

## Research Article

# Sports Nutrition Knowledge, Sources of Nutrition Information, and Desired Sports Nutrition Advice of Collegiate Student-Athletes at a Division I Institution

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• Sports nutrition knowledge; Sports nutrition advice; Board-certified specialist in sports dietetics (CSSD); Sports nutrition topics of interest

**Abstract**

While research supports the role of nutrition in exercise and athletic performance, the literature indicates sports nutrition knowledge deficits among collegiate student-athletes. Currently, only 67 Division I (DI) universities in major conferences employ a full-time board-certified specialist in sports dietetics (CSSD), with only one in the Mid-American Conference (MAC). The absence of a full-time sports nutrition specialist causes student-athletes to seek nutrition advice from potentially less credible sources. This study evaluates the sports nutrition knowledge (SNK), primary sources of nutrition information, and type of sports nutrition advice desired by NCAA Division I athletes at a university. With assistance of the athletic department, an online survey was sent to all (n=395) student-athletes. A total of 127 responses (32%) were received (44.9% male, 55.1% female). The mean sports nutrition knowledge score (MS) was 53% ± 14% (12.1 ± 3.3 of 23 questions). Female athletes (MS: 56%; 12.8 ± 2.9) scored significantly higher than male athletes (MS: 50%; 11.5 ± 3.5) (p=0.021). Only 8% of the student-athletes answered 70% or more of the questions correctly. The student-athletes reported seeking nutrition advice from strength and conditioning specialists (48%), coaches (41.7%), athletic trainers (39.4%), and the internet (66.9%). Respondents indicated nutrition is 'very important' for performance, and that a full-time CSSD would be 'very beneficial' to their athletic success. Topics of interest included weight management strategies (n=99) and meal timing/ meal plan development (n=96). These results provide evidence to support the hiring of a full-time sports dietitian as a member of the athletic staff in their effort to optimize student-athlete performance and well-being.

**ABBREVIATIONS**

CSSD: Board-Certified Specialist in Sports Dietetics; SNK: Sports Nutrition Knowledge; PI: Primary Investigator; DI: Division 1 University; NCAA: National Collegiate Athletic Association

**INTRODUCTION**

While it has been long understood that nutrition plays a role in the prevention of disease and promotion of overall health, nutrition has recently emerged as a critical component for the prevention and recovery of athletic injuries as well as for peak athletic performance [1,2]. Exercise places an increased physical demand on the body; adapting to these demands requires an overall increased energy intake and certain key nutrients for proper function and recovery [2].

Despite the many critical roles nutrients have, many collegiate student-athletes are unaware of the relationship between nutrient requirements and optimal performance [3,4]. This lack of sports nutrition knowledge (SNK) translates into less than optimal dietary patterns, which can impede athletes' training and performance [5] and can cause student-athletes to seek advice from easily accessible, but potentially unreliable, sources. Studies

indicate athletes commonly seek nutrition advice from coaches, athletic trainers, and strength and conditioning specialists who are in daily contact with the student-athletes, however, their nutrition knowledge has been shown to be less than adequate [6,7].

To aid in ensuring athletes receive optimal sports nutrition information, the National Commission for Certifying Agencies (NCCA) has established extensive criteria for eligible individuals to be board-certified specialists in sports dietetics (CSSD). This certification enables sports dietitians to gain a competitive edge in their career and provide unique services, such as sports medical nutrition therapy for specialized populations [8].

At present, most universities do not have a full-time CSSD on staff. In the fall of 2018, only 84 universities in the major college conferences (e.g., BIG 10, SEC, ACC) employed one or more full-time (40 hours or more a week) sports dietitians [9]. The increased awareness of the role of nutrition in athletic performance, combined with the 2014 revision of the National Collegiate Athletic Association's (NCAA) student-athlete feeding rules that has led to a 145% increase in the average annual food budget used by collegiate athletic departments [10], suggests

that a full-time sports dietitian is needed at the collegiate level for reasons beyond serving as an accessible, credible nutrition resource for student-athletes.

The lack of full-time sports dietitians on staff at the collegiate level can result in student-athletes seeking nutrition advice from readily accessible – although potentially inaccurate -- sources, including coaches, athletic trainers, and strength and conditioning specialists [6,7]. This dependence on less qualified professionals puts the performance and overall health of the student-athletes at risk [6]. A full-time CSSD could provide quality, evidence-based answers to athletes' questions, optimize the nutrient value of the foods purchased for the student-athletes due to the revised NCAA student-athlete feeding rule, and improve the overall knowledge and practices of student-athletes, coaches, athletic trainers, and strength and conditioning specialists [10,11]. It is hypothesized that by identifying the nutrition knowledge and preferred sources of nutrition information used by student-athletes at a Midwestern NCAA Division I (DI) school, university administration might have the evidence they need to hire a full-time CSSD who could support the athletes in their endeavor to attain maximum health and performance. Thus, the purpose of this study was to identify the SNK, preferred sources of nutrition information, perception of the importance of nutrition for athletic performance, and the type of advice athletes would like to receive from a board-certified specialist in sports dietetics (CSSD) of student-athletes at a Midwestern NCAA DI school. The results of this study will provide evidence that can be used in support of hiring full-time CSSDs to help athletes attain maximum health and performance.

## MATERIALS AND METHODS

This study was approved as exempt by the Ball State University Institutional Review Board (IRB) as protocol # 1370035-1 on January 2, 2019. To ensure the protection of all participants, all researchers involved completed the Collaborative Institutional Training Initiative (CITI) training.

### Subjects

The population included all student-athletes (n= 395) at a Mid-America Conference (MAC) university who participate in one of seven male (baseball, basketball, football, golf, swimming and diving, tennis, and volleyball), or one of 11 female (basketball, cross country, field hockey, golf, gymnastics, soccer, softball, swimming and diving, tennis, track and field, and volleyball) varsity sport teams. Per the Creative Research System sample size calculator, using a population of 395, a 95% confidence level, and a confidence interval of 5 (<https://www.surveysystem.com/sscalc.htm>), a sample of  $238 \pm 4$  athletes was needed to obtain results that reflect those of the target population.

### Instruments

The Sport Nutrition Survey used in this study was adapted, with permission, from previously validated and used surveys [6,12,13]. The online survey, written using the Qualtrics survey software ([www.Qualtrics.com](http://www.Qualtrics.com)), was formatted for use on a phone, tablet or computer. The final survey included four sections: 1) sports nutrition knowledge (SNK), 2) attitudes toward nutrition, 3) the anticipated need and use of a CSSD, and demographic questions.

The 23-question SNK section contained the following five constructs: 1) macronutrients [5 questions], 2) micronutrients [5 questions], 3) nutrient timing [4 questions], 4) hydration and electrolyte balance [4 questions], and 5) nutrition problems [5 questions]. A total SNK score was determined by subtracting the number of incorrect answers from 23. The SNK percent score was calculated by dividing the SNK total score by 23 and then multiplying by 100. In addition, individual construct scores (number and percent) were determined for each of the five constructs.

A 5-point Likert scale (1= no knowledge, 5= expert) was used to assess the student-athletes' attitudes and beliefs about nutrition's role in performance. A 10-point Likert scale (1=not beneficial, 10= extremely beneficial) was used to assess the student-athletes' anticipated need for a CSSD.

Content and construct validity had been previously established by a group of experts (i.e. 3 dietitians, 1 sports RDN, 1 associate dean to the athletic department, and 2 graduate students in nutrition and dietetics) who were familiar with the nutrition needs of student-athletes. Reliability of the instrument was established through a pilot survey given to a sample of students.

A letter of permission to conduct the study within the athletic department was requested and accepted from the Associate Dean. A letter of information and consent was provided to all participants prior to participation, to inform them of the purpose, low risk, and benefit of completing the survey. Participants were allowed to terminate the survey at any time without any prejudice from the investigator, athletic department, or university.

### Methods

An email, written by the PI, was sent to all student-athletes at the university by the Deputy Athletic Director for Internal Operations and Senior Woman Administrator, Intercollegiate Athletics Ops, who was a member of the research team. The email described the purpose of the study and encouraged the athletes to participate. The link to the Qualtrics survey was embedded in the email. To increase response rate, six days after the first email, a second email was distributed to all the student-athletes. This email thanked those who had completed the survey and requested participation from those who had not. A third email was sent to all student-athletes 13 days after the initial email, as another reminder and to increase the response rate. The process was repeated a fourth time to increase participation, as research has shown that 3-5 contacts with the target population has resulted in significantly increased completion rates of online surveys [14].

### Data analysis

The data was downloaded directly from Qualtrics into SPSS v. 25 (2018) for analysis. Descriptive statistics and frequency counts were conducted on all variables and to determine the overall prevalence of specific survey questions. A total sport nutrition knowledge (SNK) score, percent scores, and scores from each of the five constructs (i.e. the sum of the correct number of responses for questions associated with each construct), were calculated. One-way analysis of variance (ANOVA) was used to

compare differences by gender, sport, semester completed, and type of major (health profession vs. non-health profession). Fischer's Least Significant Difference (LSD) post-hoc tests were used to determine the mean differences within each group. Statistical significance was set at  $p = 0.05$ .

## RESULTS AND DISCUSSION

Of the 395 student-athletes enrolled in this Midwestern MAC University in the spring of 2019, 32% completed the survey, leaving a final sample size of 127 participants. By gender, 45% ( $n=57$ ) of the 127 respondents were male and 55% ( $n=70$ ) were female. With the exception of men's basketball, at least one student-athlete from each sport team completed the survey. By academic classification, the greatest number of responses (34.4%;  $n=43$ ) were obtained from freshman and sophomore (32.8%;  $n=41$ ) student-athletes. By academic major, more than two-thirds of the respondents (67%;  $n=85$ ) indicated they were not a "health profession" major.

### Sports nutrition knowledge

The total mean sports nutrition knowledge (SNK) score (MS) was  $12.1 \pm 3.3$  out of 23 questions, equivalent to answering 53%  $\pm 14\%$  of the questions correctly. By construct, the student-athletes correctly answered more than half of the Nutrition Problem (63%; MS:  $3.1 \pm 1.2$ ) and Nutrition Timing (55%; MS:  $2.2 \pm 1.0$ ) questions, approximately half (51%; MS:  $2.0 \pm 1.1$ ) of the Hydration/Electrolyte Balance and Macronutrient (49%; MS:  $2.4 \pm 1.1$ ) questions, and slightly less than half of the Micronutrient (47%; MS:  $2.4 \pm 1.1$ ) questions (Table 1).

When analyzed by gender, female athletes (56%; MS:  $12.8 \pm 2.9$ ) demonstrated a significantly higher total sports nutrition knowledge (SNK) than male athletes (50%; MS:  $11.5 \pm 3.5$ ) ( $p=0.021$ ). There was no significant difference in SNK scores by sport among males ( $F=1.082$ ;  $p=0.382$ ) or females ( $F=1.598$ ;  $p=0.130$ ), as well as by academic classification ( $F=1.541$ ;  $p=0.207$ ) and major type ( $F=0.403$ ;  $p=0.513$ ) (Table 2).

### Sports nutrition knowledge constructs scores

The SNK questions ( $n=23$ ) addressed the following five constructs: 1) Macronutrients ( $n=5$  questions); 2) Micronutrients ( $n=5$  questions); 3) Nutrient Timing ( $n=4$  questions); 4) Hydration and Electrolyte Balance ( $n=4$  questions); and 5) Nutrition Problems ( $n=5$  questions). Each construct was analyzed for significant differences by gender, sport, year in college, and major type. Overall, no significant differences were detected in

the Macronutrient construct score when analyzed by gender ( $F=2.785$ ;  $p=0.098$ ), male sport ( $F=0.630$ ;  $p=0.643$ ), female sport ( $F=0.868$ ;  $p=0.558$ ), academic classification ( $F=0.760$ ;  $p=0.519$ ), or by major (health-related vs. not health-related) ( $F=0.019$ ;  $p=0.891$ ). Additionally, no significant differences were found in the Micronutrient construct score by gender ( $F=1.104$ ;  $p=0.295$ ), male sport ( $F=0.355$ ;  $p=0.839$ ), female sport ( $F=0.992$ ;  $p=0.457$ ), academic classification ( $F=1.591$ ;  $p=0.173$ ), or by major type ( $F=0.115$ ;  $p=0.735$ ). Similar to the macronutrient and micronutrient constructs, no significant differences were detected in the Nutrient Timing construct score by gender ( $F=2.262$ ;  $p=0.135$ ), male sport ( $F=1.614$ ;  $p=0.185$ ), female sport ( $F=1.666$ ;  $p=0.118$ ), academic classification ( $F=0.303$ ;  $p=0.823$ ), or by major type ( $F=0.173$ ;  $p=0.678$ ) (Table 2).

No significant differences were detected in the Hydration and Electrolyte Balance construct scores by gender ( $F=1.353$ ;  $p=0.247$ ), male sport ( $F=1.228$ ;  $p=0.311$ ), female sport ( $F=0.868$ ;  $p=0.559$ ), or academic classification ( $F=0.112$ ;  $p=0.953$ ). There was a significant difference by major type, as health-related majors ( $n=41$ ) scored significantly lower than those who were majoring in a non-health-related field ( $n=85$ ) ( $1.7 \pm 1.0$  vs.  $2.2 \pm 1.0$ , respectively;  $F=5.455$ ;  $p=0.021$ ). There were no significant differences detected in the Nutrition Problems construct when analyzed by male sport ( $F=1.667$ ;  $p=0.172$ ), female sport ( $F=4.379$ ;  $p < 0.001$ ), academic classification ( $F=1.944$ ;  $p=0.126$ ) or major (health-related vs. not health-related) ( $F=0.637$ ;  $p=0.426$ ). However, female athletes ( $3.5 \pm 0.9$ ) scored significantly higher in this construct than male athletes ( $2.7 \pm 1.3$ ) ( $F=14.957$ ;  $p < 0.001$ ) (Table 2).

### Summary: Sports Nutrition Knowledge

In sum, student-athletes demonstrated inadequate SNK by failing to reach a passing score, arbitrarily selected as 70%, on overall total SNK, as well as in each sports nutrition construct. When knowledge was assessed by gender, females were found with greater knowledge when compared to male athletes. No significant differences in knowledge were found among academic level or major type.

### Primary Sources of Sports Nutrition Information utilized by Student-Athletes

Among the 127 respondents, the strength and conditioning specialists was identified as a primary source of sports nutrition information (48%;  $n=61$ ), followed by coaches (42%;  $n=53$ ), athletic trainers (39%;  $n=50$ ), and registered dietitian

**Table 1:** Mean Sports Nutrition Knowledge (SNK) Score of the Student-Athletes, Overall and by Construct ( $n=127$ ).

Variable	Number of Questions	Mean Number Correct $\pm$ SD	Percent Correct $\pm$ SD
Overall SNK Score	23	$12.1 \pm 3.3$	$52.8 \pm 14.3$
SNK Construct			
• Nutrition Problems	5	$3.1 \pm 1.2$	$62.7 \pm 23.1$
• Nutrient Timing	4	$2.2 \pm 1.0$	$54.5 \pm 24.7$
• Hydration/Electrolyte Balance	4	$2.0 \pm 1.1$	$50.6 \pm 26.4$
• Macronutrient	5	$2.4 \pm 1.1$	$48.7 \pm 21.5$
• Micronutrient	5	$2.4 \pm 1.1$	$47.2 \pm 21.9$

Abbreviations: sports nutrition knowledge (SNK), standard deviation (SD)

**Table 2:** Overall Mean SNK Score and Mean Construct Score of the Student-Athletes by Gender (n=127) and Type of Major (Health-Related vs. Non-Health-Related) (n=126).

Variable	Male	Female	F	p
Sports Nutrition Score	11.5 ± 3.5	12.8 ± 2.9	5.425	<b>0.021</b>
Nutrition Problems	2.7 ± 1.3	3.5 ± 0.9	14.957	<b>0.000</b>
Nutrient Timing	2.1 ± 1.1	2.3 ± 0.9	2.262	0.135
Hydration/ Electrolyte Balance	2.2 ± 1.1	1.9 ± 1.0	1.353	0.247
Macronutrient	2.3 ± 1.1	2.6 ± 1.0	2.785	0.098
Micronutrient	2.3 ± 1.0	2.5 ± 1.1	1.104	0.295
Variable	Health-Related Major	Non-Health-Related Major	F	p
Overall SNK	11.9 ± 3.7	12.3 ± 3.0	0.430	0.513
Nutrition Problems	3.3 ± 1.2	3.1 ± 1.1	0.637	0.426
Nutrient Timing	2.1 ± 1.0	2.2 ± 1.0	0.173	0.678
Hydration/Electrolyte Balance	1.7 ± 1.0	2.2 ± 1.0	5.455	0.021
Macronutrient	2.5 ± 1.1	2.4 ± 1.1	0.019	0.891
Micronutrient	2.3 ± 1.2	2.4 ± 1.0	0.115	0.735

Abbreviations: sports nutrition knowledge (SNK)

nutritionists (36%; n=46) (Table 3). Using a Likert scale that ranged from 1 (no knowledge) to 5 (expert), results indicate that the athletes perceive the strength and conditioning specialists have the greatest SNK ( $4.3 \pm 0.8$ ), followed by athletic trainers ( $3.6 \pm 1.0$ ), and coaches ( $3.3 \pm 1.1$ ).

The student-athletes were asked to identify which of six resources they used to obtain sports nutrition information. Results indicated the internet (67%; n=85) was the resource most commonly used option to obtain nutrition information, followed by conferences/annual meetings/team meetings (35%; n=44) and social media (32%; n=41). Only 14% indicated they accessed academic journals for sports nutrition information (Table 3).

### The Importance of Optimal Nutrition for Athletic Performance

The student-athletes were asked their opinions regarding the importance of optimal nutrition for athletic performance using a 10-point Likert scale (1 = not important to 10 = extremely important). With a mean score of  $9.2 \pm 1.2$ , the results clearly indicate the student-athletes believe optimal nutrition is extremely important for athletic performance. No significant differences were found by gender ( $F=0.478$ ;  $p=0.491$ ), male sports ( $F=1.721$ ;  $p=0.148$ ) female sports ( $F=1.091$ ;  $p=0.385$ ), academic standing ( $F=0.886$ ;  $p=0.451$ ) or type of major using ANOVA ( $F=0.109$ ;  $p=0.742$ ).

Similarly, using a 10-point Likert scale ranging from 1 ('Not Beneficial') to 10 ('Very Beneficial'), the participants were asked to provide their opinion regarding the benefit of a full-time certified specialist in sports dietetics (CSSD). Overall, the student-athletes reported access to a CSSD was very beneficial ( $9.0 \pm 1.5$ ). There were no differences by gender ( $F=0.01$ ;  $p=0.919$ ), type of male sport ( $F=0.510$ ;  $p=0.767$ ), type of female sport ( $F=0.583$ ;  $p=0.821$ ), academic standing ( $F=0.428$ ;  $p=0.734$ ), or type of major ( $F=0.030$ ;  $p=0.864$ ).

### Awareness of and Desired Advice from a CSSD

Finally, subjects were asked to identify the sports nutrition

topics of greatest interest to them. From a list of 12 sports nutrition-related topics and services in which CSSDs hold expertise, the topic of greatest interest was weight management strategies (78%; n=99), followed by meal timing/ meal plan development (76%; n=96) and making healthy choices (72%; n=91) (Table 4). Nineteen of the 127 participants indicated they were interested in learning more about various types of diets (i.e. Paleo diet), eating strategies for on-campus and off-campus, and nutrition needs to meet individual lifestyles.

## DISCUSSION

On average, the student-athletes in the present study correctly answered just over half (52.6%) of the SNK questions. Applying an

**Table 3:** Sources of Sports Nutrition Information Utilized by Student Athletes (n=127).

Source/ Resource	N	Percent %
Internet	85	66.9
Strength and Conditioning Specialists	61	48.0
Coaches	53	41.7
Athletic Trainers	50	39.4
Registered Dietitian Nutritionist	46	36.2
Conference/ Annual Meetings/ Team Meetings	44	34.6
Friends	42	33.1
Social Media (i.e., Facebook, Instagram, Twitter)	41	32.3
Parents	40	31.5
Mobile App (i.e., MyFitness Pal)	35	27.6
College Nutrition Courses	33	26.0
Academic Journals	18	14.2
Personal Physician	17	13.4
Magazines	12	9.4
Team Physician	7	5.5



**Table 4:** List of Sports Nutrition Topics the Student-Athletes Indicated they wanted to Learn More About from a Board Certified Specialist in Sports Dietetics (CSSD).

Topic of Interests	N	Percent %
Weight management strategies	99	78.0
Meal timing/ meal plan development	96	75.6
Making healthy choices	91	71.7
Basic sports nutrition information for training and competition	86	67.7
Nutrition guidelines	79	62.2
Eating on the road	78	61.4
Recipe Selection	69	54.3
Recovery from injury	58	45.7
Hydration strategies	55	43.4
Provide workshops requested by athletes	53	41.7
Special nutrition needs (e.g. food allergies)	45	35.4
Receive counseling for medical needs (e.g. Diabetes)	17	13.4
Abbreviations: Board-Certified Specialist in Sports Dietetics (CSSD)		

arbitrary “passing” grade of 70% or above, only 8% of the athletes demonstrated an adequate SNK passing score, indicating the student-athletes have an inadequate SNK. Mirroring the results of the present study, with a mean SNK score of 54.9%, Torres-McGehee (2012) reported that 91% of the student-athletes in their study demonstrated inadequate nutrition knowledge [6]. In an assessment of 123 student-athletes from five different sports teams, Andrews (2016) reported an average nutrition knowledge score of 56.9% [3]. Similarly, Hornstrom (2011) also found that Division I MAC softball players (n=185) had inadequate nutrition knowledge, with an average score of 57% [4].

Female athletes had a significantly higher total SNK than male athletes ( $p = 0.021$ ), supporting the findings of various previous studies [15,5]. Both Jessri (2010) and Spronk (2015) found females scored significantly higher on the overall general nutrition knowledge questionnaire (GNKQ) than males ( $p < 0.001$ ;  $p = 0.017$ , respectively) [15,5]. In the present study, no significant differences in SNK were observed by sport type, academic classification, or major type. These observations are consistent with those of Andrews (2016) who found no difference in nutrition knowledge among sport teams ( $p = 0.798$ ), by class rank ( $p = 0.993$ ), or based on prior nutrition course ( $p = 0.334$ ) [3]. The results of the present study differ, however, from those reported by Shapiro (2015), who found that the student-athletes classified as juniors had a significantly higher total SNK score than freshmen and sophomores ( $p = 0.021$ ) [12].

The student-athletes in this study failed to reach the arbitrary passing score of 70% in any of the five nutrition constructs (i.e., Macronutrient (49%), Micronutrient (47%), Nutrient Timing (55%), Hydration and Electrolyte Balance (51%), and Nutrition Problems (63%)). Similar to Shapiro (2015) who reported a score of 64%, the student-athletes in the present study scored the highest in the Nutrition Problems construct (63%) [12]. Likewise, Torres-McGehee (2012) reported student-athletes correctly answered just over half (51%) of the macronutrient and micronutrient questions and the student-athletes in the present

study correctly answered 49% of the Macronutrient questions and 47% of the Micronutrient questions [6].

With an average score of 51%, the student-athletes in the present study demonstrated an inadequate knowledge of fluid and electrolyte balance. Similar results of an average score of 55.6% were reported by Magee (2017), with additional findings that 32% of the student-athletes were dehydrated prior to exercise, and that these participants had a significantly lower nutrition knowledge score than the hydrated athletes ( $p = 0.001$ ) [16]. In sum, the SNK of DI student-athletes in the present study was found to be inadequate, both overall and by construct, when analyzed by gender, sport type, academic classification, and major type.

The top three sources of sports nutrition information the student-athletes reported turning to were strength and conditioning specialists (48%), coaches (42%), and athletic trainers (39%). A smaller, but growing, percentage of student-athletes (36.2%) reported turning to a registered dietitian nutritionist for information. In comparison, Trakman (2019) reported that two of the most commonly utilized sources among Australian athletes were dietitians (20%) and nutritionists (16%) [17]. Similar to the current study, Torres-McGehee (2012) reported the most commonly used sources of nutrition information by student-athletes were the strength and conditioning specialists (16.2%), athletic trainers (11.4%), and coaches (7.7%), and hypothesized this may be due to their accessibility and daily contact with these professionals. Torres-McGehee (2012) also assessed the nutrition knowledge of the participating strength and conditioning specialists, athletic trainers, and coaches, and results showed that while many strength and conditioning coaches and athletic trainers demonstrated adequate knowledge, they were also found to be overly confident in questions they answered incorrectly. This suggests that these professionals should take caution with addressing nutrition concerns, and instead refer to a CSSD, the sports nutrition expert [6].

The student-athletes in the present study believe that, among their most commonly used sources of nutrition information, the strength and conditioning specialists have the greatest SNK ( $4.3 \pm 0.8$ ), followed by athletic trainers ( $3.6 \pm 1.0$ ), and coaches ( $3.3 \pm 1.1$ ). These results concur with those of Shapiro (2015) who reported similar findings (i.e., Strength and conditioning specialists ( $3.9 \pm 0.9$ ); athletic trainers ( $3.4 \pm 0.9$ ); coaches ( $2.8 \pm 1.0$ )). Interestingly, in both studies, the student-athletes rated their own SNK about equal to or slightly greater than that of coaches, one of their most commonly utilized sources [12].

In the present study, almost two-thirds of the respondents (67%;  $n=85$ ) reported that they commonly search the internet for nutrition information. A much smaller percentage (14%) reported reading academic journal articles. Zuniga (2017) reported similar findings, with almost half (45%) of the participants reporting that they used the internet as a common source of nutrition information while only (5.8%) reported using academic journals to find nutrition information [7]. In contrast, Abbey (2017) reported that only 21% of collegiate athletes used ‘websites’ to obtain nutrition information [18]. Similarly, Trakman (2019) reported that only 19% of the participants

turned to the internet to obtain sports nutrition information [17]. Nonetheless, despite the wide range in the percent of athletes who turn to the internet for sports nutrition information (i.e., 19% to 67%), its use is concerning due to the varying degrees of reputability, accuracy, and credibility [7]. Therefore, it appears that it would be beneficial to increase the accessibility of credible sports dietitians to student-athletes, as well as to teach them how to recognize and access reliable sports nutrition information.

Overall, the results of this study demonstrate that many student-athletes use less-than-credible sources of nutrition information regardless of their perceived level of SNK. Despite the easy access to and common use of, student-athletes do not necessarily believe these sources are knowledgeable about sports nutrition. These results are supported by previous research [6,7,12,18] and provide evidence for the need to increase the presence of full-time CSSD's employed in collegiate settings, as it has been made clear that part-time employment fails to provide adequate access to student-athletes.

The results regarding the student-athletes' attitudes and beliefs about the importance of proper nutrition, and the anticipated benefits of having access to a CSSD, indicate that student-athletes believe 'proper nutrition' is 'very important' to their athletic performance, with an average score of  $9.2 \pm 1.2$  out of 10, with no difference by gender. Shapiro (2015) found similar results with student-athletes rating nutrition a  $9.5 \pm 0.9$  out of 10, as 'very important' for the enhancement of performance [12]. Torres-McGehee (2012) reported that student-athletes rated the importance of adhering to a healthful diet as  $8.6 \pm 1.6$  out of 10 [6]. These results provide evidence that, although they do not rate their own nutrition knowledge as high, collegiate student-athletes positively value and acknowledge the important role nutrition plays in athletic performance. Thus, it would seem prudent for universities to provide the athletes with someone who can offer quality, evidence-based sports nutrition guidance.

In the current study, student-athletes were given a description of the qualifications and requirements of CSSD eligibility specialization, as well as the services CSSDs are qualified to provide. Following this, student-athletes were asked to rate their opinion on having a full-time sports dietitian as a member of the athletic staff. The student-athletes clearly indicated they would find it very beneficial, with a score of  $9.0 \pm 1.5$  out of 10. Shapiro (2015) found a similar strong belief in the benefit have having access to a CSSD with a rating of  $9.2 \pm 1.3$  out of 10 [12]. Previous research has shown the beneficial effects sports dietitians on nutrition awareness and dietary habits of collegiate athletes. Hull (2016) reported improved dietary options and choices, such as access to post-workout nutrition options (60.5%), choosing chicken as their post-workout protein (62.5%), and being less likely (49% less) to consume fast food before practice or competition, were observed among athletes utilizing a sports dietitian compared to athletes who were not [11]. Valliant (2012) also showed the beneficial impacts of sports dietitian counseling sessions, including significantly improved ( $p = 0.001$ ) nutrition knowledge scores on a post- sports dietitian counseling sessions test, compared to their pre-test scores. These collegiate athletes also demonstrated significant ( $p < 0.05$ ) improvements in overall energy, carbohydrate, and protein intake [19].

The results of the final research question indicated that student-athletes are interested in learning about various sports nutrition-related topics from a CSSD. The most popular topics chosen by student-athletes included: 1) meal timing/ meal plan development; 2) making healthy choices; 3) basic SNK for training/competition; 4) nutrition guidelines; and 5) eating on the road. Fewer respondents were interested in topics such as the nutrition needs for individual medical conditions, such as diabetes. Similarly, Shapiro (2015) found the most common topics of interest were developing meal plans (82.1%), making healthy choices (68.7%), meal timing (61.9%), and eating on the road (61.9%), as compared to receiving counseling for medical needs (6.7%) [12]. Additionally, Trakman (2019), reported that the athletes were more interested in learning about sports nutrition (35%) and general healthy eating (33%) [17].

## SUMMARY

The SNK deficit that remains among collegiate student-athletes combined with the lack of adequate access to sports dietitians has resulted in their use of less credible sources of nutrition information, despite their belief in the importance of proper nutrition, awareness of the beneficial services of CSSDs, and their interest in further sports nutrition education and guidance from a CSSD. The results of this study indicate student-athletes, when provided with proper access, would utilize and benefit from a full-time CSSD, through a variety of services in which the CSSD holds expertise.

## CONCLUSION

Over the last decade, there has been an increase in awareness of nutrition for optimal athletic performance and overall health. This increase has introduced the creation of a board-certified specialist in sports dietetics (CSSD) position to athletic department staff, however, at present, the majority of universities still have not made the investment in a full-time CSSD. For this decision to be made, universities need evidence indicating the need for, and beneficial impact of, a CSSD as a member of the athletic staff. In an effort to provide this evidence, the present study assessed the current sports nutrition knowledge (SNK), as well as the attitudes toward nutrition for athletic performance, at one MAC University.

Based on the results of the SNK survey (i.e., correctly answering, on average,  $53\% \pm 14\%$  of the questions correctly), the student-athletes who participated in this study failed to demonstrate a passing score (i.e., equal to or greater than 70%), both overall and by construct, providing evidence of a lack of adequate SNK among student-athletes by gender, sport, year in college, and major type. Although neither male nor female student-athletes attained on average a passing score, the female athletes in this study demonstrated a significantly higher level of SNK than did the male athletes.

Interestingly, when SNK was assessed by major type, no difference in overall SNK scores were detected. However, in the hydration and electrolyte balance construct, non-health-related majors scored significantly higher than health-related majors. Despite this, neither group achieved a passing score in this construct. This finding was unexpected as one would assume health-related majors would have greater exposure to health and

nutrition-related topics throughout their course work than non-health-related majors. These results provide further evidence of a SNK deficit among all student-athletes, regardless of their area of study.

At the time of the study, the university where this study took place had a newly-hired, part-time CSSD on staff. While a small percent of subjects reported having had contact with a registered dietitian nutritionist (RDN), the majority of the student-athletes indicated they used other athletic department staff members, including their strength and conditioning coaches, athletic trainers, coaches, and the internet. This evidence, combined with the SNK deficit, indicates a part-time CSSD position is not able to provide adequate access and services to the student-athletes.

Positive findings from this study include the student-athletes' beliefs toward the role of nutrition and athletic performance and the potential role of a full-time CSSD at the collegiate setting. These results reflect the trend in increasing understanding of proper nutrition for optimal athletic performance, and the increasing presence of CSSDs at the collegiate level. Additionally, this indicates that the student-athletes acknowledged the beneficial role CSSDs play as the nutrition expert in this demanding field.

The student-athletes in this study identified a variety of nutrition-related topics they would like to learn more about from a CSSD. This wide range of nutrition-related topics, along with the student-athletes belief that access to a full-time CSSD would be "very beneficial," indicates the student-athletes would use a full-time CSSD for a variety of services. Based on the evidence presented and the fact that the CSSD is the only professional nutrition expert able to provide these requested services, hiring a full-time CSSD would appear to be a wise investment.

### Limitations of the study

Every study has limitations, and this study is no exception. Power analysis indicated  $238 \pm 4$  responses were needed to obtain results representative of the population, however only 127 participants completed the survey (32% response rate). Additionally, there was an unequal representation from each athletic team, making a comparison between sports difficult. Lastly, it is possible the student-athletes did not have an opportunity to interact with the part-time CSSD prior to taking the survey, as the CSSD at the particular university had been hired only six months prior to the survey.

### Recommendations for future research

To aid in support of the addition of a certified specialist in sports dietetics to the athletic department staff, further research is warranted. Based on the results of this study, suggestions for future research include distributing the survey to a broader student-athlete population, among various universities in the MAC and other conferences. Additionally, it is recommended that the results of a SNK survey be compared between universities with full-time CSSDs, part-time CSSDs, and no CSSDs on staff.

In summary, despite the increase in awareness of nutrition's role in athletic performance, a knowledge deficit remains among NCAA DI student-athletes at this MAC University. The student-athletes turn to easily accessible athletic department staff including strength and conditioning coaches, athletic trainers,

and coaches, along with the internet, to obtain sports nutrition information, potentially resulting in athletes obtaining inaccurate information or a lack of nutrition education. Student-athletes at this university have shown an interest in learning more about various nutrition-related topics, indicate they believe nutrition is very important, and feel a CSSD would be very beneficial to their athletic success. Understanding the nutrition needs of student-athletes and providing them with adequate nutrition services is critical, as a lack thereof may impede their ability to achieve optimal athletic performance, recovery, and overall health. Although further research is warranted in universities with a larger student-athlete population to assess for consistent findings with those of this study, the evidence is clear – student-athletes at this university are in need of a full-time CSSD on staff to improve their SNK and their nutrition-related eating behaviors, as they strive to improve their athletic performance.

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