-related coursework and those who did not. International athletes were found to have significantly better NK (p=.005) compared to domestic

athletes. Athletes living off-campus alone or with roommates had better NK (p=.02) compared to students living on-campus or off-campus with family. No significant differences were found between sport teams with respect to either NB or NK. Fourth year/senior athletes were found to have significantly better NK compared to both first year/freshman athletes (p=.029) and second year/sophomore athletes (p=.028).

Conclusions: This study revealed that while differences do appear to exist among the collegiate athletes in this population with respect to levels of NK, there seems to be very little difference across the population with respect to NB. The results of this study also indicate that NK may not be a good predictor of NB in collegiate athletes and that despite adequate NK, barriers to improved NB may exist.

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Chapter 1

Introduction

At the collegiate level, most notably at the NCAA Division I level, there is a great deal of emphasis placed on competitiveness and athletic success. Consequently, interest in diet and sports nutrition, including the use of dietary supplements, among collegiate athletes is very high.[1] However, it is unclear if nutrition interest among collegiate athletes translates into improved knowledge regarding diet as well as improved dietary habits and behaviors.

The diet of an athlete is one factor among many that has a great influence on athletic performance and overall health and wellness.[2,3] For many athletes at the collegiate level, the quality of their diets and meeting their nutritional needs are not high on the list of priorities.[4] Complicating matters are busy class schedules and demanding workout and competition commitments which may burden athletes and encourage a reliance on quick meals or "fast-foods" which can be low in nutritional-density.[4,5] Likewise, busy schedules may also provide a rationale for the athletes skipping meals and perhaps falling short of both calorie and nutrient needs.[5] With that said, collegiate athletes require regular, well-balanced meals to meet the fueling demands of training and competition as well as the demands of academia.

A study completed by Ziegler et al.[5] which examined the dietary practices of elite male and female figure skaters, demonstrated that the greater the level of competitiveness of the sport, the greater the athlete's concerns were regarding the quality of their health behaviors including diet. Factors influencing nutrient intake and quality of diet were cited as lack of time, a busy training schedule, and a greater emphasis on physical appearance, leanness, and body image.[5]

Such factors have the potential to negatively impact the diet of a collegiate athlete despite the adequate availability of healthy food choices and the resources for proper diet planning.

A comprehensive study of collegiate athletes would provide members of the athletic department, including nutritionists, athletic trainers, and coaches, with meaningful information on the nutritional status of athletes. Ideally, the study should collect demographic data to aid in the identification of specific groups at greater risk for poor nutrition knowledge and behavior. The collection of anthropometric information, including height, weight, body mass index (BMI), and weight history, would help to identify those requiring intervention to enhance health and athletic performance. An indication of where collegiate athletes get their nutrition information as well as preferred vehicles for receiving nutrition information would be helpful when considering the design of subsequent educational and behavioral interventions. In addition, the study should collect information regarding the depth of nutrition knowledge of collegiate athletes and the adequacy of practiced nutrition behaviors. The resulting data collected from such a study would aid the athletic department in the design and implementation of targeted and meaningful nutrition interventions for the collegiate athletes. The end result being improved athletic performance and recovery from training and competitions, improved focus and cognitive performance, improved resistance to injury, and better overall health and well-being.[2,3]

Nutrition education interventions, can help can collegiate athletes better understand the role of diet in performance, recovery, and health and can help them to make the most appropriate food and fluid choices to attain peak performance.[6,7] Despite having access to targeted and customized nutrition resources, collegiate athletes are likely to obtain nutritional information from a wide variety of sources; such as sports and fitness magazines, parents, teammates,

coaches, and trainers.[8,9] Ultimately, the athlete has the control and responsibility to make nutrition decisions that are in his or her best interest.

This aim of this study was to utilize a comprehensive assessment tool to answer the following questions regarding the nutrition behavior and nutrition knowledge of collegiate athletes:

1) What is the relationship between nutrition behavior and nutrition knowledge?

2) What are the differences between genders of collegiate athletes with respect to nutrition behavior and nutrition knowledge?

3) Do collegiate athletes who have previously taken nutrition-related coursework have improved nutrition behavior and nutrition knowledge?

4) Are there differences between international and domestic collegiate athletes with respect to nutrition behavior and nutrition knowledge?

5) What is the relationship between a collegiate athlete's living situation and their nutrition behavior and nutrition knowledge?

6) Do differences between sports teams exist with respect to nutrition behavior and nutrition knowledge?

7) What is the influence of the race/ethnicity of a collegiate athlete on nutrition behavior and nutrition knowledge?

8) What is the influence of year in school of a collegiate athlete on nutrition behavior and nutrition knowledge?

Hypotheses

The following hypotheses were based on a comprehensive literature review performed during the process of developing this research study.

1. There will be a positive correlation between nutrition behavior and nutrition knowledge.
2. Female athletes will score better than male athletes with respect to both nutrition behavior and nutrition knowledge scores.
3. Athletes having taken previous nutrition-related coursework will score higher on both nutrition behavior and nutrition knowledge.
4. International student-athletes will score higher on both nutrition behavior and nutrition knowledge compared to domestic athletes.
5. Athletes residing off-campus will score higher on nutrition knowledge compared to athletes residing on-campus. Athletes residing on-campus will score higher on nutrition behavior compared to athletes residing off-campus.
6. There will be no significant difference between sports teams with respect to nutrition behavior and nutrition knowledge scores.
7. There will be a significant difference between different races/ethnicities with respect to nutrition behavior and nutrition knowledge scores.
8. There will be a significant difference between nutrition behavior and knowledge scores with respect to an athlete's year in school.

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Chapter 2

Review of the Literature

This review will discuss the literature relevant to the current study, including the role of diet in athletic performance and health, nutrition knowledge among collegiate athletes, and nutrition behaviors of collegiate athletes.

Role of diet in athletic performance and health

It has been well established that diet can have a profound impact on athletic performance.[1,2,3,4] In addition to the physical demands associated with athletic competition, many sports also place a significant cognitive demand on the athlete. Research conducted by Kanarek and Swinney[2] demonstrated the beneficial effects of well-spaced meals and snacks on cognitive performance in a population of adult college students. Consequently, research and interest in the topic of sports nutrition for the benefit of enhanced physical and cognitive performance continues to advance, with new studies more closely examining the role of macro and micronutrients and dietary supplements on performance and recovery.[5] The athlete who is looking to optimize athletic performance should follow a well-designed plan for diet and hydration. According to Burke[3], the goals of this plan should include meeting calorie and nutrient requirements, achieving and maintaining an appropriate body weight and composition, supporting adaptation and recovery between training sessions, and maintaining optimal health.

Consuming adequate calories for energy should be the top dietary priority for an athlete. Achieving a balance between caloric intake and expenditure will help an athlete maintain body weight and lean body mass and contribute to optimal athletic performance.[6] Caloric needs for

athletes may vary considerably depending on a number of factors including body size and composition and sport played.[1] Research has shown that an inadequate calorie intake relative to expenditure will likely result in compromised physical performance.[1,3,6] Additionally, in a situation with limited calorie intake, energy stores consisting of glycogen, fat, and lean muscle tissue will be used to make up the deficit. The loss of lean muscle tissue would likely result in the loss muscular strength and endurance.[1] Furthermore, diets inadequate in calories have been shown to often result in poor essential nutrient intake.[1,6]

Body weight and composition are two attributes that contribute to optimal athletic performance.[1] Together, these two attributes may influence an athletes' success in a given sport. Body weight may influence the speed, power, and stamina of an athlete, while body composition can affect the strength, agility, and appearance of an athlete.[1] Many athletes require a high strength-to-weight ratio for optimal performance. Since body fat adds weight without adding strength, many sports emphasize leanness. However, too much leanness or too little body fat may also result in compromised athletic performance and even health complications.[1] The caloric intake of an athlete in relation to his or her established caloric need, will be a great determinant of body weight and composition.[1,5,6] Athletes should strive to maintain a body weight and composition that allows for optimal performance by consuming a diet that provides the appropriate number of calories for energy. Athletes who are not at an appropriate body weight or composition should seek guidance in the manipulation of calorie intake, increasing intake in a manner that facilitates healthy weight gain or reducing calorie intake in a manner which facilitates appropriate weight loss.[7,8,9]

In addition to consuming the appropriate number of calories to achieve optimal body weight and composition, an athlete should strive to meet macronutrient requirements for protein,

carbohydrate, and fat as well as requirements for vitamins, minerals, and fluid.[1] According to the Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine on Nutrition and Athletic Performance[1], an athlete requires 55%-58% of energy from carbohydrate, 12%-15% of energy from protein, and 25%-30% of energy from fat. Athletes should also strive to meet established requirements for vitamin and mineral micronutrients with a particular emphasis on the minerals calcium, iron, and zinc which research has shown to be the primary minerals low in the diets of athletes, especially female athletes.[1] According to the Dietary Guidelines for Americans[10], consumption of a varied diet and the inclusion of foods from all food groups is an efficient way to meet requirements for vitamins and minerals. Research has indicated that athletes who put themselves at greatest risk for micronutrient deficiencies are those who restrict calorie intake or employ extreme weight loss practices, eliminate one or more food groups from their diets, or consume high-carbohydrate, low-micronutrient-dense diets.[1] Athletes who practice any of these behaviors may require a multivitamin/mineral supplement to meet their micronutrient needs.[1] Exercise performance and athletic competitiveness may also be influenced by the hydration status of an athlete as performance is impaired with progressive dehydration.[1,11] Additionally, a state of dehydration increases an athletes' risk of potential dangerous conditions such as heat exhaustion and heat stroke.[1,3] Consequently, athletes should strive to maintain appropriate levels of hydration before, during, and after physical activity.

A review of the scientific literature indicates that athletes tend to focus on nutrition as it relates to their immediate competitive pursuits more than nutrition as an influence on overall health.[3] However, the overall health of an athlete can have a significant impact on the ability of an athlete to perform, recover, and reduce the risk of sickness and injury during periods of heavy

training and competition.[3] Collegiate athletes are expected to perform at a high competitive level and research supports a relationship between the dietary practices and behaviors of collegiate athletes and their health and competitiveness.[4,8,12]

Nutrition knowledge among collegiate athletes

Previous studies have found that collegiate athletes generally maintain a positive attitude toward nutrition and recognize the relationship between nutrition and athletic performance and health.[13] Despite this positive attitude, a number of studies have found that collegiate athletes lack adequate knowledge critical for preventing nutrition-related issues with performance and health.[13,14,15,16] Zawila et al.[13] found that female, collegiate cross-country runners lacked appropriate nutrition knowledge and were consequently at increased risk for health and performance issues. This same study also demonstrated that collegiate athletes who completed a nutrition-related course scored higher on an evaluation of nutrition knowledge compared to athletes with no previous coursework. In a study conducted by Burns et al.[14], which examined collegiate athletes' use of nutritional supplements, it was found that despite access to qualified sources for nutrition information, athletes had many misconceptions regarding the roles of protein, vitamins, and dietary supplements. Additional studies support the conclusion that collegiate athletes generally have a poor grasp of proper nutrition information.[15,16]

A number of different factors may contribute to the poor nutrition knowledge of collegiate athletes. It has been speculated that this may be the result of the athletes lacking the motivation to take advantage of the available resources for nutrition information or failing to use them properly.[15] Collegiate athletes may obtain nutrition knowledge from a number of different

sources including coaches, trainers, nutritionists, friends and teammates, parents, or books and magazines. Corley et al.[17] conducted a study on the nutritional knowledge and dietary practices among college coaches and found that poor knowledge and eating habits of coaches may significantly influence the eating habits of their athletes. In the previously mentioned study by Burns et al.[14], nutrition misconceptions among collegiate athletes were also thought to be linked to poor information coming from members of the coaching or athletic training staff.

The quality of sources for nutrition information can obviously vary between and even within sources. One can safely assume that not all coaches, athletic trainers, or parents possess the same level of knowledge with respect to appropriate dietary practices. Torres-McGehee et al.[18] found in a study that examined sports nutrition knowledge among coaches, athletic trainers, and strength and conditioning specialists that athletic training staff and strength and conditioning specialists generally had adequate knowledge of nutrition. In contrast, coaches and collegiate athletes did not have adequate nutrition knowledge and were poor sources of nutrition information.

Availability of an on-campus nutritionist or nutrition services is viewed as a great potential benefit to the collegiate athlete as well as to the coaching and athletic training staff. The role and value of the on-campus nutritionist for athletics has been outlined by Clark[9], a sports nutritionist at Penn State University, in a commentary on working with college athletes, coaches, and trainers at a major university. Providing guidance to food service providers on campus regarding menu items, expanding dining hours, providing workshops on eating disorders, weight gain, or weight loss are some examples of programs and services that may be provided by a nutritionist. The role of a sports nutritionist in educating and counseling collegiate athletes has also been discussed by Vinci[19] who outlined the benefits of providing both

individual and team counseling sessions. Female athletes in particular may benefit from a multidisciplinary team which includes not only a nutritionist, but also the team physician, clinical psychologist, and athletic trainer.[19] This multidisciplinary team may help to prevent and treat issues of disordered eating which are much more prevalent among female athletes compared to male athletes.[20] A paper by Quatromoni[20] highlighted clinical observations from nutrition services in college athletics, and presented evidence of the need for comprehensive nutrition services for collegiate athletics. The author also advocates for a multidisciplinary team for the prevention and treatment of eating disorders among female athletes.

Collegiate athletes' history with nutrition-related coursework also seems to have a significant bearing on nutrition knowledge.[13,22] Werblow et al.[22] demonstrated that athletes who had some form of nutrition education, including nutrition-related coursework, had higher nutrition knowledge and attitude scores than those that did not. The relationship between nutrition-related coursework and knowledge was also supported in the study by Zawila.[13]

In some cases, gender also appears to be associated with differences in nutrition knowledge among collegiate athletes.[23,24,25] In a study completed by Paugh[23] at the California University of Pennsylvania, found that female athletes scored significantly higher on survey questions related to nutrition knowledge compared to male athletes. Dunn et al.[25] reported similar findings with female collegiate athletes scoring higher than male athletes on tests of nutritional knowledge. These results may possibly be related to the finding that female collegiate athletes tend to seek out and receive more nutrition information than male collegiate athletes.[24]

The level of competition an athlete participates in seems to also influence interest and knowledge about nutrition.[21,26] Studies have shown that collegiate athletes have a greater interest in nutrition and are more knowledgeable about diet than high school athletes but that elite level and professional athletes have interest and knowledge greater than collegiate athletes.[21] Despite the potential influence of competitive level, limited research indicates that there may be little to no difference in nutrition knowledge between collegiate athletes and non-athlete college students. A study by Barr[27] which examined the dietary knowledge of female varsity athletes and non-athlete, university students, found that the athletes had no greater knowledge than the non-athlete students.

Nutrition behaviors of collegiate athletes

While it has been previously established that collegiate athletes generally lack adequate nutrition knowledge, studies have also indicated that collegiate athletes practice poor nutrition behavior.[12,16,28] A study by Shriver et al.[12] examined the dietary intakes and eating habits of college athletes numerous concerns were identified. The study found that only 9% of the athletes evaluated were meeting established energy needs. Additionally, 75% of the athletes failed to consume adequate carbohydrate to support training and recovery. Poor hydration practices and meal skipping were also identified as issues with the majority of athletes found to be consuming no regular breakfast.[12] Hoogenboom et al.[16] examined the nutrition knowledge and eating habits of female collegiate swimmers found that the majority of athletes did not consume a well-balanced diet with 96% not meeting the recommended dietary allowance (RDA) for key nutrients including protein, iron, and calcium. In a study examining the nutrient intakes and dietary behaviors of both male and female collegiate athletes, Hinton et al.[28] found that in both male and female studied, only 15% had adequate intake of carbohydrate while only 26% had

adequate intake of protein, both key macronutrients essential for athletic performance and recovery.

The dietary behaviors of collegiate athletes often include the use various dietary supplements.[14,26,27,29,30] Barr[27] reported that collegiate athletes were more likely to use nutritional supplements when compared to non-athlete, college students. Sobal and Marquart[26] reported in a review of the literature regarding vitamin/mineral supplement use among athletes that collegiate athletes were more likely to use supplements that high school athletes but not as likely to use supplements when compared to elite athletes. In a study by Froiland et al.[29] which examined nutritional supplement use among collegiate athletes and their sources of information found that 89% of the athletes in the study reported using supplements including sports drinks and meal replacements. Burns et al.[14] assessed intercollegiate athlete use of nutritional supplements and the role of athletic trainers and dietitians in nutritional counseling and determined that athletes had various misconceptions regarding the use of vitamin/mineral, protein, and meal replacement supplements. The study also implicated athletic trainers and coaches as poor sources of information for the athletes.[14] Darvishi et al.'s[30] research on the use of nutritional supplements among male collegiate athletes concluded that although less than half of the athletes in the study reported using supplements, their information resources regarding supplements was poor.

The relationship between nutrition knowledge and nutrition behavior has not been clearly established. Higher levels of nutrition knowledge do not always translate to better nutrition behaviors. In a study on the dietary habits and nutrition knowledge of college athletes, Paugh determined that an increased understanding of nutrition was positively correlated to better dietary habits.[23] Additionally, Nichols et al.[11] demonstrated that there was a significant positive

correlation between knowledge and behavior in collegiate athletes with respect to hydration and fluid replacement practices. In contrast to these findings, a study conducted by Perron and Endres[31] which reported on knowledge, attitudes, and dietary practices of female athletes found no significant correlation between nutrition knowledge and dietary behaviors. Perron and Endres concluded that factors such as an athletes' concern regarding body weight may explain why adequate nutrition knowledge does not necessarily result in better dietary practices.[31] Many sports, especially those requiring attributes of speed, agility, and flexibility favor leanness.[21] This may encourage an athlete to voluntarily restrict caloric and consequently nutrient intake in an attempt to lose weight or reduce body fat or to engage in a weight loss diet that is insufficient to meet the needs of a competitive athlete.[31] Perron and Endres also determined that a reliance on others for food selection may also have negative implications on the diet quality of athletes.[31] Collegiate athletes are often resigned to eating foods available in on-campus dining facilities, at team training tables, or at the restaurants chosen by the coaches when travelling for competitions. While healthy food choices may be available through these options, there are often also many options available which may not constitute healthy food choices for athletes.[8] Ziegler et al.[21] which examined the nutrient intakes of male and female figure skaters also found they were compromised by lack of time, busy training schedules, and concerns regarding weight and body image. Additionally, Quatromoni has cited the rigorous demands of collegiate sports participation along with the "realities" of college lifestyle, which include alcohol consumption and reliance on low-quality, fast foods as reasons for increased nutritional risk among collegiate athletes.[20] For the collegiate athlete living off-campus, the disconnect between adequate nutrition knowledge and appropriate dietary habits may be exacerbated by additional factors such

as time demands of travel to and from campus and limited availability of resources to purchase and prepare healthy meals.[33]

Previous studies have shown that gender, race/ethnicity, and living situation may also have an influence nutrition behavior.[23,29,25,28,32,33,34] The study by Paugh found that female collegiate athletes had better eating habits than males.[23] This finding supports research conducted by Dunn et al. which also concluded that female collegiate athletes make better nutrition choices than males.[25] Hinton et al.[28] found that male collegiate athletes were more likely than female collegiate athletes to exceed recommended intakes for total fat, saturated fat, cholesterol, and sodium, which are all nutrients associated with chronic health issues. Hinton et al.[28] also reported that interest in weight loss was much greater in female athletes compared to males, with 62% of females indicating a desire to lose more than 5 pounds compared to 23% of males. Gender influence on nutrition behavior also seems to extend to dietary supplement use.[29] Froiland et al.[29] found that females were more likely to take supplements they associated with weight loss or improved health including vitamin/mineral supplements and calcium while males were found to be more likely to take supplements they associated with performance enhancement including protein supplements, weight gainers, and creatine.

Research on the influence of race/ethnicity on the nutrition behavior of collegiate athletes specifically, is limited. However, a study conducted by Winkleby and Cubbin[32] which examined racial/ethnic disparities in health behaviors in the general population found that blacks and Hispanics have higher fat intake, poorer diets, and increased obesity compared to white/Caucasians. This finding has been linked to lower socioeconomic status of blacks and Hispanics compared to whites/Caucasians.[32] Winkleby and Cubbin also noted that individuals born in the United States had higher predicted prevalence of unhealthy dietary behaviors than

those born outside of the U.S., after adjustment for education and income and that the more an ethnic or racial minority is immersed in the culture of the United States, the worse the predicted nutrition behavior.[32] However, more research is required to examine the role that race and ethnicity may play on the nutrition knowledge and behavior of collegiate athletes.

As previously mentioned, the living situation, on-campus versus off-campus, of a college student may also have an influence on eating behavior.[33,34] A study conducted by Small et al., found that living off-campus resulted in a decline in fruit and vegetable consumption which is a key indicator of healthy diet.[33] Off-campus students reported several barriers to healthy diet which included high workloads, lack of time, and transportation issues.[33] Many college students share off-campus apartments with roommates and must negotiate how food will be purchased, prepared, and shared. Low-cost foods that allow for quick preparation, which are often low in nutritional density, may be easiest to agree upon, prepare, and keep fresh. Consequently, reliance on these foods may result in compromised energy and nutrient intake.

Purpose of the study

Review of the current research supports the belief that factors including gender, exposure to nutrition-related coursework, race/ethnicity, and living situation may all be influences on the nutrition knowledge and behavior of collegiate athletes. In the interest of developing appropriate and meaningful nutrition interventions for collegiate athletes, it is important to better understand the magnitude of these influences. The purpose of this study was to evaluate and understand the relationship of these variables on the nutrition knowledge and behavior of the collegiate athletes at FDU to ultimately enhance the scope and quality of nutrition services that are provided to

them. The end result of these efforts would be the improved health and athletic performance of these athletes.

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Chapter 3

Methods

Research design

The research design used for this study was descriptive and cross-sectional. The dependent variables were nutrition behaviors and nutrition knowledge. The independent variables were gender, living situation, previous completion of nutrition-related coursework, international vs. domestic student status, race/ethnicity, sport played, and year in school. The survey was provided to all currently eligible and active collegiate athletes at Fairleigh Dickinson University (FDU) providing the researcher with a captive audience. The researcher for this study is a member of the Department of Athletics at FDU and serves as the nutrition consultant to the athletes.

Recruitment of subjects

The subjects for this study consisted of collegiate athletes from the Metropolitan campus of Fairleigh Dickinson University which is designated as a National Collegiate Athletic Association (NCAA) Division I institution. The survey tool was provided to 171 male and female student-athletes listed on the rosters of one of the following teams: men's tennis (n=8), women's tennis (n=7), men's track & field (n=16), women's track & field (n=15), women's volleyball (n=8), men's soccer (n=18), women's soccer (n=17), women's basketball (n=15), baseball (n=26), softball (n=14), men's golf (n=4), women's golf (n=4), women's bowling (n=11), and women's fencing (n=8). Members of the men's basketball team were not included in the study at the request of the FDU Department of Athletics.

Procedures

The survey was approved by the Institutional Review Board (IRB) at Fairleigh Dickinson University (Appendix B). The research was conducted exclusively at the Fairleigh Dickinson University Metropolitan campus. The coaching staff from each team surveyed was asked to forward the survey to all currently active team members on their roster. Approximately one week before receiving the link to the survey, the coaches received an email message (Appendix C) explaining the purpose of the survey and asking for their cooperation in distributing the survey. Coaches then received an email containing a message for the athletes and a survey link for the specific teams they coached. Separate survey links for each team were created to help monitor response rates. In some cases, such as Men's and Women's Tennis, Men's and Women's Golf, Men's and Women's Track & Field/XC, only one survey link was created for both genders since both the men's and women's teams had the same coaching staff.

The message for the athletes included information about the purpose of the survey, an emphasis that participation was voluntary, and that the survey would take approximately 10-15 minutes to complete. By clicking on the survey link, the athletes were taken to the Informed Consent (Appendix D). Participants were then given the option to proceed by advancing to the next page which was the first page of the survey. Eligible athlete participants were given approximately six weeks to complete the survey. During this six week period, coaches received occasional reminder e-mails to encourage the participation of their athletes. The goal was to achieve a response rate of 80% for each team as well as an overall response rate of 80%. Response rates for each individual team are included in Appendix E.

Survey tool

The FDU Athlete Nutrition Survey (Appendix A) examined dietary behaviors and nutritional knowledge. On on-line survey instrument was developed using Qualtrics Survey Software (Provo, Utah). The survey was divided into six sections: 1) Body Type and Injury History, 2) Diet Practices, 3) Nutrition Education, 4) Nutrition Behavior, 5) Nutrition Knowledge, 6) Demographics.

The scales used the for the Nutrition Knowledge (NK) and Nutrition Behavior (NB) sections of the survey were adapted from a study conducted by Paugh at California University of Pennsylvania which examined the dietary habits and nutritional knowledge of collegiate athletes at an NCAA Division III institution, the results of which were subsequently published as an abstract in The Journal of Athletic Training in 2006.[1] The original scales developed by Paugh had been utilized in several additional studies.[2,3,4] A study conducted by Matkovic et al. examined the nutrition knowledge and habits of basketball coaches and found that they were not appropriately knowledgeable to serve as sources of nutrition information for their players.[2] Additionally, a study conducted by Cigrovski et al. utilized the Paugh scales to assess the nutritional knowledge and dietary habits of young athletes' advisors.[3] This study noted that the subjects were most knowledgeable on topics related to the effect of nutrition on sports performance.[3] The study also found that there was a positive correlation between nutrition behavior and knowledge. An additional study by Matkovic et al. using the scales to examine the nutrition knowledge and nutrition habits of tennis coaches found that the subjects lacked appropriate nutrition knowledge and habits and that a positive correlation existed between nutrition knowledge and habits.[4]

In addition to a history of use in other published studies, the scales developed by Paugh represented an appealing option for the current study since they were also developed with a collegiate athlete subject pool and provided scales to assess both NK and NB. Other studies examined in the search for both NK and NB scales revealed several options for evaluating nutrition knowledge but found that nutrition behavior was often assessed through more intensive methods focused on nutrient intake such as food frequency questionnaires or evaluation of diet records.[6,7] Due to the size of the subject population being studied, use of a nutrition behavior evaluation tool other than a scale was considered excessively time consuming and therefore prohibitive.

The scales adapted from Paugh for the current study were assessed for reliability or internal consistency by calculating Cronbach's alpha.[5] This does not appear to have been done for the scales used in the Matkovic et al. and Cigrovski et al. studies. The alpha level for the NB scale was determined to be α=.52 while the NK scale was determined to be α=.60. The alpha levels calculated were indications that both the NK and NB scales had questionable reliability. To address this issue, an Item-Total correlation was conducted for each scale to eliminate items contributing to low internal consistency. The NK scale was revised from 19 questions in total down to 12 questions with a resultant, acceptable Cronbach's alpha of .71. The NB scale was revised from 9 original questions down to 6 total questions with an improved Cronbach's alpha of .70. Cronbach's alpha levels of .70 or greater are considered acceptable and can be an indication of scale homogeneity which relates to improved validity.[5]

Body Type and Injury History

The Body Type and Injury History section asked participants to self-report body weight and height and provide feedback on whether or not they feel at an appropriate weight for their sport by providing an Agree or Disagree response to a single item. Additionally, this section asked participants to describe injury history for the previous 12 months and indicate whether or not injuries have limited ability to play or practice with a single item. Possible responses included: I have been injury-free; I have had one injury which limited my ability to play or practice; I have had multiple injuries which limited my ability to play or practice

Diet Practices

The Diet Practices section of the survey asked participants to provide information on special diets they might be following including diets for weight loss, weight gain, or a vegetarian diet plan. Participants were asked to provide Yes or No responses to each of four questions relating to whether or not they were on a special diet.

Nutrition Education

The Nutrition Education section of the survey included questions related to the subject's interests and preferences for nutrition education. The first question asked the subjects how they typically received information regarding nutrition. Responses included: Coach; Magazine/Book; Athletic Trainer; Strength Coach; Parents; On-campus Nutritionist; Off-campus Nutritionist; or Other. This section also asked subjects to indicate whether or not they have taken any nutrition-related coursework at FDU by providing a "Yes" or "No" response. Those answering "Yes" to this question were then asked to indicate which specific course(s) were taken by checking boxes corresponding to available nutrition-related courses. Subjects were also asked to indicate their

preferred methods for receiving nutrition information. Possible responses included: Team Lecture; Written Handout; Online/Webpage; or One-to-one meeting with nutritionist.

Nutrition Behavior

The Nutrition Behavior (NB) section asked subjects to provide information on their dietary practices relating to frequency and composition of meals, snacks, beverages, and dietary supplements. Participants responded to the questions in this section using a four point Likert scale ranging from (1) Never, (2) Occasionally, (3) Very Often, to (4) Always. This section consisted of 6 questions in total. The questions in this section included how often subjects consumed breakfast, skipped meals, consumed sweetened beverages, calcium-rich foods, and how often they consumed adequate servings of fruits and vegetables, as well as how often the relied on "fast food" options. The specific questions utilized to evaluate NB are shown in Appendix F. Scores from the items were summed, with a higher score indicating more positive dietary practices. Questions #2, #5 and #11 were reverse scored. The possible range of scores was from 6, which would indicate negative or poor dietary practices, to 24, which would indicate positive or very good dietary practices.

Nutrition Knowledge

The purpose of the Nutrition Knowledge (NK) section was to evaluate the knowledge the subjects had regarding some commonly held dietary beliefs and guidelines, including information on the importance of diet in relation to athletic performance, hydration, meal timing, carbohydrates, and proteins. This section consisted of 12 questions in total. Answers for questions in this section were provided using a four point Likert scale ranging from (1) Strongly Disagree, (2) Disagree Somewhat, (3) Agree Somewhat, to (4) Strongly Agree. The possible

range of scores was from 12 which would indicate poor nutritional knowledge to 48 which would indicate very good nutritional knowledge. Questions #12, #13, and #18 were reverse scored. A scoring key for both the Nutrition Behavior and Nutrition Knowledge sections is provided in Appendix F.

Demographics

The final section of the survey, Demographics, asked subjects to provide information on gender, year in school, international or domestic student status, race/ethnicity, current living situation, sport played, and whether or not they were currently in their competitive season.

Statistical analysis

Descriptive data were calculated as frequencies (%). A Pearson correlation (*r*) was used to determine relationship between nutrition knowledge and nutrition behavior. An independent samples t-test (*t*) was used to determine differences between male and female gender, whether or not an athlete had previous nutrition-related coursework, and NK and NB. A one-way analysis of variance (ANOVA) (*F*) was used to determine differences between living situation, sport played, race/ethnicity, year in school, and NK and NB. The level of significance was set at .05 to test the acceptability of the stated hypotheses. Additionally, effect size was calculated to quantify the size of differences found between groups. Effect size was expressed as Cohen's *d* for differences between gender groups, athletes who had previous or no previous nutrition coursework, and international vs. domestic athletes. Effect size was expressed as Eta^2 for differences between sports played, races/ethnicities, living situations, and year in school.

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Chapter 4

Results

Response rate

The number of eligible subjects for this study was 171. Eligible subjects were currently enrolled students on the active roster of a recognized sports team at FDU. A total of 140 athletes completed at least part of the survey for an overall response rate of 81.8% (Appendix E). Response rate by team ranged from a high of 100% (women's tennis, men's golf) to a low of 61% (men's soccer).

Demographic data

The subject sample consisted of athletes enrolled at Fairleigh Dickinson University (n=140). Demographics of the sample are shown in Table 1. The sample was primarily female (n=73, 57.5%), freshman and sophomore (n=78, 60.9%), residing on-campus (n=93, 81.6%), domestic students (n=91, 71.1%) and Non-Hispanic, White/Caucasian (n=81, 57.9%).

Hypothesis testing

1. There will be a positive correlation between NB and NK. A Pearson correlation was used to determine if there was a positive correlation between NB and NK.

Results: No relationship was found to exist between the variables of NB and NK($r=.163$, $p=.075$).

2. Female athletes will score better than male athletes with respect to NB and NK scores. An independent-samples *t*-test was used to determine if there was a difference between gender for NB and NK.

Results: As shown in Table 2, there were no significant differences between male and female athletes with respect to both NB (t=-.513, p=.609) and NK scores (t=-.022, p=.983). Effect size for both NB (*d*=.104) and NK (*d*=.063) were considered small.

3. Athletes having taken a previous nutrition-related course will score higher on both NB and NK. An independent samples T-Test was used to determine if there was a difference between athletes who have taken a previous nutrition-related course and those who had not and NB and NK.

Results: Table 3 illustrates that there were no significant difference for NB between individuals who had previous nutrition-related coursework and those that did not (t=1.43, p=.16). However, individuals who had previous nutrition-related coursework report significantly greater NK (t=2.27, p=.025) compared to those who have no previous nutrition-related coursework. Effect size for NB (*d*=.300) was considered small while effect size for NK (*d*=.505) was considered moderate.

4. International athletes will score higher on both NB and NK compared to domestic athletes. An independent samples T-Test was used to determine if there was a difference between international and domestic athletes and NB and NK.

Results: As shown in Table 4, there was no significant difference in NB score for international athletes compared to domestic athletes (t=1.69, p=.093). However, international athletes did have significantly better NK (t=2.87, p=.005) compared to domestic athletes. Effect size for NB (*d*=.445) was considered small-moderate while effect size for NK (*d*=.525) was considered moderate.

5. Athletes residing off-campus will score higher on NK compared to athletes residing on-campus. Athletes residing on-campus will score higher on Nutrition behavior compared to athletes residing off-campus. An ANOVA test was used to determine if the living situation of athletes influenced NB and NK.

Results: Living situation was not related to nutrition behavior of athletes (F=1.58, p=.211) (Table 5a). However, athletes living off campus alone or with roommates had significantly better nutrition knowledge (F=3.81, p =.02) compared to athletes living off campus with family or on-campus (Table 5b). Effect size was considered small for both NB (Eta^2=.028) and for NK (Eta^2=.068).

6. There will be no significant difference between sports teams with respect to NB and NK scores. An ANOVA test was used to determine if the sport played by an athlete influenced nutrition behavior and nutrition knowledge.

Results: As illustrated in Table 6a and 6b, the sport played by an athlete was not related to NB (F=1.72, p=.085) or NK (F=1.49, p=.154). Effect size for NB (Eta^2=.089) was considered small while effect size for NK (Eta^2=.122) was considered modest.

7. There will be a significant difference between different races/ethnicities with respect to NB and NK scores. An ANOVA was used to determine if the race/ethnicity of an athlete influenced NB and NK.

Results: As shown in Table 7a, there was no significant difference between races/ethnicities for NB (F=2.42, p=.071). Table 7b shows there was also no significant difference found between the races/ethnicities of the athletes and NK (F=.21, p=.89). Effect size for NB (Eta^2=.064) and NK (Eta^2=.006) were considered small.

8. There will be a significant difference between NB and NK scores with respect to an athlete's year in school. An ANOVA was used to determine if year in school influenced NB and NK.

Results: As shown in Table 8a, there was no significant difference between year in school for NB (F=2.17, p=.096). Table 8b illustrates significant differences between athletes in the first/freshman and forth/senior year of school with respect to NK (F=3.83, p=.029) as well as athletes in the second/sophomore and forth/senior year of school for NK (F=3.83, p=.028). Forth/senior year students demonstrated significantly better NK compared to first/freshman and second/sophomore year athletes. Effect size for both NB (Eta^2=.051) and NK (Eta^2=.089) were considered to be small.

Table 1. Demographics of the sample (n=140)

Characteristic	**n**	***%***
Gender		
Male	54	42.5
Female	73	57.5
Sport		
Baseball	22	15.7
Women's Bowling	9	6.4
Women's Fencing	5	3.6
Golf	7	5
Men's Soccer	11	7.9
Softball	11	7.9
Tennis	14	10
T&F/XC	24	17.1
Women's Volleyball	6	4.3
Women's Basketball	15	10.7
Women's Soccer	16	11.4
Year in School		
Freshman	46	35.9
Sophomore	32	25
Junior	23	18
Senior	27	21.1
Previous Nutrition Course		
Yes	28	20.3
No	110	79.9
Living Situation		
On-Campus	93	81.6
Off-Campus with Family	6	5.3
Off-Campus alone	15	13.2
International Student		
Yes	37	28.9
No	91	71.1

Table 2. Relationship between athlete gender and nutrition behavior and nutrition knowledge (n=124)

	Male		Female			
Measure	**M**	**SD**	**M**	**SD**	**t**	**p**
NB Score	16.1	2.2	16.4	3.3	-.513	.609
NK Score	36.7	5.3	36.7	4.5	-.022	.983

Note: NB: nutrition behavior, NK: nutrition knowledge

Table 3. Relationship between previous nutrition-related coursework and nutrition behavior and nutrition knowledge (n=132)

	Previous Nutrition Course		No Previous Nutrition Course			
Measure	**M**	**SD**	**M**	**SD**	**t**	**p**
NB Score	17.0	3.6	16.0	2.9	1.43	.156
NK Score	38.8	5.1	36.3	4.8	2.27	.025

Note: NB: nutrition behavior, NK: nutrition knowledge

Table 4. Relationship between international athletes vs. domestic athletes and nutrition behavior and nutrition knowledge (n=125)

	International		Domestic			
Measure	**M**	**SD**	**M**	**SD**	**t**	**p**
NB Score	16.9	3.5	15.9	2.9	1.69	.093
NK Score	38.6	6.0	35.9	4.1	2.87	.005

Note: NB: nutrition behavior, NK: nutrition knowledge

Table 5a. Relationship between living situation of athletes and nutrition behavior (n=111)

Residence Location	M	SD	F	df	p
			1.58	2	0.21
On Campus	15.8	2.9			
Off Campus with Family	17.8	2.7			
Off Campus alone/roommate	16.6	3.4			

Table 5b. Relationship between living situation of athletes and nutrition knowledge (n=103)

Residence Location	M	SD	F	df	p
			3.81	2	0.02
On Campus	35.9[a]	4.9			
Off Campus with Family	37.1	3.5			
Off Campus alone/roommate	39.2[a]	4.2			

Note: "a" indicates a significant difference in nutrition knowledge between athletes residing off campus alone or with roommates and athletes living on campus.

Table 6a. Relationship between sport played and nutrition behavior (n=125)

Sport Team	M	SD	F	df	p
			1.72	10	0.085
Baseball	16.5	2.5			
W. Bowling	17.2	3.8			
W. Fencing	17.7	5.5			
Golf	16.0	3.1			
M. Soccer	14.2	2.5			
Softball	15.6	2.8			
Tennis	17.7	3.2			
T&F/XC	15.9	3.3			
W. V-ball	20.5	.7			
W. Basketball	15.0	2.9			
W. Soccer	16.4	2.8			

Note: T&F/XC: Track & Field/Cross Country

Table 6b. Relationship between sport played and nutrition knowledge (n=121)

Sport Team	M	SD	F	df	p
			1.49	10	0.154
Baseball	34.6	3.7			
W. Bowling	39.0	4.8			
W. Fencing	39.3	5.7			
Golf	35.0	4.9			
M. Soccer	37.9	6.3			
Softball	35.2	3.7			
Tennis	39.1	7.5			
T&F/XC	36.6	3.4			
W. V-ball	41.0	5.7			
W. Basketball	36.4	4.8			
W. Soccer	36.9	3.6			

Note: T&F/XC: Track & Field/Cross-Country

Table 7a. Relationship between race/ethnicity and nutrition behavior (n=110)

Race/ethnicity	M	SD	F	df	p
			2.42	3	0.07
White/Caucasian	16.8	3.1			
Black	14.9	2.5			
Hispanic	15.2	3.1			
Multiracial	18	0			

Table 7b. Relationship between race/ethnicity and nutrition knowledge (n=106)

Race/ethnicity	M	SD	F	df	p
			0.21	3	0.89
White/Caucasian	37.0	4.9			
Black	37.0	4.7			
Hispanic	36.0	5.9			
Multiracial	35.0	0			

Table 8a. Relationship between year in school and nutrition behavior (n=125)

Year in school	M	SD	F	df	p
			2.17	3	0.096
First/Freshman	16.1	2.8			
Second/Sophomore	16.6	3.1			
Third/Junior	14.9	3.5			
Fourth/Senior	17.0	3.1			

Table 8b. Relationship between year in school and nutrition knowledge (n=115)

Year in school	M	SD	F	df	p
			3.83	3	0.012
First/Freshman	35.7[a]	4.7			
Second/Sophomore	35.5[b]	4.7			
Third/Junior	37.8	4.5			
Fourth/Senior	39.1[a,b]	5.2			

Note:

"a" indicates a significant difference in nutrition knowledge between first/freshman year and forth/senior year in school.

"b" indicates a significant difference in nutrition knowledge between second/sophomore year and fourth/senior year in school.

Chapter 5

Discussion and Conclusions

Discussion of results

This study provided results that will inform the development and implementation of interventions aimed at improving the nutrition knowledge and behaviors of the collegiate athletes at Fairleigh Dickinson University. The influences of gender, previous nutrition-related coursework, international vs. domestic student status, living situation, sport played, race/ethnicity, and year in school with respect to nutrition knowledge and behavior were examined.

It was hypothesized that a positive correlation between nutrition behavior and nutrition knowledge would be observed. The rationale that the more knowledgeable an athlete was with respect to proper nutrition, the better the resultant dietary behaviors and choices has been supported by previous research.[1,2] However, in this study, no significant relationship was found to exist between the variables of nutrition behavior and nutrition knowledge. Based on these findings, college athletes who possess appropriate nutrition knowledge should not be expected to practice better nutrition behaviors compared to those without appropriate nutrition knowledge. Other research on collegiate athletes, as well as the general collegiate student body, has also demonstrated a lack of a relationship between nutrition knowledge and nutrition behavior.[3,4] Peron and Endres found no significant correlation between nutrition knowledge and diet behaviors in young, female athletes.[3] Additionally, a study by Jacobsen et al. which examined the nutrition practices and knowledge of male and female collegiate athletes found that despite

efforts at nutrition education, few improvements in diet behavior were observed.[4] As Ziegler et al.[11] and Quatromoni[19] have suggested, there are numerous challenges to the development of healthy eating habits for collegiate athletes in spite of having adequate knowledge regarding appropriate dietary practices. These challenges include lack of time due to demanding athletic training schedules as well as academic commitments.[11,19] This lack of time may result in meal skipping or reliance on "fast foods" lacking nutritional density.

Additionally, an athletes' concerns about body weight, composition, and body image should be considered as potential challenges to diet quality.[3,11] Efforts to lose weight or body fat or to meet the standards of a particular body image may influence an athlete to restrict calories and nutrients or to practice a fad diet which does not meet the nutritional requirements of the athlete.[19] The availability and accessibility of healthy food choices is also a potential influence on the diet quality of collegiate athletes.[19] When healthy food choices are not available in sufficient quantity, adequate knowledge of proper nutrition may become irrelevant as an influence on diet behavior. While most college campus dining facilities offer healthy nutrition options, those options may be outnumbered compared to less desirable options and athletes may lack the time and motivation required to make the appropriate choices.[19] Living off campus may exacerbate this challenge for the collegiate athlete.[10] Small et al. found that diet quality was more compromised in college students living off campus, compared to on-campus residents, due to the influences of commute time, financial constraints, sharing of food with roommates, and limitation on food preparation ability.[10]

As diet has been clearly shown to impact athletic performance as well as overall health and wellness, improving the diets of college athletes should be considered a priority for the athletic department.[5] It should also be understood that coaches, athletic training staff, and even

parents can have a considerable influence on the dietary beliefs and behaviors of college athletes.[4,6,7] Consideration should be given to the inclusion of these individuals in nutrition education interventions if appropriate. However, barriers that prohibit nutrition education from resulting in improved dietary behaviors must be identified and addressed.

The hypotheses of this study also stated that there would be a significant difference between male and female athletes with respect to nutrition behavior and knowledge, with female athletes reporting significantly better nutrition knowledge compared to male athletes and consequently also significantly better nutrition behavior. Previous research has indicated female athletes typically score higher than male athletes when evaluated on nutritional knowledge and dietary behaviors, possibly due to increased emphasis on body weight and body image in the female population.[2,8] Additionally, research has indicated that females are more likely to seek nutrition information from qualified sources such as academic coursework or consultation with a nutritionist, while males are more likely to receive information on nutrition from potentially less qualified sources such as coaches, training staff, teammates and friends.[4] In contrast with previous research, this study showed no significant difference between male and female athletes with respect to both nutrition behavior and nutrition knowledge scores. Within the collegiate athlete population at Fairleigh Dickinson University, gender does not appear to influence differences in nutrition behavior or nutrition knowledge.

Hypothesis 3 stated that athletes with previous nutrition-related coursework would have better nutrition behavior and nutrition knowledge. A study by Zawila et al. found that collegiate athletes who completed a nutrition course did demonstrate better nutrition knowledge compared to those who did not which supports the hypothesis.[9] This study did find that athletes who had previous nutrition-related coursework did in fact have significantly greater nutrition knowledge

compared to those who had no previous nutrition-related coursework. Interestingly, no significant difference was found in nutrition behavior between individuals who had previous nutrition-related coursework and those that did not have this related coursework. This implies that influences other than nutrition knowledge, beyond what was measured in this study, must have a significant impact on dietary behaviors and habits despite adequate nutrition knowledge and supports the additional finding of this study that nutrition behavior and nutrition knowledge were not significantly correlated. As previously mentioned, these influences may include availability of food choices or lack of financial resources to secure appropriate and nutritious foods and may have particular bearing for individuals living off campus or from low income households.[10] Additionally, factors such as lack of time due to demanding practice, competition, and class schedules could prevent an athlete from making proper food choices despite having the knowledge to do so.[11] In some circumstances, the nutrition knowledge and dietary practices of the coaching staff may have a significant influence on the dietary behaviors of collegiate athletes.[12] This may be particularly true when athletes are subject to "training tables", which are mandatory team meals in which food items are often pre-selected by the coaching staff or when the athletes are traveling for competitions and relying on fast-food restaurants and hotel buffets for many meals. The interest a collegiate athlete has in altering body weight or lean body mass may also impact dietary behaviors.[11] Athletes who have an interest in weight loss or a lean body will often voluntarily compromise the quality and quantity of their nutrient intake. While collegiate athletes participating in any sport may demonstrate such an interest, this appears to be more prevalent in sports which emphasize leanness or sports in which practice and competition uniforms are revealing of one's body shape and size.[12] In the subject population of this study, those sports might include women's volleyball, certain events in track & field, and perhaps even

in sports such as soccer where a lean body type might equate with improved speed, quickness, and agility.

It was hypothesized that international collegiate athletes would have better nutrition behavior and nutrition knowledge compared to domestic athletes. While there is very limited research related to this topic, the basis for this hypothesis relates to work examining the differences in the ways that international athletes view the purpose of collegiate sports in contrast to domestic athletes at the same Division I level of NCAA competition.[14] A study by Popp et al. highlighted the point that a limitation of any study involving international student-athletes is the tendency to group all international student-athletes together. Because international collegiate athletes come from many different countries, cultures, and backgrounds, they represent an incredibly diverse group. Additionally, Popp et al. found that while most domestic collegiate athletes develop their skills in school-based competition, most international collegiate athletes have developed their skills in elite club-based systems and may even have experience representing their home nation in international competition.[14] These findings have two potential influences on the differences in nutrition behavior and knowledge between international and domestic collegiate athletes found in the current study. International collegiate athletes coming from elite, club-based programs are likely to have had greater exposure to sports nutrition resources including education and access to nutritional counseling which would not be as readily available to domestic athletes coming from high school based programs. Secondly, since international collegiate athletes often represent their nation's elite, their level of competitiveness may be greater than that of domestic collegiate athletes. Previous studies have demonstrated that a higher level of competitiveness is associated with a greater interest and investment in proper nutrition.[11] International collegiate athletes who have previously competed at an elite or national

level would likely have a greater interest and knowledge regarding diet compared to domestic collegiate athletes who have not experienced that level of competition.

The current study found that international collegiate athletes at FDU had significantly better nutrition knowledge compared to domestic athletes. While the international athletes in this study also had better nutrition behavior compared to domestic athletes, the difference was not statistically significant. Additional research might be able to document other influences on nutrition behavior and knowledge in international collegiate athletes compared to domestic athletes. Based on the findings noted by Popp et al., research examining the nutrition behavior and knowledge differences within sub-groups of international collegiate athletes based on country or region of origin and cultural differences would also be warranted.

It was additionally hypothesized that collegiate athletes residing off-campus would have better nutrition knowledge than athletes living on-campus and in contrast, collegiate athletes living on-campus would have better nutrition behavior than athletes living off-campus. This hypothesis is consistent with previously conducted research which indicates that individuals living off-campus tend to be further along in their college education and would have had greater opportunity for nutrition education or nutrition-related coursework.[10] This is potentially related to the finding that athletes who had previously taken nutrition-related coursework had significantly better nutrition knowledge than athletes without previous nutrition-related coursework. Previous research also indicates that dietary behaviors among the general student population are typically poor and associated with low fruit and vegetable consumption and higher consumption of added sugars and calorically-empty foods and that living off-campus can exacerbate these issues.[10]

In the current study, the living situation of a collegiate athlete did not have an influence on nutrition behavior; there was no significant difference found between athletes living off-campus compared to athletes living on-campus. However, athletes living off-campus alone or with roommates had significantly better nutrition knowledge compared to athletes living off-campus with family or on-campus. This finding is at least in part consistent with the observation that athletes living off-campus on their own or with roommates tend to be further along in their college education and would have had more opportunity for nutrition education and supported by the finding of this study that fourth/senior year athletes had significantly better nutrition knowledge compared to both first/freshman year and second/sophomore year athletes. This relationship does not account for the finding that there was no difference in nutrition knowledge between student-athletes living off campus with family and those living on-campus. A possible explanation may be that athletes living off-campus with family may include those who are not very far along with their college education, including freshmen and sophomores, and consequently those who have had limited exposure to nutrition education or coursework.

It was hypothesized that there would be no significant differences between sports teams with respect to nutrition behavior and nutrition knowledge. This study found that the sport played by an athlete did not have a significant influence on nutrition behavior or nutrition knowledge. In this regard, the collegiate athletes participating in this study appear to be fairly homogenous. This finding is in accordance with findings in the study conducted by Paugh et al. which found no significant differences between different collegiate athletic teams with respect nutrition knowledge and nutrition behavior.[2]

Research from general population studies[15] led to the hypothesis that white/Caucasian collegiate athletes would have better nutrition knowledge and behavior than athletes of other

races/ethnicities, including black/African American or Hispanic. This hypothesis is consistent with previous studies in the general population which find that blacks and Hispanics tend to have higher fat intake and poorer diets compared to white/Caucasians.[15] The reason for poorer dietary habits among blacks and Hispanics in the general population is often linked to lower socioeconomic status which has been shown to predict lower nutrition knowledge as well as poorer diet quality.[15] It is interesting to note that this study found that there was no significant difference between races/ethnicities and nutrition behavior or nutrition knowledge. While the collegiate athletes involved in this study likely come from varied socioeconomic backgrounds, there are consistencies with respect to availability of food and nutrition education while under the care of the university. All college students, including athletes, have the same eating options available to then while dining on campus. Likewise, athletes are generally provided similar menu options and financial resources for the purchase of meals when the teams are traveling for competition. These observations may explain the lack of difference with respect to sport played and nutrition knowledge and behavior. Essentially, despite differences in socioeconomic background, college athletes in different sports may be provided a "level playing field" with respect to availability of nutrition resources and food choices.

The data collected as a result of this study will be considered in the development of nutritional interventions for collegiate athletic teams at FDU. Projected educational interventions might include the creation of a sports nutrition information webpage containing resources on information such as proper food choices, hydration guidelines, and meal timing considerations. In addition, greater accessibility to nutrition coursework and the possible development of a sports nutrition course offering will be examined. However, it must be considered that enhancing nutrition knowledge alone may not be sufficient to result in

meaningful improvements in the diet behaviors of the collegiate athletes at FDU. This finding should not diminish the importance of nutrition education as improved behaviors do not occur without adequate knowledge. In addition to nutrition education, the development of behavioral intervention programs should also be considered. These behavioral interventions may include one-on-one counseling sessions with athletes which would involve goal setting and progress tracking through diet records or the exploration of incentives which would reward the athletes for the practice of improved eating habits.[20]

Limitations of the study

This study was limited by the fact that it was cross-sectional in nature and reflected the subject's characteristics only at the time the survey was administered. Additionally, the fact that only athletes from FDU were included in the study presents challenges to external validity and the global applicability of results. An additional limitation which must be considered is the accuracy of self-reported nutrition and diet-related data which has been questioned for similar studies.[16]

Despite an Item-Total correlation which resulted in improved and acceptable Cronbach's alpha levels for both the NB scale (α=0.70) and the NK scale (α=0.71) used compared to the original NB and NK scales, potential challenges to construct validity remain. According to Messick in his landmark paper on the validity of psychological assessment, the construct validity of psychometrics may be examined in six distinguishable aspects: content, substantive, structural, generalizability, external, and consequential.[17] A full investigation of these aspects relative to the NB and NK scales were beyond the scope of the current study.

Messick has outlined two significant threats to construct validity: construct underrepresentation and construct-irrelevant variance.[17] The validity of the NB and NK scales may be challenged by construct underrepresentation. As a result of Item-Total correlation and the subsequent elimination of scale items which would lower alpha values, there is risk of the scale becoming too narrow and perhaps failing to include important dimensions of the constructs of nutrition behavior and knowledge.[17] A low number of items being included in a scale may also serve to reduce the alpha value of that scale.[18]

While Cronbach's alpha provides a measure of the internal consistency of items in a scale, it is not a sufficient evaluation of the homogeneity of a scale.[18] Internal consistency is concerned with the interrelatedness of items included in a scale while homogeneity refers to whether or not a scale is unidimensional.[18] A scale is considered unidimensional if it measures a single latent construct.[18]

Additionally, there is the concern that subjects participating in the study may be familiar with the preferable responses to scale questions and may provide responses that are not truly representative of their nutrition behavior or knowledge. This is referred to as construct-irrelevant easiness and is a form of construct-irrelevant variance.[17]

Conclusions

The results of this study have led to the following conclusions:

1. Collegiate athletes who have better nutrition knowledge would not necessarily be expected to practice better nutrition behaviors. Barriers to improved behavior which

were not evaluated in the scope of the current study may exist which limit an athlete's ability to practice good nutrition behaviors despite an adequate level of nutrition knowledge.

2. Athletes who had previously taken nutrition-related coursework reported better nutrition knowledge than athletes without previous coursework. However, previous coursework does not seem to significantly improve nutrition behavior.
3. International collegiate athletes have better nutrition knowledge compared to domestic collegiate athletes.
4. Athletes living off-campus alone or with roommates have better nutrition knowledge than athletes living off-campus with family members or athletes living on-campus.
5. Differences in gender, race/ethnicity, and sport played do not appear to significantly influence the nutrition knowledge and behavior of collegiate athletes.

Recommendations

Based on the results of this study, the following recommendations for future research are outlined below:

1. Future studies which evaluate the nutrition knowledge and behavior of collegiate athletes should explore the use of scales and other measures which have previously been determined to have good reliability and validity.
2. Future studies may want to compare nutrition knowledge and behaviors of collegiate athletes with that of the non-athlete student body. The purpose of such studies would

reveal whether or not collegiate athletes are at an advantage or disadvantage with respect to nutrition within the student population.

3. A closer examination of international and domestic student status and nutrition knowledge and behavior may shed light on the differences observed as a result of this study. This may provide some indication of whether or not increased efforts in nutrition education should be directed toward domestic collegiate athletes.
4. Additional research should be conducted to identify barriers to better nutrition behavior despite adequate nutrition knowledge. It is clear that within the subject pool used for this study that better nutrition knowledge does not translate to improved dietary behaviors. It would be important to identify and resolve these barriers as failure to do so may render efforts to improve nutrition knowledge fruitless.

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Appendix A: FDU Athlete nutrition survey

FDU Athlete Nutrition Survey

Section I: Medical

Please enter your current weight in pounds: _____

Height: _____ ft. _____in.

Injury history: *Please select the following statement that best describes your injury history over the past 12 months.*

I have been injury-free

I have had one injury which limited my ability to play or practice

I have had multiple, two or more, injuries which limited my ability to play or practice

1. I currently feel that I am at an appropriate weight for my sport? **Agree Disagree**

Section II: Diet Practices

2. Are you currently on a diet to lose weight? **Yes No**

3. Are you currently on a diet to gain weight? **Yes No**

4. Are you currently following a special diet for reasons other than weight loss/gain? **Yes No**

If yes, please explain:_____

5. Do you currently consider yourself to be a vegetarian? **Yes No**

Section III: Nutrition Education

6. How do you most typically receive information regarding nutrition/sports nutrition?

Coach Magazine/Book Athletic Trainer Strength Coach On-campus nutritionist

Off-campus nutritionist Parents Other: (Please describe _____)

7. Have you taken or are you currently taking a nutrition-related course? **Yes No**

8. What would be your preferred method for receiving nutrition/sports nutrition information?

Team lecture One-to-one meeting with nutritionist Written handout Online/Webpage

Section IV: Nutrition Behavior

For each of the following questions, please indicate the number on the following scale that best applies. Please consider your nutrition behavior over the last month.

(4) Always: 5-7 days per week **(3) Often: 3-4 days per week**

(2) Sometimes: 1-2 days per week **(1) Never: Does not occur at all**

9. How often do you eat breakfast in the morning?

10. Based on three (3) meals per day, how often do you skip at least one meal per day?

11. How often do you take vitamin and/or mineral supplements?

12. How often do you record what you eat?

13. How often do you drink sweetened (added sugar) beverages like soda, iced tea, fruit punch?

14. How often do you drink sports drinks like Gatorade or PowerAde?

15. How often do you eat "starchy" carbohydrates like bread, cereal, rice, pasta, potatoes?

16. How often do you consume at least 5 servings of fruits and/or vegetables in a day?
(A serving of fruit/vegetable equals 1 cup raw or ½ cup cooked…1 cup is approximately the size of a tennis ball.)

17. How often do you consume at least 2-3 servings of calcium-rich dairy product in a day?
(A serving of dairy product would include 1 cup of milk, cottage cheese, or yogurt, 2 slices of cheese.)

18. How often do you snack on sweets such as candy, cookies, cake, donuts, ice cream?

19. How often do you eat "fast food" such as McDonalds, Burger King, Wendy's?

20. How often do you take a nutritional supplement other than a vitamin/mineral supplement?

Section V: Nutrition Knowledge

Please select the number on the scale below indicating to what extent you agree or disagree with each of the following statements.

(4) Strongly agree

(3) Agree somewhat

(2) Disagree somewhat

(1) Disagree strongly

21. The quality of your diet affects performance as an athlete.

22. Diet affects mental performance such as ability to remember things and reaction time .

23. Skipping meals can negatively affect athletic performance.

24. A meal/snack should be consumed 2-4 hours prior to a workout or competition.

25. A meal/snack should be consumed within 30-60 minutes following a workout or competition.

26. Foods high in carbohydrate are fattening.

27. An athlete should consume approximately 60% of total calories from carbohydrates.

28. Carbohydrates are easier and quicker to digest than fats or proteins.

29. An athlete should consume 20-30% of total calories from fat.

30. Fat is slower to digest than carbohydrates and proteins.

31. An athlete requires 12-15% of total calories from protein.

32. Athletes tend to consume more protein than they need.

33. Consuming more protein than is needed is beneficial for athletes.

34. Drinking eight (8) glasses of water per day will meet the hydration needs of an athlete.

35. Drinking beverages that contain caffeine can lead to dehydration.

36. Drinking beverages that contain alcohol can lead to dehydration.

37. Energy drinks such as *Red Bull*, *Monster*, or 5 *Hour Energy* improve athletic performance.

38. Sports drinks such as *Gatorade, PowerAde* improve athletic performance.

39. Sports drinks should be avoided during workouts/competition because of their sugar content.

40. Thirst is the best indicator of whether or not an athlete is hydrated.

Section VI: Demographics

Gender: **Male Female**

Year in school: **Freshman Sophomore Junior Senior Grad**

Are you an international student? **Yes No**

What race/ethnicity would you classify yourself as? Please select all that apply.

White African American Hispanic

Asian/Pacific Islander Native American

Where do you currently reside? **On-Campus/Dorm Off-campus on your own**

Off-campus at home with your family

Please select sport Played:

Baseball

Women's Bowling

Women's Fencing

Golf

Men's Soccer

Softball

Tennis

T&F/XC

Women's Volleyball

Women's Basketball

Women's Soccer

Appendix B: IRB approval

December 11, 2012

Scott Fisher, Director, Fitness Center
Sports Nutrition Consultant to the Department of Athletics
Metropolitan Campus
Fairleigh Dickinson University

Dear Mr. Fisher:

The project, IRBEX#: PT-2012/12-001004 *Understanding Dietary Behaviors and Perceptions of Student Athletes*, was reviewed on December 11, 2012 and determined to qualify as exempt from 45 CFR 46, as stated in 45 CFR 46.101(b) under Category (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation. The project may proceed.

A determination that the research is exempt does not imply that investigators have no ethical responsibilities to subjects in such research; it means that the regulatory requirements related to
continuing review, informed consent, and certain IRB policies do not apply to the research.

If changes are made to the project so it no longer meets the above applicable category for exemption found at 45 CFR 46.101 (b), the following materials must be submitted for IRB Review and approval:

- Application for Full/Expedited Review and appendices;
- Description of proposed revisions;
- Any new or revised materials, such as recruitment fliers, letters to subjects, or consent documents; and
- Any updated letters of approval from cooperating institutions and IRBs.

If you have any questions about the information provided in this letter, please contact me at (201) 692-2219 or via e-mail at kim_diccianni@fdu.edu.

Sincerely,

Kim R. Diccianni, CIP
Human Research Compliance Manager
Fairleigh Dickinson University IRB

Appendix C: Recruitment message to coaches

Greetings Coaches,

I am conducting a survey to better understand the dietary habits and nutrition beliefs among our student-athletes. This information will be used in the future to develop better programs and interventions to educate them on improving their diets for better health, injury resistance, and athletic performance.

The student-athletes will be asked to take an on-line survey which I would like your assistance in providing to them. Sometime next week I hope to send you an email which will include information for your student-athletes and a web-link to the survey. The survey will take approximately 10-15 minutes to complete and will ask them about their current dietary practices and behaviors as well as their nutrition beliefs. To be eligible for the survey they must be 18 years of age or older and currently on your team's roster.

The survey does not ask for any information that would identify who the responses belong to. No personally identifiable information will be shared because the names of the student-athletes are in no way linked to their responses. The student-athletes decision to participate in this survey is completely voluntary but I hope that you will encourage it. They will be able to stop at any time and do not have to answer any questions they do not want to answer. I am hoping for a response rate of 80% for each team to insure the information collected will be truly representative of your team's needs.

If you would like additional information about this survey, please feel free to contact me. Thanks in advance for your assistance with this project.

Warmest regards,

Scott

Scott Fisher, R.D.
Director of the Fitness Center/Sports Nutritionist
Fairleigh Dickinson University
Dept. of Athletics
1000 River Rd. (T-FC1-01)
Teaneck, NJ 07666
Phone: 201-692-2690
Fax: 201-692-2696
email: sfisher@fdu.edu

Appendix D: Informed consent

You must be 18 years of age or older to participate in this study.

This survey asks questions about the dietary practices and perceptions among FDU student-athletes. The Department of Athletics would like to use this information in the future to develop educational programs and interventions aimed at improving the eating habits and nutrition knowledge of our student-athletes. This study is being conducted at Fairleigh Dickinson University and the purpose of this study is research to improve upon the nutritional services currently offered. We encourage you to respond honestly and we ensure you that your answers will remain confidential.

Principal Investigator: Scott Fisher, R.D Fitness Center, 100 River Rd. (T-FC1-01), Teaneck, NJ 07666 (201) 692-2690; sfisher@fdu.edu
Purpose of the Study: To better understand the dietary practices and perceptions of the student-athletes at the FDU Metropolitan campus.
Procedures to be followed: You will be asked to answer 40 questions on a survey.

Voluntary Participation:

You do not have to participate in this project if you do not want to. If you decide not to participate, you will not be treated differently or lose any benefits that you are otherwise entitled. Since no identifiers are collected, we will not know who participated or not. You may skip any questions you do not want to answer or exit the browser at anytime if you decide not to continue.

Duration: It will take about 15 minutes to complete the survey.

Statement of Confidentiality: Your participation in this research is confidential. The survey does not ask for any information that would identify who the responses belong to. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared because your name is in no way linked to your responses. Your confidentiality will be kept to the degree permitted by the technology used. No guarantees can be made regarding the interception of data sent via the internet by any third parties. However, computer IP addresses are not collected or any other information that may identify you to protect your privacy and ensure the data is confidential.

Contact information: Please contact Scott Fisher at (201) 692-2690 with questions or concerns about this study. If you have any questions about your rights as a research subject, please contact the FDU Institutional Review Board Administration at (201) 692-2219.

Completion of the survey implies that you have read the information in this form and consent to take part in the study. Please print this page for your records or future reference.
Please click the arrow for the next page if you agree to participate in this study.

Scott Fisher, R.D.
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Appendix E: Survey response rate by team

Team	Eligible Subjects	Responses	Response Rate
Men's Tennis	**8**	**7**	**87.5%**
Women's Tennis	**7**	**7**	**100%**
Men's T&F/XC	**16**	**12**	**75.0%**
Women's T&F/XC	**15**	**12**	**80.0%**
Women's Volleyball	**8**	**6**	**75%**
Women's Soccer	**17**	**16**	**94.1%**
Men's Soccer	**18**	**11**	**61%**
Softball	**14**	**11**	**78.6%**
Baseball	**26**	**22**	**84.6%**
Women's Bowling	**11**	**9**	**81.8%**
Women's B-Ball	**15**	**14**	**93.3%**
Men's Golf	**4**	**4**	**100%**
Women's Golf	**4**	**3**	**75%**
Women's Fencing	**8**	**5**	**62.5%**

Total Eligible Subjects: **171**

Total Responses: **140**

Overall Response Rate: **81.8%**

Appendix F: Revised NB and NK scales

Revised Nutrition Behavior (NB) scale

Question

1. **How often do you eat breakfast?**
2. **Based on three (3) meals per day, how often do you skip at least one meal per day? (Reverse scored)**
3. **How often do you drink sweetened (added sugar) beverages like soda, iced tea, fruit punch? (Reverse scored)**
4. **How often do you consume at least 5 servings of fruits and/or vegetables per day?**
5. **How often do you consume at least 2-3 servings of calcium-rich dairy product in a day?**
6. **How often do you eat "fast foods" such as McDonalds, Burger King, Wendy's? (Reverse scored)**

Potential responses

(4) Always: 5-7 days per week

(3) Often: 3-4 days per week

(2) Sometimes: 1-2 days per week

(1) Never: Does not occur at all

Range of possible scores: 6-24

Revised Nutrition Knowledge (NK) scale

Question

1. **The quality of your diet affects your performance as an athlete.**
2. **Diet affects mental performance such as the ability to remember things and reaction time.**
3. **Skipping meals can negatively affect athletic performance.**
4. **A meal or snack should be consumed 2-4 hours prior to a workout or competition.**
5. **Foods high in carbohydrate are fattening. (Reverse scored)**
6. **An athlete should consume approximately 60% of total calories from carbohydrate.**
7. **An athlete should consume 20-30% of total calories from fat.**
8. **Fat is slower to digest than protein or fat.**
9. **An athlete requires approximately 15% of total calories from protein.**
10. **Athletes tend to consume more protein than they need.**
11. **Energy drinks such as Red Bull, Monster, 5-Hour Energy improve athletic performance. (Reverse scored)**
12. **Sports drinks such as Gatorade, PowerAde improve athletic performance.**

Potential responses

(4) Strongly agree

(3) Agree somewhat

(2) Disagree somewhat

(1) Disagree strongly

Range of possible scores: 12-48