**FUTURISTIC TRENDS IN ASSESSMENT TECHNIQUES OF FEMALE ATHLETE TRIAD**

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**ABSTRACT-**

This abstract provides an overview of recent advancements in assessment techniques of female athlete triad. Female athletic participation continues to grow throughout the world. This has many positive effects on health and well-being, but it has also led to a unique set of health problems. The female athlete triad was first described in 1992 by the American College of Sports Medicine, consisting of disordered eating, amenorrhea, and osteoporosis. Low energy availability, from either dietary restriction or increased expenditure, is the factor that leads to the pathological states of menstrual function and bone mineral density. Athletes especially at risk are those in sports requiring leanness or low body weight. Prevention and early recognition of triad disorders is crucial to ensure timely intervention and treatment. Treatment is centered on restoring energy availability to adequate levels (30 kcal.kg-1.d-1) to re-establish normal metabolic functioning. All those who work with female athletes must remain vigilant in the education, recognition and treatment of athletes at risk. Continued research and knowledge of the triad disorders aids the development of prevention and treatment strategies to allow women to continue to enjoy the benefits of regular exercise and physical activity throughout their lives. The objective of this review is to explore latest screening tools used in assessment of the triad and to assess the effectiveness of various physiotherapeutic interventions of the triad.

**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.[1]

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 additional testing in order to make a definitive diagnosis.

The link between low energy availability (with or without disordered eating), menstrual dysfunction, and low bone mineral density is known as Female Athlete Triad.

The female athlete triad is more common in high school, collegiate, elite athletes and in sports with subjective judging (gymnastics, figure skating) or endurance sports that emphasize leanness (example running).The prevalence of any one of the triad conditions among physically active women and female athletes ranged from 16.0% to 60.0%, the prevalence of any two conditions ranged from 2.7% to 27.0%, and the prevalence of all three symptoms ranged from 0% to 15.9%, according to a study of 65 studies by Gibbs et al. Weigh-sensitive sports, such as those emphasizing leanness and or aesthetics, those where weighing less gives a performance advantage or those which require an athlete to be in a certain weigh class to compete, could lead to chronic energy deficiency by either restring dietary intake, by excessive exercising or by both.

**ETIOLOGY OF THE TRIAD**

It is generally hypothesized that the development of the triad follows a typical progressive pattern. The female athlete starts dieting because she thinks that being lighter will help her perform better. The athlete's diet becomes more restrictive for a variety of reasons, and her eating behaviour becomes unhealthy. The resulting energy restriction and pathogenic weight control behaviours predispose her to menstrual dysfunction and subsequent decreased BMD. According to this hypothesized scenario, the triad disorders are interlinked, such that the existence of one disorder is linked, directly or indirectly, to the others.

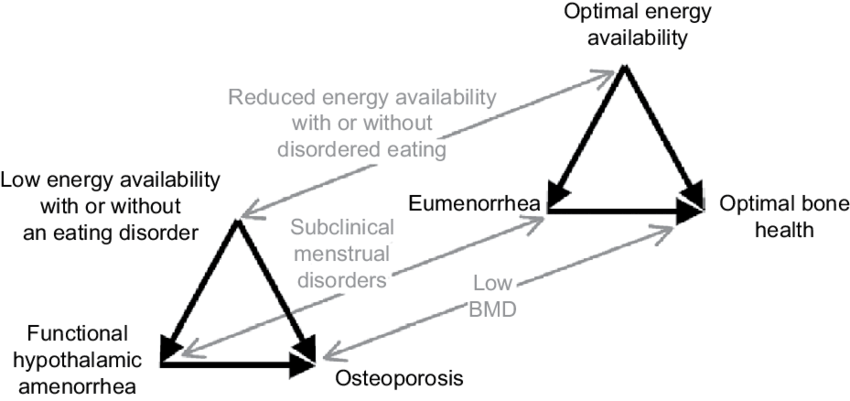


Figure1 : Female athlete triad

**HEALTH CONSEQUENCES**

IMPACT OF FAT ON QUALITY OF LIFE

Several health consequences occur in athletes with the triad. Menstrual dysfunction may lead to infertility due to lack of ovarian follicular development, anovulation, or luteal-phase defects. Alternatively, in some young women recovering from the triad, while menses are being restored, premature ovulation may occur and result in unexpected pregnancy in the absence of contraception. There are also negative consequences associated with hypoestrogenism. Low levels of estrogen can cause endothelial dysfunction, resulting in cardiovascular disease. Women with hypoestrogenism have elevated low-density lipoprotein cholesterol levels. Menstrual irregularity increases this risk of injury. Amenorrheic athletes have 2 to 4 times greater risk for stress fracture than their eumenorrheic counterparts. Low bone density also puts these women at risk for suboptimal peak bone mass acquisition. While the effects may not be immediate after diagnosis of the triad, a decrease in peak skeletal BMD, along with skeletal demineralization occurring slowly over time, can lead to these conditions.Similarly, the resumption of menses does not resolve BMD issues immediately but starts the necessary rebuilding of bone to decrease the risk of future osteoporosis and fracture. Depending on the age of the patient, the duration of the triad, and the time to recovery, BMD may stabilize and even improve but not necessarily “catch up” to normal, age-appropriate BMD.

The effect that low energy availability has on athletic performance varies depending on the severity and duration of the low energy state as well as the physical demands of the sport. Longer durations of restricted energy availability are associated with more dramatic negative effects on performance. Likewise, athletes in endurance sports with high energy demands (distance running, swimming, cycling, basketball) show more effects on performance than athletes in lower energy demand sports (gymnastics, diving, weightlifting).

**RISK FACTORS**

The primary cause of Female Athlete Triad is Low energy availability. Athletes can knowingly or unknowingly alter two components of EA: daily dietary energy intake or daily exercise energy expenditure. Anything that alters, more specifically reduces, daily dietary energy intake has a potential of becoming a risk factor for developing LEA. Factors affecting dietary intake are manifold: ED2-s, DE behaviours, food intolerances or allergies, beliefs, pressure from coaches, family or peers, low self-esteem, biological and genetic factors and in this day of age also social media platform.Chronic under-fuelling causes reregulation of organ systems in order to conserve energy for more vital processes.

Female Athlete Triad may occur in any sport, regardless of athletic level, regardless of age, however sports which emphasize aesthetics, and are often subjectively judged, that require an athlete to be in a certain weight class, or sports where weighing less gives a performance advantage. For example, dancing, diving, gymnastics, and ice skating belong in a group of sports that emphasized leanness and are subjectively judged. Wrestling, boxing, and rowing belong in weight class sports. Running, ski jumping, high jump and cycling belong to a group of gravitational sports, where leanness gives a performance advantage.

Sports with high energy expenditure, such as rowing and cycling, or even increased training volume can cause LEA.

**Diagnostic tests for the female athlete triad**

1. **Low energy availability**

* Overt signs: body mass index < 17.5 kg/m2 or
* body weight < 85% of expected
* Calculation (with aid of daily food logs and accelerometer):
* Energy intake [kcal] – exercise energy expenditure /fat-free mass or lean body mass
* Resting metabolic rate
* Tri-iodothyronine (T3) level

**Screening tools –**

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

1. **Low bone mineral density**

* Dual-energy x-ray absorptiometry (DEXA) if any of the following:
* Oligomenorrhea or amenorrhea ≥ 6 months
* Disordered eating or an eating disorder ≥ 6 months
* Stress fracture or other fracture from minimal trauma

**Interpretation:**

* Low bone mineral density
* Ages 5–19: Z score ≤ –2.0
* Age ≥ 20: Z score between –1.0 and –2.0 with a history of nutritional deficiency, hypoestrogenism, stress fracture, or other secondary risk factor fracture

**Osteoporosis**

Ages 5–19: Z score ≤ –2.0 plus clinically significant fracture

Age ≥ 20: Z score ≤ –2.0 plus secondary cause of osteoporosis

1. **Menstrual dysfunction**

* Rule out pregnancy and outflow tract obstruction
* Oligomenorrhea: > 35 days between menses
* Amenorrhea: Absence of menses

Laboratory tests to consider:

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

**History and Examination**

**Uterine pathology and outflow tract disorder**

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FINDINGS

**Disorders of sexual differentiation**

Initial investigation (based on history and examination)

* LH. FSH, hCG
* Prolactin
* TSH, free T4
* Estradiol, Testosterone (total and free), progesterone
* Progesterone challenge test
* Pelvic test

**Rule out pregnancy**

Abnormal TSH, Prolactin and progesterone

Increased gonadotropin

Negative progesteronechallenge test

Normal gonadotropin Possibly increased FSH increased testosterone level and positive progesterone challenge test

Low to normal gonadotropins

Negative progesterone challenge test

Possibly increased prolactin

Primary ovarian insufficiency

Hypothalamic pituitary etiology

Rule out outflow tract obstruction if not done so previously

Consider FHA

Specific investigation of endocrine disorder

Chronic anovulation/ PCOS

**DIAGNOSIS**

TABLE 2: Amenorrhea algorithm FSH- follicle-stimulating hormone;

HCG- human gonadotropin hormone ; PCOS, polycystic ovarian syndrome; TSH, thyroid-stimulating hormone

**MANAGEMENT OF TRIAD**

Management of Triad-related components is complex and multi-factorial. As such, a multi-disciplinary approach is vital. Each team member provides a unique perspective and has a well-defined role within the team. Because every athlete has unique needs, not every health care professional listed in Table may be involved in the care of the athlete; the primary care physician typically oversees the multidisciplinary team and makes recommendations related to which team members are necessary in the care of the athlete.

The need for an individualized program to provide appropriate care for the athlete cannot be overemphasized. Research has shown large intra individual variability in physical characteristics and physiological attributes in female athletes who play the same sport and even large variability in the same position within that sport.

**Non pharmacological Treatment**

Weight-bearing exercise is a primary non pharmacological strategy for increasing and maintaining BMD and geometry across the life-span. Bone tissue is highly responsive to dynamic and high-magnitude loading, high-impact loading, and resistance training. However lean mass has been reported to be a strong predictor of hip BMD among anorexic adolescents, adolescent athletes and non-athletes.

**Pharmacological Treatment**

Exercise and adequate nutrition are important for treatment and prevention. Weight-bearing and dynamic exercises have a positive effect on bone formation and BMD, especially in premenopausal females. Calcium and vitamin D supplements may be desirable in some cases. The recommended amount of calcium and vitamin D intake for adults is 1,000 mg and 600 to 800 IU, respectively.

**Replacement of Gonadal Steroids**

The major gonadal steroids include estrogen, progesterone, and testosterone, all of which are low in the athlete with amenorrhea.

**Estrogen replacement**

Given the low endogenous concentration of IGF-1 in athletes with amenorrhea, further reduction in IGF-1 levels secondary to the administration of oral estrogen likely limits the beneficial anti resorptive effects of estrogen. In addition, the type and dose of estrogen have been implicated in the lack of efficacy of oral estrogen in increasing BMD in energy-deficient states.

Vaginal estradiol administration also circumvents hepatic first-pass metabolism, and a vaginal estrogen-progesterone combination contraceptive ring is now available. Transdermal estradiol replacement with cyclic progesterone may be considered in young athletes ≥16 and <21 years of age with FHA to prevent further bone loss. Antidepressants are often utilized for bulimia nervosa, anorexia nervosa following weight restoration, and for concomitant depression and anxiety disorders.

Bisphosphonates approved for the treatment of postmenopausal osteoporosis should not be used in the young athlete with functional hypothalamic amenorrhea for two reasons. The first is because of their unproven efficacy in women of child-bearing age.

**Role of the Physical Therapist**

The physical therapist and exercise physiologist are the only team members with expertise in exercise metabolism, training adaptations, sports biomechanics, and exercise prescriptions. Furthermore, the physical therapist brings additional expertise in the assessment and intervention of athletic and orthopaedic injuries. This expertise makes the physical therapist an integral part of any interdisciplinary team. The following is a partial list of the objectives for working with this population.

Examination, evaluation, assessment, and rehabilitation of athletic and orthopaedic injuries, assessment of physical strength and conditioning, biomechanical analysis, evaluation of the training program, modifications of the training program, prevention of injuries, a link to other sport professionals as needed (strength and conditioning specialist, speed trainer), body composition assessment(if appropriately trained), and education of the athlete regarding rest-recovery ratios and cross training.

It is beyond the scope of this review to discuss specific intervention plans; however, some key considerations are provided. Physical therapy practice guidelines for the treatment of osteoporosis and other skeletal demineralization disorders provide an initial template for intervention. The patient with the triad, however, is more complex than these separate guidelines would suggest.

**Weight-Bearing Exercise and the Triad**

The use of higher load plyometric jump training to stimulate osteogenesis was recently demonstrated to increase BMD in adolescent girls. This suggests that plyometric training could be incorporated to assist girls in obtaining their peak BMD. Weight-bearing activities and trunk-strengthening exercises at an appropriate intensity are required to stimulate and maintain training adaptations and skeletal muscle hypertrophy, and to increase BMD.

Resistance training improve fat-free mass, play a role in bone acquisition in the premenopausal female. Most importantly, any training program geared toward increasing BMD needs to have both components. Athletic trainers and physical therapists play a key role in educating the athlete on interventions to improve BMD in the female athlete with Triad-related conditions. Once resistance training and weight-bearing activities are allowed, the athletic trainer or physical therapist will design an exercise program that includes the appropriate amount of impact and resistance training while concurrently meeting the sport-specific goals of the athlete.

**CONCLUSION**

Despite the low level of evidence, the role of physiotherapy in the treatment and management of Female Athlete Triad is clear. Physiotherapists play a part in pre-seasonal examinations and evaluations, assessments of movement and strength, preventing injuries and rehabilitation of injuries. Physiotherapists provide their expertise in biomechanical analysis of basic movements and athletes, parents, coaches, other team members and the public about Female Athlete Triad, its components, possible health, and performance consequences.

Physiotherapists refer their clients to other specialists for further counselling or diagnosis if necessary.

Physiotherapists are a part of a multidisciplinary team which represents a unified front. All team members of the teamwork in unison to provide best possible care for the athletes.

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