

# RECENT ADVANCEMENTS IN ASSESSMENT TECHNIQUES OF FEMALE ATHLETE TRIAD: A LITERATURE REVIEW

## Abstract

This abstract provides an overview of recent advancements in assessment techniques of female athlete triad. Female participation in sports is on the rise worldwide, yielding positive health benefits. However, it has also led to specific health issues. The female athlete triad, identified in 1992 by the American College of Sports Medicine, encompasses disordered eating, amenorrhea, and osteoporosis. Inadequate energy intake, resulting from restricted diet or high expenditure, contributes to menstrual and bone density problems. Athletes in sports emphasizing leanness or low weight are particularly susceptible. Timely detection and prevention are vital for addressing triad disorders. Treatment involves restoring energy intake to appropriate levels (30 kcal.kg-1.d-1) to normalize metabolism. Those involved in female athletics must prioritize educating, recognizing, and treating at-risk athletes. On-going research about the triad disorders aids in crafting prevention and treatment approaches, enabling women to benefit from exercise throughout their lives. This review aims to examine the latest assessment tools for the triad and evaluate the effectiveness of physiotherapeutic interventions.

**Keywords:** Female Athlete, menstrual function, health implications, Medicine

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## I. INTRODUCTION

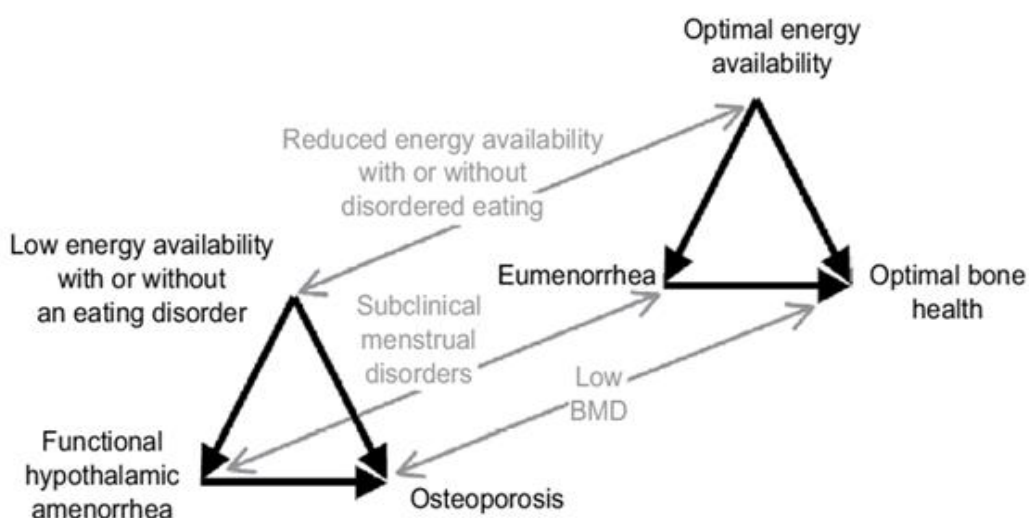
When the American College of Sport Medicine (ACSM) first described the condition, known as Female Athlete Triad, in a consensus meeting called The Task Force on Women's Issues in 1992, it was made better known. The association among female athletes' disordered eating (DE), amenorrhea, and osteoporosis was the main topic of discussion at this conference. Low energy availability (i.e., burning more calories than one consumes), menstruation dysfunction, and low bone mineral density are the three symptoms that make up the female athlete triad.<sup>[1]</sup>

Athletes can experience the symptoms of or be diagnosed with the Triad without having all three components present at the same time. In fact, the appearance of even one component is sufficient to warrant testing in order to make a definitive diagnosis. The connection between insufficient energy intake (with or without eating disorders), irregular menstrual function, and decreased bone mineral density is referred to as the Female Athlete Triad.

## II. LITERATURE REVIEW

The triad is more prevalent among high school, college, and elite athletes, as well as in sports that rely on subjective judging (like gymnastics and figure skating) or endurance activities emphasizing reduced body weight, such as running. According to a study of 65 research papers by Gibbs et al., the occurrence of any individual triad component among physically active females and female athletes varied from 16.0% to 60.0%. The prevalence of any two of these conditions ranged from 2.7% to 27.0%, while the presence of all three symptoms ranged from 0% to 15.9%. Sports that prioritize weight, particularly those focused on achieving leanness or aesthetics, those where lower weight confers a competitive advantage, or those necessitating specific weight classes for participation, could result in chronic energy insufficiency due to restricted dietary intake, excessive exercise or both.

## III. ETIOLOGY OF THE TRIAD



**Figure 1:** Female Athlete Triad

Commonly theorized is that the progression of the triad typically unfolds in a predictable manner. The female athlete begins restricting her diet with the belief that achieving a lesser weight will enhance her performance. The athlete's diet becomes more restrictive for a variety of reasons, and her eating behaviour becomes unhealthy. The consequent energy limitation and harmful weight management practices make her more susceptible to menstrual irregularities and subsequently reduced bone mineral density (BMD). In accordance with this proposed sequence of events, the triad conditions are interconnected, meaning that the presence of any one disorder is directly or indirectly associated with the others.

#### **IV. HEALTH CONSEQUENCES**

**Impact of Fat on Quality of Life:** Numerous health implications arise in athletes experiencing the triad. Menstrual irregularities can result in infertility due to inadequate development of ovarian follicles, anovulation, or luteal-phase abnormalities. Conversely, during recovery from the triad, some young women might experience premature ovulation leading to unexpected pregnancies in the absence of contraception, while their menstruation is being re-established. Hypoestrogenism also yields adverse effects. Insufficient estrogen levels can trigger endothelial dysfunction, culminating in cardiovascular ailments. Women with low estrogen levels exhibit elevated levels of low-density lipoprotein cholesterol. The risk of injury is heightened by irregular menstrual cycles. Athletes with amenorrhea face 2 to 4 times greater vulnerability to stress fractures compared to those with regular menstruation. Additionally, reduced bone density exposes these women to suboptimal attainment of peak bone mass, increasing the risk of future complications. While the immediate effects might not manifest upon triad diagnosis, a decline in peak skeletal bone mineral density (BMD) and gradual skeletal demineralization can lead to these conditions over time. Similarly, the resumption of menstrual cycles doesn't immediately rectify BMD issues, but rather initiates the essential process of bone rebuilding to mitigate future risks of osteoporosis and fractures. Depending on the patient's age, triad duration, and recovery time, BMD might stabilize or even improve, though it may not fully "catch up" to normal, age-appropriate levels. The impact of reduced energy intake on athletic performance differs based on the extent and length of the energy deficiency, alongside the physical requirements of the sport. Prolonged periods of constrained energy intake have a more pronounced detrimental influence on performance. Similarly, athletes engaged in endurance disciplines with substantial energy requirements (such as distance running, swimming, cycling, and basketball) exhibit greater performance repercussions compared to those participating in sports with lower energy demands (like gymnastics, diving, and weightlifting).

#### **V. RISK FACTORS**

The main factor contributing to the development of the Triad is lack of sufficient energy availability. Athletes can intentionally or unintentionally modify two aspects of Energy Availability: their daily calorie intake or their daily calorie expenditure through exercise. Any factor that leads to a reduction in daily calorie intake can increase the risk of low energy availability. Several factors influence dietary intake, including disordered eating behaviours, energy deficit behaviours, food allergies or intolerances, personal beliefs, external pressures from mentors, relatives, or peers, diminished self-worth, inherent and genetic elements, and the influence of social media platforms in today's context. Persistent

inadequate energy intake prompts the reconfiguration of bodily systems, aiming to preserve energy for vital physiological functions. The triad can manifest in any sport, irrespective of the athlete's skill level or age. However, it is more prevalent in sports that prioritize aesthetics and involve subjective evaluation, those demanding athletes to fit specific weight categories, or sports where having a lighter body weight provides a competitive advantage. For instance, activities like dancing, diving, gymnastics, and ice skating fall within the category of sports that emphasize being lean and involve subjective evaluation.

Wrestling, boxing, and rowing are sports categorized by weight divisions. On the other hand, running, ski jumping, high jump, and cycling are categorized as gravity-dependent sports, where being lean provides a competitive advantage. Sports characterized by substantial energy expenditure, like rowing and cycling, as well as those involving intensified training volume, have the potential to lead to low energy availability (LEA).

## Tests for the Female Athlete Triad's Diagnosis

### 1. Low Energy Availability

- Observable indications: when the body mass index falls below 17.5 kg/m<sup>2</sup> or
- Having a body weight below 85% of expected
- Calculation (with aid of daily food records and accelerometer):
- Energy intake [kcal] – exercise energy expenditure /fat-free mass or lean body mass
- Measurement of metabolic rate at rest
- Assessment of Tri-iodothyronine (T3) level

### Screening Tools

- Athletic Milieu Direct Questionnaire (AMDQ)
- The Physiologic Screening Test (PST)
- Female Athlete Screening Tool (FAST)
- Brief Eating Disorders in Athletes Questionnaire (BEDA-Q)

### 2. Reduced Bone Mineral Density

Dual-energy x-ray absorptiometry (DEXA) is recommended under the following circumstances

- Oligomenorrhea lasting 6 months or more
- Presence of Disordered eating or an eating disorder for a period of 6 months or more
- History of stress fracture or other fracture resulting from minimal trauma

### Reduced Bone Mineral Density

- **Ages from 5 to 19:** Z score equal to or less than –2.0

- **Age more than or equal to 20:** Z score ranging from  $-1.0$  and  $-2.0$  in combination with a history of factors like nutritional deficiency, hypoestrogenism, stress fracture, or other secondary risk factor fracture

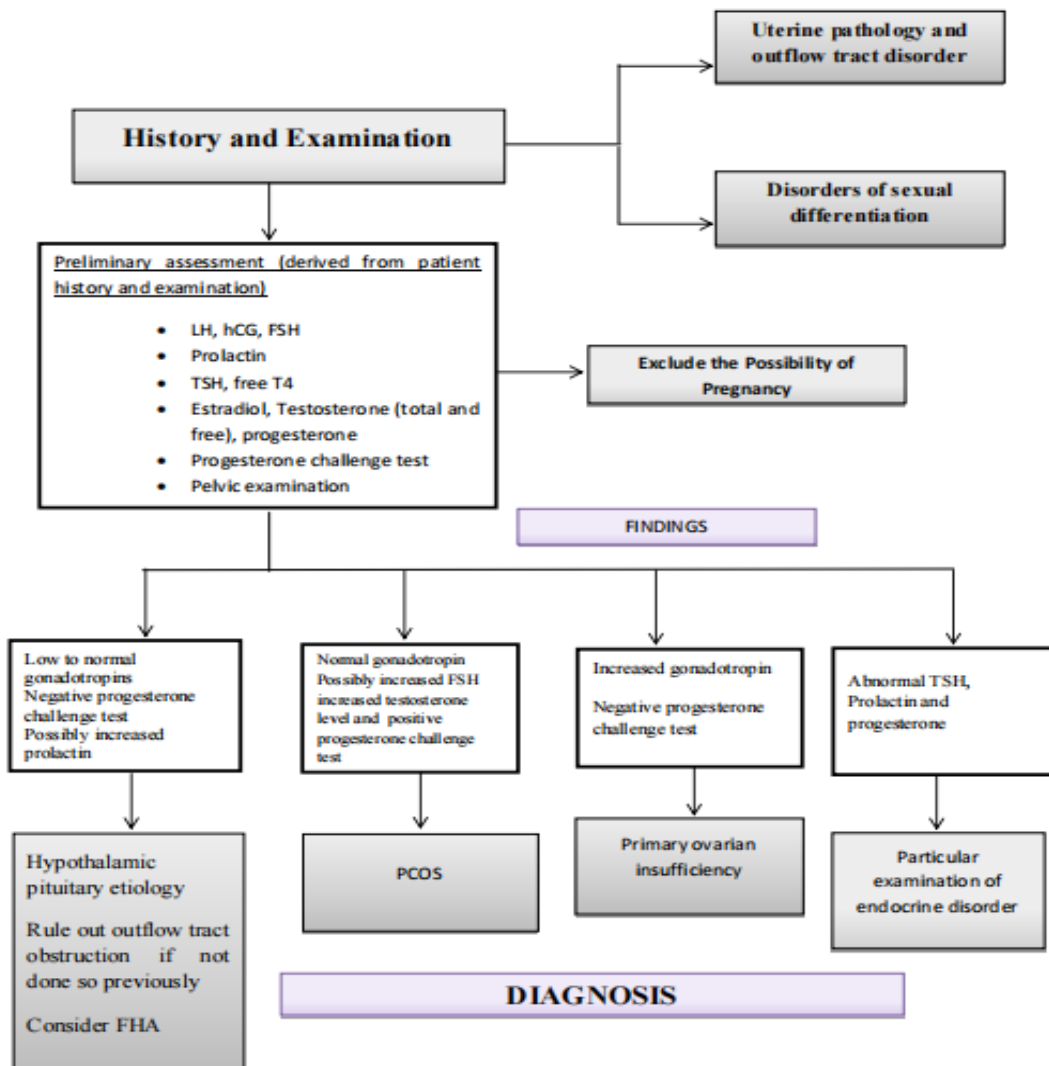
### Osteoporosis

- **Age from 5 to 19:** Z score equal to or less than  $-2.0$  plus clinically significant fracture
- **Age more than or equal to 20:** Z score equal to or less than  $-2.0$  plus secondary cause of osteoporosis

### 3. Menstrual Dysfunction

- Exclude pregnancy and blockage of the outflow tract
- Oligomenorrhea: Gap of more than 35 days between menstrual cycles
- Amenorrhea: Absence of menstruation

**Table 2: Amenorrhea Algorithm**



FSH – follicle stimulating hormone HCG- human gonadotropin hormone PCOS- polycystic ovarian syndrome TSH- thyroid-stimulating hormone

### Laboratory Tests to Consider

- Follicle-stimulating hormone
- Prolactin
- Progesterone challenge
- Thyroid-stimulating hormone, thyroxine (T4)

## VI. MANAGEMENT OF TRIAD

The treatment of Triad-related factors is intricate and influenced by various factors. Thus, a collaborative approach involving multiple disciplines is crucial. Each team member offers distinct insights and holds specific responsibilities within the team. Given that each athlete's requirements differ, not all healthcare professionals might be part of the athlete's care; usually, the primary care physician supervises the multidisciplinary team and determines the essential team members for the athlete's care. The importance of tailoring a personalized program for effective athlete care cannot be overstated. Studies have demonstrated significant variations in physical traits and physiological attributes among female athletes participating in the same sport, and even notable diversity within the same position within that sport.

- 1. Non Pharmacological Treatment:** Engaging in weight-bearing exercises stands as a key non-pharmacological method for enhancing and preserving bone mineral density (BMD) and structure throughout one's lifespan. Bone tissue is notably receptive to dynamic and forceful loading, impactful activities, and resistance training. Nevertheless, it's worth noting that lean body mass has emerged as a potent indicator of hip BMD among anorexic adolescents, as well as adolescent athletes and non-athletes.
- 2. Pharmacological Treatment:** Physical activity and proper nutrition play vital roles in both treating and preventing the condition. Weight-bearing and dynamic exercises notably contribute to bone development and bone mineral density (BMD), particularly in premenopausal women. In certain instances, calcium and vitamin D supplements could be beneficial. For adults, the recommended daily intake is 1,000 mg of calcium and 600 to 800 IU of vitamin D.
- 3. Gonadal Steroids Replacement:** The primary gonadal hormones consist of progesterone, estrogen and testosterone, all of which exhibit reduced levels in athletes experiencing amenorrhea.
- 4. Replacement of Estrogen:** Due to the already low levels of IGF-1 in athletes, the administration of oral estrogen could further decrease IGF-1 levels. The positive anti-resorptive effects of estrogen are restricted by this decline. Moreover, the type and dosage of oral estrogen have been implicated in the lack of effectiveness in increasing bone mineral density (BMD) in individuals with energy-deficient conditions.

Vaginal administration of estradiol bypasses the liver's initial metabolic processing, and a combination contraceptive ring containing vaginal estrogen and progesterone is now available. For young athletes aged 16 to 21 with functional hypothalamic amenorrhea (FHA), transdermal estradiol replacement coupled with cyclic progesterone may be considered to prevent further bone loss.

Antidepressants are commonly used for treating anorexia nervosa, bulimia nervosa after weight restoration, and for addressing concurrent anxiety disorders and depression.

Bisphosphonates, approved for postmenopausal osteoporosis, should not be used in young athletes with FHA due to two reasons. Firstly, their effectiveness hasn't been proven in women of childbearing age.

- 5. Role of the Physical Therapist:** Among the team members, the physical therapist and exercise physiologist possess specialized knowledge in exercise metabolism, training responses, sports biomechanics, and designing exercise regimes. Additionally, the physical therapist offers skills in evaluating and addressing athletic and orthopaedic injuries. These competencies render the physical therapist an essential component of the interdisciplinary team. The following outlines a partial set of goals when collaborating with this demographic.

The physical therapist and exercise physiologist bring expertise in a range of areas, including:

- Examining, evaluating, and treating athletic and orthopaedic injuries
- Assessing physical strength and conditioning
- Conducting biomechanical analyses
- Evaluating training programs and making necessary adjustments
- Implementing injury prevention strategies
- Collaborating with other sports professionals as required (such as strength and conditioning specialists or speed trainers)
- Conducting body composition assessments (if appropriately trained)
- Educating athletes on rest-recovery ratios and cross-training practices.

- 6. Weight-Bearing Exercise and the Triad:** Recent research has shown that engaging in higher load plyometric jump training can promote bone formation and elevate bone mineral density in adolescent girls. This suggests that including plyometric exercise training might help girls achieve their highest BMD levels. To stimulate and sustain training adaptations, as well as skeletal muscle growth and increased BMD, it's essential to incorporate trunk-strengthening workouts and weight-bearing exercises at the proper intensity. Resistance training contributes to enhancing fat-free mass and also plays a role in fostering bone development in premenopausal women. Importantly, any approach aiming to enhance bone mineral density (BMD) must encompass both these aspects. Athletic trainers and physical therapists are pivotal in educating female athletes with Triad-related conditions about interventions that can enhance their BMD. When resistance training and weight-bearing activities become permissible, the athletic trainer or physical therapist will develop an exercise regimen that incorporates the right balance

of impact and resistance training. This program will also align with the athlete's sport-specific objectives.

## VII. CONCLUSION

Even though there's not an extensive body of supporting evidence, the role of physiotherapy in addressing and managing the Female Athlete Triad is apparent. Physiotherapists play a role in preseason assessments, examining mobility and strength, preventing injuries, and facilitating injury recovery.

They provide their specialized knowledge in analysing essential movements from a biomechanical perspective and also educate athletes, coaches, parents, fellow team members, and the wider public about the Female Athlete Triad, its components, and the possible effects it may have on health and performance.

When necessary, physiotherapists direct their patients to other experts for further counselling or diagnosis. They are integral members of a multidisciplinary team, working together cohesively to ensure the best possible care for athletes. All team members collaborate in harmony to deliver optimal care to athletes.

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