Nutritional Aspects of the Female Athlete

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KEYWORDS

• Energy • Macronutrients • Iron • Calcium • Vitamin D • Hydration
• Gastrointestinal (GI) • Supplements

KEY POINTS

- Female athletes report a lower energy availability (EA) than male athletes. Low EA, in turn, may affect menstrual cycle, injury risk, and performance.
- Female athletes may require individualized strategies for carbohydrate and protein timing with dosage based on hormonal fluctuations. However, current research advocates individualizing recommendations based on body weight, training intensity, and duration.
- Female athletes exhibit low levels of many of the essential micronutrients, suggesting that recommendation levels may be too low for active women.
- Although research implies that hormonal variations in women do not alter fluid or electrolyte needs enough to alter current recommendations, further research is needed.
- Other nutritional concerns, such as runner's gut, celiac disease, eating disorders, supplements, and the microbiome, all present intriguing areas of interest for additional research in female athletes.

NUTRITIONAL CONCERNS

Every athlete has specific needs based on his or her individual sex, size, sport, exercise intensity, duration of activity, phase of training, and even the season in which the sport is played. Nutritionally, the female athlete is unique in many ways, with needs that may vary based on hormonal fluctuations related to the menstrual cycle. This article provides an overview of the distinct nutritional needs and concerns of the physically active female, including energy availability (EA), macronutrient needs, micronutrient needs, hydration, supplements, and other nutritional issues, such as gastrointestinal (GI) issues, eating disorders, the microbiome, and celiac disease (CD). Although there is some research focusing specifically on the female athlete

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and her exceptional nutritional concerns, further gender-specific exploration is needed in all areas.

Energy Needs

Energy intake plays an important role for the female athlete. Although female athletes require less overall energy than male athletes, research shows that many come up short of their energy needs, putting them at higher risk for injury, menstrual dysfunction, and decreased performance. EA is the amount of energy available for the metabolic processes of the body after energy is used for exercise, and normalized for fat-free mass (FFM):

EA = Energy intake (EI) – Energy expenditure (EE) per kilogram of FFM[1]

The threshold for low EA has been defined as 30 kcal/kg FFM/d, but more research is needed to validate this number and its long-term implications.[2] The multiple causes of low EA include disordered eating, intentional but rational efforts to decrease body weight (BW) for sport, and the unintentional failure to meet energy requirements. Some issues, such as time management, food availability, and lack of nutritional knowledge, also may affect EA.[1] On the other hand, factors may increase energy *needs* above expected levels, making it more difficult for female athletes to meet their requirements: cold, fear, stress, heat, altitude, injuries, medications, and hormonal changes.[3]

Inadequate EI and nutrition may lead to decreased performance in addition to affecting growth and physiologic development in female athletes. A recent survey found that 45% of recreational female athletes were classified as "at risk" for low EA, with those in individual sports at a higher risk for low EA than those in team sports.[4] Koutedakis and Jamurtas[5] reported that female dancers consume less than 70% of recommended daily energy needs. A study of female soccer players also supports the theory that female athletes underfuel their bodies, with consumption of 500 fewer kilocalories than their estimated needs.[6] Almost twice as many adolescent female swimmers had insufficient EI compared with controls in a 3-year study assessing bone health.[7] The swimmers displayed negative bone density *z*-scores, likely attributed to inadequate energy and/or calcium intake. Conversely, Coutinho and colleagues[8] found that female athletes had a higher EI than the general recommendations by the Academy of Nutrition and Dietetics; however, these provided recommendations may have been inaccurate relative to the needs of athletes.

The effect of ovarian suppression on female athletes with low EA has been studied. Female swimmers exhibiting low EA with secondary ovarian suppression had impaired performance (decreased by 9.8%), whereas the females with cyclic menstrual function showed an 8.2% improvement in performance.[9] Total triiodothyronine (TT3) was 19% lower in ovarian-suppressed females and EA was 90% lower than their eumenorrheic counterparts. Performance also worsened if the energy deficit was not corrected. This was the first study of its kind.

Energy density (ED), defined as "…energy (kcal) per gram weight of food," affects EA.[10] A low-ED diet consists of a high volume of food with low energy content.[10] Consumption of a low-ED diet (ie, fruits, vegetables, high-fiber grains) enhances weight management and satiety, yet has been associated with problems such as exercise-associated menstrual dysfunction (ExMD) and low EA relative to EI.[10] Recent research shows that 44% of female athletes with ExMD who consumed a low-ED diet failed to meet the energy demands of their sport.[10] Reed and colleagues[11] also reported that active females with ExMD exhibited lower ED diets than those with regular menstrual cycles. In addition, subjects also had lower resting EE, EI, and consumed more