Female Athlete Triad

Low Energy Availability, Menstrual Dysfunction, Altered Bone Mineral Density

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KEYWORDS

• Female athlete triad • Anorexia • Amenorrhea • Osteoporosis

KEY POINTS

- The female athlete triad (FAT) consists of 3 components: low energy availability, menstrual dysfunction, and decreased bone mineral density.
- Those most at risk include those involved in esthetically pleasing sports that emphasize low body weight.
- Restricting calories, whether purposeful or unintentional, causes the body to conserve energy by altering metabolism and neuroendocrine pathways.
- Because of the many possible factors that contribute to low energy availability, treatment of individuals presenting with 1 or more of the components of the FAT may require intervention of a multidisciplinary team.
- Education on appropriate nutrition and calorie consumption for female athletes is a key component of prevention because low energy availability is the primary driving factor of the triad.

INTRODUCTION

Female participation in sports is often associated with many physiologic, sociologic, and psychological benefits. However, the development of the female athlete triad (FAT) may have an alarming effect on the overall health and development of physically

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active women, which extends beyond their level of performance on the field. The FAT consists of 3 distinct interrelated conditions: low energy availability, menstrual dysfunction, and altered bone mineral density (BMD).[1–10] The components of the FAT should be viewed on a spectrum varying from normal function to dysfunction. This spectrum allows for a broader and less rigid view of presenting symptoms that makes for an easier diagnosis and earlier treatment plan. The 3 components can occur on a sliding scale that may occur at different rates in accordance with the athlete's diet and exercise habits.[7,9]

EPIDEMIOLOGY

The FAT is most commonly seen in female athletes competing in sports or activities that emphasize low body weight. Gymnastics, cross-country running, ballet dancing, figure skating, and swimming are a few examples, with gymnastics being the most common. Often, athletes are under intense stress to maintain a lean body mass to better enhance their athletic performance.[1,5,6,9,10] However, in doing so, female athletes may find themselves performing below their peak level because of the associated conditions that play a part in the FAT. It is often manifested under specific conditions; the high desire to improve athletic performance, a win-at-all-costs mentality, and coach/parents' negligence in adequately recognizing the signs that make up the FAT.[9]

CAUSE

A study published in the *Medicine & Science in Sports & Exercise* reported that the prevalence of 2 components of the triad was between 3% and 27% and the expression of any single component was 16% to 60%, indicating that most athletes only present with 1 or 2 of the 3 components of the triad.[4,7,10,11] Another study received from the *Archives of Pediatric and Adolescent Medicine* revealed that, out of 170 high school female athletes, 18.3% met the criteria for disordered eating, 23.5% for menstrual irregularity, and 21.8% for low bone mass. However, of these athletes, only 5.9% presented with 2 components and 1.2% presented with all 3.[12]

Low Energy Availability

Exercising extreme weight control for the sake of performance and aesthetic purposes is a common feature in physically active women. Energy availability is expressed as the total dietary energy in calories (calories in) minus the total exercise energy expended (calories out), or the amount of energy that remains in the body that is available for sports performance.[4,7,9] Low energy availability is considered to be the driving force and cornerstone of the triad and may be the result of either decreased caloric intake or increased output.[4,7,9,10] In any case in which an athlete intensifies her workload during training, she also needs to increase her caloric intake as well to protect against any energy imbalance.[4,7,10]

In the short term, an athlete may have decreased strength, power, and stamina caused by an energy deficiency from failure to maintain proper food fueling with carbohydrates and protein intake or inadequate stores.[7,10] In a study published in the *Journal of Sports Science* involving female collegiate soccer players (a sport usually not associated with disordered eating), up to one-third of the team displayed low energy availability (<30 kcal/kg) over the course of the season.[13]

Low energy availability is not synonymous with disordered eating in that most cases occur without an eating disorder.[4,7,9,10] Some athletes are unaware, or lack the nutritional knowledge, that the amount of calories expended during exercise is not replaced by their total dietary intake.[7] A study published in the *International Journal*

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