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ENERGY AND MACRONUTRIENT RECOMMENDATIONS FOR FEMALE SOCCER ATHLETES: WHAT SPORT PRACTITIONERS MIGHT BE INTERESTED TO KNOW

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ABSTRACT

Female soccer sport is recently gaining popularity across the world. However, there remains little research on nutritional recommendations devoted to this group. This can pose a challenge for sports and health practitioners when conducting interventions in this group. A few authors suggested nutritional recommendations for energy and macronutrients close or similar to those used in males, usually around 7 – 12 g/kg/day for carbohydrates, 1.2 -1.7 g/kg/day for protein, 0.5 – 1 g/kg/day for fat and different resting energy expenditure formulas for energy. Still, these recommendations have not been made quite clear or at least emphasized for use amongst female soccer athletes, including the timing of these macronutrients before, during, and after training or competition. Noting the physiological and body composition differences between males and females, this review aims to explore available nutritional recommendations for female athletes so that they, coaches, and sports practitioners have a clear guide for adherence during training and intervention sessions.

Keywords: *Athletes, females, soccer, energy, macronutrients*

INTRODUCTION

Dietary practice is an essential component determining the athlete's overall performance during soccer training, competition, recovery, and overall health. The type of food, proportions of macronutrients, timing, and frequency all contribute to the athlete's body composition. Soccer is a popular sport among male athletes, and the latter have clear dietary guidelines to practice during their training or competition. Recently, participation has also gained popularity among the female population as well (Kirkendall, 2020; Emmonds et al., 2018). A few studies involving female groups focused more on anthropometric status and body composition (Kammoun et al., 2020; Booysen et al., 2019). However, there remains little research on energy and macronutrient guidelines for this group of athletes (Dobrowolski et al., 2020; Dobrowolski & Włodarek, 2019). Due to this encounter, sports practitioners, who are most of the time used as nutrition information sources by athletes (Turocy et al., 2011), may often apply available nutritional recommendations suggested for male soccer athletes to females (Emmonds et al., 2019). The latter can, at times, be disingenuous noting the general differences related to nutritional requirements and body composition among these two genders (Dobrowolski et al., 2020). To avoid concepts such as the 'low energy availability' among athletes (Magee et al., 2020), this paper attempts to explore these vague dietary aspects of sport in females to guide athletes, coaches, and sports practitioners towards improved nutritional practices and/or interventions during sports engagement.

Soccer as sport

Soccer is a competitive sport that demands a certain level of fitness, agility, and flexibility. A 90-minute competition can cover approximately 10 km encompassing various movements (such as jumping, jogging, sprinting, and tackling). To cover the required field distance during competition, nutritional demands are often drastically increased with the taxation of both aerobic and anaerobic systems of energy production. Failure to meet the required optimal nutritional demands, early fatigue, cramps, and perhaps fainting during competition is probable. The nutritional demands of athletes differ according to the activity required given the field position. On the other hand, the position of a soccer player will, furthermore, determine the body composition of the same athlete (Booysen et al., 2019). For instance, a goalkeeper has less movement in the field compared to a striker and middle fielder, and thus, their nutritional demands and body composition will vary. Nutritional recommendations in soccer have been well researched with more focus on nutritional recommendations for male athletes. One study by Leão et al. (2022) focusing on female soccer athletes applied general soccer recommendations for males. The latter study raises concerns around the differences known between males and females, for example, physiological and body fat composition differences (body fat percentages); males 10 – 22% and females 20 – 32% (Turocy et al., 2011). It is possible that the study by Leão et al., (2022) may have focused on the demands of soccer sport (duration of the match, field positions, and levels of professionalism) while overlooking these differences between the two genders. This potentially leads to compromised female soccer performance. There is, therefore, a need to tailor gender-specific nutritional requirements in soccer for optimal nutritional support, which will positively impact their sports performance, body composition, and overall health and well-being.

Energy

During soccer training or competition, energy expenditure is immensely increased, which can affect metabolic function and, ultimately, sports performance (Turocy et al., 2011). A carefully planned nutritional strategy that meets overall energy expenditure demands can optimize energy stores, reduce fatigue, support training, achieve and maintain optimal body mass, and promote rapid recovery (Caruana-Bonnici et al. 2019). Female soccer athletes are prone to suboptimal energy intakes due to the practice of restricting some macronutrients, for instance, CHO, in fear of gaining weight (McHaffie et al., 2022) posing a challenge for them to meet their daily energy requirements even during performance (Dobrowolski & Włodarek, 2019). The effects posed by low-energy diets (LED) on the physiological and metabolic functioning of the athlete can be found in detail elsewhere (Turocy et al., 2011). However, to alleviate these effects of LED in sport, several energy-estimating formulae are suggested for use in athletes. For instance, Mifflin-St. Jeor (MSJ) (Mifflin et al., 1990) and Harris-Benedict (HB) formula

[Female: BEE = 655.1 + (9.563 × weight in kg) + (1.850 × height in cm) - (4.676 × age)]

(Harris & Benedict, 1918), which take cognizance of anthropometric variables, age, and activity factor (Turocy et al., 2011). These formulas often underestimate requirements

particularly for athletes with more muscular tissues (Turocy et al., 2011). The HB formula seems to offer lower energy requirements for females than that of males possibly making it more suitable for male athletes (Jagim et al., 2018). On the other hand, the MSJ formula is suggested as suitable for use among obese individuals (Stubelj et al., 2020). Given these highlighted formula differences and physiological demands noted among these two genders; the Cunningham formula for resting metabolic rate (RMR)

$$[\text{RMR (kcal/day)} = 500 + 22 \times \text{fat-free mass (kg)}]$$

(Cunningham, 1991) is suggested for use alternative to HB and MSJ among the female athletes (Jagim et al., 2018). Still, this formula accounts for some anthropometric variables of athletes (weight), activity factor, and thermic effect of food to determine total energy requirements for athletes. Predictive equations are other methods of estimating energy requirements expressed per kilograms of body weight (kcal/kg). Although not gender-specific, several formulae are suggested for use in sports. For instance, Sale and Elliot-Sale (2019) recommend energy of above 30 kcal/kg, while the International Society of Sports Nutrition (ISSN) recommends 25 – 35 kcal/kg/day for soccer athletes who train more than five times a week (Kerksick et al., 2018). However, a slightly higher energy requirement of 47 – 60 kcal/kg for females is thought adequate to maintain balance during training or competition (Dobrowolski et al., 2020). When planning for nutritional requirements in sport, practitioners need to consider that predictive formula generalize nutritional requirements, while the Harris Bennedict is said to be closely accurate for males. This might possibly imply that the Cunningham formula might be a suitable formula to use for determining energy requirements in female athletes.

Carbohydrates

Carbohydrates (CHO) are crucial for optimal performance in soccer, as muscle glycogen is the predominant substrate for energy production during competition. However, CHO consumption among female athletes is often suboptimal (Dobrowolski & Włodarek, 2019) as they associate CHO intake with altered (mainly towards increased) body composition (McHaffie et al., 2022). This was also reported among female adolescent soccer athletes in Brazil (Noronha et al., 2020). In another study involving 41 Polish professional female soccer athletes, the CHO intake was reported suboptimal (Dobrowolski & Włodarek, 2019). Suboptimal CHO in sport can negatively affect performance, physical, technical, and cognitive parameters, which in turn reduce the capacity of training and performance, resulting in early fatigue (McHaffie et al., 2022). Fatigue is a common phenomenon often experienced by athletes during prolonged sessions of 90 minutes or more of submaximal to intermittent high-intensity activity (Caruana Bonnici et al., 2019). This phenomenon results as the skeletal muscles are depleted of glycogen, which also affects the central nervous system, and they both result in poor sports performance due to limited contraction of skeletal muscles (Caruana Bonnici et al., 2019). The ISSN recommends CHO of 8 – 10 g/kg/day, which must be distributed to cover the pre-, during, and post-match competition/training. A slightly lower end of the range of 7 – 10 g/kg/day was recommended by the National Athletics Trainers Association for moderate to high-intensity exercises lasting up to 1 – 3 hours (Turocy et al., 2011). The recommended

intake pre-match is 1 – 4 g/kg consumed 1 – 4 hours before kick-off (Dobrowolski et al., 2020; Kerksick et al., 2018). During the training or competition, 6 – 8 % of CHO in 150 – 200 ml solution every 15 – 20 minutes is recommended. Immediately after competition amount of 1 – 1.2 g/kg CHO should be consumed (Dobrowolski et al., 2020) within 30 minutes post-competition, then up to 3 – 4 thereafter (Kerksick et al., 2018).

Protein

Protein contains amino acids necessary for the synthesis of hormones and enzymes responsible for metabolism and other bodily activities (Wolfe, 2006). The metabolism of amino acids can also serve as an auxiliary fuel source during the intense prolonged phases of a soccer match (Hawley et al., 2006). Usually, when glycogen levels are suboptimal, this additional fuel source will contribute 3% of the overall energy required during soccer activity. Additionally, protein is essential for the changes that result from training (Stokes et al., 2018). The intake of a small amount (20 – 25 g) of high-quality protein that includes leucine, particularly after exercise, enhances protein synthesis, promotes the remodeling of both muscle tissue, and enhances endothelial renewal (Yang et al., 2018). In a study by Poulios et al. (2018), evidence is provided that protein consumption may be advantageous for eccentric and concentric lower limb muscle strength and high-speed running performance. Suboptimal protein intake (< 1.1 g/kg) was reported among female soccer athletes during the league involving 41 athletes (Dobrowolski & Włodarek, 2019). According to Burke et al. (2016), early CHO depletion may increase the use of protein as an energy source. There-fore, athletes should aim for a daily protein intake of 1.2 – 1.7 g/kg/day (Dobrowolski et al., 2020) to counteract these effects. A slightly higher recommendation of 1.4 – 2.0 g/kg/day is, however, made by the ISSN (Kerksick et al., 2018). The latter should be divided into 0.25 – 0.4 g/kg consumed 2 – 3 hours before training. Immediately after the training, 0.25 – 0.3 g/kg of high-quality protein consumed within 30 minutes, post-training is recommended (Kerksick et al., 2018).

Fat

Fat, also known as lipids, is a concentrated source of energy (Collins et al., 2021; Volek et al., 2015) necessary for several bodily functions, including the preservation of body heat, cushioning of vital organs, and the provision of valuable energy storage and supply (Caruana-Bonnici et al., 2019). The oxidation of fat to produce energy during performance is, however, dependent on the type of sport (Purdom et al., 2018). The macronutrient is necessary for low-intensity aerobic activities and for recovery from high-intensity exercises (Purdom et al., 2018). Fats provide energy for submaximal exercises and or sporting codes in the presence of CHO. However, as the exercise intensifies the contribution of fat towards total energy utilization reduces as the rate of fat dation is inversely related to CHO intake during the performance (Purdom et al., 2018). Fat is usually calculated based on the remaining amount of calories once protein and CHO are determined (Turocy et al., 2011). Therefore, Dobrowolski et al., (2020) recommend an intake of 20 – 30% of the total energy as fat to avoid a compromise between protein and CHO intake. The latter is equivalent to 0.5 – 1 g/kg/day recommendation when expressed relative to body mass (Kerksick et al., 2018). Table 1 summarises the energy and macronutrient recommendations for females in soccer.

Table 1. *Nutrient recommendations (Kerksick et al., 2018; Dobrowolski et al., 2020)*

Variable	Recommendation
Energy	RMR (kcal/day) = 500 + 22 × fat-free mass (kg)* 197–252 kJ (47 – 60 kcal)/kg/day
Protein	1.2–1.7 g/kg/day - High-quality protein
Pre-training amount Timing of intake	0.25–0.4 g/kg 2–3 hours before training or competition
Post-training Timing of intake	0.25–0.3 g/kg Within 30 minutes of post-training
CHO	7 – 12 g/kg/day - High glycaemic index
Pre-training amount Timing of intake	1–4 g/kg/day 1–4 hours before training or competition
During training	6–8% CHO in 150–200 ml as a solution every 15–20 minutes
Post-training Timing of intake	1–1.5 g/kg within 30 min. after training, and 3–4 hours thereafter.
Fat	Total 0.5–1 g/kg/day

**Cunningham, 1991*

CONCLUSION

The aim of this review was to highlight nutritional considerations to be made during engagements with female soccer athletes. We found that energy requirements, compared to macronutrients, generally differ given the physiological and body composition differences in males and females. Therefore, it is important for sports and health practitioners to make consultations with nutrition experts when developing nutrition support programs or meal plans. However, further intervention research in female athletes, particularly soccer, is warranted to address the diverse nutritional and training needs of this group.

Conflict of interest

The authors declare no conflict of interest for this review.

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