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Differences in perceived energy and macronutrient requirements across divisions in NCAA athletes

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ABSTRACT

Background: Sports nutrition is an impactful component to sports performance. The purpose of the current study was to investigate the sports nutrition knowledge of National Collegiate Athletic Association collegiate athletes and assess self-reported perceived requirements for energy and macronutrient intake. A secondary aim was to evaluate the awareness of physical and emotional perceptions associated with mindful eating.

Methods: Participants included NCAA Division I (DI, $n = 45$), II (DII, $n = 31$), and III (DIII, $n = 47$) athletes. Athletes completed a validated questionnaire designed to assess sports nutrition knowledge and were asked questions about their perceived dietary energy and macronutrient requirements. Daily energy intake values were calculated using a recommended relative energy intake value of 40, 50, and 60 kcal/kg/day for low, moderate, and high activity levels, respectively. Carbohydrate recommendations were calculated using 4, 6, and 8 g/kg/day, protein recommendations were calculated using relative intakes of 1.4, 1.6, and 1.8 g/kg/day, and fat recommendations were calculated from a relative percentage of total predicted daily energy requirements, equating to 15, 25, and 30% of daily energy. Additionally, athletes completed a questionnaire to assess mindfulness regarding eating habits.

Results: Overall, athletes answered 45.5 ± 13.5% of questions correctly on the nutrition questionnaire with significant differences observed between male (48.6 ± 13.6%) and female athletes (43.6 ± 13.2%; $p = 0.044$), as well as significant differences observed between DI athlete scores (38.8 ± 14.1%) and DII athletes (47.7 ± 11.4%; $p = 0.002$), and DI athletes and DIII athletes (51.71 ± 11.83%; $p = <0.001$). All athletes significantly ($p < 0.001$) underestimated daily energy intake requirements (female, 2,112 ± 575 kcal/day; male, 3,283 ± 538 kcal/day). The mindfulness eating

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habits total score was significantly higher in male athletes (65.1 ± 6.5) compared to female athletes (60.9 ± 9.5; $p = 0.009$).
Conclusions: Division I, II, and III collegiate athletes have poor sports nutrition knowledge, with Division I athletes having exhibited lower scores compared to Division II and III athletes on the sports nutrition knowledge questionnaire. Athletes from all levels of collegiate sports underestimated their energy and macronutrient requirements. Differences in mindful eating habits among female and male athletes were also evident.

1. Introduction

It is well-known that adequate fueling strategies are crucial to support the physiological demands of training and optimize sports performance for athletes. [1–3] Appropriate energy intake supports optimal performance and recovery needs by ensuring appropriate intake of macronutrients and micronutrients. Managing energy intake can also assist with maintaining body mass or manipulating body composition. [4] Additionally, sufficient energy intake promotes muscle growth, and injury prevention, while playing a valuable role in the rehabilitation of injuries. [5] The nutritional needs of athletes are unique largely due to elevated activity levels, and greater amounts of lean body mass compared to the general population. [1] As a result, athletes tend to require higher amounts of energy, protein, fat, and carbohydrates in the diet.[1]

Despite the importance of nutrition for optimal performance, and increased energy requirement of athletes, previous research has indicated that collegiate athletes tend to overestimate their actual level of understanding regarding the fundamentals of nutrition. [6] In turn, this often predisposes them to inadequate fueling practices and failure to adhere to sport-specific nutritional guidelines. [7–9] Sports nutrition knowledge (SNK) involves the understanding of unique nutrition factors that have been established to support sport-related training, optimize performance, and facilitate recovery. [10] Recent studies have assessed collegiate athletes' nutrition knowledge and have identified several themes demonstrating a lack of understanding regarding important nutritional concepts for athletes. [3,11,12] Furthermore, athletes consistently do not adhere to sport-specific nutritional guidelines, [6,13,14] often exhibiting deficiencies in total energy, specific macronutrients, micronutrients, and fluids. [15–17] Moreover, athletes often seek sports nutrition advice from coaching and athletic staff who may not have the adequate knowledge or expertise themselves. [18] Previous research has indicated that athletes who have access to sports dietitians often exhibit more positive dietary habits and make healthier choices throughout the season. [19,20] Unfortunately, depending on the level of competition, universities may not have the financial resources to hire the required dietetics staff. [19,20] According to the Collegiate and Professional Sports Dietitians Association, only 103 sports dietitians work directly with athletes full time within the NCAA. [21] As a result, collegiate athletes are often not provided adequate nutrition support services to help them meet their unique dietary requirements, which may in turn jeopardize their performance, recovery, and health.

Although there is an increased awareness of poor SNK among collegiate athletes, NCAA Division I (DI) athletes have been the focus of interest, whereas

Division II (DII) and Division III (DIII) athletes have been overlooked, [10] despite there being far greater number of athletes competing at the DII and DIII levels. [22] DI athletes are often the beneficiaries of a variety of resources that provide nutritional support, while DII and DIII athletes have very few resources available to them comparatively. [10] **Additionally, previous research has found differing factors motivating athletes to participate in sports across divisions. DII institutions typically have a focus on athletes having a balance between athletic participation and academics, whereas DIII institutions have a student-first focus for those participating in sports**. [23] Due to the varying resources between NCAA Divisions, it stands to reason that SNK as well as the perceptions of sports nutrition an athlete has may vary between NCAA Divisions.

A psychological component associated with eating and one that plays a large role in increasing the awareness and knowledge of nutrition is mindfulness. [24] Mindfulness can be described as having the ability to pay attention to the activity at hand. [24] Therefore, mindful eating is the awareness of the process of eating. [24,25] Mindful eating involves perceiving senses, tastes, smells, and textures of food, acknowledging repetitive habits, and the understanding of what triggers the initiation and stopping of eating. [24] To our knowledge, it is currently unknown how mindful eating practices influence dietary habits in athletes or how nutrition knowledge is associated with varying degrees of mindfulness. Therefore, research examining these relationships, particularly among athletes, is warranted. The purpose of the current study was to investigate the SNK of NCAA collegiate athletes and assess self-reported perceived requirements for energy and macronutrient intake. A secondary aim was to evaluate the awareness of physical and emotional perceptions associated with mindful eating and identify how it may relate to SNK.

2. Methods

2.1. Study design

Collegiate athletes were recruited to participate in a cross-sectional, mixed-cohort study. Athletes completed an electronic validated SNK questionnaire [26,27], an internally developed questionnaire examining perceived dietary requirements, and a mindful eating questionnaire. The questionnaires were distributed using an online electronic survey tool (Qualtrics, Provo, UT, USA). Participants were recruited from DI, DII, and DIII universities by contacting the coaching staff associated with the athletic departments of each university. Reminders to distribute the study information were sent to the coaching staff over the course of six months. One hundred and ninety participants began the questionnaires; 123 participants completed the **Abridged Nutrition for Sport Knowledge Questionnaire (A-NSKQ)** portion, and 74 participants completed all questionnaires. Participants had the right to exit the survey at any time and all participants provided electronic consent using an institutionally approved consent prior to completing the surveys. [19] This study was approved by Coastal Carolina University Institutional Review Board (Protocol # IRB-2021.80) on 3 March 2021.

Table 1. Descriptive summary of demographics by sex.

	Males ($n = 46$)	Female ($n = 77$)
Age (yrs.)	21.0 ± 1.4	20.6 ± 1.2
Height (cm)	182.7 ± 8.2	166.6 ± 7.5
Body Mass (kg)	84.4 ± 17.6	65.3 ± 10.7
NCAA Division		
I	14 (30.4%)	31 (40.3%)
II	18 (39.1%)	13 (16.9%)
III	14 (30.4%)	33 (42.9%)
Previous Nutrition Course		
Yes	7 (15.2%)	14 (18.3%)
No	39 (84.8%)	63 (81.8%)
Team vs. Individual Sports		
Team Sports	26 (56.5%)	50 (64.9%)
Individual Sports	19 (41.3%)	26 (33.8%)
Unknown	1 (2.2%)	1 (1.3%)

Table 2. Descriptive summary of sports by sex.

Sport	Male ($n = 46$)	Female ($n = 77$)
Soccer	11 (23.91%)	11 (14.29%)
Dance	0 (0.00%)	13 (16.88%)
Cross Country	3 (6.52%)	4 (5.19%)
Track and Field	9 (19.57%)	1 (1.30%)
Football	4 (8.70%)	0 (0.00%)
Gymnastics	0 (0.00%)	7 (9.09%)
Track and Field/Cross Country	4 (8.70%)	8 (10.39%)
Swimming and Diving	2 (4.35%)	6 (7.79%)
Tennis	3 (6.52%)	1 (1.30%)
Lacrosse	0 (0.00%)	5 (6.49%)
Baseball	5 (10.87%)	0 (0.00%)
Field Hockey	0 (0.00%)	3 (3.90%)
Volleyball	3 (6.52%)	1 (1.30%)
Basketball	0 (0.00%)	5 (6.49%)
Softball	0 (0.00%)	8 (10.39%)
Ice Hockey	0 (0.00%)	3 (3.90%)
Golf	1 (2.17%)	0 (0.00%)
Unknown	1 (2.17%)	1 (1.30%)

Due to rounding error, percentages may not sum to 100%.

2.2. Participants

In the current study, 123 NCAA collegiate athletes (DI, $n = 45$ (female, $n = 31$; male, $n = 14$); DII, $n = 47$ (female, $n = 33$; male, $n = 14$); DIII, $n = 31$ (female, $n = 13$; male, $n = 18$)) participated (Table 1). All participants were 18 years or older participating in a sport at an NCAA institution. 16 sports were represented with track and field/cross country ($n = 29$) and soccer ($n = 22$) being the most common (Table 2). There were no exclusion criteria regarding whether the athlete was currently in-season or out of season, allowing for representation of both.

2.3. Procedures

2.3.1. Abridged nutrition for sport knowledge questionnaire

The A-NSKQ consists of 35 questions assessing general and sports nutrition knowledge. The scores are automatically calculated upon submission and are interpreted as "poor"

knowledge (0–49%), "average" knowledge (50–65%), "good" knowledge (66–75%), and "excellent" knowledge (75–100%) based on previously published methods. [28] Previous research has determined the A-NSKQ is an appropriate tool to assess SNK, with high construct validity ($p < 0.001$) and good test-retest reliability ($r = 0.8$, $p < 0.001$).[28]

2.3.2. Perceived dietary requirements questionnaire

To assess perceived energy and macronutrient intake, an internally developed questionnaire previously developed by Jagim et al. [1] was utilized. Athletes were asked to specify their perceived daily energy intake requirements based on their activity level, as well as their perceived energy intake for actual consumption. **(e.g. How many total calories do you think you need to eat per day in order to maintain your weight?, How many total calories do you think you actually eat per day?)** Participants were asked the same two questions regarding macronutrient intake. The responses were compared to calculated energy and macronutrient intake levels based on low, moderate, and high activity level recommendations provided by Kerksick et al. [29] as described previously by Jagim et al. [1]. Daily energy intake values were calculated using a recommended relative energy intake value of 40, 50, and 60 kcal/kg/day for low, moderate, and high activity levels, respectively. Carbohydrate recommendations were calculated using 4, 6, and 8 g/kg/day, protein recommendations were calculated using relative intakes of 1.4, 1.6, and 1.8 g/kg/day, and fat recommendations were calculated from a relative percentage of total predicted daily energy requirements, equating to 15, 25, and 30% of daily energy.[1]

2.3.3. Perception of barriers

Athletes were also asked to rank specific barriers (travel demands of the sport, financial restrictions, access to food, lack of knowledge and information on how to eat better, lack of energy/effort, and lack of time to grocery shop and prepare meals) that prevented them from eating healthy and meeting the nutritional requirements for their respective sport. These specific barriers are commonly seen as obstacles to eating healthy within this population. The athletes were instructed to rank each barrier using a 6-point Likert scale, with 1 being the biggest barrier and 6 being the least likely to be a barrier.

2.3.4. Mindful eating questionnaire

To assess student-athlete mindfulness regarding eating habits, the Mindfulness Eating Questionnaire (MEQ) was utilized. [25] The questionnaire consisted of five subscales divided into 28 questions scored on a Likert scale format (responses range from (0) not applicable to (4) always). The subscales were Disinhibition; Awareness; External cues; Emotional Responses; Distraction, and Total Score. Questions related to the Disinhibition subscale consisted of items such as: *"I stop eating when I am full even when eating something I love."* Questions related to the Awareness subscale is: *"Before I eat, I take a moment to appreciate the colors and smells of my food."* Questions related to the External Cues subscale: *"I recognize when food advertisements make me want to eat."* Questions related to the Emotional Responses subscale: *"When I am sad, I eat to feel better."* Questions related to the Distraction subscale: *"my thoughts tend to wander while I am eating."*

2.3.5. Statistical analysis

Participant demographic data are presented using descriptive statistics by sex. Independent Samples t-test were conducted to compare differences in SNK scores between male and female athletes and between those who had previously had a nutrition course and those who had not. All normally distributed data are presented as means ± standard deviations and all non-normally distributed data are presented as median ± interquartile range (IQR). The Shapiro-Wilk test was used to determine normality. An analysis of variance (ANOVA) was conducted to determine differences in SNK scores across NCAA Divisions.

To assess perceived energy and macronutrient intake compared to calculated energy and macronutrient intake levels based on low, moderate, and high activity level recommendations, paired samples t-tests were used. When the normality assumption was violated, Wilcoxon Signed Rank tests were used to assess differences between the non-normally distributed variables.

To assess school and sex differences in scores for the Mindfulness Eating Questionnaire, two MANOVAs were conducted. Division and sex were utilized as the independent variables, while the Mindfulness Eating Questionnaire subscales (i.e. Disinhibition; Awareness; External cues; Emotional Responses; Distraction and total score) were utilized as dependent variables. A Pearson correlation analysis was conducted to examine relationships between SNK and mindful eating. All data were analyzed using the Statistical Package for the Social Sciences (IBM SPSS Statistics Version 29.0: IBM Corp. Armonk, NY, USA).

3. Results

3.1. Participants

A total of 190 athletes initiated the survey and 123 completed the A-NSKQ portion. Athletes' physical characteristics are presented in Table 1. Athletes from 15 different sports were represented (men's sports = 9, women's sports = 12). Of the 123 respondents, 102 indicated that they had never taken a nutrition course.

Table 3. Comparison of SNK scores based on demographics.

Demographic	Mean Score (SD)	p-Value
Sex		0.044
Male	48.6 (13.6)	
Female	43.6 (13.2)	
NCAA Division		
I	38.8 (14.1)	
II	51.7 (11.8)	0.002
III	47.7 (11.4)	<0.001
Previous Nutrition Course		0.038
Yes	51.0 (14.7)	
No	44.3 (13.0)	
Team vs. Individual Sports		0.040
Team Sports	43.4 (12.9)	
Individual Sports	48.6 (14.2)	

3.2. Nutrition knowledge

Table 3 provides a summary of SNK scores across each sub-group. The average overall SNK score was 45.5 ± 13.5%, ranging from 11.4% to 77.1%, which is classified as "poor." Male athletes scored significantly higher (48.6 ± 13.6%) than female athletes (43.6 ± 13.2%; $p = 0.044$). DI athlete scores (38.8 ± 14.1%) were significantly lower ($p = 0.002$) than DII athletes (47.7 ± 11.4%), and significantly lower ($p < 0.001$) than DIII athletes (51.7 ± 11.8%). There was no significant difference between Division II and Division III athletes. Athletes who had previously taken a nutrition course (51.0 ± 14.7%) scored higher than those who had not (44.3 ± 13.0%; $p = 0.038$). Additionally, team sport athletes scored lower ($p = 0.040$) (43.4 ± 12.9%) than individual sport athletes (48.6 ± 14.2%) regarding SNK scores.

3.3. Perceived energy and macronutrient intake

All athletes significantly ($p < 0.001$) underestimated daily energy intake requirements (female, 2,112 ± 575 kcal/day; male, 3,283 ± 538 kcal/day) when compared with their estimated requirement, based on a "moderate" activity level (female, 3,210 ± 463 kcal/day; male, 4,328 ± 775 kcal/day) (Table 4). Additionally, female athletes significantly ($p < 0.001$) underestimated daily energy intake requirements (2,112 ± 575 kcal/day) when compared with their estimated requirement, using a "low" activity level (2,568 ± 370 kcal/day).

Female athletes perceived carbohydrate intake requirements (268 ± 365 g/day) to be significantly ($p < 0.001$) lower than their estimated requirement (389 ± 65 g/day), whereas male athletes' perceived carbohydrate intake requirements (459 ± 341 g/day) was significantly lower ($p = 0.011$) than their estimated requirement (685 ± 127 g/day), based upon a "high" activity level. There were no significant differences between perceived protein intake for female athletes compared with their estimated requirements. However, male athletes perceived protein intake (137 ± 97 g/day) was significantly ($p = 0.028$) lower than their estimated requirement (156 ± 29 g/day), based upon a "high" activity level. Perceived fat intake among female participants (204 ± 400 g/day) was significantly ($p < 0.001$) higher than their estimated requirement (41 ± 7 g/day), based upon

Table 4. Perceptions of energy and macronutrient intake.

Variable		Perceived Requirements	n	Perceived Intake	n
Total Energy (kcal/day)					
	Male	3,283 ± 538	23	3,109 ± 773	22
	Female	2,112 ± 575	43	2,034 ± 746	35
Total Carbohydrate (g/day)					
	Male	459 ± 341	21	451 ± 404	20
	Female	268 ± 365	32	295 ± 396	33
Total Protein (g/day)					
	Male	137 ± 97	22	125 ± 73	20
	Female	129 ± 177	35	99 ± 150	35
Total Fat (g/day)					
	Male	123 ± 164	21	115 ± 151	21
	Female	204 ± 400	32	154 ± 283	32

Data presented as mean ± SD.

a "low" activity level. There was no significant difference between perceived fat intake for male athletes compared with their estimated requirement.

3.4. Perceptions of barriers

A total of 74 (females, $n = 49$; males, $n = 25$) athletes completed the survey. Overall, lack of time to grocery shop and prepare meals (females, $n = 15$, 19.5%; males, $n = 7$, 15.2%) and lack of knowledge and information on how to eat better (females, $n = 13$, 16.9%; males, $n = 6$, 13.0%) were the two biggest barriers identified. Travel demands associated with sport (females, $n = 2$, 2.6%; males, $n = 0$, 0%) and access to food (females, $n = 7$, 9.1%; males, $n = 5$, 10.9%) were the least likely nutritional barriers identified.

3.5. Mindful eating

The MANOVA for the Mindfulness Eating Questionnaire and its subscales (Disinhibition; Awareness; External cues; Emotional Responses; Distraction and Total score) revealed no differences between NCAA Divisions ($p = 0.145$). However, the subitem of Awareness was trending toward significance ($p = 0.051$), in which DII athletes were more aware of the quantity and quality of foods while eating, compared to athletes at the DI and DIII levels (DI, 2.3 ± 3.5; DII, 2.6 ± 0.54; DIII, 2.47 ± 0.42).

Findings from the MANOVA revealed no significant difference between **sex** on the mindful eating habit subitems disinhibition ($p = 0.205$), awareness ($p = 0.193$), external cues ($p = 0.174$), and distraction ($p = 0.871$). However, results reached statistical significance for the emotional response subitem ($p = 0.001$) and total score ($p = 0.010$). Females scored higher in emotional response (female 1.95 ± 0.53; male 1.50 ± 0.68) and total score (female 2.30 ± 0.23; male 2.1 ± 3.8). The Pearson correlation revealed no significant correlations between SNK and mindful eating ($p = 0.976$).

4. Discussion

The primary aim of the current study was to examine the SNK of NCAA DI, DII, and DIII athletes The main finding from the current study indicates that collegiate athletes across all divisions have a poor level of sports nutrition knowledge. Further, while DI athletes typically have more resources compared to other divisions, DI athletes SNK scores were significantly lower than both DII and DIII athletes. Moreover, male athletes had significantly higher SNK scores compared to female athletes across all divisions. Athletes who had previously taken a nutrition course had significantly higher SNK compared to those who had not.

The overall average SNK score of 45.5%, typically described as poor in regard to SNK [28], is in alignment with previous studies evaluating the sport nutrition knowledge of collegiate athletes. [1,7,10,18,30,31] Jagim et al. [1] reported an average SNK of 48% among collegiate athletes utilizing the same survey. Additionally, in a recent study assessing sport nutrition knowledge and perceptions of dietary requirements within college athletes authors found an average SNK score of 47.98%. [32] A recent narrative review reveals athletes show a lack of knowledge related to micronutrients, fluid intake, supplement use, recovery

strategies, and weight management, however athletes typically score higher on topics related to dehydration and dietary sources of nutrients. [33] These discrepancies in SNK could lead to a misinterpretation of necessary energy and macronutrient requirements associated with athletes, leading to inadequate intake. Moreover, previous research has shown that those with adequate nutrition knowledge are more likely to meet nutrition recommendations.[34]

A secondary aim of the current study was to assess the perceived dietary requirements along and perceived actual intake for energy and macronutrients, respectively. In addition to the poor SNK observed within this population, the results of the current study indicate that both male and female athletes underestimated daily energy requirements by 3,283 ± 538 and 2,112 ± 575 kcals/day. Moreover, female athletes significantly underestimated carbohydrate intake requirements by 121 g/day and overestimated fat intake requirements by 163 g/day, whereas male athletes underestimated carbohydrate intake requirements by 226 g/day and protein intake requirements by 19 g/day at various activity levels. These findings are consistent with previous research that assessed athletes' perceptions of energy intake and found that athletes frequently underestimate their energy requirements [1,32] In a recent study, the authors reported that collegiate athletes underestimated their energy (−1284 ± 685 kcal/day) and carbohydrate (−178 ± 94 g/day) requirements when compared to their predicted needs and this underestimation was more substantial in female athletes who also underestimated their protein (- 31.4 ± 29.8 g/day) and fat (−27.9 ± 18.7 g/day) requirements. [1,7] These inconsistencies between knowledge and perception demonstrate that this population not only has poor SNK, but also has a poor perception of their dietary intake.

It is not uncommon for athletes to fall short of meeting nutritional recommendations for their sport. Previous research has indicated that lack of time, access to foods, cost of foods, and lack of knowledge are common barriers reported by athletes. [35–38] Athletes from the current study indicated that a lack of time to grocery shop and prepare meals, as well as have a lack of nutrition knowledge acting as large barriers preventing them from eating healthy and meeting the demands of their sport. Interestingly, athletes ranked travel demands and food access as the least likely barriers impacting their nutrition intake. Implementing a sport nutrition education program may improve SNK, which could bring awareness to the importance of nutrition and intake requirement, which may educate the athlete regarding food preparation strategies. Furthermore, an education program may increase mindfulness eating habits and improve overall dietary intake. [39] However, previous research has been mixed in terms of relationships between SNK and appropriate dietary intake. [1] This particular population may also experience several other barriers such as social influence, financial resources, stress, and body image. [30,38] Due to the limited research, further investigation into the barriers associated with dietary intake of the collegiate athletic population is warranted.

As a secondary aim, the current study evaluated the awareness of physical and emotional perceptions associated with eating. Results related to the mindful eating pattern revealed student-athletes from a DII university demonstrated more awareness regarding their eating patterns, psychological impacts in their habits, higher self-control, and knowledge about the different characteristics of food intake compared to DI and DIII athletes. No obvious reasons exist for this finding. It is plausible that having a professional who works directly with student-athletes from

this "smaller" school demonstrated to be a good resource to educate and offer different strategies to maximize their psychological relationship toward eating habits as has been demonstrated previously. [19] Conversely, schools that scored lower on awareness, may perceive the urge to add a professional to their athletics department to increase their knowledge to build more sustainable habits toward eating patterns.

Regarding the sex differences between the scores on mindful eating pattern, the present study revealed that females were significantly more mindful than males when comparing total scores. These findings are in agreement with previous work that has found female athletes experience a greater benefit of receiving a mindfulness program intervention, which led them to be more mindful and disciplined in relation to eating habits. [40,41] In addition, female athletes scored higher on emotional eating, which is in line with studies that has demonstrated females to be more susceptible to life demands and are more prone to utilize their eating habits as a potential defensive mechanism. [42] Importantly, even though female athletes were more susceptible to emotional response toward food, the combination of other categories of the mindful eating (Disinhibition; Awareness; External cues; Distraction) provided a more balanced approach to their nutrition and eating habits than males.

This study is not without limitations. The study consisted of a small sample size, with differences in sample size across each division. **The academic status of the participants is also unknown**. Moreover, not all participants completed the full questionnaire or did not appropriately answer a question, requiring the removal of their responses from the analysis. Assessing each athlete's total daily energy expenditure individually would have provided a more precise recommendation for each athlete, particularly considering the participation from both in-season and off-season athletes. Similarly, evaluating the actual dietary intake of the athletes would have provided better insight into the relationships between nutrition knowledge and adherence to sport-specific nutritional recommendations. **Additionally, including questions related to alcohol intake would be valuable, as this could make a large impact on their daily energy intake**. Therefore, it would be advantageous for future research to examine actual dietary intake of the athletes, individualize dietary recommendations, and focus on sports with similar training demands, potentially considering playing positions as well.

5. Conclusions

Athletes associated with all NCAA divisions have a low level of SNK, particularly DI athletes. It is recommended to implement sports nutrition education strategies into collegiate athlete's routines to ensure appropriate understanding of nutritional concepts and how to utilize this information and knowledge. Collegiate athletes across all Divisions underestimate their energy and macronutrient requirements. Additionally, it is important to gain an understanding of the relationship between SNK and dietary behavior among this population. Future research evaluating dietary behavior, specifically daily intake, and implementing sports nutrition education interventions are necessary to determine best practice on improving SNK, dietary behavior, and mindful eating habits for best performance and recovery in the athletic population.

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References

1. Jagim AR, Fields JB, Magee M, et al. The influence of sport nutrition knowledge on body composition and perceptions of dietary requirements in collegiate athletes. Nutrients. 2021;13(7):2239. doi: 10.3390/nu13072239
2. Dylan JK, Kaitlyn ME, Alan JW, et al. Assessment of sport nutrition knowledge, dietary practices, and sources of nutrition information in NCAA division iii collegiate athletes. Nutrients. 2021 Aug 01;13(2962):2962–2962. doi: 10.3390/nu13092962
3. Andrews A, Wojcik JR, Boyd JM, et al. Sports nutrition knowledge among mid-major division i university student-athletes. J Nutr Metab. 2016;2016:3172460. doi: 10.1155/2016/3172460
4. Thomas DT, Erdman KA, Burke LM. Position of the academy of nutrition and dietetics, dietitians of Canada, and the American college of sports medicine: nutrition and athletic performance. J Acad Nutr Diet. 2016;116(3):501–528. doi: 10.1016/j.jand.2015.12.006
5. Debnath M, Chatterjee S, Bandyopadhyay A, et al. Prediction of athletic performance through nutrition knowledge and practice: a cross-sectional study among young team athletes. Sport Mont. 2019;17(3):13–20. doi: 10.26773/smj.191012
6. Madrigal L, Wilson PB, Burnfield JM. Nutritional regrets and knowledge in national collegiate athletic association division i athletes: establishing a foundation for educational interventions. J Issues In Intercollegiate Athletics. 2016;9:1–16.
7. Jagim AR, Zabriskie H, Currier B, et al. Nutrient status and perceptions of energy and macronutrient intake in a group of collegiate female lacrosse athletes. J Int Soc Sports Nutr. 2019;16(1):1–7. doi: 10.1186/s12970-019-0314-7
8. Vázquez-Espino K, Rodas-Font G, Farran-Codina A. Sport nutrition knowledge, attitudes, sources of information, and dietary habits of sport-team athletes. Nutrients. 2022;14(7):1345–1345. doi: 10.3390/nu14071345
9. Shriver L, Betts N, Wollenberg G. Dietary intakes and eating habits of college athletes: are female college athletes following the current sports nutrition standards? J Am College Health. 2013;61(1):10–16. doi: 10.1080/07448481.2012.747526
10. Klein DJ, Eck KM, Walker AJ, et al. Assessment of sport nutrition knowledge, dietary practices, and sources of nutrition information in NCAA division iii collegiate athletes. Nutrients. 2021;13(9):2962–2962. doi: 10.3390/nu13092962
11. Webber K, Stoess AI, Forsythe H, et al. Diet quality of collegiate athletes. College Student J. 2015 Summer;49(2):251–256.
12. Spronk I, Heaney SE, Prvan T, et al. Relationship between general nutrition knowledge and dietary quality in elite athletes. Int J Sport Nutr Exerc Metab. 2015;25(3):243–251. doi: 10.1123/ijsnem.2014-0034

13. Zuniga KE, Downey DL, McCluskey R, et al. Need for and interest in a sports nutrition mobile device application among division i collegiate athletes. Int J Sport Nutr Exerc Metab. 2017;27 (1):43–49. doi: 10.1123/ijsnem.2015-0305
14. Karpinski CA, Milliner K. Assessing intentions to eat a healthful diet among national collegiate athletic association division ii collegiate athletes. J Athletic Training (Allen Press). 2016;51 (1):89–96. doi: 10.4085/1062-6050-51.2.06
15. Rockwell MS, Nickols-Richardson SM, Thye FW. Nutrition knowledge, opinions, and practices of coaches and athletic trainers at a division i university. Int J Sport Nutr Exerc Metab. 2001;11 (2):174–185. doi: 10.1123/ijsnem.11.2.174
16. Rash CL, Malinauskas BM, Duffrin MW, et al. Nutrition-related knowledge, attitude, and dietary intake of college track athletes. Sport J. 2008 Jan;11(1):48–54.
17. Abood DA, Black DR, Birnbaum RD. Nutrition education intervention for college female athletes. J Nutr Education & Behavior. 2004;36(3):135–139. doi: 10.1016/s1499-4046(06) 60150-4
18. Riviere AJ, Leach R, Mann H, et al. Nutrition knowledge of collegiate athletes in the United States and the impact of sports dietitians on related outcomes: a narrative review. Nutrients. 2021;13(6):1772–1772. doi: 10.3390/nu13061772
19. Hull MV, Jagim AR, Oliver JM, et al. Gender differences and access to a sports dietitian influence dietary habits of collegiate athletes. J Int Soc Sports Nutr. 2016;13(1):1–16. doi: 10.1186/s12970-016-0149-4
20. Hull MV, Neddo J, Jagim AR, et al. Availability of a sports dietitian may lead to improved performance and recovery of NCAA division i baseball athletes. J Int Soc Sports Nutr. 2017;14 (1):1–8. doi: 10.1186/s12970-017-0187-6
21. Full-time sports dietitians. [cited 2022 Apr 10]. Available from: https://sportsrd.org/career-development/full-time-sports-rds-working-with-%20usas-top-institutions/
22. Association NCA. Our division iii students. [cited 2024 Jan 4]. Available from: https://www.ncaa.org/sports/2021/5/11/our-division-iii-students.aspx
23. MaC W, Chen YA. Predictors of academic motivation: the role of career self-efficacy among NCAA division ii student-athletes. J Issues In Intercollegiate Athletics. 2019;12(1):19.
24. Khan Z, Zadeh ZF. Mindful eating and it's relationship with mental well-being. Procedia Soc Behav Sci. 2014 Dec 23;159:69–73. doi: 10.1016/j.sbspro.2014.12.330
25. Framson C, Kristal AR, Schenk JM, et al. Development and validation of the mindful eating questionnaire. J Am Diet Assoc. 2009 Aug;109(8):1439–1444. doi: 10.1016/j.jada.2009.05.006
26. Trakman GL, Forsyth A, Hoye R, et al. Development and validation of a brief general and sports nutrition knowledge questionnaire and assessment of athletes' nutrition knowledge. J Int Soc Sports Nutr. 2018;15(1):1–8. doi: 10.1186/s12970-018-0223-1
27. Gina Louise T, Freddy B, Adrienne F, et al. Modifications to the nutrition for sport knowledge questionnaire (nsqk) and abridged nutrition for sport knowledge questionnaire (anskq). J Int Soc Sports Nutr. 2019 Jun 01;16(1):1–3. doi: 10.1186/s12970-019-0293-8
28. Trakman GL, Forsyth A, Hoye R, et al. The nutrition for sport knowledge questionnaire (nskq): development and validation using classical test theory and rasch analysis. J Int Soc Sports Nutr. 2017;14(1):1–11. doi: 10.1186/s12970-017-0182-y
29. Kerksick CM, Wilborn CD, Roberts MD, et al. ISSN exercise & sports nutrition review update: research & recommendations. J Int Soc Sports Nutr. 2018 Aug 1;15(1):38. doi: 10.1186/s12970-018-0242-y
30. Meghan KM, Margaret TJ, Jennifer BF, et al. Body composition, energy availability, risk of eating disorder, and sport nutrition knowledge in young athletes. Nutrients. 2023 Mar 01;15 (1502):1502–1502. doi: 10.3390/nu15061502
31. Meghan KM, Brittanie LL, Hannah AZ, et al. Prevalence of low energy availability in collegiate women soccer athletes. JFMK. 2020 Dec 01;5(4):96–90. doi: 10.3390/jfmk5040096
32. Jagim A, Luedke J, Erickson J, et al. Sport nutrition knowledge and perceptions of dietary requirements among a diverse cohort of collegiate athletes. Med Sci Sports Exerc. 2021;53 (8S):273–274. doi: 10.1249/01.mss.0000762268.93478.76

33. Jagim AR, Fields J, Magee MK, et al. Contributing factors to low energy availability in female athletes: a narrative review of energy availability, training demands, nutrition barriers, body image, and disordered eating. Nutrients. 2022 Feb 25;14(5):986. doi: 10.3390/nu14050986
34. Werner E, Betz HH. Knowledge of physical activity and nutrition recommendations in college students. J Am College Health. 2020;70(2):340–346. doi: 10.1080/07448481.2020.1750412
35. Bentley MRN, Patterson LB, Mitchell N, et al. Athlete perspectives on the enablers and barriers to nutritional adherence in high-performance sport. Psychol Sport Exerc. 2021 Jan 01;52:101831. doi: 10.1016/j.psychsport.2020.101831
36. Brauman K, Achen R, Barnes JL. The five most significant barriers to healthy eating in collegiate student-athletes. J Am College Health. 2023;71(2):578–583. doi: 10.1080/07448481.2021.1899186
37. Heaney S, O'Connor H, Geraldine N, et al. Towards an understanding of the barriers to good nutrition for elite athletes. Int J Sports Sci Coaching. 2008;3(3):391–401. doi: 10.1260/174795408786238542
38. Andrew RJ, Jennifer F, Meghan KM, et al. Contributing factors to low energy availability in female athletes: a narrative review of energy availability, training demands, nutrition barriers, body image, and disordered eating. Nutrients. 2022 Feb 01;14(5):986–986. doi: 10.3390/nu14050986
39. Sánchez-Díaz S, Yanci J, Castillo D, et al. Effects of nutrition education interventions in team sport players. A systematic review. Nutrients. 2020;12(12):3664. doi: 10.3390/nu12123664
40. Kes D, Can Cicek S. Mindful eating, obesity, and risk of type 2 diabetes in university students: a cross-sectional study. Nurs Forum. 2021 Jul;56(3):483–489. doi: 10.1111/nuf.12561
41. Ersöz Alan B, Akdemir D, Cetin FC, et al. Mindful eating, body weight, and psychological well-being in adolescence. Child Obes. 2022 Jun;18(4):246–253. doi: 10.1089/chi.2021.0121
42. Chaplin TM, Hong K, Bergquist K, et al. Gender differences in response to emotional stress: an assessment across subjective, behavioral, and physiological domains and relations to alcohol craving. Alcohol Clin Exp Res. 2008 Jul;32(7):1242–1250. doi: 10.1111/j.1530-0277.2008.00679.x