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Guest Editorial

Importance of Low Energy Availability for Athletes

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Low Energy Availability (LEA), which forms the basis of the RED-S concept, is the imbalance between the athlete's energy intake and energy expenditure. The expression of energy availability (EA) with the formula is as follows [1].

Operationally, energy availability (EA) is defined as: Energy Availability (EA) = Energy Intake (EI) (kcal) - Exercise Energy Expenditure (EEE) (kcal)/Fat Free Mass (FFM) (kg).

Energy availability (EA) is the energy expenditure required for all biological functions after the energy consumed for exercise is subtracted from the energy taken. The concept of LEA was defined for the first time in 2007 as a component of the female athlete triad with low bone mineral density and menstrual problems. The EA calculated by subtracting the energy expenditure required for exercise from the total dietary energy is considered to be the most appropriate value if the EA is > 45 kcal/kg lean body mass. Having an EA < 30 kcal/kg of lean tissue mass is associated with health problems such as stress fractures, low bone mineral density, menstrual disfunction, hormonal changes and an increased risk of suppression in the immune system. Athletes with an estimated energy availability of < 45 kcal/kg of lean tissue should be evaluated more seriously in terms of potential energy and nutrient deficiency and should be informed about the importance of meeting their energy needs [1-3].

Although there are many reasons, the imbalance between energy intake and exercise energy may be one of the main causes of LEA in athletes (Figure 1). Low or insufficient EA in athletes; It can be seen for reasons such as irregular nutrition, energy limitation, excessive fiber intake, cultural beliefs, financial inadequacy, not being able to spare time for nutrition (such as skipping breakfast) [1,4]. LEA raises concerns about sports performance and may increase the risk of nutritional deficiencies, including energy, carbohydrates, protein, essential fatty acids and certain nutrients (B vitamins, vitamin D, folic acid, calcium and iron).

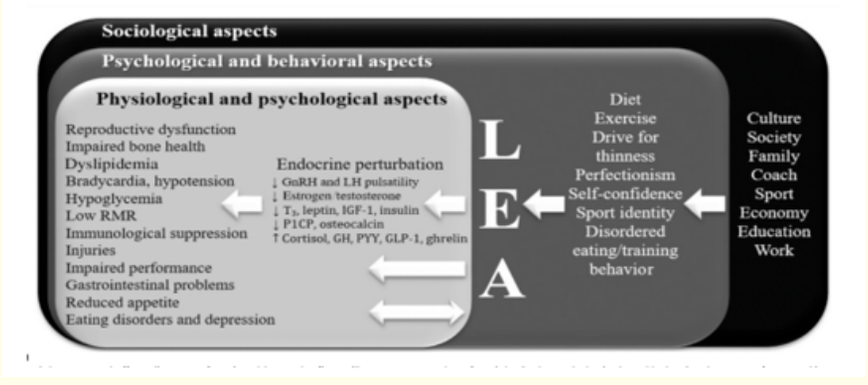

Figure 1: *Potential causes and mechanism of action of LEA in athletes [4].*

Athletes with low EA meet their macronutrient requirements with lower values of the targeted range. Athletes with low energy availability who don't get enough carbohydrates or high-quality protein have trouble with glycogen and muscle protein synthesis and bone

remodeling. Other concerns; increased inflammation, oxidative stress, insufficient intake of docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), which affect musculoskeletal health and intestinal calcium absorption. Therefore, both the amount and quality of macronutrient intakes are important for the health and performance of athletes [2].

Health effects of low energy availability

Initially, LEA leads to a negative energy balance and hence body weight loss because the body's energy reserves (e.g. adipose tissue and body proteins) contribute significantly to its fuel needs. However, long-term LEA in turn causes a number of metabolic and physiological adaptations. To prevent further weight loss, the body creates a stable equilibrium state by reducing total energy expenditure (lowering basal metabolic rate). This stable balance continues for a while [4]. However, the continuation of this situation begins to create some differences in body systems.

Endocrine system: The effects of LEA on the endocrine system have been described primarily in female athletes and more recently in male athletes; In female athletes, changes in thyroid function and appetite-regulating hormones (for example, decreased leptin and oxytocin, increased ghrelin, peptide YY and adiponectin), decreased insulin and insulin-like growth factor 1 (IGF-1), and increased cortisol have been described. Most of these are hormonal changes that occur in order to save more energy. Specific changes in men are not well understood; however, some studies have found a decrease in testosterone [1].

Menstrual function: The effects of LEA on reproductive hormones and menstrual function in female athletes have been described. However, the complex hormonal signaling pathways and effects that support them are still not fully elucidated. Current evidence concerns changes in the release of Gonadotropin-Releasing Hormone (GnRH) from the hypothalamus, followed by LH and FSH, and a decrease in estradiol and progesterone in relation to LEA. This situation paves the way for the formation of amenorrhea [1].

Bone health: It has been determined that LEA has a negative contribution to the deterioration of bone health in athletes, especially in women. It has been shown that LEA negatively affects bone prospectively. Both men and women who are involved in sports such as horse riding, marathon, swimming and cycling are at risk in terms of bone density. However, the risk of low bone mineral density increases in those with BMI ≤ 17.5 kg/m^2 or 10% weight loss in one month, which are important indicators of LEA. Low energy intake/eating disorder and menstrual disfunction are associated with low bone mineral density [1].

Metabolic changes: LEA results in a decrease in basal metabolic rate. In a study, it was determined that there was a decrease in BMR after a while in rowers of both genders whose energy expenditure was increased without changing their energy intake. It was determined that there was a decrease in BMR in those with moderate energy deficiency, and significant decreases in leptin, T3, IGF-1 and an increase in ghrelin in those with severe energy deficiency.

Hematological changes: Low ferritin and iron deficiency anemia are more important for women who lose iron with menstruation and have LEA. A decrease in iron level causes a decrease in the oxygen carrying capacity of the blood and a decrease in aerobic capacity [1].

Gastrointestinal: In the case of severe LEA such as anorexia nervosa, there are also adverse effects on the gastrointestinal tract; It has been determined that problems such as delayed gastric emptying, constipation and increased intestinal transit time are experienced.

Immunological: In the studies, it was determined that the immune system was weakened, the secretion of immunoglobulin A decreased, and the risk of disease increased (respiratory tract, gastrointestinal) in athletes with LEA.

Psychological: LEA in athletes is associated with various aspects of psychology. The desire to be thin results in lower energy intake. It has been determined that restrictive dietary behaviors are associated with mood disorders in both men and women.

Sports performance: It has been determined that there is an increased risk of injury, iron deficiency, mood disorder, decrease in glycogen storage and protein synthesis, low neuromuscular performance, high cortisol levels and low blood sugar, decrease in T3, estrogen level and lean mass [1].

Eating disorder: Eating disorders are part of the female athlete triad. The participation of women in sports is increasing day by day. In addition to the physiological changes created by sports, environmental pressures on body composition and appearance in terms of success and winning cause changes in nutritional behaviors and adversely affect the health of the athlete. It not only affects the performance of the athlete, but also has risks on health in the long run [1]. Although the risk of eating disorders in women is higher than in men, it has increased in recent years [5].

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