

Differences Between Perceived and Recommended Nutritional Needs Among Three Division I Female Sports Teams

Original Research

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Abstract

Introduction: This study evaluated the discrepancy between perceived and recommended nutritional needs among NCAA Division I female athletes (soccer, softball, and volleyball). While proper nutrition is vital for performance, many athletes lack the knowledge to meet guidelines. This research specifically investigated whether these knowledge gaps vary by sport.

Methods: Fifty-six athletes completed surveys of their perceived daily requirements for total calories, protein, carbohydrates, and fats. Perceived needs were then compared against American College of Sports Medicine (ACSM) and the International Society of Sports Nutrition (ISSN) for low, medium, and high activity levels. Researchers calculated difference scores and utilized repeated measures ANOVAs to identify discrepancies based on sport and intensity.

Results: A significant main effect of activity level existed across all nutrients ($p < .001$, $\eta^2 p = 0.984$) showing that discrepancies between perceived and recommended intakes worsened as training intensity increased. While interactions between activity level and sport were significant for all metrics ($p < .001$), specific differences between soccer, softball, and volleyball were minimal. Follow-up tests for kilocalories and protein showed general sport effects at various activity levels, but Tukey-adjusted pairwise comparisons were not significant. For carbohydrates and fats, no sport-specific effects were detected. Essentially, athletes across all sports consistently struggled to accurately estimate their increasing nutritional demands.

Conclusions: Overall, the findings suggest a need for targeted nutrition education in sports where athletes tend to underestimate their dietary requirements.

Key Words: Nutritional knowledge, caloric recommendations, macronutrients.

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Introduction

Proper nutrition is a key component of athletic performance, recovery, and long-term health in collegiate athletes. Leading organizations such as the American College of Sports Medicine (ACSM) have published position stands backing the importance of adequate macronutrient and energy intake and their benefits on reducing injury risk, optimizing performance, and their promotion of recovery and physiological adaptations from training across the competitive season¹. In contrast,

inadequate dietary intake in combination with high energy expenditure in athletes can lead to nutrient deficiencies such as Relative Energy Deficiencies in Sport (RED-S) which represents a low energy balance, negatively affecting recovery, athletic performance, and other health metrics in young athletes². Even with the vast amount of established nutritional



information and guidelines available to these athletes, many do not meet the recommended dietary intakes, often due to inaccurate perceptions of dietary needs, misinformation, and limited nutritional knowledge.

Female athletes appear to be the most vulnerable to nutritional inadequacies in comparison to male athletes. Female athletes also commonly experience unique physiological demands in relation to hormonal regulation, bone mineral density, and reproductive health that are worsened by the consequences of low energy and nutrient intake. The interrelated effects on female athletes' menstrual function, metabolic health, and bone mineral density due to a chronic negative energy balance, is referred to as the Female Athlete Triad. A negative energy balance, defined as the difference between the number of calories an individual consumes and the energy expenditure of the individual, can lead to deleterious effects in athletic performance³.

Adequate intake of the macro and micronutrients is vital for female athletes to sustain the physiological demands of training and the competitive season. Some of the most common macronutrient energy and micronutrient disparities stem from protein, carbohydrates, iron, calcium, and vitamin D⁴. With carbohydrates serving as the primary fuel source for higher intensity exercise or sports activities, female athletes who under consume this macronutrient can experience severe sports performance decrements in cognitive function, coordination, and aerobic performance⁵. Additionally, female athletes experiencing a low energy availability (LEA) below 30 kcal/kg of carbohydrates were associated with increased risk of injury, reduced neuromuscular performance, and endocrine suppression⁵. With protein being the crucial macronutrient for muscle protein synthesis, immune function, and tissue repair, some researchers recommend intakes as high as 1.8-2.0 g/kg per day to avoid reductions in fat free mass (FFM) in high energy expenditure athletic populations⁶. Even with these known recommendations, female athletes still tend to fall below this metric with reported averages of 1.2-1.4 g/kg per day⁷. It is also well known the importance of dietary fat in the athlete's diet with its ability to meet caloric needs due to its gram to kilocalorie ratio in addition to fats' role in hormone regulation, production, and the absorption of the fat-soluble vitamins. In contrast to the other macronutrients, current data suggest female athletes consume dietary fat that falls within the ranges proposed by the popular sport nutrition organizations, with anywhere from 20-35% of daily calories coming from dietary fat⁸.

These frequent patterns of underconsumption of nutrients are often a result of restrictive or disordered eating, misconceptions surrounding sports nutrition, or social pressures to maintain lower levels of body fat distribution. Some of the reported underconsumption of the macronutrients falls outside the scope of clinically diagnosed eating disorders, further highlighting the role of misinformation concerning nutritional knowledge and energy requirements for the female athlete. This notion has been supported by researchers with data showing that less than 10% of collegiate athletes possess sufficient understanding of core nutritional principles concerning energy intake and fueling for sports performance¹. Therefore, when athletes possess a lack of nutritional knowledge, they heavily rely on their immediate support circle, such as coaches and trainers, for guidance but often these individuals cannot provide evidence-based, individualized plans, athlete's need which can result in compromised athletic performance⁹.

Macronutrient and energy requirements increase in a linear fashion with training intensity and volume. Similarly to previous notions, it is common for athletes to underestimate their own activity levels throughout their training blocks and competitive seasons, often causing them to inadvertently reduce their amount of macronutrient support required to meet these caloric expenditures. In most sports nutritional strategies, it is common for practitioners to utilize low, medium, and high activity levels to classify the various training intensities based on the number of calories an athlete or individual will need to consume based on their body mass in kilograms. Organizations such as the ISSN list activity ranges from 25-35 kcal/kg/day for low physical activity, and anywhere from 40-70 kcal/kg/day for moderate and high intensity activity levels¹⁰. Additionally, the ACSM lists low activity levels at or below 30 kcal/kg/day, with the optimal range for most moderate activities around 45 kcal/kg/day¹¹.

Due to limited research dealing with compared perceived and recommended energy and nutrient needs among female athletes, evaluating these differences is essential for identifying gaps in nutritional knowledge and informing targeted, sport-specific interventions. By calculating deviation scores for energy, carbohydrates, proteins, and fats, this study aims to clarify the extent of misalignment between established nutritional guidelines and recommendations and athlete perceptions. Understanding the discrepancies may help support the development of nutritional education strategies that could help optimize performance, well-being, and long-term health for female collegiate athletes. Therefore, the purpose of this study was to assess the differences between perceived and recommended nutritional needs in NCAA Division I female athletes across three sports: soccer, softball, and volleyball.

Methods

Participants were asked to complete one laboratory visit that was completed in the morning between 6-9 am, lasted no longer than 1 hour, and took place within 2 weeks of the start of the preseason training camp for each respective sport (i.e. soccer, softball, and volleyball). The visit consisted of two primary assessments, a body composition assessment via dual energy x-ray absorptiometry (DXA; Horizon Wi, Hologic, Bedford, MA, USA) followed by a survey regarding the athlete's nutritional perceptions. This survey assessed participants' perceptions regarding recommended daily intakes for their activity levels for total kilocalories (kcal), proteins (PRO), carbohydrates (CHO), and fats (F). These perceived needs were then compared to the guidelines derived from the American College of Sports Medicine (ACSM) and the International Society of Sports Nutrition (ISSN) recommendations for low, medium, and high levels of daily activity^{10, 11}.

Participants

Prior to the start of this study, institutional review board (IRB) approval was obtained from the participating institution (Protocol #24-203; date of approval 6/12/2024). Participants were recruited from the university's women's soccer, softball, and volleyball teams. In order to be considered eligible participants had to be a current athlete on the university's soccer, softball or volleyball teams and considered generally healthy (i.e. report no known disease or other condition that could be negatively affected by participating in the study). Potential participants were also considered ineligible if they met one of the following criteria: they had an amputation or physical deformity large enough that it would invalidate the body composition results obtained from the device, or had a meaningful amount of implanted metal (such as a full joint replacement), currently pregnant or trying to become pregnant, self-reported a history of an eating disorder during the initial screen. All screening procedures were completed at the start of the single laboratory visit. Upon agreeing to participate and being confirmed eligible, individuals provided their written informed consent before continuing with the measurement portion of the laboratory visit. To maintain confidentiality, each participant was assigned a unique, anonymous ID number for all subsequent data collection and analysis.

Protocol

Body Composition Assessment

Prior to the visit participants were asked to abstain from consuming any food and or fluids (dry fast) for 8 hours and abstain from all vigorous physical activity (anything greater than a brisk walk) for 12 hours. Compliance with these guidelines was verbally assessed upon the participant's arrival prior to beginning any assessment. Following the completion of enrollment procedures participants' body mass and height were measured via a calibrated digital scale (Seca 769, Hamburg, Germany) and stadiometer (HM200P, Charder Medical, Taichung City, Taiwan). The mass scale was calibrated on the morning of the laboratory visit. Body composition (BF%) was then assessed via DXA via methods previously employed by this laboratory. In short, throughout the test, participants were asked to lay prone on the exam table in clothing lacking metal (e.g. a sports bra and spandex shorts) with their arms by their sides and their legs straight. In order to aid the participants in maintaining a standardized position, custom positioning blocks were employed. Following the completion of the test, segments were manually adjusted per manufacturer guidelines and an NHANES correction was applied to the final BF%.

Nutritional Perceptions: Survey and Determination of Recommended Intakes

Following the successful body composition assessment, participants were escorted into a separate room to complete a survey for perceptions of nutritional needs. This survey asked them to complete questions regarding how much they believed they needed to intake in a day for their given activity level for kcal, PRO, CHO and F. The survey was administered through Qualtrics.

To determine recommended intakes, the participants' fasted body weights were multiplied by fixed factors representing low, medium, and high levels of activity (See Table 1). These factors were derived by integrating ACSM and ISSN position stand guidance as follows: (1) we extracted the ranges provided by each organization for each macronutrient, (2) prioritized the organization that provided the most activity-load-specific guidance, and (3) selected single representative values within the overlapping ranges, rounded to simple values for interpretability and scoring. Specifically, for CHO, we used ACSM's explicit training-load tiers (3–5, 5–7, and 6–10 g/kg/day for light, moderate, and high training loads) and selected 3, 6, and 9 g/kg/day as representative values consistent with ISSN's range of 5–12 g/kg/day. For PRO, both organizations recommend 1.2–2.0 g/kg/day; we selected 1.2, 1.6, and 2.0 g/kg/day to represent low, medium, and high activity levels. For F, we converted percentage-based recommendations to g/kg/day using conservative minimums from the sports nutrition literature (~0.5–1.0 g/kg/day). For energy, we operationalized targets using ACSM's energy availability framework (optimal ~45 and risk below ~30 kcal/kg/day) combined with

published NCAA/ISSN-informed survey values (40/50/60 kcal/kg/day), selecting 30, 45, and 60 kcal/kg/day for low, medium, and high activity tiers^{10, 11}. These derived values were confirmed with certified sports nutritionists (CISSNs) and registered dietitians actively advising athletes to ensure alignment with current practice.

Table 1. Values used to determine relative recommended intakes at the varying activity levels.

| | Low Activity | Medium Activity | High Activity |
|----------------------|--------------|-----------------|---------------|
| Energy (kcal/kg/day) | 30 | 45 | 60 |
| PRO (g/kg/day) | 1.2 | 1.6 | 2.0 |
| CHO (g/kg/day) | 3 | 6 | 9 |
| F (g/kg/day) | 0.5 | 0.75 | 1.0 |

Kcal: kilocalories; PRO: protein; CHO: carbohydrate; F: fat; g: grams; kg: kilogram.

Statistical Analysis

To control for differences in body size and associated intake recommendations, perceived intake values were converted to difference scores by subtracting the recommended intake from the perceived intake for each participant (perceived-recommended). For example, if an athlete perceived a requirement of 2000 kcal/day and the recommended intake was 2500 kcal/day, the resulting difference score was -500 kcal/day. This transformation was performed for energy (kcal), protein, carbohydrates, and fat at all activity levels. Negative scores represented an underestimation while positive scores represented an overestimation.

Difference scores were analyzed using a 3×3 repeated-measures analysis of variance (RMANOVA) with activity level (low, medium, high) as the within-subject factor and sport (soccer, volleyball, softball) as the between-subject factor. Although group sizes were unequal (soccer $n=23$, volleyball $n=19$, softball $n=14$) due to recruitment realities in this population, ANOVA has previously been reported to be robust to moderate imbalance and variance heterogeneity, particularly when coupled with effect size reporting to contextualize statistical power. To confirm robustness, key between-sport comparisons were additionally examined using Welch-type procedures that relax equal-variance and normality assumptions; these sensitivity analyses yielded the same overall interpretation as the standard ANOVA framework. We therefore retained the standard repeated-measures ANOVA approach for consistency and interpretability. When a significant activity level \times sport interaction was observed, follow-up one-way ANOVAs were conducted to compare sports within each activity level for the corresponding difference scores. If a significant effect of sport was detected in these follow-up analyses, Tukey-adjusted post hoc pairwise comparisons were used to control for multiple comparisons. Statistical significance was set at $p < .05$. Effect sizes are reported as partial eta squared (η^2_p). All analyses were performed in R (version 4.5) using the afex package.

Results

Participants

A total of 56 athletes (SO $n=23$, VB $n=19$, SB $n=14$) completed this investigation and were included in the final analysis. The sample included forty-eight participants (86%) who identified as Caucasian, four (7%; SO $n=1$, VB $n=1$, SB $n=2$) who identified as Hispanic or Latino, and four (7%; SO $n=1$, VB $n=3$, SB $n=0$) who identified as African American or Black. Academically, the group maintained a mean GPA of 3.5 on a 4.0 scale. A high percentage of the participants (98.5%) received financial support, with 44.9% receiving an academic scholarship, 10.1% receiving an athletic scholarship, and 43.5% receiving a combination of both. Full participant characteristics can be found in Table 2 below.

Kilocalories

A significant main effect of activity level was noted ($p < 0.001$, $\eta^2_p = 0.984$). However, this was overridden by an activity level by sport interaction ($p < 0.001$, $\eta^2_p = 0.177$). Notably, substantial intra-group variation was observed across all sports, particularly within the softball team (± 1640 kcal/day at low activity levels). This high degree of variance indicates a wide disparity in perceived needs within the same team. At the high activity level, follow-up one-way ANOVAs demonstrated a significant omnibus effect of sport on deviations from recommended energy intake ($F(2, 26.2) = 3.41$, $p = .048$). However, no individual between-sport comparisons reached statistical significance after Tukey correction, indicating that the overall effect was not driven by any single pairwise comparison.

Table 2. Participant Characteristics

| Sample | Age (yrs) | Height (cm) | Weight (kg) | BMI (kg/m ²) | BF% (%) | FFMI (kg/m ²) |
|-------------|------------|-------------|-------------|--------------------------|------------|---------------------------|
| Soccer | 19.1 ± 1.2 | 167.5 ± 4.7 | 63.3 ± 6.2 | 22.6 ± 1.8 | 31.9 ± 3.6 | 14.3 ± 0.9 |
| Volleyball | 19.8 ± 1.4 | 177.3 ± 9.5 | 72.0 ± 10.0 | 22.9 ± 2.3 | 33.2 ± 3.5 | 14.2 ± 1.1 |
| Softball | 19.9 ± 1.1 | 167.0 ± 4.7 | 70.3 ± 10.7 | 25.1 ± 3.2 | 34.3 ± 4.6 | 15.2 ± 1.1 |
| Full Sample | 19.6 ± 1.3 | 170.7 ± 8.2 | 68.0 ± 9.5 | 23.3 ± 2.6 | 33.0 ± 3.9 | 14.5 ± 2.6 |

Data is presented as mean ± standard deviation. Yrs: years; cm: centimeters; kg: kilograms; m: meters; BMI: body mass index; FFMI: fat free mass index from dual energy x-ray absorptiometry.

Protein

A significant main effect of activity level was noted ($p < 0.001$, $\eta^2p = 0.984$). Although, this was overridden by an activity level by sport interaction ($p < 0.001$, $\eta^2p = 0.180$). Similar to the kilocalorie data, protein perception difference scores displayed large variability (Softball low activity SD ± 405.7g; Soccer 124.0 g; Volleyball 62.2 g) suggesting the highly individualized nature regarding the lack of nutritional knowledge. Follow-up one-way ANOVAs demonstrated a significant omnibus effect of sport on deviations from recommended energy intake for all activity levels (Low: $F(2, 25.4) = 3.52$, $p = .045$; Med: $F(2, 25.4) = 3.80$, $p = .036$; High: $F(2, 25.4) = 4.09$, $p = .029$). However, similar to the kilocalorie findings, post hoc pairwise comparisons with a Tukey correction failed to detect any significant differences by sport for any activity level.

Carbohydrates

A significant main effect of activity level was noted ($p < 0.001$, $\eta^2p = 0.984$). Although, this was overridden by an activity level by sport interaction ($p < 0.001$, $\eta^2p = 0.177$). Consistent with other macronutrients, the softball group exhibited much larger variances (± 541 g) compared to soccer (± 216 g) and volleyball (264 g), further highlighting the heterogeneity in nutritional perceptions. Follow up one-way ANOVAs failed to detect an effect of sport on deviations from recommended nutrient intake for any activity level.

Fat

Activity level showed a significant main effect ($p < 0.001$, $\eta^2p = 0.984$). that differed by sport ($p < 0.001$, $\eta^2p = 0.174$). Dramatic variability was continued in this category with the softball group (± 241.4 g) approximately four to five times that of the volleyball (45.2 g) and soccer (± 56.5 g) groups. However, follow-up one-way ANOVAs did not identify sport-related differences in deviations from recommended nutrient intake at any activity level.

Differences between perceived and recommended intakes for varying activity levels can be found in Table 3 while absolute perceived and recommended intakes for varying activity levels are in Table 4.

Table 3. Differences between perceived and recommended intakes for varying activity levels among female Division I NCAA athletes.

| Nutritional Aspect | Activity Level | Soccer (n=23) | Volleyball (n=19) | Softball (n=14) | One-way ANOVA p-value |
|--------------------------------|----------------|---------------|-------------------|-----------------|-----------------------|
| <i>Kilocalories (kcal/day)</i> | Low | -247.5 ± 641 | -615.8 ± 865 | -704.0 ± 1640 | 0.256 |
| | Med | -1197.3 ± 652 | -1696.2 ± 887 | -1758.5 ± 1695 | 0.111 |
| | High | -2147.1 ± 677 | -2776.6 ± 932 | -2813.0 ± 1763 | 0.048* |
| <i>Protein (g)</i> | Low | 78.2 ± 124.0 | 8.0 ± 62.2 | 163.5 ± 405.7 | 0.045* |
| | Med | 52.8 ± 124.0 | -20.68 ± 62.2 | 135.57 ± 406.5 | 0.036* |
| | High | 27.61 ± 124.1 | -49.37 ± 62.3 | 107.64 ± 407.4 | 0.029 |
| <i>Carbohydrates (g)</i> | Low | 60.7 ± 216 | -4.16 ± 264 | 121.43 ± 541 | 0.604 |
| | Med | -128.9 ± 215 | -220.1 ± 270 | -89.3 ± 542 | 0.458 |
| | High | -318.9 ± 216 | -436.1 ± 279 | -300.1 ± 546 | 0.327 |
| <i>Fat (g)</i> | Low | 48.4 ± 56.5 | 26.32 ± 45.2 | 100.1 ± 241.4 | 0.254 |
| | Med | 32.52 ± 56.7 | 8.42 ± 45.3 | 82.64 ± 241.9 | 0.219 |
| | High | 16.9 ± 57.2 | -9.53 ± 45.4 | 65.2 ± 242.2 | 0.181 |

Data is presented as means ± standard deviation. Differences were calculated by perceived intake - recommended intake for each

nutritional aspect. A negative value represents perceived needs were below recommended and a positive value represents perceived needs were above recommended. G: grams; kcals: kilocalories; NCAA: National Collegiate Athletic Association. * indicates $p < 0.05$.

Table 4. Absolute perceived and recommended intakes for varying activity levels among female Division I NCAA athletes.

| Nutritional Aspect | Activity Level | Soccer (n=23) | Volleyball (n=19) | Softball (n=14) | Full Sample (n=56) |
|--------------------------------|----------------|----------------|-------------------|-----------------|--------------------|
| <i>Kilocalories (kcal/day)</i> | | | | | |
| | Perceived | 1652.2 ± 657.7 | 1545.0 ± 898.7 | 1405.0 ± 1573.5 | 1554.0 ± 1016.0 |
| | Low | 1899.7 ± 185.7 | 2160.8 ± 300.4 | 2109.0 ± 319.9 | 2040.6 ± 286.4 |
| | Med | 2849.5 ± 278.6 | 3241.2 ± 450.6 | 3163.5 ± 479.9 | 3060.9 ± 429.6 |
| | High | 3799.3 ± 371.5 | 4321.6 ± 600.7 | 4218.0 ± 639.9 | 4081.2 ± 572.8 |
| <i>Protein (g)</i> | | | | | |
| | Perceived | 154.2 ± 124 | 94.4 ± 64.6 | 248.3 ± 403.5 | 157.4 ± 222.4 |
| | Low | 76.0 ± 7.4 | 86.4 ± 12.0 | 84.4 ± 12.8 | 81.6 ± 11.5 |
| | Med | 101.3 ± 9.9 | 115.2 ± 16.0 | 112.5 ± 17.1 | 108.8 ± 15.3 |
| | High | 126.6 ± 12.4 | 144.1 ± 20.0 | 140.6 ± 21.3 | 136 ± 19.1 |
| <i>Carbohydrates (g)</i> | | | | | |
| | Perceived | 250.7 ± 218.2 | 211.8 ± 262.8 | 332.2 ± 541.3 | 257.9 ± 336.2 |
| | Low | 190.0 ± 18.6 | 216.1 ± 30.0 | 210.9 ± 32.0 | 204.1 ± 28.6 |
| | Med | 379.9 ± 37.1 | 432.2 ± 60.1 | 421.8 ± 64.0 | 408.1 ± 57.3 |
| | High | 569.9 ± 55.7 | 648.2 ± 90.1 | 632.7 ± 96.0 | 612.2 ± 85.9 |
| <i>Fat (g)</i> | | | | | |
| | Perceived | 80.2 ± 56.3 | 62.4 ± 46.0 | 135.4 ± 240.7 | 87.9 ± 128.4 |
| | Low | 31.7 ± 3.1 | 36.0 ± 5.0 | 35.1 ± 5.3 | 34.0 ± 4.8 |
| | Med | 47.5 ± 4.6 | 54.0 ± 7.5 | 52.7 ± 8.0 | 51.0 ± 7.2 |
| | High | 63.3 ± 6.2 | 72.0 ± 10.0 | 70.3 ± 10.7 | 68.0 ± 9.5 |

Data is presented as means ± standard deviation. G: grams; kcals: kilocalories; NCAA: National Collegiate Athletic Association.

Discussion

The purpose of this investigation was to assess the differences in perceived and recommended nutritional needs in NCAA Division I female athletes across three sports: soccer, softball, and volleyball. Findings indicate that the female athletes in this study demonstrated a significant discrepancy between perceived and recommended intake and a gap that widens drastically as physical activity increases. While these athletes demonstrated a moderate ability to estimate needs for low-activity days, they systematically failed to account for the increased energy demands of high-intensity training, placing them at potential risk for LEA and RED-S complications. These findings were consistent across all macronutrients, aligning with previous research concluding that athletes generally lack nutritional knowledge, while highlighting discrepancies between sports.

Consistent with previous literature, the observed underestimation of energy and macronutrient requirements aligns with documented gaps in sports nutrition knowledge within the collegiate athletic environment¹. Similar discrepancies between perceived training demands and actual energy needs have been identified as a primary contributor to LEA among female athletes¹², placing athletes at elevated risk for RED-S related health and performance consequences⁴.

A critical finding was the main effect of activity level on perceived caloric needs. As the physiological demands of the sports increased from low to high activity, the athletes' perception of their required intake remained relatively unchanged. At the "high" activity level, participants across all three sports underestimated their caloric needs by an average of over 2,000 kcal per day. This suggests that while these athletes may have a basic understanding of general nutrition for a sedentary or average lifestyle, they lack the specific knowledge required to scale their caloric intake for their unique performance demands. Without this knowledge, these athletes may operate in a severe caloric deficit, which is of great concern. It is well-documented that caloric deficit can impair recovery, increase injury risk, and disrupt hormone function in female athletes^{12,13,14}.

Results further illuminated a skewed perception of macronutrient needs. Carbohydrate requirements were consistently underestimated. Interestingly, protein and fat needs were more variably misconceived, with more adequate to

overestimations at lower activity levels. Despite carbohydrates being the primary fuel source for high-intensity glycolytic sports, participants consistently underestimate their needs, especially at higher activity levels, which may hinder their performance and recovery and drive the caloric deficit¹⁰. Conversely, protein recommendations were generally more accurate and were consistently overestimated by soccer, and especially softball athletes. This suggests a prioritization of protein for muscle recovery or body composition management over glycolytic fuel requirements for performance. Fat intake was almost exclusively overestimated, aside from a slight underestimation at high intensities by volleyball players. One possible explanation is that these athletes are adhering to a low carbohydrate high protein diet, which may be suboptimal for anaerobic sports performance^{14, 15}.

The substantial variability in athlete responses serves as a significant finding in itself. Despite a significant activity level x sport interaction, high intra-group variability, particularly within softball, prevented pairwise differences from reaching statistical significance. However, these large standard deviations, particularly within these softball athletes, (e.g., protein SD \pm 405.7 g at low activity) compared to soccer (\pm 124.0 g) and volleyball players (\pm 62.2 g), frame a critical narrative regarding team culture. Such extreme heterogeneity indicates the nutritional information is not systemic in a single direction (e.g., the whole team-undereating), rather it suggests a complete lack of standardized nutritional education within that specific team. Distinct trends in macronutrient prioritization were evident, with protein more accurately estimated as compared to fat or carbohydrate requirements. Furthermore, these sport-specific patterns may reflect different cultural or aesthetic norms across sports, particularly given the comparable body composition profiles observed across teams. Therefore, these findings underscore the potential role of sport-specific social and educational environments in shaping nutrition perceptions among female college athletes^{16, 17}.

It is important to note the limitations of this investigation. The sample was predominantly Caucasian (86%), which may limit the generalizability of these findings to more diverse athletic populations. Additionally, the large standard deviations, particularly in the softball group, indicate that nutrition knowledge is highly individualized. The investigation was also limited to Division I female athletes, with sample sizes limited to one university. Future research should examine the root cause of these misconceptions and include other female collegiate athletes to better generalize findings across the population.

Conclusions

Results demonstrate that female Division I athletes significantly underestimate the energy and carbohydrate requirements of high-intensity training. Nutrition education interventions must move beyond general “healthy eating” guidelines and focus specifically on periodized nutrition. Educational interventions should include a proactive approach where athletes are taught to recognize the signs of under fueling, such as persistent fatigue, sleep disruptions, menstrual disruptions, frequent illness, and slow healing. Recognition of these signs will help athletes get the support they need before their health or performance is affected. Furthermore, strategic interventions should extend to the education of coaching staffs and athletic trainers to guarantee they, too, understand the energy and carbohydrate demands of high-intensity training. This type of education and collaboration would go a long way in ensuring that training loads are synchronized with nutritional intake. By creating an environment where emphasis is placed on fueling just as much as recovery, and rest, this can mitigate the risk of RED-S and protect the long-term health of female athletes, allowing them to perform at their best while reducing the likelihood of illness or injury.

Conflict of Interest

The authors declare no conflicts of interest.

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