RESEARCH ARTICLE

The Effect of a Single Sports Nutrition Didactic Session on Division I Athletes

Authors

Harry Stafford MD: UNC CH Department of Family Medicine/ Human Performance Center /Sports Medicine and North Carolina Central University Athletics /590 Manning Drive Chapel Hill NC 27599 harry_stafford@med.unc.edu 919-599-1745 ***Corresponding author*** ORCID# 0000-0002-9104-9867
Josh Berkowitz MD: UNC CH Department of Orthopedics 3137D Bioinformatics Building CB# 7055 Chapel Hill NC 27599
Nailah Adams MD: UNC CH Department of Family Medicine 590 Manning Drive Chapel Hill NC 27599
Lauren Porras MD: UNC CH Department of Family Medicine /Orthopedics 590 Manning Drive Chapel Hill NC 27599
Zach Sandbulte MD: Novant Health System 105 Vest Mill Cir, Winston Salem, NC 27103
Brent Fisher MD: UNC Asheville Department of Orthopedics 111 Victoria Road
Asheville, NC 28801
Chistopher Felton DO: UNC CH Department of Family Medicine 590 Manning Drive Chapel Hill NC 27599
Jason Booth MD: UNC CH Department of Family Medicine 590 Manning Drive Chapel Hill NC 27599
Wanda Reed CMA ROT: UNC CH Department of Family Medicine 590 Manning Drive Chapel Hill NC 27599
Yanira DeLao ATC: UNC CH Department of Family Medicine 590 Manning Drive Chapel Hill NC 27599
Samantha Wells: UNC CH Department of Family Medicine 590 Manning Drive Chapel Hill NC 27599
Latisha Johnson ATC: UNC CH Department of Family Medicine 590 Manning Drive Chapel Hill NC 27599
Jonathon Nelson-Chavis ATC: UNC CH Department of Family Medicine 590 Manning Drive Chapel Hill NC 27599
Jennifer Ketterly RD, CSSD: UNC CH Department of Family Medicine and North Carolina Central University 590 Manning Drive Chapel Hill NC 27599
David Berkoff MD: UNC CH Department of Orthopedics 3142 Bioinformatics Bldg CB# 7055 Chapel Hill NC 27599

Abstract

Background: Each year thousands of athletes encounter medical problems (e.g., syncopal episodes, stress fractures, anorexia, bulimia) that may have been prevented if appropriate nutritional counseling had been provided. This study aimed to investigate whether a didactic session regarding nutrition was superior to providing athletes with a booklet about nutrition to increase knowledge among collegiate athletes.

Methods and Study Design: This was a randomized, prospective interventional study of 108 Division I college athletes. All participants were given a previously validated nutritional knowledge survey (Shifflet). Group 1 (n=39) was given a nutritional booklet (created by the authors) and a 1-hour didactic session from a sports nutritionist. Group 2 (n=34) received the booklet and a 5-minute overview of the booklet. Group 3 (n=35) received the booklet alone. The athletes were retested 14 days later. A one way analysis of variance (ANOVA) between subjects was conducted to compare pre- and post-test scores across all three groups.

Results: There was not a statistically significant difference between group ($p>.05$] assessment scores for the three conditions. However, the mean change score from pre-test to post-test increased across all three-treatment groups.

Conclusions: A single sports nutrition didactic session did not increase nutritional knowledge beyond providing a nutrition booklet alone.

Significance of Findings: A single nutrition didactic session is not sufficient enough to educate athletes about proper nutritional habits. Athletes may require multiple sessions in order to accomplish this goal.

Key Words: Nutrition, Health Education, Clinical Medicine, Athletics

Introduction:

The importance of appropriate nutrition to balance caloric expenditure for optimal performance is well known among physically active individuals, even more so for the elite athlete [1]. According to the American College of Sports Medicine, adequate calorie intake is needed to maintain lean muscle mass, immune function, and athletic performance [2]. If calorie intake is insufficient, the body uses fat and lean tissue mass as fuel, which can result in a loss of strength, endurance, and other related medical problems such as heat exhaustion, stress fractures, and other musculoskeletal injuries [2].

Most athletes nearly double their total daily energy expenditure within 3-4 hours of intense training. Average daily caloric

expenditures can range from 1800 kcal in women's gymnastics to 3600 kcal in men's rowing to 4800 kcal in a triathlon [3]. Adequate nutrition is vital, not just to replace the energy expended during practice and games, but also critical during post-activity recovery periods and the off-season [4].

Many athletes also skip meals, and this has been shown to negatively influence their cognitive abilities and may alter metabolism due to reduced availability of carbohydrates to the brain. Conversely eating breakfast significantly improves performance by restoring the level of liver and muscle glycogen after overnight fasting [5}. For these reasons, medical teams attempt to provide athletes with adequate nutritional information in an effort to keep athletes in peak health and condition. Student athletes often receive their nutritional information from multiple sources including their parents, athletic trainers, magazines, coaches, nutrition classes, and physicians. This results in various levels of sports nutrition knowledge. In some cases, student athletes may receive erroneous information or hold inaccurate beliefs about sports nutrition leading these athletes to adopt unhealthy eating habits. [6] For example, Grandjean et al. found that 98% of athletes believed a high protein diet improved performance, and 75% believed that athletes need more vitamins than non-athletes [7]. In fact, numerous studies conducted over several years have provided evidence that nutritional education and knowledge is lacking among college athletes, particularly for topics surrounding protein intake, vitamin and mineral supplementation, and nutritional ergogenic aids [7]. Although athletes have a greater need for nutritional knowledge they often score in the range of 50% on nutritional knowledge tests [8]. Moreover, despite several studies in which athletes reported knowing what their appropriate nutritional intake should be, there were discrepancies in their nutritional knowledge base when tested formally and in their practiced nutritional habits [2, 9]. While it has been well established that efforts to increase nutritional knowledge should be increased in order to optimize nutritional status, ensure proper recovery, and maximize athletic performance, , the most effective teaching method remains elusive. [5,10] The purpose of this study was to investigate if a didactic intervention session about nutrition was superior to a booklet outlining sports nutrition to increase student athlete knowledge of nutrition.

Methods and Study Design:

The present study was a randomized prospective interventional study that was approved by the hospital Institutional Review Board (IRB) for Research with Human Subjects. Written consent was collected for each subject. The study was conducted at a National Collegiate Athletic Association (NCAA) Division I member institution in the eastern United States. The athletic department at the participating university did not provide any structured nutrition information to athletes, require nutrition courses or employ a sports dietitian. The inclusion criteria were athletes currently participating in team practices and at least 18 years of age. The study was advertised on several information boards at the university.

These boards were located in the team meeting rooms, athletic training rooms, and weight rooms. One hundred and twenty two athletes between the ages of 18 and 22 attended the initial meeting to receive information on the study. Each participant was fully informed of the scope and risks of the study prior to signing an IRB approved consent form. All participants were given a previously validated nutritional survey developed by Shifflett (2002). Each survey contained a knowledge component (20 questions), demographic and background items (10 questions), information on perceived understanding of athletes' nutritional needs, healthy diet, eating habits, and sources of nutritional information (4 questions). After completing the survey assessment, the participants were randomly divided into three different treatment groups. Group I (n=43) received a one-hour slide presentation on sports nutrition provided by a registered dietitian and the sports nutrition booklet (created by the authors). Group II (n=39) received a 5-minute discussion and an overview of the nutrition booklet, both provided by the team physician; and Group III (n=40) received the booklet alone. The presentation provided by the dietitian covered multiple topics including caloric intake, hydration, vitamins and minerals, protein, fat, eating disorders, and banned substances. The nutrition booklet, developed by the authors, provided a comprehensive discussion of the necessary dietary requirements for active student athletes. Key subject matter discussed in the booklet include stress factures, water/fluids and electrolytes, fast food nutritional information, ergogenic aids, and vegetarian diet, as well as an overview of carbohydrates, proteins, fats, and calories. Prior to conducting the study, the nutrition booklet was reviewed by sports medicine physicians, a registered dietitian, and athletic trainers. The final version of the nutrition booklet incorporated recommended changes from each reviewer. We then conducted an initial meeting with student athletes to provide them information on the study and obtain informed consent. Demographic information, responses to sources of nutritional information, and perceived understanding of educational needs of athletes were summarized and a nutritional knowledge composite score (based on the number correct responses) was obtained for each participant. An overall mean composite nutritional knowledge score was then calculated for each group. Each group was informed that the follow-up session would occur in 14 days where they would complete the survey again (post–intervention test).

Some athletes were lost due to attrition, which resulted in a slight decrease in the size of each group (n=39, n=34, and n=35, respectively). The remaining participants completed the post survey assessment. An overall group mean score was obtained for the post assessment. A one-way analysis of variance (ANOVA) was conducted to assess between-group differences of the pre- and post-nutritional survey assessment scores.

Results

The mean pre-test and post-test scores for each athlete group are displayed in Table 1. There was no statistically significant difference found between the groups, with

p>0.05 for the three conditions both at pre-test [F(2,105) = 1.80, p=0.170] and at post-test [F(2,105) = 1.57, p=0.213]. Notably, the mean score did improve in all three groups as displayed in Table 1.

There was no correlation found between years of competitive experience and pre-test or post-test scores in this study. There was also no correlation found between prior exposure to an undergraduate health education course and test scores. Previous exposure to an undergraduate nutrition course was not found to improve scores.

Thirty-seven percent of the athletes surveyed reported that the primary source on which they rely for information about nutrition is their athletic trainer. Twenty-three percent reported that their primary source of nutrition information is their parents, with another 14% reporting their primary source to be prior undergraduate nutrition or health courses. Full details are presented in Table 2.

On equivalent scales from 0-10, each athlete was asked to self-report his/her assessment of: a) the quality of his/her eating habits; b) how well he/she understands the nutritional needs of athletes, and; c) how important it is for athletes to adhere to a healthy diet. For the entire group surveyed, the mean score for eating habits was 5.7, for understanding an athlete's nutrition needs was 7.0, and for the importance of athletes maintaining a healthy diet was 8.6.

Table 1. Mean pre-test and post-test scores, divided by assigned group. Maximum possible score is 20.

	Group 1	**Group 2**	**Group 3**	**All Athletes**
Pre-test	8.3	7.4	8.2	7.9
Post-test	9.6	8.3	8.9	8.9

Table 2. Percentage of athletes citing each source as the primary source on which they rely for information about nutrition. "Common sense" was the most commonly cited "Other" source.

Source of Nutrition Information	**% of Athletes Citing as Primary Source**
Athletic Trainer	37
Parents	23
College Nutrition/Health Courses	14
Coach	9
Other	9
Magazines	4
Friends	3
Academic Journals	1

Discussion

It has been well established that proper nutrition is a critical component of an athlete's well-being and performance. Appropriate amounts of macronutrients and micronutrients must be available for energy transfer for an athlete to perform at an elite level. Several medical problems experienced by athletes have been attributed to an

imbalance between caloric and nutrient intake and expenditure. Optimal blood glucose and electrolyte levels as well as balanced hydration are required to avoid syncopal episodes associated with hypoglycemia or exercise-induced hyponatremia [11]. For example, overall low energy availability from disordered eating or excessive exercise, most commonly seen in weight-sensitive sports, is one of the hallmarks of the female athlete triad [12, 13, 6]. The occurrence of these conditions may have been prevented if the athletes received appropriate nutritional counseling.

Athletes have also been shown to have a greater increase in anaerobic metabolism and muscle glycogen depletion [3], and thus must have sufficient glycogen stores for sports requiring anaerobic bursts and to prevent the utilization of other macronutrients such as muscle protein as energy sources. This is particularly important in endurance activities, as insufficient substrate levels can disrupt the homeostasis of bone microdamage and repair, resulting in osteopathologic conditions from stress reactions to complete bone fractures [14, 15]. Some research has found that many athletes do not obtain the appropriate nutritional intake to support their nutritional needs. This was shown in a study by Shriver et el, where 75% of participants in the study failed to consume the minimum amount of carbohydrates required to support training, and only 27% of participants ate a regular breakfast [5].

The problem of inadequate nutrition knowledge among collegiate athletes is pervasive, persistent, and difficult to resolve. Educational interventions to address this issue can be effective, but the ideal method by which to provide nutrition information to athletes remains unknown. College athletes routinely cite athletic trainers, strength and conditioning coaches, and other team staff as important sources of nutrition information, yet these professionals may not have an adequate knowledge base. [16, 8]. Although certified athletic training programs, medical schools, strength and conditioning certifications require nutrition education and training, the training varies greatly depending on the program. A study by Torres-McGehee et el found that athletic trainers and strength coaches had adequate nutritional knowledge by scoring 77.8 % and 81.6 % respectively, on a nutritional survey. Conversely, athletic coaches scored only 35.9% on the same test. This finding underscores not only the lack of nutrition knowledge among athletic coaches but also importance of sports nutrition personnel. A qualified sports nutritionist has key training and knowledge important for any athletic program but there are very few programs in the country with a sports nutritionist. For this reason, it is important for strength coaches and athletic trainers to have an appreciation for educating athletes on their nutritional needs and perhaps a larger role[2]. Further, considering cost effective means to incorporate a registered dietitian to the sports medicine team via part-time or consulting models, or through strategic partnerships with industry or healthcare agencies would enhance health and performance efforts and potentially impact lifelong athlete well-being.

As shown in this and several prior studies, many college athletes do not demonstrate a strong nutrition knowledge

base [16, 17, 18]. While our study did not show one particular approach for providing nutrition information to be better than another, each of the simple interventions provided were effective in improving nutritional knowledge. Considering that other experiences, which could be expected to improve nutrition knowledge, such as increased competitive experience or undergraduate coursework in health and nutrition, failed to yield a benefit in our study, it is important to recognize that some educational interventions can lead to improvement. This is of particular significance given that formal instruction in nutrition sciences among college undergraduates, with the exception of those with a major in the field, is generally limited to 1- to 3-credit elective courses. Moreover, there are only 156 graduate programs in nutrition science, 22 of which have a Master of Science specifically in sports nutrition [7,19]. Although we did not see increased scores in those who had previously completed health and nutrition courses, Weeden et al found significantly higher nutritional knowledge scores for athletes that completed a college level nutrition course. The athletes in the study completed courses taught by a registered dietitian. (20). An increased number of educational sessions can also increase nutritional knowledge as shown in a study by Abood et el. In their study, the athletes were given eight one hour sessions on sports nutrition topics. The authors found a statistically significant improvement in nutritional knowledge and positive dietary changes [21].

Assessing nutrition knowledge is important because it ultimately impacts dietary intake. A review by Spronk et al [22] examined this relationship looking at 29 studies using a variety of instruments in both community and athletic populations. The majority, 65.5% reported a weak but positive association between higher nutrition knowledge and dietary intakes. Occurring most often were positive dietary behaviors around fruit and vegetable intakes. The authors identify nutrition knowledge as a key component of 'health literacy' and go on to discuss previously described links between low health literacy and poor health outcomes and higher healthcare costs. Therefore the positive association between knowledge and behavior as well as the impact knowledge can have on outcomes support the investment in nutrition education efforts [22]. This can be especially so for athlete's given adequate dietary intakes have been shown to improve performance and support health and recovery as stated earlier.

Supporting the positive association found by Spronk et al, nutrition knowledge in 30 male, elite English rugby players during the competitive season also showed that players scoring higher on a nutritional knowledge test had improved intakes as measured by a validated food frequency questionnaire (FFQ) [23]. Again, here fruit and vegetable intake was highly correlative with knowledge scores, as well as likelihood to consume carbohydrate-rich foods. Results showed that those in the highest nutrition knowledge quintile were 25 times more likely to meet recommended daily intakes for fruit and vegetables. Overall starchy foods, fruits and vegetables, oily fish and milk were all consumed more frequently in those with classified as having good nutritional

knowledge compared to those in the poor nutrition knowledge group. However, of particular note and importance is that despite international nutrition recommendations for sport and national guidelines promoting starchy foods as staple foods the athletes in this study were unaware of these recommendations. Upon closer evaluation all athletes in the poor knowledge group and close to half of those in the good nutrition knowledge group incorrectly answered questions on starchy foods consumption. Those in the poor knowledge group consumed significantly less. Since an athlete relies on carbohydrate as a primary energy source especially during exercise bouts that are intense and prolonged in nature, negative performance impacts become of concern. The mean nutritional knowledge score was 73% and considered adequate in this study but poorer in some sub categories suggesting that knowledge could be improved in relation to current recommendations especially carbohydrate consumption [23].

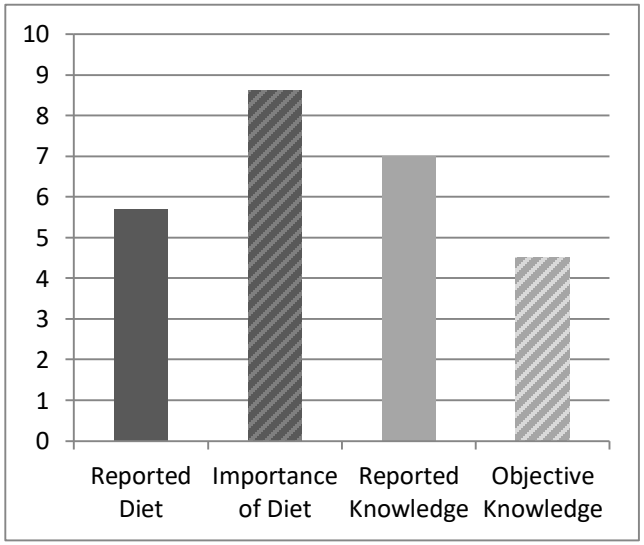
One of the few studies investigating the association between nutrition knowledge and diet quality was done with 101 Australian elite athletes across four Australian State Sport Institutes. The General Nutrition Knowledge Questionnaire was used to measure general nutrition knowledge and the quality of dietary intake was assessed using an adapted version of the Australian Recommended Food Score (A-ARFS) calculated from a validated FFQ. A significant positive weak association between overall knowledge and diet quality was found which the authors concluded explained 6.8% of the variance in overall diet quality [24]. Those domains with high scores on the A-ARFS were water, condiments and sauces, fruits, and grains; whereas dairy and protein intakes were lowest. Macro- and micronutrient contributions of the dairy and protein food groups are of prime concern for athlete bone health, recovery, maintenance of lean muscle mass and others. Of note was that those athletes reporting prior contact with a registered dietitian had significantly higher nutrition knowledge, however this did not translate to improved quality in this study [24].

With an established positive association of nutrition knowledge with dietary intakes the method of nutrition education delivery aiming to improve knowledge bares further consideration. While we were not able to elucidate a superior method in the current study others have found significance. Valliant et al [10] evaluated 11 NCAA volleyball players for total energy and micronutrient intakes during two off-season training periods and conducted pre- and post- nutrition intervention knowledge surveys. Athlete 3-day food records were collected over four months and used to assess the baseline and post intervention dietary intake. Intervention consisted of four individualized dietary education sessions by a registered dietitian specific to individual and activity needs. Initial dietary assessments revealed that the athletes did not meet recommended energy requirements and met on average only 56% of estimated needs. However after the intervention period the % estimated energy requirements met rose significantly to 70% for the team. Further, at baseline the average percent of carbohydrate and protein was 48%

and 59% respectively and rose significantly in both to 66% and 72% respectively post nutrition education intervention. Despite significant improvements in macronutrient intakes post intervention intakes still did not reach recommended levels for sport. A significant improvement in the team's nutrition knowledge was also seen after the intervention with every participant answering more items correctly on the knowledge survey as compared to baseline [10]. Similar to our findings, the media, internet, coach, and trainer were identified as primary sources of nutrition information prior to the intervention. However, afterwards the volleyball players identified the sports dietitian as the number one source of nutrition information. The individual counseling approach to nutrition education delivered by a registered dietitian produced significant positive changes in both nutrition knowledge and dietary intakes. Strategies designed to provide education around assessed intake gaps may be a way to improve effectiveness of nutrition education interventions and ultimately address potential negative health and performance impacts of these deficiencies.

In our study we also found inconsistency between how collegiate athletes rate their understanding of the nutritional needs of athletes (mean 7.0 out of 10, or 70%) and their performance on a validated test of nutrition knowledge (mean of 45% correct answers in our study, Figure 1). Even still, athletes recognize the gap between their understanding of nutrition principles and the importance of being able to maintain a healthy diet (mean of 8.6 out of 10). Factoring in the self-reported poor eating habits of these athletes in practice (mean of 5.7 out of 10), the causes of which can be the source for speculation, it is important that further research be conducted in order to identify optimal methods to increase the nutrition knowledge of these athletes to an acceptable level.

Figure 1. Mean athlete rating of personal dietary habits, the importance of athletes maintaining a healthy diet, personal nutritional knowledge, and nutrition post-test scores.



Limitations

One limitation of our study was that it was conducted at a Division I university. Thus no athletes from NCAA Division II and III institutions participated in the study. Without this information, the findings we report cannot be generalized to college athletes across all NCAA divisions. A second limitation is that the athletes who volunteered to participate in the study may have a greater interest in nutrition than other student athletes thus the findings here should also be interpreted with caution. This also indicates another reason the findings may not be generalizable to all student athletes.

Recommendations

For the small percentage of athletes who have access to a full-time sports nutritionist, making frequent use of these skilled professionals is likely to be extremely valuable in improving knowledge of nutrition and nutrition related behaviors. For the large remaining majority of collegiate athletes without access to such a resource, we suggest at minimum a brief intervention led by a registered dietitian. Additionally we encourage athletic administrators and sports medicine staffs to work collaboratively to recognize the positive impacts on student-athlete health and performance by exploring strategies and partnerships to incorporate nutrition expertise in a way that respects the departments' financial limits. Other options include educational sessions with strength coaches or athletic trainers before or after team training sessions or team meetings. Another option for universities that do not have the resources to provide a sports dietitian to their athletes is to require first year athletes to take a nutrition course for academic credit. Future studies should focus on assessing differences in factual knowledge and application based knowledge on resulting dietary behavior change. Additionally, it could be beneficial to look closer at whether including athletic trainers, coaches and other team staff in the interventions further improves outcomes, or if repeated interventions over time yield additional benefit.

Acknowledgments

The authors would like to thank the Medical Foundation of North Carolina for supporting the study with grant funding. We also acknowledge the athletic trainers and sports nutrition staff at North Carolina Central University and The University of North Carolina for assisting with recruitment and education of the athletes that participated in the study. We also want to express a sincere thank you to B. Shifflett who gave us permission to utilize the Nutrition Questionnaire for our study.

Declaration of interest statement

The authors whose names are listed in this manuscript certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing

arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Ethical approval: "All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards."

References

1. Maughan R. The athlete's diet: nutritional goals and dietary strategies. Proc Nutr Soc. 2002;61(1):87–96. PMID: 12002799
2. Torres-McGehee TM, Pritchett KL, Zippel D, Minton DM, Cellamare A, Sibilia M. Sports Nutrition Knowledge Among Collegiate Athletes, Coaches, Athletic Trainers, and Strength and Conditioning Specialists. *Journal of Athletic Training*. 2012;47(2):205-211.
3. McArdle WD, Katch FI, Katch VL. Exercise Physiology: Energy, Nutrition, and Human Performance. 6th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2007.
4. Moore, D. R. (2015). Nutrition to support recovery from endurance exercise: optimal carbohydrate and protein replacement. *Current sports medicine reports*, *14*(4), 294-300.
5. LH Shriver, NM Betts, G Wollenberg Dietary intakes and eating habits of college athletes: are female college athletes following the current sports nutrition standards? Journal of American College Health 61 (1), 10-16
6. Frederick L, Hawkins ST. A comparison of nutrition knowledge and attitudes, dietary practices, and bone densities of postmenopausal women, female college athletes, and nonathletic college women. J Am Diet Assoc. 1992 Mar;92(3):299-305.
7. American Society for Nutrition. Graduate Program Directory. https://www.nutrition.org/education-and-professional-development/graduate-program-directory/. Accessed July 27, 2015.
8. Burns RD, Schiller MR, Merrick MA, Wolf KN. Intercollegiate student athlete use of nutritional supplements and the role of athletic trainers and dietitians in nutrition counseling. J Am Diet Assoc. 2004;104(2):246–249.
9. Dunn, D., Turner, L. W., & Denny, G. (2007). Nutrition knowledge and attitudes of college athletes. *The Sport Journal*, *10*(4).
10. Valliant, M. Nutrition Education by a Registered Dietitian Improves Dietary Intake and Nutrition Knowledge of a female Volleyball Team. Nutrients 2012, 4, 506-516. (1)
11. Hew-Butler T[1], Rosner MH, Fowkes-Godek S, Dugas JP, Hoffman MD, Lewis DP, Maughan RJ, Miller KC, Montain SJ, Rehrer NJ, Roberts WO, Rogers IR, Siegel AJ, Stuempfle KJ, Winger JM, Verbalis JG. Statement of the Third International Exercise-Associated Hyponatremia Consensus Development Conference, Carlsbad, California, 2015. Clin J Sport Med. 2015 Jul;25(4):303-20.
12. Matzkin E, Curry EJ, Whitlock K. Female Athlete Triad: Past, Present, and Future. J Am Acad Orthop Surg. 2015 Jul;23(7):424-32.
13. Perriello VA. Aiming for healthy weight in wrestlers and other athletes. Contemp Pediatr. 2001 Sep:18(9):55-74.
14. Volpe SL. Magnesium and the Athlete. Curr Sports Med Rep. 2015 Jul-Aug;14(4):279-83.

15. Warden SJ, Davis IS, Fredericson M. Management and prevention of bone stress injuries in long-distance runners. J Orthop Sports Phys Ther. 2014 Oct;44(10):749-65.
16. Shifflett,B. Understanding of Athletes Nutritional Needs among Athletes, Coaches, and Athletic Trainers. Research Quarterly for Exercise and Sport. September 2002, Vol 73 no3 pp. 357-362. (2)
17. Jacobson BH, Sobonya C, Ransone J. Nutrition practices and knowledge of college varsity athletes: a follow-up. J Strength Cond Res. 2001;15(1):63–68.
18. Rosenbloom CA, Jonnalagadda SS, Skinner R. Nutrition knowledge of collegiate athletes in a Division I National Collegiate Athletic Association institution. J Am Diet Assoc. 2002;102(3):418–420.
19. Pendergast L, Steinmuller P. SCAN Sports Nutrition-Exercise Science Education Programs. http://scan-dpg.s3.amazonaws.com/ media /files/66b74aad-5988-4873b1892722039270ef/Sports%20Nutrition%20Education%20Programs% 20A-Z_050114.pdf. Accessed July 27, 2015.
20. Weeden A, Olsen J, Batacan J, Peterson T. Differences in Collegiate Athlete Nutritional Knowledge as Determined by Athlete Characteristics. USSA in contemporary Sports Issues. October 14, 2014.
21. Abood, Doris A., David R. Black, and Rachel D. Birnbaum. "Nutrition education intervention for college female athletes." *Journal of nutrition education and behavior* 36.3 (2004): 135-139. (6)
22. Spronk I, Kullen C, Burdon C, O'Connor H. Relationship between nutrition knowledge and dietary intake. *Br J Nutr*. 2014;111(10):1713-1726.
23. Alaunyte I, Perry JL, Aubrey T. Nutritional knowledge and eating habits of professional rugby league players: does knowledge translate into practice?. *J Int Soc Sports Nutr*. 2015;12:18. Published 2015 Apr 17.
24. Spronk I, Heaney SE, Prvan T, O'Connor HT. Relationship Between General Nutrition Knowledge and Dietary Quality in Elite Athletes. *Int J Sport Nutr Exerc Metab*. 2015;25(3):243-251.

