

A Potential Screening Tool for Nutritional Preparedness in Collegiate Level Female Athletes: A Pilot study

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ABSTRACT

Background: Diet monitoring is part of an athlete's health and performance assessment, and adequate nutrition is known to be a method that can positively influence the reduction in exercise-induced injury. However, the concept of nutritional preparedness as a screening tool to identify low energy availability for the competitive season is not mainstream practise. **Objectives:** Our pilot study investigated three aims: 1) changes to nutritional status from the pre-competition phase to the competition phase, 2) living status impact on athlete's food accessibility, and 3) whether nutritional preparedness in the pre-competition phase influenced the potential for low energy availability during the competition phase. **Methods:** Female volleyball athletes (N=21, 19-22 yrs., 80% lived off campus) were recruited from 3 universities (Ambrose, Calgary, New Brunswick- Saint John) through social media sites, and word of mouth. Two cross-sectional questionnaires (questions derived from the Short Food Frequency-Q, LEAF-Q, and RED-S screening tool-Q) were administered prior to and during the competitive season. **Results:** The nutritional assessment score significantly decreased from the pre-competition to competition phase, respectively (n=20, 26.11 ± 4.25 ; n=12, 20.64 ± 4.74 ; $p=0.022$). Many athletes (6/12) reported an injury during the competitive season with an average time loss from sport of 8-14 days. **Conclusions:** These findings suggest that collegiate female volleyball athletes have a potential for low energy availability, regardless of living status. Future research should build on the nutritional preparedness concept as a method of screening for low energy availability and the influence on injuries sustained during the competition phase.

Key words: Nutritional Status, Energy Deficiency, Female, Athletes, Volleyball

INTRODUCTION

The term Relative Energy Deficiency in Sport (RED-S) was developed in 2014 and defined as the dysfunction of a variety of physiological systems "caused by a relative energy deficiency" (Mountjoy et al., 2015). Low energy availability underpins RED-S and may occur because of an inadvertent failure to meet energy demands, i.e., high energy expenditure or inadequate energy intake, or a combination brought on by a rapid change in training or competition intensity (Jagim et al., 2022). RED-S has gained traction both in clinical practice and recent literature (Cabre et al., 2022), with an emphasis on low energy availability prior to symptom manifestation or injury occurrence (Melin et al., 2014; Wasserfurth et al., 2020). Although a more holistic approach to training has been recognized (Burke et al., 2018; Mujika et al., 2018; Stellingwerff et al., 2018; Ackerman et al., 2019), limited approaches exist to aid in the early detection of low energy availability from a pre-season perspective (Heikura et al., 2022).

Similar to training phases or blocks in a yearly periodization plan, there are different dietary phases that can be

identified within the competitive season (Bompa and Haff, 2009). Recently, the distinction between "competition nutrition" and "training nutrition," defined as the transition period between pre-competition and competition dietary status, has been acknowledged (Heikura et al., 2022). This "transition phase" may be an important precursor in the potential development of low energy availability in high-performance athletes that experience this rapid and intense shift in training intensity and volume (Close et al., 2016).

Low energy availability and RED-S are assessed primarily through self-report survey questionnaires. The LEAF-Q assesses physiological symptoms, gastrointestinal function, and menstrual function (Melin et al., 2014). The RED-S Specific Screening Tool (RST) investigates risk factors and symptoms of RED-S/low energy availability including activity levels (i.e., amount of physical activity per day) (Davelaar et al., 2020). These questionnaires, although not specifically designed to assess the impact of pre-competition nutritional status or nutritional preparedness, do have several questions that may be able

to address the “transition phase” (pre-competition and competition).

Changes to an athlete’s nutritional status can be defined as modifications to an athlete’s dietary habits from pre-competition to competition that result in the failure to obtain adequate energy for fuel or lead to a deficiency of various macro and micronutrients over time (Heaton et al., 2017). Identifiable changes to an athlete’s diet may occur from various underlying factors, including socioeconomic (SES) considerations. Specifically, at the collegiate level this change in diet may be influenced by no longer having parental oversight of meals and/or decreased access to high-quality foods due to budget constraints experienced when attending a post-secondary institution (Thomas et al., 2016). This complex intersection between physiological, psychological, and sociological components may cloud the potential association between nutrition status and low energy availability in post-secondary athletes. Nonetheless, whether the potential for low energy availability in athletes occurs due to a negative shift in energy demands or SES factors associated with post-secondary living circumstances, the inclusion of nutritional screening could act as an early warning system for professional nutritional intervention (Sesbreno et al., 2021; Brace et al., 2018; Slavina, 1991).

The presence of low energy availability can indicate a deficiency in both macronutrients (insufficient calories) and micronutrient intake (Munoz et al., 2020; Logue et al., 2020). Insufficient consumption of macronutrients for exercise, specifically carbohydrates, may be implicated in developing an energy deficit that increases injury risk while decreasing the ability to recover from injury, prolonging an athlete’s leave from competition (Munoz et al., 2020). Micronutrient deficiencies in folate, pantothenic acid, vitamins D, E and K, calcium, iron, and magnesium are exceedingly common among female athletes with low energy availability (Manore et al., 2007). A change in an athlete’s nutritional status (i.e., decreased energy intake levels with a strong consideration towards micronutrients) in the pre-competition phase could act as a proxy towards the potential for low energy availability (Heikura et al., 2022). Several factors contribute to an athlete’s low energy availability (Jagim et al., 2022), however the root cause of low energy availability is yet to be identified, as previously stated. Therefore, a need exists for further investigation into additional prevention and proactive treatment strategies, with nutritional preparedness being one (Jagim et al., 2022; Logue et al., 2018).

High-level volleyball athletes participate in 90-minute or more practices and matches that are characterized by frequent, explosive movements, indicating the necessity for a robust nutritional program to support these athletes in both the short term and long term (Sesbreno et al., 2021). Previously it has been identified that without such a program there is the potential for undesirable outcomes in relation to low energy availability (Anderson, 2010; Beals, 2002; Sesbreno et al., 2021). There are also sex-based differences in the metabolic response to exercise, which may be further magnified in female high-performance athletes (Tarnopolsky et al., 2001; Wohlgenuth et al., 2021). Not surprisingly, the sport

of volleyball is also known to result in injury occurrence patterns (Sole et al., 2017) and adequate nutrition intake is known to be a method that can positively influence the reduction in exercise-induced injury (Tipton 2015). Finally, participation in team-based sports at the collegiate level is impacted by unique timetable constraints such as the regulation of organized training throughout the academic year. Considering these constraints, coupled with the changes in living circumstances and no record of pre-season nutritional status, additional research specifically involving collegiate athletes’ nutritional preparedness is warranted. Therefore, our study investigated 3 aims in female collegiate level volleyball players: 1) changes to nutritional status from the pre-competition phase (pre-season) to the competition phase (in season), 2) living status impact on athlete’s food accessibility, and 3) whether nutritional preparedness in the pre-competition phase influences the potential for low energy availability during the competition season.

METHODS

Design and Participants

A cross-sectional study design was employed and two short questionnaires using the online Qualtrics platform (<https://www.qualtrics.com/>) accessed on a personal computer/laptop, tablet, or smartphone were administered, one prior to competition (pre-season) and one during competition (in season). Both questions included the following demographic data: year and month of birth, academic year enrolled in, (1st, 2nd, 3rd, 4th, 5th+), current year of athletic eligibility (1st, 2nd, 3rd, 4th, 5th), and living arrangements (off campus with family, off-campus alone, off-campus with roommate(s), or on-campus residence).

Participants were recruited through university social media sites, posters, and word of mouth. Twenty collegiate female volleyball athletes from 3 universities (Ambrose 5; Calgary 11; New Brunswick- Saint John 4) met the inclusion criteria of 18 years or older. Athletes who did not participate in regular season competition were excluded. Our sample size of 21 was based feasibility of recruitment and (Julious 2005) on similar studies investigating low energy availability in volleyball athletes, which ranged from 8-22, respectively (Anderson, 2010; Mielgo-Ayuso et al., 2015; Sesbreno et al., 2021). Athletes were provided with the details of the study and completed an informed consent prior to participation. Ethical approval was obtained from the Conjoint Health Research Ethics Board (REB22-1717), and the study adhered to the guidelines established by the Declaration of Helsinki.

Survey Measures

Nutrition status

The athletes’ nutritional status was assessed thru a series of questions aimed at evaluating dietary habits and energy intake between the pre-competition and competition phases. This was measured using an eight-point Likert scale modified from the Short Food Frequency Questionnaire (Mukher-

jee et al., 2021). Participants indicated the frequency of consumption associated with eight food groups (1= “never”, 2= “once per week”, 3= “twice per week”, 4= “three times per week”, 5= “four times per week”, 6= “five times per week”, 7= “six times per week”, 8= “seven or more times per week”). The sum of the scores from the eight food groups provided an indication of an athlete’s nutritional status and food accessibility. The score range was from 8 (minimum) to 64 (maximum) and an increasing score represented better nutritional status and higher food accessibility. The potential for low energy availability was therefore defined as a decrease in the nutritional status of an athlete from pre-competition phase (preseason) to the competition phase (in-season).

Injury

Four questions assessed injury (see Table 1) adapted from the two validated questionnaires (LEAF-Q; Female RED-S Screening Tool) (Sim & Burns, 2021).

Measured nutritional preparedness

Nutritional preparedness was assessed by seven piloted questions (see Table 2). Participants were asked if they consulted a healthcare professional regarding adequate nutritional preparation for competition (1=yes, 0=no). If yes, participants were asked to identify the type of practitioner (1=family doctor, 2=sports medicine doctor, 3=registered dietician (RD), 4=nutritionist, 5=physiotherapist, 6=other) and describe the nutrition advice they received from that practitioner. Participants were also asked if nutritional education was offered through their sport, where they find the bulk of their nutrition information and if they have ever been prescribed supplements.

Procedure

The surveys were available during the winter academic semester of 2023. The data was stored on the Qualtrics servers, exported in excel and stored on a password encrypted file on the University of Calgary’s servers.

Statistical Analysis

The questionnaires were matched based on participant’s ID (Month/YOB, Year of post-secondary education, and year of eligibility) between the pre-competition and competition surveys. All statistical analyses were completed using SPSS (SPSS V29; IBM Inc., Chicago, IL, USA) and the demographic data and nutritional preparedness scores were reported descriptively (mean, standard deviations (\pm)). Participants were grouped based on the sample mean for the nutrition assessment score. One-tailed, Paired T-Test was used to analyze and assess changes between pre-competition and competition dietary habits (i.e., nutrition assessment score change). A one-way ANOVA was used to identify differences in the nutrition assessment score based on living situations. Statistical significance was set at $p < 0.05$.

Table 1. Questions from the LEAF-Q and Female RED-S Screening tool (Sim & Burns, 2021)

LEAF-Q	
Q1. Have you had to take time off from your training, or participation in competitions during the last year due to injuries?	No, not at all (1) Yes, once or twice (2) Yes, three or four times (3) Yes, five times or more (4)
Q2. If yes, for how many days absence from training or participation in competition due to injuries have you had in the last year?	1-7 days (1) 8-14 days (2) 15-21 days (3) 22 days or more (4)
Q3. If yes, what kind of injuries have you had in the last year?	Open-ended
Female REDs Screening Tool	
Q4. Have you had a stress fracture at some point in your athletic career? (Example: didn’t happen while falling down, getting in an accident, accidentally running into someone or something)	Yes (1) No (2)

Table 2. Piloted nutritional preparedness questions (n=7)

Q1. Did you consult with a healthcare professional (i.e., Family doctor, nutritionist, registered dietician) about adequate nutritional preparation for competition?	Yes (1) No (2)
Q2. If yes, what kind of healthcare practitioner? Select all that apply.	Family doctor (1) Sports medicine doctor (2) Registered dietician (RD) (3) Nutritionist (4) Physiotherapist (5) Other (6)
Q3. If yes, what did they recommend that you do to ensure you are prepared to compete?	Open-ended
Q4. Where do you get the bulk of your nutrition information from? Select all that apply.	A medical professional (1) Online sources (2) Scholarly articles (3) Peers (4) Other (5)
Q5. Has nutritional education ever been offered to you through your sport?	Yes (1) No (2)
Q6. Have you been prescribed supplements?	Yes (1) No (2)
Q7. If yes, please specify the type and dose.	Open-ended

RESULTS

Twenty-one athletes completed the pre-competition survey with a mean age of 20.30 ± 1.08 yrs. (age range 19-22). The

majority were in their second year of post-secondary education (2.3 ± 1.03 yrs.) and their second year of collegiate sport eligibility (1.9 ± 0.64 yrs.). Most athletes (80%) lived off campus and 50% lived at home with their family (Table 3). One athlete was excluded from the nutritional status analysis due to incomplete responses. The response rate for the competition phase survey was 60% ($n=12$).

The mean nutritional assessment questionnaire score significantly decreased from the pre-competition to competition phase, respectively ($n=20$, 26.11 ± 4.25 ; $n=12$, 20.64 ± 4.74 ; $p=0.022$). Half of the participants (6/12) self-reported an injury during the competitive phase (i.e., hamstring strain, wrist sprain, neck injury, dislocated thumb, ankle roll, knee strain, patella issues, hamstring pulled, shoulder), and 25% (3/12) reported an average time loss of 8-14 days (Melin et al., 2014) (Table 4).

The nutritional preparedness assessment results found that 20% (4/20) of athletes reported consulting with a healthcare practitioner prior to the competitive phase. Within this group, two athletes reported speaking with a nutritionist, another with a nutritionist and family physician, and one with a weight coach. When asked to describe the nutritional information received from healthcare practitioners, the athletes self-reported that the advice centered around nutritional preparation prior to the day of competition (i.e., eat carbohydrates the night before a match, eat a big meal the night before or drink lots of water).

A little more than a third of the athletes 35% (7/20) self-reported being prescribed supplements (Table 5) and the most common supplements prescribed were Vitamin B12 and Iron. Additionally, 35% (7/20) of athletes reported receiving nutritional education through their sport, while 70% (14/20) used information from online sources.

DISCUSSION

Our study found that the nutritional status of collegiate-level female volleyball athletes decreased over the competitive phase when assessed using our survey questionnaire. While the concept of nutritional preparedness is relatively new, it is possible that this decline in nutritional status could be a consequence of inadequate nutritional preparation for the competitive season. These results are in alignment with several cross-sectional studies in both male and female elite volleyball athletes where a trend of underfeeding for sport was established (Mukherjee et al., 2021; Beals, 2002; Hassapidou, 2001; Mielgo-Ayuso et al., 2015).

Most participants reported limited consultation with a healthcare professional regarding their nutrition prior to the competitive phase. The recommendations offered by the health care practitioners focused only on the short term, such as fueling for the game the next day and hydration with no long-term considerations. Our athletes were also at the collegiate level and some research has shown that athletes at more elite levels (international or national) have higher nutrition knowledge and are more responsible in their food choices while prioritizing performance (Malsagova et al., 2021; Spendlove et al., 2011). Limited knowledge surrounding nutrition for sport performance likely contributed to

Table 3. Athlete demographics and living status ($N=21$)

Year of post-secondary education	<i>n</i> (%)
1 st	5 (25.0)
2 nd	7 (35.0)
3 rd	5 (25.0)
4 th	3 (15.0)
Year of eligibility	
1 st	5 (25.0)
2 nd	12 (60.0)
3 rd	3 (15.0)
Living Status	
Off-campus with family	11 (50.0)
Off-campus with roommates	5 (25.0)
Off-campus alone	1 (5.0)
On-campus residence	4 (20.0)

Table 4. Self-reported time loss from sport due to injury ($n=12$)

Duration	<i>n</i> (%)
1-7 days	1 (8.3)
8-14 days	3 (25.0)
15-21 days	1 (8.3)
22+days	1 (8.3)

Table 5. Self-reported prescribed supplement consumption ($n=7$)

Prescribed supplement	<i>n</i>
Multi-vitamin	1
Vitamin B12	3
Vitamin C	2
Vitamin D	1
Iron	3
Magnesium	1
Vitamin B6	1
Omega-3	1

the extremely low nutritional assessment scores that were measured both pre-competition and during competition, respectively (26.11 ± 4.25 ; 20.64 ± 4.74) when compared to a maximum achievable score of 64 (Mukherjee et al., 2021). The athletes' overall low nutritional status and decreasing trend from pre-competition to competition suggests improvement is needed regarding the translation of dietary information for adequate energy availability in female volleyball players.

Our study did not find an interaction between living status and nutritional status or food accessibility ($F(2, 9) = 0.264$, $p = 0.772$). This is consistent with other cross-sectional studies that concluded that regardless of living status, volleyball athletes lack adequate nutrition in both quantity and quality (Papadopoulou et al., 2002). While this finding can be defined as positive in that an inequitable impact of living

status on food accessibility was not found, we must not take this out of context, given the collective decline in the mean nutritional assessment score. This outcome further emphasizes the necessity for an external intervention (20% reported consultation with a health provider) to promote beneficial dietary habits during pre-season training for preparation for in-season training in this population of female volleyball players (Dijkstra et al., 2014).

This combination of inadequate nutritional preparation for competition, a declining nutritional status over the competitive phase and the lack of nutritional information and professional guidance to athletes may render them susceptible to insufficient energy availability. Also, self-reported injuries were considerable in our participants during the competitive phase. We can speculate that the reduction in nutritional status of these athletes may have influenced some aspects of the development of and or recovery period from these injuries.

Strengths and Limitations

This study adds to the limited literature on the transition period between pre-competition and competition dietary status. Also, employing a short questionnaire as a screening tool to identify energy deficiencies during this transition period could help avoid low energy availability during the competitive season. There are, however, limitations to a cross-sectional study design, as causality cannot be inferred given that the time sequence is unknown (Levin, 2006). As well dietary recall may have resulted in recall bias (Levin, 2006), however this was unlikely as only three months had passed between the start of the competitive season and the time of data collection. In future studies, it would be prudent to include an element of temporality when assessing dietary habits. Further research employing a more systematic approach to assessing nutritional status would allow trends in dietary habits to be recognized in real-time and associated with specific points throughout the competitive season.

CONCLUSIONS

In conclusion, these collegiate female volleyball athletes demonstrated a negative change in nutritional status from the pre-competition phase to the competition phase of their competitive season, regardless of their living status. This downward change in nutritional status as measured by questionnaires, if sustained, has the potential to result in low energy availability which is strongly associated with many health and performance consequences proposed by the RED-S models (Ackerman et al., 2019; Mountjoy et al., 2018). The need for a proactive prevention strategy (including nutrition education) focusing on athlete's dietary habits in the "transition phase" from preseason to in season should be further studied to build upon this concept of nutritional preparedness as a method of screening for potential low-energy availability and the impact this may have on injuries sustained during the competition phase.

Author Contributions

Author One and Author Two contributed to the conceptual design of the study. Author One wrote the first draft and performed the statistical analysis. Author Two wrote the second draft. Both authors contributed to the manuscript's revision and read and approved the submission.

REFERENCES

- Ackerman, K.E., Holtzman, B., Cooper, K.M., Flynn, E.F., Bruinvels, G., Tenforde, A.S., Popp, K.L., Simpkin A.J., Parziale, A.L. (2019, May). Low energy availability surrogates correlate with health and performance consequences of Relative Energy Deficiency in Sport. *British Journal of Sports Medicine*, 53(10):628-633. doi: 10.1136/bjsports-2017-098958.
- Anderson, D.E. (2010). The impact of feedback on dietary intake and body composition of college women volleyball players over a competitive season. *The Journal of Strength & Conditioning Research*, 24(8), 2220-2226. doi: 10.1519/JSC.0b013e3181def6b
- Beals, K.A. (2002). Eating behaviors, nutritional status, and menstrual function in elite female adolescent volleyball players. *Journal of the American Dietetic Association*, 102(9), 1293-1296.
- Bompa, T., & Haff, G. (2009). *Periodization theory and methodology of training* (5th ed.). Human Kinetics Champaign, IL: Kendall/Hunt Publishing Company.
- Brace, A.M., De Andrade, F.C., & Finkelstein, B. (2018). Assessing the effectiveness of nutrition interventions implemented among US college students to promote healthy behaviors: a systematic review. *Nutrition and Health*, 24(3), 171-181. doi: 10.1177/0260106018785528
- Burke L.M., Hawley J.A., Jeukendrup A., Morton J.P., Stellingwerff T., Maughan R.J. (2018). Toward a common understanding of diet-exercise strategies to manipulate fuel availability for training and competition preparation in endurance sport. *International Journal of Sport Nutrition, Exercise and Metabolism*, 8 451-463. doi: 10.1123/ijsnem.2018-0289
- Cabre, H.E., Moore, S.R., Smith-Ryan, A.E., & Hackney, A.C. (2022). Relative Energy Deficiency in Sport (RED-S): Scientific, Clinical, and Practical Implications for the Female Athlete. *Deutsche Zeitschrift für Sportmedizin/ German Journal of Sports Medicine*, 73(7), 225. doi: 10.5960/dzsm.2022.546
- Close, G.L., Hamilton, D.L., Philp, A., Burke, L.M., & Morton, J.P. (2016). New strategies in sport nutrition to increase exercise performance. *Free Radical Biology and Medicine*, 98, 144-158.
- Davelaar, C.M.F., Ostrom, M., Schulz, J., Trane, K., Wolkin, A., & Granger, J. (2020). Validation of an age-appropriate screening tool for Female Athlete Triad and Relative Energy Deficiency in Sport in young athletes. *Cureus*, 12(6):e8579. doi: 10.7759/cureus.8579
- De Souza, M.J., Koltun, K.J., & Williams, N.I. (2019). The role of energy availability in reproductive function in the female athlete triad and extension of its effects to

- men: an initial working model of a similar syndrome in male athletes. *Sports Medicine*, 49(Suppl 2), 125-137. doi: 10.1007/s40279-019-01217-3
- Dijkstra, H.P., Pollock, N., Chakraverty, R., & Alonso, J. (2014). Managing the health of the elite athlete: a new integrated performance health management and coaching model. *British Journal of Sports Medicine*, 48(7), 523-531. doi: 10.1136/bjsports-2013-093222
- Hassapidou, M. (2001). Dietary assessment of five male sports teams in Greece. *Nutrition & Food Science*, 31(1), 31-35. <https://doi.org/10.1108/00346650110362571>
- Heaton, L.E., Davis, J.K., Rawson, E.S., Nuccio, R.P., Witard, O.C., Stein, K.W., & Baker, L.B. (2017). Selected in-season nutritional strategies to enhance recovery for team sport athletes: a practical overview. *Sports Medicine*, 47, 2201-2218. doi: 10.1007/s40279-017-0759-2.
- Heikura, I.A., Stellingwerff, T., & Areta, J.L. (2022). Low energy availability in female athletes: From the lab to the field. *European Journal of Sport Science*, 22(5), 709-719. doi: 10.1080/17461391.2021.1915391.
- Jagim, A.R., Fields, J., Magee, M.K., Kerksick, C.M., & Jones, M.T. (2022). 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*, 14(5), 986. doi: 10.3390/nu14050986
- Julious, S.A. (2005). Sample size of 12 per group rule of thumb for a pilot study. *Pharmaceutical Statistics*, 4:287-91. <https://doi.org/10.1002/pst.185>
- Kobayashi, S., Asakura, K., Suga, H., & Sasaki, S. (2017). Living status and frequency of eating out-of-home foods in relation to nutritional adequacy in 4,017 Japanese female dietetic students aged 18-20 years: A multicenter cross-sectional study. *Journal of Epidemiology*, 27(6), 287-293. doi: 10.1016/j.je.2016.07.002.
- Levin, K.A. (2006). Study design III: Cross-sectional studies. *Evidence-Based Dentistry*, 7(1), 24-25.
- Logue, D., Madigan, S.M., Delahunt, E., Heinen, M., McDonnell, S.J., & Corish, C.A. (2018). Low energy availability in athletes: a review of prevalence, dietary patterns, physiological health, and sports performance. *Sports Medicine*, 48, 73-96. doi: 10.1007/s40279-017-0790-3.
- Manore, M.M., Kam, L.C., & Loucks, A.B. (2007). The female athlete triad: components, nutrition issues, and health consequences. *Journal of Sports Sciences*, 25(S1), S61-S71. doi: 10.1080/02640410701607320
- Malsagova, K.A., Kopylov, A.T., Sinitsyna, A.A., Stepanov, A.A., Izotov, A.A., Butkova, T.V., Chingin, K., Klyuchnikov, M.S., Kaysheva, A.L. (2021). Sports Nutrition: Diets, Selection Factors, Recommendations. *Nutrients*, 13, 3771. <https://doi.org/10.3390/nu13113771>
- Melin, A., Tornberg, Å.B., Skouby, S., Faber, J., Ritz, C., Sjödin, A., & Sundgot-Borgen, J. (2014). The LEAF- questionnaire: a screening tool for the identification of female athletes at risk for the female athlete triad. *British Journal of Sports Medicine*, 48(7), 540-545. doi: 10.1136/bjsports-2013-093240.
- Mielgo-Ayuso, J., Zourdos, M.C., Calleja-González, J., Urdampilleta, A., & Ostojic, S.M. (2015). Dietary intake habits and controlled training on body composition and strength in elite female volleyball players during the season. *Applied Physiology, Nutrition, and Metabolism*, 40(8), 827-834. doi: 10.1139/apnm-2015-0100
- Mountjoy, M., Sundgot-Borgen, J., Burke, L., Carter, S., Constantini, N., Lebrun, C., & Ackerman, K. (2015). The IOC relative energy deficiency in sport clinical assessment tool (RED-S CAT). *British Journal of Sports Medicine*. <http://dx.doi.org/10.1136/bjsports-2015-094873>
- Mountjoy, M., Sundgot-Borgen, J., Burke, L., Ackerman, K.E., Blauwet, C., Constantini, N., & Budgett, R. (2018). International Olympic Committee (IOC) consensus statement on relative energy deficiency in sport (RED-S): 2018 up-date. *International Journal of Sport Nutrition and Exercise Metabolism*, 28(4), 316-331. doi: <https://doi.org/10.1136/bjsports-2018-099193>
- Mujika I., Halson S., Burke L.M., Balague, G., Farrow D. (2018). An integrated, multifactorial approach to periodization for optimal performance in individual and team sports. *International Journal of Sport Physiology Performance*, 13 538-561. <https://doi.org/10.1123/ijspp.2018-0093>
- Mukherjee, M.S., Sukumaran, S., Delaney, C.L., & Miller, M.D. (2021). Validation of a short food frequency questionnaire to measure dietary intake of a selection of micronutrients in oncology patients undergoing systemic therapy. *Nutrients*, 13(12), 4557. doi: <https://doi.org/10.3390/nu13124557>.
- Munoz, N., Posthauer, M.E., Cereda, E., Schols, J. M., & Haesler, E. (2020). The role of nutrition for pressure injury prevention and healing: the 2019 international clinical practice guideline recommendations. *Advances in Skin & Wound Care*, 33(3), 123-136. doi: <https://doi.org/10.1097/01.ASW.0000653144.90739.ad>.
- Papadopoulou, S.K., Papadopoulou, S.D., & Gallos, G.K. (2002). Macro-and micro-nutrient intake of adolescent Greek female volleyball players. *International Journal of Sport Nutrition and Exercise Metabolism*, 12(1), 73-80. doi: <https://doi.org/10.1123/ijsnem.12.1.73>
- Sesbreno, E., Dziedzic, C.E., Sygo, J., Blondin, D P., Haman, F., Leclerc, S., & Mountjoy, M. (2021). Elite male volleyball players are at risk of insufficient energy and carbohydrate intake. *Nutrients*, 13(5), 1435. doi: <https://doi.org/10.3390/nu13051435>
- Sim, A., & Burns, S.F. (2021). questionnaires as measures for low energy availability and relative energy deficiency in sport (RED-S) in athletes. *Journal of Eating Disorders*, 9(1), 1-13. doi: <https://doi.org/10.1186/s40337-021-00396-7>.
- Slavin, J.L. (1991). Assessing athletes' nutritional status: Making it part of the sports medicine physical. *The Physician and Sportsmedicine*, 19(11), 79-94.
- Sole, C., Kavanaugh, A., & Stone, M. (2017). Injuries in Collegiate Women's Volleyball: A Four-Year Retrospective Analysis. *Sports*, 5(2), 26. <http://dx.doi.org/10.3390/sports5020026>

- Solly, H., Badenhorst, C.E., McCauley, M., Slater, G.J., Gifford, J.A., Eructi, B., Beck, K.L. (2023, May). Athlete Preferences for Nutrition Education: Development of and Findings from a Quantitative Survey. *Nutrients*, 15(11):2519. doi: <https://doi.org/10.3390/nu15112519>.
- Spendlove, J.K., Heaney, S.E., Gifford, J.A., Prvan, T., Denyer, G.S., O'Connor, H.T. (2011). Evaluation of general nutrition knowledge in elite Australian athletes. *British Journal of Nutrition*, 107, 1871–1880. doi: <https://doi.org/10.1017/S0007114511005125>
- Stellingwerff, T., Morton, J.P., Burke, L.M. (2019, Mar. 1). A Framework for Periodized Nutrition for Athletics. *International Journal of Sport Nutrition and Exercise Metabolism*, 29(2):141-151. doi: <https://doi.org/10.1123/ijsnem.2018-0305>.
- Tarnopolsky, M.A., Zawada, C., Richmond, L.B., Carter, S., Shearer, J., Graham, T., & Phillips, S.M. (2001). Gender differences in carbohydrate loading are related to energy intake. *Journal of Applied Physiology*, 91(1), 225-230. doi: <https://doi.org/10.1152/jap.2001.91.1.225>
- Thomas, D.T., Erdman, K.A., & Burke, L.M. (2016, Mar.). American College of Sports Medicine Joint Position Statement. Nutrition and Athletic Performance. *Medicine Science Sports and Exercise*, 48(3):543-68. doi: <https://doi.org/10.1249/MSS.0000000000000852>
- Tipton, K.D. (2015). Nutritional Support for Exercise-Induced Injuries. In *Sports Medicine* (Vol. 45, pp. 93–104). Springer International Publishing. <https://doi.org/10.1007/s40279-015-0398-4>
- Wasserfurth, P., Palmowski, J., Hahn, A. Krüger, K. (2020). Reasons for and Consequences of Low Energy Availability in Female and Male Athletes: Social Environment, Adaptations, and Prevention. *Sports Medicine – Open*, 6, 44. <https://doi.org/10.1186/s40798-020-00275-6>
- Wohlgemuth, K.J., Arieta, L.R., Brewer, G.J., Hoselton, A.L., Gould, L.M., & Smith-Ryan, A.E. (2021). Sex differences and considerations for female specific nutritional strategies: a narrative review. *Journal of the International Society of Sports Nutrition*, 18(1), 27. doi: <https://doi.org/10.1186/s12970-021-00422-8>.