Implications of the Female Athlete Triad for the Growing Adolescent

Kayla Carlson PA-S2
Oregon Health and Science University

Introduction and History

In 1971 only 3% of high school women in the United States participated in organized athletics.[1] Since the passage of the landmark legislation Title IX in 1972 which acted to prohibit sex discrimination in federally funded programs, the rate of organized female sports participation in high schools has witnessed a growth of over 900%, and intercollegiate sports by 450%.[2] In 2010 more than 3 million young women participated in organized high school athletics.[2] The widespread benefits of of sport participation for women are well researched and include improvements in self-esteem, academic performance, and mental health, with subsequently lowered risk of high-risk behaviors and obesity. [3-5] However, with this growth in sport involvement a set of documented health problems unique primarily to the female athlete, have emerged.[4]

As first described by the American College of Sports Medicine (ACSM) in 1992, the Female Athlete Triad or Relative Energy Deficiency refers to the interrelationship among energy availability, menstrual function, and bone mineral density. The first definition published by the ACSM consisted of the following three components: disordered eating, amenorrhea, and osteoporosis. Fifteen years later a more inclusive definition was published acknowledging that the triad existed on a spectrum of dysfunction from optimal health to disease related to energy availability (EA), menstrual function, and bone mineral density. Because of the interplay among factors, as well as data documenting the compounding risk of bone fracture with each risk factor experienced, the new criteria only requires 1 component for diagnosis. It is important to note that an individual may suffer from 1, 2, or all components simultaneously.[6-9] The presence of any component of the triad should prompt further assessment and evaluation for other components. The spectrum of energy availability from optimal to low with or without disordered eating,

amenorrhea, and low bone mineral density (BMD) pose significant short term and potentially lifelong health risks to physically active girls and women. Most often, the clinical endpoint of highest concern is bone health.

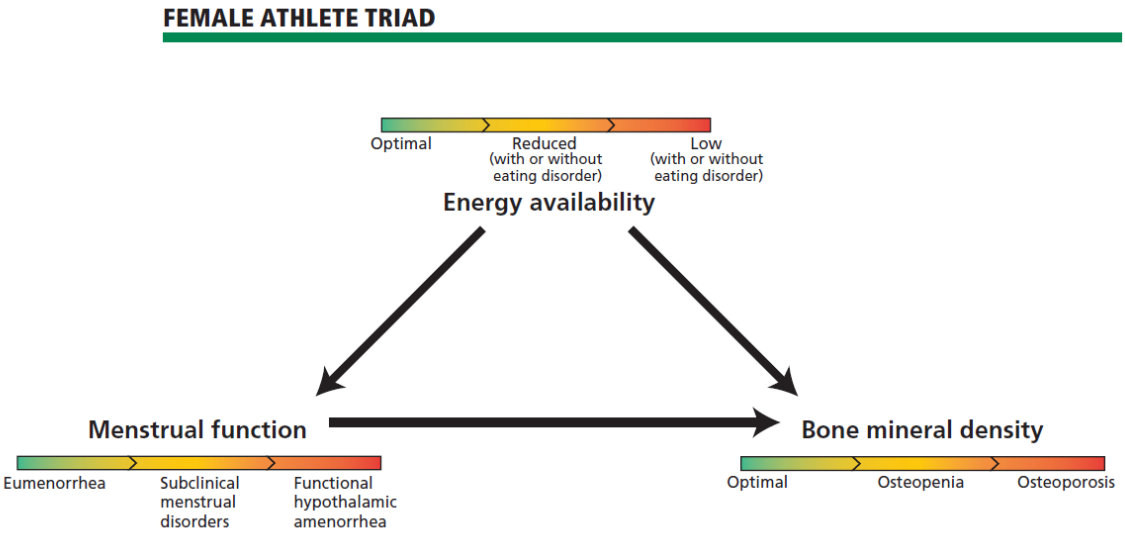

Figure 1. The components of the female athlete triad are linked. Energy availability and menstrual dysfunction play causative roles in bone mineral density pathology. Within each component of the triad a spectrum of dysfunction exists, with all 3 components exhibiting serious health end points including low energy availability, functional hypothalamic amenorrhea, and osteoporosis. [10]

Healthy People 2030: Reduce the Proportion of Adults with Osteoporosis

In 2013-14, 7.3% of adults in the United States aged 50 years and older were diagnosed with osteoporosis. Statistically women are more likely than men to develop osteoporosis and the consequences may lead to high costs, disability, and death. As part of Healthy People 2030, the target is to lower the number of those impacted by osteoporosis to 5.5%.[11] For athletes impacted by the triad, appropriate intervention, especially during the adolescent years, may reduce the risk of osteoporosis with aging.

Prevalence

A meta-analysis of 65 studies reviewing female athletes across all levels of play (age=21.8 ± 3.5 years) of varying geographical location globally found that the prevalence of any one of the triad conditions ranged from 16.0% to 60.0%, the prevalence of any 2 ranged from 2.7% to 27%, and the prevalence of all 3 ranged from 0-15.9%.[12] The discrepancy observed in the literature was attributed to inconsistency and limitations of the studies reviewed including use of multiple criteria to define the triad and lack of good documentation. While it is known that the triad affects adolescent athletes, the magnitude is not well documented.[12] Athletes at greatest risk for disordered eating and amenorrhea are those who participate in "lean" sports or sports that encourage a thin body physique for performance (Evidence Category A).[5,12] Participants in sports including ballet, gymnastic, cheerleading, or endurance running are 2 to 3 times more likely to suffer from the triad than those in "non-lean" sports.[12] Despite the level of incidence reported, studies regarding awareness of the triad reveal that this is a problem few are discussing among athletes, medical providers, or coaches.[1-3,10]

Awareness

In recent surveys, a quarter to half of athletes failed to recognize short periods of amenorrhea as abnormal and only a third could identify the relationship between menstrual function and bone health. In the same study, 22% of lean sport athletes reported that they would not seek treatment for amenorrhea. This answer contrasted sharply with the "non-lean" sport control whom only 3.2% would not seek treatment.[2]

Medical providers are ideally located to play a key role in early identification and screening of the triad during sport physicals or well child visits. Unfortunately, according to the American Academy of Pediatrics (AAP), the majority of physicians report receiving no education either in medical school or through continuing medical education on the triad or its consquences.[4] This

statement is validated by other studies documenting similar results. A 2009 study revealed only 20% of pediatricians, 41% of orthopedic surgeons, and 50% of family medicine physicians could correctly identify all 3 components of the triad.[4] Lastly, a study conducted in 2015 that surveyed a total of 931 physicians of varying specialties documented that only 37% had heard of the triad.[1]

In addition to a medical pre-participation sports physical, medical screening in the preseason is often conducted by individual athletic programs. Despite recommendations from the Female Athlete Coalition, the International Olympic Committee, and six other US medical societies to screen for the triad using a standard pre-participation physical evaluation (PPE) form, almost 90% of universities use no standardized PPE form and over half of Division I universities use forms missing more than 50% of the recommended screening items.[2,8] Awareness for the triad and its components remain low.

Mechanism: Low Energy Availability

Originally known as "disordered eating", energy availability (EA) remains the cornerstone of the triad and is defined as energy intake, often in the form of calories, minus energy output (EO). EO occurs to maintain homeostasis, complete activities of normal living, and is utilized during exercise. Optimal EA for female athletes has been identified to be approximately 45 kcal/kg fat-free mass (FFM) per day but may be higher in growing and developing adolescents.[3] When EO exceeds EA the body's physiologic response is to reduce the amount of energy used for reproduction, thermoregulation, cellular maintenance, and growth. This shift in energy resources promotes survival but impairs health. Energy restriction may occur due to a direct decrease in energy intake or failure to increase caloric consumption to meet exercise demands.[13,14]

While disordered eating (DE) and/or active weight loss may or may not be present for low EA to exist, it is crucial to reflect that the prevalence of disordered eating has been found to range from 18-35% in adolescent and young female athletes and is statistically higher among athletes in lean sports (grade A evidence).[2,5,14] Many triggers for the onset of DE in athletes have been identified; including casual comments from coaches, parents, and peers regarding weight and performance. Despite equivocal empirical support, many athletes and coaches are firmly entrenched in the ideology that weight or body fat reduction enhance performance.[15] DE is associated with substantial short and long term adverse emotional and physical outcomes. Patients with DE report poorer peer interactions with subsequent higher rates of depression, anxiety, and suicide.[14] DE can also lead to vitamin deficiencies, specifically calcium and vitamin D, further impacting bone health. To conclude, DE should be always be ruled out in individuals experiencing the triad.[2,4,7]

Low EA can also occur by over exercising. In one study of over 300 high school female athletes, almost 60% of females reported training outside of scheduled practice sessions. The clinical significance of over training can be paramount. In females with disordered eating, "over exercising" is the variable most strongly associated with suicidal tendency.[14]

According to the Female Athlete Triad Coalition, low EA cannot be diagnosed by estimating energy balance or by using weight stability as an indicator for energy balance. As a first pass, in adults a Body Mass Index (BMI) <17.5 kg/m2 or in adolescents <85% of expected body weight may be used to estimate low EA. BMI is not an appropriate tool to use in adolescents. Referral to an experienced sports dietitian or exercise physiologist competent to gather information regarding dietary intake and energy expenditure may be required to make an accurate estimate of EA. Accurate assessment of energy intake and energy output is complicated by a variety of

factors including underreporting of intake as well as underreporting of exercise. Ideally physically active women should aim for at least 45kcal/kg of FFM/day of energy intake to maintain adequate EA for optimal health.[13] Low EA is considered the cornerstone of the triad and treatment is centered on restoring EA. EA<30 kcal/kg FFM per day disrupts menstrual function and adversely impacts bone health.[4]

Mechanisms: Menstrual Dysfunction

Menstrual patterns are an indicator of overall health and are considered by many to be the 5th vital sign.[16] The second component of the triad, menstrual function, occurs along a spectrum that can range from eumenorrhea to widespread dysfunction of varying etiologies. Such dysfunction may range from anovulation and luteal dysfunction to oligomenorrhea and amenorrhea (primary or secondary).[4,14] Eumenorrhea is defined by cycles occurring at median internals of 28 +/- 7 days. Primary amenorrhea is defined as a delay in the onset of menses by the age of 15 years or if the individual lacks other signs of pubertal development by 14 years of age. Secondary amenorrhea is defined as a cessation of menarche for 3 or more consecutive months after menarche has been achieved. Oligomenorrhea is classified as regular menstrual cycles lasting longer than 35 days. Luteal phase deficiency is defined by markedly low progesterone or a luteal phase lasting less than 11 days. Anovulation and luteal phase deficiency are often asymptomatic menstrual disturbances thus making them more difficult to diagnose based on history alone, yet still have adverse impacts on overall health.[3,4]

A broad differential including the exclusion of pregnancy (grade C evidence) is important to avoid missing emergent pathology. All patients with menstrual dysfunction should be evaluated by an appropriate medical provider including assessment of serum follicle-stimulating hormone, luteinizing hormone, prolactin, and thyroid-stimulating hormone levels (grade C evidence).[13,16]

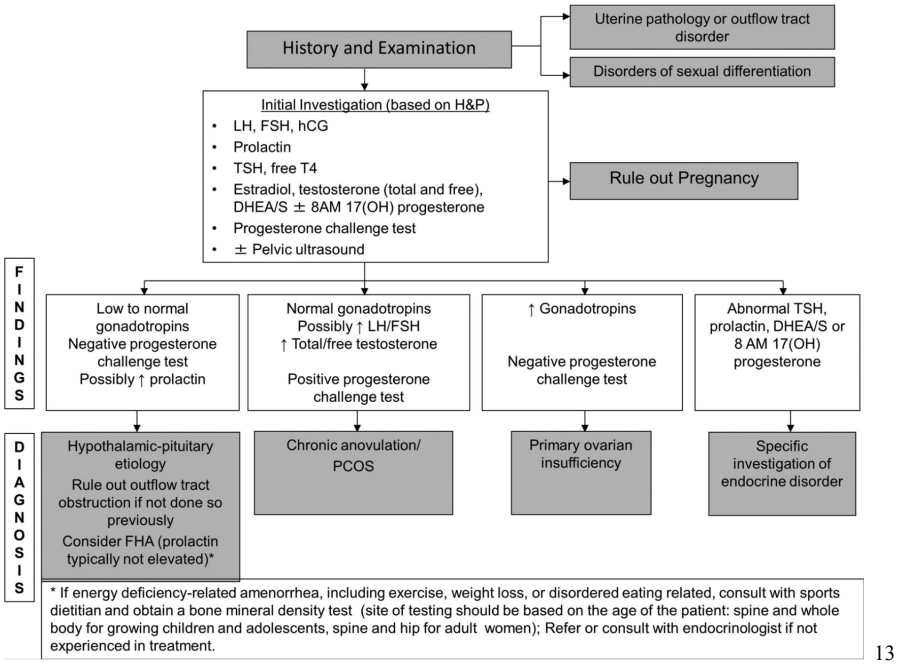

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Figure 2: *Amenorrhea algorithm recommended by the Female Athlete Triad Coalition for athletes with menstrual dysfunction.*

Determining the prevalence of menstrual disturbances is complicated by the normality of the irregularity of menses during the first 2 years post menarche, the use of hormonal contraceptives, as well as potential bias of survey methods.[14,16,17] Menstrual dysfunction should not be diagnosed until the patient is more than 2 years post menarche as approximately 90% of females experience normalization of menses within 2 years of menarche.[14] Of the published studies of menstrual dysfunction among adolescent athletes researched by the American Academy of Pediatrics, only one study included a sedentary control group. The 2009 prospective study included eighty varsity athletes and eighty sedentary students and reported that 54% of the adolescent athletes had documented menstrual irregularity, whereas only 21% of sedentary adolescents reported menstrual irregularity.[4] Other studies show estimates that among collegiate women the

prevalence of secondary amenorrhea to be as high as 65% in collegiate long-distance runners compared to 2-5% of collegiate non-sport women.[10]

Optimal reproductive function relies heavily on the pulsatility of gonadotropin-releasing hormone (GnRH) from the hypothalamus. Upon release from the hypothalamus, GnRH stimulates the anterior pituitary to releases luteinizing hormone (LH) and follicle-stimulating hormone (FSH) in a pulsatile manner. These hormones act on the ovaries to produce estrogen and progesterone to promote normal menstruation.[16,18] Amenorrhea may be partially explained by the imbalance between energy intake and expenditure. Separating EA into its two components, intake, and output, is necessary to induce the etiology of menstrual dysfunction within the triad.

Small studies show that the prevalence of amenorrhea increases from 3% to 60% as training mileage increases from <13 to >113 km/week with subsequent body weight loss from >60kg to <50kg.[18] This data could support the myth that exercise alone induces menstrual dysfunction, however additional research falsifies that ideology.[3,18] The primary driver for menstrual dysfunction related to the triad occurs when EA falls below 30kcal/kg FFM per day independent of exercise variability.[7,18]

Negative energy balance, low fat mass, and stress induce a hypometabolic state that stunts the pulsatile manner of GnRH release in the hypothalamus, resulting in a cascade of effects including suppression of LH pulsatility, manifesting as menstrual dysfunction or eventually Functional Hypothalamic Amenorrhea.[7,16,18] In a randomized, repeated-measures, prospective cohort experiment involving 29 regularly menstruating habitually sedentary women, LH pulsatility was compromised after 5 days of low EA independent of exercise variability. Likewise, increases in exercise in the setting of adequate EA did not not affect LH pulsatility.[18]

While additional studies are needed to support these findings, this often cited study concluded that low EA is the driving force behind menstrual dysfunction.[3,18]

The interrelation between energy availability and menstruation is furthermore connected to the third component of the triad, bone mineralization. Menstrual function is of great importance regarding bone health, as the absence of estrogen favors bone demineralization.[7]

Mechanism: Low Bone Mineral Density

The new definition of the triad recognizes that bone health can range from optimal to osteoporosis. Among female athletes, stress fractures are a major concern, as the incidence may be over 20% in lean-sport athletes compared to 9.2% among all female athletes.[19] Bone remodeling is a process that continues throughout life and is determined by the interaction between bone formation and bone resorption. Exercise normally acts in favor of normal bone metabolism and athletes who perform weight-bearing exercise on average have 5-15% higher bone mineral density (BMD) than nonathletes.[7] However the bone health of the athlete is compromised when EA<30kcal/kg FFM per day.

During times of negative energy balance several hormonal adaptations ensue. Low growth hormone (GH), and insulin-like growth factor-1 (IGF-1), low free T3, and high cortisol levels act to directly suppress bone synthesis. Estrogen, a hormone explained in greater detail in the section Mechanism: Menstrual Dysfunction, is also essential for bone health. Estrogen acts to spur the growth of the axial skeleton by stimulating secretion of GH, as well as accelerate osteoblast function and inhibit osteoclast function. Thus, low estrogen upregulates osteoclast bone resorption and BMD gradually decline as the number of missed menstrual cycles increases. As a result, stress fractures occur more commonly in athletes with menstrual dysfunction and/or low

BMD. One study reported that 28% of adolescent amenorrhoeic endurance athletes reported a history of bone fracture; a stark contrast to the 5-17% of eumenorrheic athletes and controls.[7]

The physiologic interplay between low EA and menstrual dysfunction regarding overall bone health is evident by the dose-response relationship among triad risk factors and the development of bone injury. In a prospective study of 259 female adolescents and young adults it was reported that the risk of bone stress injury increased from "15% to 21% for active females meeting criteria for only 1 risk factor, to 21% to 30%, and 29% to 50% for active females meeting criteria for 2 or 3 simultaneous risk factors. Additionally, in [a] regression analysis, the percentage of active girls and women sustaining an injury increased from 6% to 17%, 21%, and 46% as the number of concurrent triad-related risk factors increased".[9]

Triad-Components and Long Term Effects

Adolescence and young adulthood constitute critical periods of rapid bone mass accrual. On average, adolescent girls achieve 40% of their peak bone mass (PBM) during puberty and 90% of PBM is gained by the age of 18.[7] Only 5-12% of bone mass is gained between the ages 20 to 30.[4,7] If left untreated it is estimated that amenorrhoeic women will lose approximately 2-3% of bone mass per year.[8] This loss is especially problematic if it occurs during years of peak bone development. Due to the regression of mass instead of accrual, athletes who suffer from the triad during years of peak bone development are at a 3-fold higher risk of developing stress fractures compared to same age peers.[2] All athletes with 1 or more high-risk triad factors or 2 or more moderate risk factors should have DXA testing to measure BMD. A Z score of <-1.0 should prompt further evaulation.[4,13]

Figure 3: Indications for DXA Testing[13]	
≥1 High Risk Triad Factors	**Or ≥2 Moderate Risk Triad Factors**
History of a DSM5 diagnosed ED	Currently experiencing or history of DE for 6 months or longer
BMI ≤17.5 $kg \cdot m^{-2}$, <85% estimated weight, or recent weight loss of ≥10% in 1 month	BMI between 17.5 and 18.5 $kg \cdot m^{-2}$, 85-90% estimated weight, or recent weight loss of 5% to 10% in one month
Menarche at ≥16 years or age	Menarche between 15 and 16 years of age
Currently experiencing or history of <6 menses over 12 months	Currently experiencing or history of 6-8 menses over 12 months
Two prior stress reactions/fractures, one high-risk stress reaction/fracture, or a low-energy nontraumatic fracture	One prior stress reaction/fracture
Prior Z-score of less than -2.0 (after at least 1 year from baseline DXA)	

Bone loss associated with the triad is particularly concerning since current studies suggest that full recovery of bone mass may not be possible despite resumption of menses and improved EA; additional studies are needed as results are highly variable amongst studies and long-term follow up is scarce among research. On average, athletes who regain menses with weight gain document a 2-3% improvement in hip and and spine BMD over the course of 22 months.[19] Other studies document slight improvement as well. In the 1984 landmark study testing the correlation between menstruation and bone health, runners with menstrual dysfunction for a duration of 6-10 years reported 14% lower lumbar spine BMD compared to runners who were regularly eumenorrheic or only had intermittent menstrual irregularity. In a 1-year follow-up study to the 1984 report, despite resumption of menses those with a history of amenorrhea or oligorrhea still

had 13% less BMD than those who were eumenorrheic at baseline. Lastly another observational investigation involving amenorrhoeic dancers reported an average 17% increase in spine BMD for those who regained menses, however, BMD did not normalize to healthy control levels after 2 years.[19] These studies underscore the importance of broadening educating regarding the relationship between menstrual cycle and bone health. The potentially irreversible consequences emphasize the need for prevention, screening, early diagnosis, and treatment.

Treatment: It Takes a Team

A multidisciplinary approach to the management of triad-related components is vital. The need for an individualized program addressing the unique needs of each patient cannot be overemphasized. The main goal of treatment is centered on restoring EA through nutrition or caloric intake to an optimal state as evidenced by resumption of menses (grade B evidence).[16] Recommendations should be individualized and consider patient preference, how the athlete fell into negative energy balance, or where the athlete is in the competitive season. For athletes with accidental low EA, referral to a registered dietician or sports nutritionist may be adequate, however for those with DE a referral to a mental health professional is paramount.

Team member(s)	Roles
Athlete	Abides by the guidelines established with team members Communicates concerns (and successes) with team members Keeps lines of communication open
Family members (parents, siblings)	Support and encourage the athlete Create a positive environment for the athlete Provide an environment for success (purchase healthy food choices, set a good example by making good food and exercise choices)
PCP: pediatrician or family practice physician who specializes in sports medicine[72]	Oversees the team Performs PE and orders appropriate studies Orders appropriate medication(s)
Registered dietitian/nutritionist	Educates the athlete regarding general health food choices as well as sport-specific food choices related to training and competition Oversees the restoration of positive energy balance; research suggests that 30 kcal/kg FFM/day is enough to restore a female athlete to a eumenorrheic state May use a 3-day food diary to assess caloric consumption
Gynecologist and/or endocrinologist	May be involved to determine the cause of menstrual dysfunction, especially if typical causes have been ruled out by the PCP
Physical therapist	Provides rehabilitation guidelines for injury management (stress fractures, overuse injuries) and recovery Makes exercise recommendations to promote bone acquisition[36,73–75]
Athletic trainer	Manages injuries and educates the athlete in injury prevention Provides daily support and encouragement for the athlete and maintains open communication with all team members regarding the athlete's progress[73–78]
Psychologist/psychiatrist	Determines if there is an underlying diagnosis (anxiety, depression) that may be triggering Triad-related conditions; the psychiatrist prescribes medication when necessary Provides support and management strategies for coping with the condition

Figure 4[14]**:** *roles and responsibilities of multidisciplinary team members*

Prescribed changes in energy intake should be gradual, beginning with approximately a 20-30% increase in caloric intake over baseline energy needs. The weight gain needed to regain menses has a typical range of approximately 5-10% of body weight or 1-4kg.[13] While measurements of weight and BMI should not be the focus, a successful treatment plan often requires standardized periodic monitoring of body weight and weekly weigh-ins are appropriate early in treatment.[14,19]

Other nonpharmacologic methods aimed to improve BMD include optimizing calcium and vitamin D levels, as well starting weight-bearing exercises with resistance training.[14] The AAP currently recommends a daily intake of 1300mg of calcium for children and adolescents ages 9-18 and 600 IU vitamin D for children and adolescents ages 1-18 years.[4]

Regarding pharmacologic strategies, while estrogen-containing hormone oral contraceptives have shown to be effective in improving BMD among post-menopausal women, they have not proven effective in improving BMD outcomes for premenopausal women impacted by the triad and should not be used for that purpose (grade C evidence).[16]

Guidelines for athletes who want/need to reduce weight or change body composition

Athletes in weight-sensitive sports who seek to lose weight should be guided by healthcare professionals. Primary prevention in the form of education regarding nutrition and mental health to minimize risk of developing DE should be prioritized. To minimize the threat to health, the Internal Olympic Committee (IOC) recommends that weight loss should conducted in the off season and include a thorough body composition assessment prior to intervention, taking a history of past or current status of menstrual function, and conducting a nutritional assessment

for dietary deficiencies. Female athletes should consume sufficient energy to maintain EA>30-45kcal/kg FFM per day and a gradual weight loss at approximately 0.5kg/week is recommended. To induce a weight loss of 0.5kg/week an energy deficit of approximately 500kcal/day is needed. The proportion of body fat should be no lower than 12% for women after weight loss.[8,20]

Prevention is Key: Education

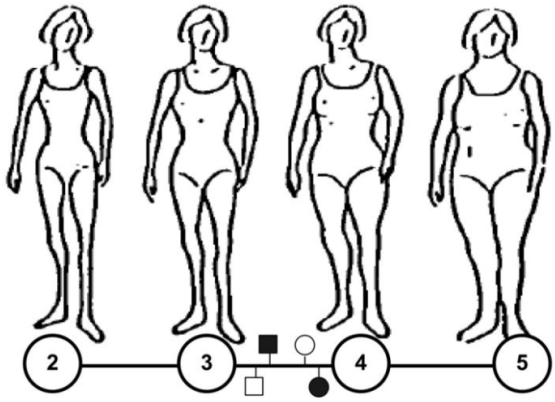
Educational programs regarding the triad and the importance of maintaining optimal EA and regular menstrual cycles must be far reaching and include athletes, coaching staff, trainers, school administration, teammates, family, and friends. While the National Collegiate Athletic Association (NCAA) has promoted 10 strategies to be utilized among coaches and administrators aimed to reduce the likelihood of DE among their athletes, it is not yet clear whether this increased awareness translates to improved outcomes among athletes.[21] Primary prevention efforts to expand athlete knowledge that healthy eating and nutrition (not dieting and weight loss) enhance performance, while promoting awareness that "high performance does not always mean that the athlete is healthy" needs to be prioritized.[8]

Despite the documented increased prevalence of eating disorders (ED) among athletes and its ties to the triad very few studies regarding preventing ED with female athletes have been conducted. Triad specific prevention programs have not been researched. Historically, psychoeducational interventions have been used to prevent ED, however research indicates that while didactic psychoeducation alone is effective at increasing knowledge, it is not effective at reducing ED pathology. Cognitive dissonance-based prevention (DBP) has shown long lasting reductions as high as 60% in ED risk factors being maintained through 2- and 3-year follow-up periods. DBP utilizes the theory that inconsistencies between beliefs and behaviors will produce dissonance and thus promote a change in beliefs. In DBP participants work through a series or

interactive activities with the aim of creating cognitive dissonance against the thin-ideal standard.[15]

In one notable study, eighteen public high schools from northwest Oregon and southwest Washington participated in a prospective randomized trial by The Athletes Targeting Healthy Exercise and Nutrition Alternatives (ATHENA). ATHENA set out to test the efficacy of using combination coach-led and peer-led curriculum-based learning to address such issues as preventing depression, building self-esteem, and deconstructing societal pressures to be thin for high school athletes. The curriculum involved eight 45-minute small group sessions integrated into a team's normal practice time. Squad leaders used manuals with scripted lessons that walked each group through role playing activities including practicing refusal skills and establishing shared healthy behavior expectations. Participants worked together to create public service campaigns to discourage ED.

In short-term follow up reports DBP successfully reduced risk taking behavior. When compared to the control group who did not receive the curriculum, intervention student-athletes reported significantly less ongoing and new use of diet pills ($P<0.05$), less use of athletic enhancing substances ($P<0.05$), less belief in the media ($P<0.005$), and healthier eating behaviors ($P<0.01$). All graduates older than 18 years of age were later included in follow-up mail surveys. One to three years following high school graduation, ATHENA participants reported less disordered eating practices and body-shaping drug use compared to the control group. When asked to select the "most healthy and most attractive female physiques", ATHENA graduates chose a significantly heavier body image compared to the control group ($p<0.05$ and $p<0.01$).[22]



	Most healthy*	Most attractive**
Intervention	3.9 (0.6) ●	3.4 (0.7) ■
Control	3.8 (0.7) ○	3.2 (0.8) □

Mean (S.D.) *p<0.05 **p<0.01

Figure 5: *Most Healthy and Most Attractive Physiques*

Another exploratory study that set out to test the efficacy of peer-lead DBP to reduce the rate of ED included a specific session regarding the female athlete triad. In that session participants learned about the the triad, listed ways to avoid the triad, participated in role plays which included speaking against the sport-specific thin-ideal, and were asked to write a letter to a hypothetical teammate they felt might be at risk for or struggling with an ED or body image issue. Interestingly after that session, seven athletes came forward concerned that they might have the triad. The athletes admitted to not reporting their menstrual irregularity due to misconstrued belief that the question was not important and that they just "wanted to say what they thought the sport medicine staff wanted to hear". Additionally, it was later reported by coaches that several peer leaders had transitioned to serving as "triad police" and continued informing fellow students of the connection between menstrual disorder and low bone density after completing the program.[15]

The AAP suggests utilizing peer-led interventions emulating the ATHENA trial to reduce the prevalence of the triad at the team-level.[4] Peers are well suited to teaching and advocating for one another about the medical complications associated with the triad. While there are multiple limitations to the findings of both of these studies, these studies support that sport team-based learning with peer leaders is effective at reducing the risk of disordered eating and other risk-taking behaviors.[15,21,22] It is important to note that sessions should be tailored to the specific needs of the sport.

Prevention is Key: Screening

Practicing pediatricians, pediatric residents, and medical students should also be educated about the triad so that they can act to detect and promptly refer at-risk athletes.[4] As recommended by the IOC and AAP, athletes ought to be screened for the triad at the time of a well-child visit and/or PPE, especially those in "lean" sports. Multiple screening tools for the triad exist. The AAP recommends a form that contains 8 of the 12 questions suggested by the Female Athlete Triad Coalition. A "yes" to any of the triad questions should prompt further evaluation.

The Female Athlete Triad Coalition's Recommended Screening Questions for the Female Athlete Triad[4]	
Question	Included on the Fourth-Edition PPE Form
1. Do you worry about your weight or body composition?	√
2. Do you limit or carefully control the foods that you eat?	√
3. Do you try to lose weight to meet weight or image/appearance requirements in your sport?	√
4. Does your weight affect the way you feel about yourself?	-
5. Do you worry that you have lost control over how much you eat?	-

6. Do you make yourself vomit or use diuretics or laxatives after you eat?	-
7. Do you currently or have you ever suffered from an eating disorder?	√
8. Do you ever eat in secret?	√
9. What age was your first menstrual period?	√
10. Do you have monthly menstrual cycles?	√
11. How many menstrual cycles have you had in the last year?	√
12. Have you ever had a stress fracture?	√

Figure 6: *Female Athlete Triad screening questionnaire as recommended by the Female Athlete Triad Coalition and the AAP. Answering yes to any of the questions should prompt further questioning regarding the triad.*

Conclusion

The myth that amenorrhea is an expected consequence of exercise must be debunked. Adolescent athletes need to understand the consequences of menstrual function or dysfunction on overall health. An athletic community reinforcing low weight or encouraging athletes to continue to compete at personal risk should no longer be the norm. BDP strategies utilizing peer-based learning is shown to be effective for igniting potential long-term cultural change regarding triad prevention and should be incorporated into practice time. Providers should be educated about the triad so that proper screening and referring can be conducted at PPE. Considering that for most women 90% of peak BMD is achieved by the age of 18, time is of the essence.[7]

Work Cited

1. Curry EJ, Logan C, Ackerman K, McInnis KC, Matzkin EG. Female Athlete Triad Awareness Among Multispecialty Physicians. *Sports Med Open.* 2015;1(1):38.
2. Javed A, Tebben PJ, Fischer PR, Lteif AN. Female athlete triad and its components: toward improved screening and management. *Mayo Clin Proc.* 2013;88(9):996-1009.
3. Temme KE, Hoch AZ. Recognition and rehabilitation of the female athlete triad/tetrad: a multidisciplinary approach. *Curr Sports Med Rep.* 2013;12(3):190-199.
4. Weiss Kelly AK, Hecht S. The Female Athlete Triad. *Pediatrics.* 2016;138(2):e20160922.
5. Aurelia Nattiv MD, FACSM (Chair); Anne B., Loucks PD, FACSM; Melinda M. Manore, Ph.D., R.D., FACSM;, Charlotte F. Sanborn PD, FACSM; Jorunn Sundgot-Borgen,, Ph.D.; and Michelle P. Warren MD. Position Stand: The Female Athlete Triad *American College of Sports Medicine* 2007:1867-1882.
6. Chamberlain R. The Female Athlete Triad: Recommendations for Management. *Am Fam Physician.* 2018;97(8):499-502.
7. Lambrinoudaki I, Papadimitriou D. Pathophysiology of bone loss in the female athlete. *Ann N Y Acad Sci.* 2010;1205:45-50.
8. Mountjoy M, Sundgot-Borgen J, Burke L, et al. The IOC consensus statement: beyond the Female Athlete Triad--Relative Energy Deficiency in Sport (RED-S). *Br J Sports Med.* 2014;48(7):491-497.
9. Barrack MT, Gibbs JC, De Souza MJ, et al. Higher incidence of bone stress injuries with increasing female athlete triad-related risk factors: a prospective multisite study of exercising girls and women. *Am J Sports Med.* 2014;42(4):949-958.
10. Mehta J, Thompson B, Kling JM. The female athlete triad: It takes a team. *Cleve Clin J Med.* 2018;85(4):313-320.
11. Reduce the proportion of adults with osteoporosis — O-01. HealthyPeople.gov. Health People 2030 Web site. https://health.gov/healthypeople/objectives-and-data/browse-objectives/osteoporosis/reduce-proportion-adults-osteoporosis-o-01/data. Published 2030. Updated 9/1/2030. Accessed 9/1/2020.
12. Gibbs JC, Williams NI, De Souza MJ. Prevalence of individual and combined components of the female athlete triad. *Med Sci Sports Exerc.* 2013;45(5):985-996.
13. De Souza MJ, Nattiv A, Joy E, et al. 2014 Female Athlete Triad Coalition Consensus Statement on Treatment and Return to Play of the Female Athlete Triad: 1st International Conference held in San Francisco, California, May 2012 and 2nd International Conference held in Indianapolis, Indiana, May 2013. *Br J Sports Med.* 2014;48(4):289.
14. Thein-Nissenbaum J, Hammer E. Treatment strategies for the female athlete triad in the adolescent athlete: current perspectives. *Open Access J Sports Med.* 2017;8:85-95.
15. Becker CB, McDaniel L, Bull S, Powell M, McIntyre K. Can we reduce eating disorder risk factors in female college athletes? A randomized exploratory investigation of two peer-led interventions. *Body Image.* 2012;9(1):31-42.
16. Klein DA, Paradise SL, Reeder RM. Amenorrhea: A Systematic Approach to Diagnosis and Management. *Am Fam Physician.* 2019;100(1):39-48.
17. The Female Athlete Triad. *Med Sci Sports Exerc.* 2007;39(10):1867-1882.
18. Loucks AB, Thuma JR. Luteinizing hormone pulsatility is disrupted at a threshold of energy availability in regularly menstruating women. *J Clin Endocrinol Metab.* 2003;88(1):297-311.
19. Southmayd EA, Hellmers AC, De Souza MJ. Food Versus Pharmacy: Assessment of Nutritional and Pharmacological Strategies to Improve Bone Health in Energy-Deficient Exercising Women. *Curr Osteoporos Rep.* 2017;15(5):459-472.

20. Sundgot-Borgen J, Meyer NL, Lohman TG, et al. How to minimise the health risks to athletes who compete in weight-sensitive sports review and position statement on behalf of the Ad Hoc Research Working Group on Body Composition, Health and Performance, under the auspices of the IOC Medical Commission. *Br J Sports Med.* 2013;47(16):1012-1022.
21. Joy E, Kussman A, Nattiv A. 2016 update on eating disorders in athletes: A comprehensive narrative review with a focus on clinical assessment and management. *Br J Sports Med.* 2016;50(3):154-162.
22. Elliot DL, Goldberg L, Moe EL, et al. Long-term Outcomes of the ATHENA (Athletes Targeting Healthy Exercise & Nutrition Alternatives) Program for Female High School Athletes. *J Alcohol Drug Educ.* 2008;52(2):73-92.