Advances in Management of the Female Athlete Triad and Eating Disorders

Karie N. Zach, MD,a,b, Ariane L. Smith Machin, PhDc, Anne Z. Hoch, DOb,d,*

Since Congress passed Title IX in 1972, which ensured women would have equal opportunities for interscholastic sports participation in public institutions at the high school and college level, the number of females participating in athletics has increased dramatically. In 1971–1972, there were 3.7 million males participating in high school athletics, compared with 300,000 females. National data gathered for the 2009–2010 high school season noted 4.5 million males and 3.2 million females, which represents virtually a 1000% increase in female athletes.1 A similar trend has also been observed at the collegiate level. Among Division I, II, and III schools, the number of female athletes grew from 74,000 in 1982 to 178,000 athletes in 2008, an increase of 140%.2

There are numerous potential benefits for women who participate in athletics. Female athletes have been shown to have higher self-esteem, better grades, higher graduation rates, less depression, have lower rates of teen pregnancy, and engage less in “high-risk behaviors,” such as drug use.3 However, secondary to a complex combination of endocrine and metabolic factors, female athletes are at risk for a serious health concern: the female athlete triad (triad). The purpose of this article

KEYWORDS

• Female athlete triad • Endothelial dysfunction • Folic acid • Disordered eating

There was no funding needed to support this work.
The authors have no financial disclosure.
a Department of Orthopaedic Surgery, Sports Medicine Center, Medical College of Wisconsin, 8700 Watertown Plank Road, Milwaukee, WI 53226, USA
b Department of Physical Medicine and Rehabilitation, Medical College of Wisconsin, 8700 Watertown Plank Road, Milwaukee, WI 53226, USA
c Women’s Sports Medicine Program, Sports Medicine Center, Medical College of Wisconsin, 8700 Watertown Plank Road, Milwaukee, WI 53226, USA
d Women’s Sports Medicine Program, Department of Orthopaedic Surgery, Sports Medicine Center, Medical College of Wisconsin, 8700 Watertown Plank Road, Milwaukee, WI 53226, USA
* Corresponding author. Department of Orthopaedic Surgery, Sports Medicine Center, Medical College of Wisconsin, 8700 Watertown Plank Road, Milwaukee, WI 53226.
E-mail address: azeni@mcw.edu

doi:10.1016/j.csm.2011.03.005
sportsmed.theclinics.com
0278-5919/11/$ – see front matter © 2011 Elsevier Inc. All rights reserved.
is to provide an update on new issues related to management of the triad, including the relationship between athletic-associated amenorrhea and endothelial dysfunction, the role of optimizing energy availability within the context of disordered eating, amenorrhea, and bone density, and therapeutic approaches to individual, group-based, and pharmacologic interventions.

HISTORY OF THE FEMALE ATHLETE TRIAD

In June 1992, the American College of Sports Medicine (ACSM) convened a panel of experts to address a set of disorders observed in adolescent and young adult female athletes: disordered eating, amenorrhea, and osteoporosis. In 1997, the ACSM position statement defined the triad, and identified the population at risk and the need to screen female athletes. Subsequently, 10 years later, directed by the plethora of research in this area, the ACSM updated its definition of the triad. The 2007 position statement defines the triad as a spectrum of interrelationships among energy availability, menstrual function, and bone mineral density (BMD), which may have clinical manifestations including eating disorders, functional hypothalamic amenorrhea, and osteoporosis. Athletes are distributed along a spectrum between health and disease (Fig. 1). The ideal female athlete is to the far right of the spectrum, which defines optimal health. The athlete may fall anywhere along the spectrum, and medical interventions should not be deferred until the athlete has reached the far left of the spectrum, which defines “significant pathology.” In the 2007 ACSM position statement, a new consequence of athletic associated amenorrhea, impaired endothelium-dependent arterial vasodilation, was introduced, which is discussed in the endothelial dysfunction section elsewhere in this article.

Energy availability refers to a spectrum of eating issues that ranges from optimal energy availability to low energy availability, with or without an eating disorder. Energy availability, based on the work of Loucks, is defined as the amount of “unused” dietary energy remaining after exercise training for all other metabolic processes. Athletic amenorrhea was changed to include a spectrum of menstrual function ranging from eumenorrhea to amenorrhea, including oligomenorrhea, luteal deficiency, and anovulation. The definition of primary amenorrhea was reduced from 16 to 15 years.

Significant changes were also introduced to elucidate the third component of the triad, osteoporosis. The 1997 ACSM position statement used the World Health Organization (WHO) criteria for diagnosing osteopenia and osteoporosis. Numerous studies have established the WHO criteria for fracture risk in postmenopausal women, but assessing the impact of low bone mass on fracture risk to other populations is problematic, primarily because there is no established standard to adjust for bone size, pubertal stage, skeletal maturity, or body composition. The 2007 ACSM statement incorporated the International Society for Clinical Densitometry (ISCD) recommendations, that BMD in premenopausal women and children be expressed as z scores, to compare individuals to age-matched and sex-matched controls. z Scores below –2.0 are defined as “low bone density below the expected range for age” in premenopausal women, and as “low bone density for chronologic age” in children. The ISCD also recommends an established diagnosis of osteoporosis at z score of less than –2.0 and the presence of secondary clinical risk factors including either amenorrhea, eating disorders, hyperparathyroidism, or glucocorticoid exposure. Because athletes participating in weight-bearing sports typically have 5% to 15% higher BMD than nonathletes, the ACSM recommends further clinical investigation for a BMD z score of less than –1.0 in an athlete.

PREVALENCE OF THE FEMALE ATHLETE TRIAD

Recently, numerous studies have offered insightful information and have documented the prevalence of the triad at various competition levels (Table 1). Despite increased awareness and meaningful research, the triad is highly prevalent in athletes. However, varying methodology used in these studies to classify disordered eating, menstrual dysfunction, and low BMD precludes meaningful comparisons.

At the high school level, one study showed that 78% of varsity female athletes had one or more components of the triad, and 50% reported menstrual dysfunction. In another study of high school athletes, 18.2%, 23.5%, and 21.8% met criteria for disordered eating, menstrual irregularity, and low bone mass, respectively. By comparison, both these studies found that a lower percentage of subjects had all 3 criteria (1% and 1.2%, respectively). In Division II collegiate female athletes from 7 different sports, Beals and Hill found 25% of athletes with disordered eating, 26% with menstrual dysfunction, and 10% with low BMD, with a z score of less than –1.0. Similar to the studies in high school athletes, only 2.6% had all 3 components of the triad.

Among young Turkish athletes between 16 and 25 years of age in 10 sports, Vardar and colleagues found a prevalence rate of 1.36%. In female runners between 18 and 25 years of age, Cobb and colleagues reported that 36% met criteria for abnormal menses; those runners with menstrual dysfunction had lower BMD than eumenorrheic runners, and there was an association with disordered eating and menstrual dysfunction. In a study of recreational female triathletes, 60% had at least one component of the triad. Torstveit and Sundgot-Borgen found that 4.3% of elite Norwegian athletes had evidence of all 3 components, with 60% classified as “at risk” for the triad. In Brazilian elite swimmers, 47% had at least one of the components and 1.3% had all 3 components of the triad. Finally, a recent study in 2011 of professional ballet dancers reported a 14% prevalence of the triad and impaired brachial artery vasodilation. Of significant concern, 64% of the dancers had evidence of endothelial dysfunction.

ENDOTHELIAL DYSFUNCTION

The triad of low energy availability, menstrual dysfunction, and low BMD in females is well documented in the literature. There is increasing evidence for a potential fourth
### Table 1
Female athlete triad prevalence studies: methodology

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Disordered Eating</th>
<th>Menstrual Dysfunction</th>
<th>Bone Mineral Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicols19 2006</td>
<td>High school athletes</td>
<td>EDE-Q</td>
<td>1° Amen = 16 y; 2° Amen ≥3 mo; Oligo &gt;35 d</td>
<td>z score &lt; −1, &lt; −2</td>
</tr>
<tr>
<td>Hoch et al,18 2009</td>
<td>High school athletes</td>
<td>EAT-26, 3-day food for EA</td>
<td>1° Amen = 15 y old; 2° Amen ≥3 cycles; Oligo &gt;35 d</td>
<td>z score &lt; −1</td>
</tr>
<tr>
<td>Cobb et al,22 2003</td>
<td>Runners 18–26 y</td>
<td>EDI-DT, EDI-BD, EDI-BT</td>
<td>Amenorrhea/Oligo 0–9 menses/year</td>
<td>g/cm², no T or z score</td>
</tr>
<tr>
<td>Beals and Hill20 2006</td>
<td>College athletes; 7 sports</td>
<td>Selected questions from EDI, EDE-Q</td>
<td>1° Amen = 16 y old; 2° Amen ≥3 cycles, &lt;12 cycles in 12 mo, &lt;6 cycles in 6 mo, &gt;10 d variation in cycle</td>
<td>z score &lt; −1, &lt; −2</td>
</tr>
<tr>
<td>Vardar et al,21 2005</td>
<td>Turkish athletes 16–25 y; 10 sports</td>
<td>EAT-40</td>
<td>1° Amen = 16 y old; 2° Amen ≥3 cycles; Oligo &gt;35 d</td>
<td>T score &lt; −1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Torstveit and Sundgot-Borgen24 2005</td>
<td>Elite Norwegian athletes 13–39 y</td>
<td>EDI-DT, EDI-BD, selected questions, interview</td>
<td>1° Amen = 16 y old; 2° Amen ≥3 cycles; Oligo &gt;35 d; short luteal &lt;22 d</td>
<td>z score &lt; −1</td>
</tr>
<tr>
<td>Schtscherbyna et al,25 2009</td>
<td>Elite Brazilian swimmers 11–19 y</td>
<td>EAT-26, BITE, BSQ</td>
<td>1° Amen = 16 y old; 2° Amen ≥6 mo or period = 3 cycles; Oligo &gt;35 d</td>
<td>z score &lt; −2</td>
</tr>
<tr>
<td>Hoch et al,23 2007</td>
<td>Triathletes</td>
<td>EAT-26, 3-day food for REE</td>
<td>History of amenorrhea</td>
<td>T and z score</td>
</tr>
<tr>
<td>Hoch et al,26 2011</td>
<td>Professional ballet dancers</td>
<td>EDE-Q, 3-day food for EA</td>
<td>1° Amen = 15 y old; 2° Amen ≥3 cycles; Oligo &gt;35 d</td>
<td>z score &lt; −1</td>
</tr>
</tbody>
</table>

<sup>a</sup> Only patients with disordered eating and menstrual dysfunction had bone mineral testing done.

**Abbreviations:**
- 1° Amen: primary amenorrhea
- 2° Amen: secondary amenorrhea
- BITE: Bulimic Investigatory Test Edinburgh
- BSQ: Body Shape Questionnaire
- EA: energy availability
- EAT-26: 26-item Eating Attitudes Test
- EAT-40: 40-item Eating Attitudes Test
- EDE-Q: Eating Disorder Examination Questionnaire
- EDI-BD: Body Dissatisfaction subscale of the Eating Disorder Inventory
- EDI-BT: Bulimic Tendencies subscale of the Eating Disorder Inventory
- EDI-DT: Drive for Thinness subscale of the Eating Disorder Inventory
- REE: resting energy expenditure
- Oligo: oligomenorrhea
component, endothelial dysfunction—a well-established “sentinel” event in the pathogenesis of cardiovascular disease. In addition, cardiovascular disease is the number one cause of death in women. Therefore, early detection of endothelial dysfunction and appropriate, timely therapeutic interventions for the triad are cornerstones of long-term health and longevity in young athletic women with amenorrhea.

The techniques used for assessment of coronary reactivity are invasive and expensive, and not ideal for clinical purposes, especially if serial measurements are required. An alternative approach is to noninvasively examine vascular function in a peripheral vessel, sustaining the belief and understanding that vascular disease is a systemic process. The gold standard for noninvasive assessment of endothelial function is brachial ultrasound scanning. High-resolution ultrasonography can easily be used to assess flow-mediated dilation (FMD) of the brachial artery. Brachial artery diameter and flow velocity are measured both at baseline and following induction of reactive hyperemia by forearm occlusion using a blood pressure cuff. Athletes with normal endothelial function typically show an increase in diameter in the range of 5% to 15%. The authors endorse this as a valid technique, because several studies have shown a positive relationship between brachial artery endothelial dysfunction and coronary artery endothelial dysfunction.

Anderson and colleagues demonstrated a close relation between coronary artery endothelium-dependent vasomotor responses to acetylcholine and FMD in the brachial artery. The positive predictive value of abnormal brachial dilation in predicting coronary endothelial dysfunction was 95%. In a study by Neunteufl and colleagues, FMD of the brachial artery was significantly impaired in patients with coronary artery disease (CAD) compared with controls. Lieberman and colleagues reported that FMD of the brachial artery was significantly lower in young adults (<40 years old) who showed angiographic evidence of CAD, as compared with FMD in age-matched healthy controls.

In turn, the association between brachial artery endothelial dysfunction and coronary artery endothelial dysfunction is important, because coronary artery endothelial dysfunction has been shown to correlate with cardiovascular events. For example, Schachinger and colleagues noted a greater incidence of cardiovascular events (death, unstable angina, myocardial infarction, ischemic stroke) in patients with impaired coronary function. Suwaidi and colleagues noted no cardiac events (cardiac death, myocardial infarction, revascularization) in patients with normal or mild coronary endothelial dysfunction, compared with a cardiac event rate of 14% in those with severe coronary endothelial dysfunction. Moreover, similar findings by Halcox and colleagues and Targonski and colleagues identified that coronary endothelial dysfunction is independently associated with an increased risk of cardiovascular events.

A few important studies document a detrimental relationship between athletic amenorrhea and brachial artery endothelial dysfunction. Hoch and colleagues studied 32 female collegiate athletes who ran at least 25 miles per week. Baseline brachial artery diameters were similar among amenorrheic, oligomenorrheic, and control groups. However, brachial artery FMD was significantly lower in amenorrheic athletes (1.08% ± 0.91%) compared with the oligomenorrheic athletes (6.44% ± 1.28%) and the control group (6.38% ± 1.38%). Rickenlund and colleagues noted similar results, with a significant decrease in FMD of the brachial artery in amenorrheic endurance athletes compared with oligomenorrheic and eumenorrheic athletes.

Finally, a strong case for routine assessment of FMD may be made based on the data from the recent 2011 study on professional ballet dancers, 64% of whom had decreased FMD of the brachial artery. Of the ballet dancers with decreased FMD,
72% reported menstrual dysfunction, 14% had been treated with oral contraceptive (OC) therapy secondary to amenorrhea, and 14% were eumenorrheic. There was no suitable explanation for decreased FMD in the eumenorrheic dancers, and it was beyond the scope of that study to determine whether they were ovulatory. Possible explanations include nutritional deficiencies or decreased aerobic fitness. Nevertheless, this study showed correlations both between abnormal FMD and estrogen levels, and abnormal FMD and low BMD (Fig. 2). These correlates are important because currently, FMD testing is not performed routinely. It must be noted that there were important limitations to the aforementioned studies that included only a small, “select” population of athletes, and large-scale studies are needed for further evaluation.

TREATMENT OF ENDOTHELIAL DYSFUNCTION IN THE FEMALE ATHLETE

Studies have examined the potential for treating impaired FMD. In men, regular aerobic exercise has been shown to restore endothelial-dependent vasodilation.43–45 The mechanism of improved endothelial dysfunction is thought to be partially due to increased nitric oxide (NO) bioavailability.43 In female athletes, Rickenlund and colleagues46 demonstrated significantly increased FMD after 9 months of treatment with a low-dose, monophasic combined OC (30 µg ethinyl estradiol and 150 µg levonorgestrel). FMD in amenorrheic endurance athletes increased from 1.42% ± 0.98% before OC treatment to 4.88% ± 2.2% after OC therapy. This finding demonstrates that OC therapy can potentially restore impaired endothelial function mediated via the protective effects of estrogen.

However, in 2002 the Women’s Health Initiative (WHI) study found a 22% increased risk of cardiovascular events in postmenopausal women using hormone replacement therapy that included both estrogen and progestin.47 In addition, a recent 2010 follow-up study of the WHI trial published in the Journal of the American Medical Association noted increased incidence of breast cancer and breast cancer mortality in postmenopausal women treated with estrogen and progestin.48 Therefore, although this risk has been described in postmenopausal women, alternative therapeutic interventions to restore endothelial function must be investigated in young athletes.

Folic acid supplementation is a potential option for treatment. Folates have been suggested to contribute to the endogenous regeneration of tetrahydrobiopterin, an essential cofactor for endothelial NO synthase production,49 which may result in increased NO production following daily supplementation (Fig. 3). In vitro data suggest a direct antioxidant effect of folates on vasculature,50 thereby increasing NO bioavailability and improving FMD.51 There have been numerous, small-scale studies that have documented improvement of endothelium-dependent vasodilation with folic acid supplementation.

Folic acid has been documented to improve endothelium-dependent vasodilation in men with hypertension, CAD, congestive heart failure, diabetes mellitus type 2, hyperhomocystinemia, and peripheral vascular disease.52–58 These studies suggest that in these patient populations, high-dose folic acid may offer vasculoprotective effects. There have been several recent studies on “select” female athlete populations noting improved FMD after folic acid supplementation (Table 2). Hoch and colleagues59 showed that folic acid supplementation, 10 mg/d for 4 to 6 weeks, significantly improved brachial artery FMD in eumenorrheic women runners when compared with a placebo, control group. A separate study by Hoch and colleagues60 in amenorrheic female runners noted improvement of brachial artery FMD after 4 weeks of folic acid supplementation at a dose of 10 mg/d. A more recent study in female ballet
Fig. 2. Correlation between abnormal FMD (%) and estrogen and whole-body BMD z score. (From Hoch AZ, Papanek P, Szabo A, et al. Association between the female triad athlete and endothelial dysfunction in dancers. Clin J Sport Med 2011;21(1):123; with permission.)
dancers showed improved FMD after 4 weeks of folic acid supplementation at a dose of 10 mg/d.61

The risks of folic acid supplementation are small. Folic acid is a water-soluble vitamin that is regularly eliminated in the urine. Multiple studies have shown that 10 mg daily is safe and improves FMD.54,56,57,59,60,62 At a dose of 10 mg daily, there have been no studies that have reported side effects54,56,57,62,63 and significantly, the US Food and Drug Administration (FDA) Med Watch system does not list any adverse effects of folic acid at this dose. However, side effects such as upset stomach, sleep disturbances, and skin problems have been noted at doses higher than 15 mg/d. High doses of folic acid have also been shown to provoke seizures in patients taking anticonvulsant medications.64 The National Institutes of Health have advised caution in patients with concurrent vitamin B12 deficiency, because folic acid supplementation may silently conceal and exacerbate deficiency.65

Fig. 3. Production of nitric oxide (NO) by endothelial cells. Folates have been suggested to participate in the regeneration of tetrahydrobiopterin (BH4), an essential cofactor in the production of NO. Ach, acetylcholine; ecSOD, extracellular superoxide dismutase; eNOS, endothelial nitric oxide synthase; L-Arg, l-arginine; ROS, reactive oxygen species. (From Gielen S, Hambrecht R. Effects of exercise training on vascular function and myocardial perfusion. Cardiol Clin 2001;19(3):361; with permission.)

<table>
<thead>
<tr>
<th>Patients</th>
<th>Treatment</th>
<th>Dose</th>
<th>Time</th>
<th>FMD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eumenorrheic runners59</td>
<td>Folic acid</td>
<td>10 mg</td>
<td>4–6 wk</td>
<td>3.5 ± 0.6 vs 0.1 ± 0.2 (folic acid vs placebo therapy)</td>
</tr>
<tr>
<td>Amenorrheic endurance athletes46</td>
<td>Oral contraceptive</td>
<td>30 µg ethinyl estradiol &amp; 150 µg levonorgestrel</td>
<td>9 mo</td>
<td>1.42 ± 0.98 → 4.88 ± 2.2 (after oral contraceptive therapy)</td>
</tr>
<tr>
<td>Amenorrheic runners60</td>
<td>Folic acid</td>
<td>10 mg</td>
<td>4 wk</td>
<td>3.0 ± 2.3 → 7.7 ± 4.5 (after folic acid therapy)</td>
</tr>
<tr>
<td>Professional ballet dancers61</td>
<td>Folic acid</td>
<td>10 mg</td>
<td>4 wk</td>
<td>2.9 ± 1.5 → 7.1 ± 2.3 (after folic acid therapy)</td>
</tr>
</tbody>
</table>
a recent study suggested that folic acid supplementation may increase the risk of colorectal adenoma in patients with a known history of colorectal adenomas. Despite potential side effects at higher doses, the prospective benefits from low-dose folic acid supplementation in athletes may outweigh the risks, especially in athletes opposed to estrogen supplementation. Clinicians could potentially recommend folic acid on a daily basis to athletes with endothelial dysfunction; however, large-scale studies are needed to accurately determine the lowest efficacious dose and optimal duration of treatment.

Disordered Eating: Energy Availability

Treatment of the triad often involves a multidisciplinary team approach including a sports physician, registered sports dietician, certified sports psychologist and, optimally, family, coaches, and friends. The main focus of treatment is to remedy low energy availability and provide emotional support, which can be an especially challenging task if an athlete has a concomitant eating disorder. The first step is to meet with a sports dietician who is familiar with the clinical implications of the triad and is knowledgeable with calculating energy availability. “Energy availability” is defined as the amount of dietary energy remaining for other bodily functions after exercise training. The gold-standard approach is to have the athlete fill out a 3-day food diary, including 2 weekdays and 1 weekend day, and to weigh food portions. The dietician should always review proper meal portion sizes before the athletes record food weight. During this period, the athlete can also wear an accelerometer to determine how many calories are being expended. Subsequently, the dietician can use the food record and accelerometer data to appropriately calculate energy availability and formulate a meal plan to accurately correct low energy availability.

Support for a causal relationship between energy availability and menstrual cycles was provided by Williams and colleagues, who demonstrated that in exercising monkeys, amenorrhea could be reversed by increasing food intake while maintaining a daily training program. If the energetics of the restoration of menstrual cycle in monkeys holds true for women who are undergoing equivalent training, an approximately 20% increase in calories would lead to ovulation in about 2 months, and a 50% increase in calories would lead to ovulation in about 2 weeks. In a study of 100 adolescent girls with anorexia nervosa, 86% of patients resumed menses within 6 months after increasing their weight to 90% of standard body weight.

In addition to reversal of low energy availability and amenorrhea, adequate calcium and vitamin D supplementation, and weight training are effective therapies for the third component of the triad, low BMD. A case report by Fredericson and Kent showed a significant increase in BMD in a female athlete after gaining weight. This finding is encouraging because it contradicts the concept that low BMD is irreversible in adolescents and young athletes. Weight-training programs have been shown to increase BMD, and should be implemented in all athletes with low BMD. Antiresorptive therapies, for example, bisphosphonates, have not been tested and are not approved by the FDA in younger patients with low BMD. The use of bisphosphonates is controversial as this population secondary to their potential for teratogenicity. Furthermore, bisphosphonates can linger in mineralized bone for several years.

EATING DISORDERS

Sport participation for the female athlete has become a possible risk factor for developing an eating disorder. In a survey of National Collegiate Athletic Association (NCAA) institutions, Dick found that 93% of the reports from athletic directors
indicated that eating disorders occurred among their female athletes. Eating disorders may increase the risk of depressive disorders, anxiety disorders, substance abuse, and health problems. Furthermore, eating disorders can increase distress and functional impairment, as well as inpatient hospitalization, suicide attempts, and mortality. Because of these potentially negative, long-term consequences, it is imperative that thorough and expeditious treatment be available and readily accessible to athletes.

**Advances in Multidisciplinary Team Approach**

An approach to the treatment and management of symptoms of eating disorders involves the use of a multidisciplinary team (team). The method was initially recommended as a primary way to manage athletes with symptoms of eating disorders more than 20 years ago, and while this approach is largely unchanged, the complexity and degree of involvement of individuals has changed. It has been suggested that the team should consist of a broader range of individuals, including coaches, athletic trainers, team physicians, sport dieticians, sport psychologists, and perhaps sports administrators. Bonci and colleagues also suggest that registered sports dieticians should have an expertise in treating the athletic population. Moreover, the ACSM 2007 position statement emphasized that the first goal of treatment should be to increase energy availability by increasing energy intake and/or reducing energy expenditure.

Thompson and Sherman have suggested several considerations while assembling a team. First, the sports medicine physician should be the main coordinator for the athlete’s care. Second, the physician determines the degree of involvement of each team member and ensures that his or her contribution is therapeutic. Third, each of the team members must operate within acceptable ethical guidelines. The team should be used for a variety of roles and needs to be aware of the various aspects of the treatment process. The team should have a strategy for approaching high-risk or symptomatic athletes, and recognize that the timing of the therapeutic approach to an athlete is a pivotal component of good care. The team members should have a good relationship with the athlete, or at least be comfortable discussing sensitive and important issues. Members of the team should also work together to address standards for safely returning the athlete to participation, adequately monitor symptoms and therapeutic strategies, and potential communication with teammates and the media.

Trattner-Sherman and Thompson recommend declaring the athlete “injured” and treating the athlete with an eating disorder akin to an athlete with a physical injury, which would typically prevent athletic participation. Confidentiality must not be compromised unless the athlete has explicitly agreed to communicate with all members of the team. In addition, the athlete should be informed regarding scheduled meetings of the multidisciplinary team to discuss their progress and/or evaluation of therapy. During the management process, it may be helpful to generate a “contract” that outlines clear and concrete expectations that will need to be accomplished by the athlete before returning to sports participation. This agreement would help eliminate ambiguity about the recovery process and create leverage for the athlete to be motivated to engage in healthier behaviors.

**Advances in Psychotherapy**

It is imperative that the clinician treating the individual has special expertise and knowledge regarding the athletic population, as there are many unique aspects to sport that need to be considered and managed. While the athlete is working with...
the multidisciplinary team, he or she may use individual therapy, group therapy, or pharmacotherapy, and may be hospitalized depending on the severity of symptoms. Individual therapy is one of the most common treatment approaches, as this provides an opportunity to gain both a greater understanding of the psychological roots of eating disorders and whether the eating disorder predated the athlete’s involvement in athletics. In addition, psychotherapy is helpful for the athlete to learn more effective coping strategies (eg, relaxation techniques, assertiveness training, identifying and modifying negative thinking patterns), manage eating-disorder symptoms (eg, identify “risky” moods or situations, learn how to engage in alternative behaviors, engage in self-monitoring), and possibly restore weight while alleviating the anxiety that can surround this phase of treatment.

Cognitive-behavioral treatment (CBT) for eating disorders is currently considered to be the most effective treatment, especially for bulimia. CBT incorporates a broad range of treatment approaches, but most are conceptualized using Beck’s cognitive therapy. In CBT, a client undergoes approximately 20 treatment sessions with a focus on 3 major stages. The main goals include normalization of eating, reducing attempts to diet, eliminating binge eating and purging, and altering beliefs, thoughts, and values that maintain the patterns of disordered eating. For example, in one phase of treatment athletes would be asked to identify thoughts immediately preceding an identified event or trigger (eg, eating a particular type of food, not engaging in regular exercise) and create counterstatements that would oppose their automatic thoughts that they could use to manage some of the intense and maladaptive thought patterns that contribute to the maintenance of unhealthy attitudes and behaviors. This same treatment approach can be used for those experiencing symptoms of anorexia, with only minor variation and typically an extended time frame.

Despite the potential advantages of CBT, other studies have suggested that CBT is unsupportive for about 50% of treated individuals. Therefore, researchers have proposed that comorbidity with other disorders and other factors related to the athlete may contribute to therapeutic effectiveness. For example, CBT directly attempts to change the content of maladaptive eating-related cognitions; however, some of the egosyntonic cognitions associated with eating disorders can be resistant to direct modification efforts. Consequently, new approaches to treatments for eating disorders have been investigated.

A more recent intervention, acceptance and commitment therapy (ACT), relies on the premise that a client’s reaction to a thought or feeling is changeable, but that the internal experience is unaffected. ACT attempts to teach clients how to be more accepting of distressing cognitions and feelings because attempting to control unwanted experiences is often ineffective and occasionally may prove to be counterproductive. A treatment protocol for eating disorders has been developed and applied, and the two central components of ACT, mindfulness and acceptance, are associated with better treatment outcomes in eating disorders. Another reason why ACT might be particularly useful for the treatment of eating pathology relates to the treatment process of identifying and clarifying individuals’ ultimate life values. By helping identify core values and broader goals emanating from them (eg, achieve pregnancy in the future), ACT helps clients to both reorient toward more meaningful activities and to become more willing to tolerate internal discomfort for the sake of what they identify as “truly important.”

In addition to CBT and ACT, dialectical behavior therapy (DBT) has also received attention for its promising results. DBT, a cognitive-behavioral treatment originally developed for women with borderline personality disorder, is a comprehensive, multimodal, skills-based treatment that balances behavioral strategies with
acceptance-based strategies and targets life-threatening, therapy-interfering, and quality-of-life interfering behaviors. During treatment, DBT addresses deficits in interpersonal relationships, affect regulation, and impulse control. Although DBT has been very helpful for individuals who have been diagnosed with an eating disorder and concurrent disorder (such as borderline personality disorder), researchers have suggested that DBT is effective for those without Axis II pathology. For example, researchers have postulated that eating pathology represents a maladaptive method to regulate negative affect, and that the techniques within DBT can assist in reducing symptoms of eating disorders. In one study, Safer and colleagues applied DBT to individuals diagnosed with binge and purge behaviors, and found that 28.6% were abstinent from binge eating and purging behaviors as opposed to zero participants in the wait-list control condition.

Finally, enhanced cognitive behavioral therapy (CBT-E) is a transdiagnostic approach applicable to all types of eating disorders, though modifications are made for significantly underweight individuals. Fairburn developed two forms of CBT-E; one focuses solely on eating disorders, whereas the other explores low self-esteem and extreme perfectionism issues. Although CBT-E is based on a cognitive-behavioral approach, it does not place as much importance on traditional CBT methods such as formal thought records, cognitive restructuring, Socratic reasoning, and formal behavioral experiments. Instead, the treatment explores the commonly encountered traits of clinical perfectionism, core low self-esteem, and interpersonal difficulties. These components are important to address because if they are not resolved, an individual may be more resistant to treatment and experience a relapse of eating-disorder symptoms. In one study, Fairburn and colleagues found that the majority of patients (n = 154) responded rapidly to CBT-E, and the changes were sustained over the following year, the time at which relapse is most likely to occur. Approximately two-thirds of those who completed treatment had a complete and lasting response, with many of the remainder showing substantial improvement. To date, there have not been any studies investigating CBT-E within the athlete population. It would be helpful to continue to investigate the effectiveness of this approach within this population, as it seems to be a promising treatment protocol for the management of all eating disorders.

Advances in Pharmacotherapy

Although several psychotherapies have been shown to be effective in reducing eating and associated psychopathology, growing research suggests that pharmacotherapies may also be effective, and can be an adjunct to, traditional therapy. Selective serotonin-reuptake inhibitor (SSRI) antidepressants, antiepileptic drugs, the selective norepinephrine reuptake inhibitor atomoxetine, the atypical antipsychotic olanzapine (Zyprexa) and antiobesity medications have all shown promise in reducing a variety of symptoms of eating disorders. However, among the drug treatments, SSRIs (Paxil and so forth) are the first-line treatments of choice, especially in primary care, and may be a good initial option if an athlete presents with symptoms of disordered eating. The scope of this article does not allow all details to be provided regarding all uses and research in anorexia, bulimia, and binge-eating disorder. For more information regarding pharmacotherapy with anorexic patients, refer to Crow and colleagues, Pike and colleagues, or Zhu and Walsh. For an in-depth review of pharmacotherapy research with bulimic patients, refer to Mitchell and colleagues or Zhu and Walsh. As a general guideline, when incorporating pharmacotherapy with athletes it is important to be aware of the level of competition, and the possible ban on various substances by different
governing bodies within the athletic context.\textsuperscript{127} The NCAA\textsuperscript{128} indicates that there is no complete list of banned drug examples. Athletes are therefore advised and encouraged to check and review, with their athletic department medical staff, the labels of all products, medications, and/or supplements prior to consumption.

**Advances in Intervention Programs**

Whereas individual therapy typically affects the individual in treatment, prevention and intervention programs aim to target and modify attitudes and behavior within a larger group setting. Initial prevention programs for eating disorders consisted primarily of didactic psychoeducation, and were usually directed toward adolescents.\textsuperscript{129,130} The rationale of these programs was that information about the adverse effects of eating disorders would prevent individuals from using maladaptive methods as a means of weight control.\textsuperscript{131} For example, most programs taught students about natural changes in body composition associated with physical maturation, and encouraged development of a positive body image.

Although the first phase of intervention programs had good intentions, they were not entirely effective in reducing eating pathology.\textsuperscript{131} Therefore, the second phase of eating-disorder prevention programs were developed. These programs were also didactic in format, and included additional information on resisting the sociocultural pressures of thinness and suggestions for healthy-weight–control methods.\textsuperscript{132} These programs were developed under the pretext that sociocultural pressures were extremely important in the development of eating disorders, and that extreme dieting and compensatory behaviors emerged as a result of trying to meet “appropriate” cultural standards of weight. For instance, these programs included components that aimed to facilitate knowledge, to resist negative media images about eating and “body image,” and to develop coping skills to resist sociocultural pressures regarding thinness and dieting.

Recently, the prevention programs have targeted high-risk populations, using interactive groups focusing on risk factors that have been researched as predictors of eating disorders.\textsuperscript{131} The effects of these programs offered to high-risk individuals have been shown to be more effective than universal programs offered to all available participants.\textsuperscript{133} It has been hypothesized that the individuals with initially prominent symptoms may be more willing to integrate themselves into therapeutic eating-disorder programs, enhancing the desired effects.\textsuperscript{134} These individuals may be experiencing more distress, motivating them to become actively engaged in the program. In addition, the interactive programs are more likely to involve exercises that allow participants to apply the skills taught in the intervention, which may increase skill acquisition.\textsuperscript{131}

Athletes Targeting Healthy Exercise and Nutrition Alternatives (ATHENA) is a universal, selective program for middle and high school sport participants that is scripted, coach facilitated, and peer led.\textsuperscript{135} The program was created to decrease risk factors for eating disorders and the use of diet and performance-enhancing drugs. The curriculum includes components to build skills to control mood, counter media influences, and provide information on sports nutrition and strength training. In addition, information is presented on factors that contribute to the risk of disordered eating and the use of body-shaping drugs. The curriculum was provided to sports teams in small groups led by an assigned peer leader in 8 45-minute sessions. Although the ATHENA program initially showed significant decreases in the targeted risk factors and reduced the ongoing and new use of body-shaping substances,\textsuperscript{135} 1 to 3 years later athletes did not show continued reductions in eating pathology.\textsuperscript{136}
<table>
<thead>
<tr>
<th>Therapy</th>
<th>Empirical Support</th>
<th>Theoretical Underpinnings</th>
<th>Athlete Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive-Behavioral Therapy (CBT); Beck</td>
<td>Brownley et al,93 2007</td>
<td>Focuses on identifying and modifying thoughts, emotions, and behaviors; focuses on the present; can be brief or long term</td>
<td>Gains an awareness of automatic thoughts, mood shifts, and behaviors that are affecting food choices, body image distortions, and ability to maintain weight</td>
</tr>
<tr>
<td></td>
<td>Shapiro et al,94 2007</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wilson et al,95 2007</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceptance and Commitment Therapy (ACT);</td>
<td>Heffner et al,102 2002</td>
<td>Uses mindfulness and acceptance strategies; observing and experiencing versus directly trying to deliberately modify negative thoughts, emotions, or behaviors</td>
<td>Begins to “just notice,” accept, and embrace uncomfortable or negative thoughts/emotions toward food, eating, or body size and shape</td>
</tr>
<tr>
<td>Hayes and Wilson99, 1994</td>
<td>Baer et al,103 2005</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kristeller et al,104 2006</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dialectical Behavioral Therapy (DBT);</td>
<td>Safer et al,109 2001</td>
<td>Targets emotional regulation by teaching adaptive skills to foster self-monitoring, regulation of emotions, and distress tolerance; emphasizes acceptance, change, and mindful awareness</td>
<td>Observes their emotional regulation cycle and patterns, understands and accepts environmental or personal cues that impact mood, disordered eating, or body distortions; take action</td>
</tr>
<tr>
<td>Linehan105 1993</td>
<td>Telch et al,142 2001</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ben-Porath et al,143 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhanced Cognitive Behavioral Therapy</td>
<td>Fairburn et al,112 2009</td>
<td>Offers two approaches, one focusing on eating disorders and the other exploring low self-esteem and perfectionism; uses a highly structured yet personalized approach to tackling core dysfunctional beliefs and eating behavior</td>
<td>Identifies underlying thought processes and personality characteristics contributing to the development and maintenance of disordered eating, and explores the impact of these variables on self-esteem, mood, and interpersonal relationships</td>
</tr>
<tr>
<td>(CBT-E); Fairburn110 2008</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissonance-Based Prevention (DBP); Stice</td>
<td>Matusek et al,144 2004</td>
<td>Attempts to elicit inconsistencies between eating and body size/shape attitudes and behaviors through activities, discussion, and participating in body activism; develops healthier attitudes and behaviors by conclusion of group</td>
<td>Identifies and discusses cultural and sport-specific body ideals, recognizes how participating in this dynamic has emotional and physical costs, identifies alternative attitudes and behaviors, participates in body activism, and practices resisting ideals</td>
</tr>
<tr>
<td>et al,137 2008</td>
<td>Green et al,145 2005</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Becker et al,146 2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Becker et al,139 2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Another approach that has generated some positive findings among eating-disorder symptoms involves dissonance-based prevention programming. The dissonance-based approach attempts to elicit inconsistencies between attitudes and behaviors through various activities and discussions, with the ultimate intention of reestablishing a “new” consistency that is congruent with healthier and more adaptive functioning. For example, participants will take a stand against the socioculturally prescribed “thin-ideal” and engage in other acts of activism (e.g., identifying behaviors previously deemed “unacceptable,” such as wearing shorts, and engaging in this behavior at least once) which, according to dissonance theory, will begin to influence their behaviors to be more congruent with their new attitudinal change.

The Female Athlete Body Project is a multiyear program based on the work by Stice and colleagues that uses a cognitive-dissonance approach for the prevention of eating disorders within the athlete population. The program was peer led and occurred in 3 sessions of 75 to 80 minutes. Topics included definitions of the sport-specific and athlete-specific thin ideal, factors that enhance sport performance, and the female athlete triad. Results suggest that participants experienced significant decreases in the thin-ideal internalization, negative affect, eating pathology, and body dissatisfaction post treatment, and that those changes were maintained at 6-week follow-ups for all measures except thin-ideal internalization.

Further, Becker and colleagues pilot-tested the effectiveness of an athlete-modified peer-led version of dissonance-based prevention and healthy-weight intervention at reducing eating-disorder risk factors in female college athletes. In their study, 157 student athletes representing 9 varsity sport teams at a Division III University were enrolled. The program consisted of two phases: the first phase consisted of the participation in the Female Athlete Body Project, and in the second phase participants were randomly assigned to the dissonance-based or healthy-weight–based interventions. Significant, positive findings in both the dissonance and healthy-weight groups included reductions in thin-ideal internalization, dietary restraint, bulimic pathology, shape and weight concern, negative affect at 6 weeks, bulimic pathology, shape concern, and negative affect at 1-year follow-up. In addition, the investigators suggested that the use of the Female Athlete Body Project led to a noticeable increase in students spontaneously seeking medical consultation for the triad.

Thus these recent interventions that focus on specific risk factors for eating disorders will be more effective than those that focus on nonestablished risk factors. Specifically, programs that focus on increasing resistance to sociocultural pressures for thinness, body satisfaction, self-esteem, and healthy-weight management skills cause greater and more positive behavioral and attitudinal changes than those that consist of only psychoeducation or use variables that are not established eating-disorder risk factors, such as stress and coping skills. Specific information regarding each therapeutic approach and applications to athletes are shown in Table 3. It is imperative that researchers continue investigating promising programs, as there is a major lack of research and interventions specifically designed for the unique needs of the athlete population.

SUMMARY

While the prevalence of all 3 components of the triad is low in female athlete populations, there is a much higher risk of having at least one of the components. One can argue that having just one component of the triad is a red flag that needs to be addressed to prevent the other 2 components. It is extremely challenging to compare prevalence studies, as each study uses different methodological tools for screening.
As a general recommendation, there should be a consensus on which screening tools to use for disordered-eating menstrual dysfunction, and on reporting low BMD for research purposes. Endothelial dysfunction is a potential fourth component, which is concerning for future cardiovascular risk, public health issues, and athletic performance. Folic acid should be considered a potential safe and inexpensive therapeutic treatment to restore endothelial-dependent vasodilation, although the optimal dosage and length of treatment is yet to be defined. There are various options for treating disordered eating in the athletic population, including a multidisciplinary team that can treat low energy availability. Athletes are owed a “duty of care,” and high schools, colleges, universities, and various athlete-focused clinics should develop and offer a comprehensive education and treatment program that includes education, screening, an intervention protocol, and a treatment plan. Consistent school policies to protect the athlete are also needed.

ACKNOWLEDGMENTS

The authors would like to thank Karen Gonzalez, BS, MS, for her editorial expertise.

REFERENCES


