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Make no bones about it!

WE JUST CELEBRATED 45 years since the passing of Title IX, which opened the floodgates for women's participation in sports. According to a report by the National Collegiate Athletic Association,¹ in this interval, the participation rate of high school girls increased 1,000 percent, and Division I colleges have the highest female athletic participation rate, with women accounting for 46.7% of athletes.

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Participating in competitive sports is especially important for women because it increases self-confidence. Indeed, there is a direct relationship between athletics and women in leadership roles. A 2013 Ernst and Young survey of 821 high-level executives demonstrated that 90% of the women and 96% of the women in chief executive positions had played sports.²

Twenty years after Title IX was passed, physicians identified a triad of symptoms commonly seen in female athletes. The original definition of the female athletic triad consisted of eating disorders, irregular menstrual cycles, and reduced bone mineral density (BMD).³ Malnutrition led to abnormalities in the menstrual cycle, which in turn affected bone density. The triad was thought to most commonly affect women participating in weight-dependent or judging sports, such as gymnastics, ice-skating, and endurance running. However, many athletes remained undiagnosed because specific criteria for the triad diagnosis remained elusive.

In 2007, the American College of Sports Medicine updated the diagnostic guidelines, defining the female athlete triad as a constellation of abnormalities in energy availability,

menstrual function, and BMD.⁴ Each of these 3 components is part of a spectrum ranging from normal to varying degrees of pathology. Thus, the female athlete no longer needs to demonstrate pathology in all 3 components of the triad to be diagnosed with the syndrome. The presence of 1 or 2 of the components on the pathologic side of the spectrum falls under the umbrella of the triad and may meet the criteria for diagnosis, prompting further assessment.

In 2014, the International Olympic Committee (IOC) coined the term *relative energy deficiency in sport* (RED-S).⁵ The IOC authors intended for RED-S to be a more comprehensive and broader definition for the triad. As defined in the IOC consensus statement, RED-S is "impaired physiological function including, but not limited to, metabolic rate, menstrual function, bone health, immunity, protein synthesis, [and] cardiovascular health caused by relative energy deficiency."⁵ The statement indicates that the underlying problem is "energy deficiency relative to the balance between dietary energy intake and energy expenditure required for health and activities of daily living, growth, and sporting activities."⁵ The IOC consensus statement also expands the vulnerable population, discussing the susceptibility of male athletes, athletes of nonwhite ethnicity, and athletes with a disability.

Although there is some contention as to how we should refer to this syndrome, the most important facet is that it can be identified in an office setting. Awareness is key to prevention. Unfortunately, in a 2015 survey of 931 physicians, only 37% could identify the 3 components of the triad.⁶ If you do not ask your patients about their nutrition, eating habits, and menstrual cycle, it is not possible to identify any potential problems.

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■ WHY IS THIS SO IMPORTANT?

Simply stated, it is important to diagnose and treat the triad syndrome to maintain optimal bone health. About 90% of peak bone mass is acquired by age 18. Bone density continues to build until about the age of 25, after which it is only possible to maintain. If young athletes are losing bone density, it cannot be replaced. Athletes who have a relative energy deficiency and are not maximizing bone growth will potentially struggle with lower bone mineral density later in life. Early awareness of bone health is paramount to sustaining it as we age.

Osteoporosis, often called a silent disease, affects more than 75 million men and women in the United States, Europe, and Japan.⁷ According to the International Osteoporosis Foundation, more than 8.9 million fractures are secondary to osteoporosis worldwide each year. Astoundingly, this epidemic equates to an osteoporotic fracture every 3 seconds.⁸

As physicians, we need to do what we can to prevent this, and the easiest prevention is maintaining bone health and adequate nutrition early in life. We know that weight-bearing exercise is important for bone health, but it is counterintuitive to think that active patients who are running and playing sports may be negatively affecting bone health if they have a relative energy deficiency.

Many females (professional athletes, competitive athletes, or just women who want to

stay active) exercise excessively and restrict calories to lose or maintain weight. This can be a formula for disaster resulting in a sidelining bone stress injury. A stress fracture occurs when bone experiences more stress or impact than it can handle from overtraining or increasing training too quickly, not providing enough time for the bone to strengthen. Stress fractures can also occur when bone mineral density declines, lowering the impact threshold. This is most often a direct result of a relative energy deficiency or poor nutrition. The incidence of stress fractures in female athletes is 2 to 3 times higher than that in male athletes, and female athletes with missed menstrual cycles have a 2 to 4 times higher risk of stress fractures than females with a normal monthly menstrual cycle.⁹

The triad syndrome is seen not only in women but in all athletes—including men and Paralympic athletes.^{10,11} According to Tenforde et al,¹⁰ male athletes, particularly those who participate in sports requiring leanness such as cycling and running, can exhibit nutritional deficits, reduced sex hormone levels, and impaired bone health.¹⁰

If we can educate patients on the importance of maintaining a healthy diet and supplying active bodies with the energy they need, then many of these injuries could be prevented.

Make no bones about it. ■

■ REFERENCES

1. **Wilson AS; NCAA Research Department.** 45 years of Title IX: the status of women in intercollegiate athletics. www.ncaa.org/sites/default/files/TitleIX45-295-FINAL_WEB.pdf. Accessed February 5, 2018.
2. **Ernst and Young; Women Athletes Business Network.** Perspectives on sport and teams. www.ey.com/br/pt/about-us/our-sponsorships-and-programs/women-athletes-global-leadership-network---perspectives-on-sport-and-teams. Accessed February 5, 2018.
3. **Matzkin E, Curry EJ, Whitlock K.** Female athlete triad: past, present, and future. *J Am Acad Orthop Surg* 2015; 23:424–432. doi: 10.5435/JAAOS-D-14-00168.
4. **Nattiv A, Loucks AB, Manore MM, Sanborn CF, Sundgot-Borgen J, Warren MP; American College of Sports Medicine.** American College of Sports Medicine position stand. The female athlete triad. *Med Sci Sports Exerc* 2007; 39:1867–1882. doi: 10.1249/mss.0b013e318149f111.
5. **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; 48:491–497. doi: 10.1136/bjsports-2014-093502.
6. **Curry EJ, Logan C, Ackerman K, McInnis KC, Matzkin EG.** Female athlete triad awareness among multispecialty physicians. *Sports Med Open* 2015; 1:38. doi: 10.1186/s40798-015-0037-5.
7. **Who are candidates for prevention and treatment for osteoporosis?** *Osteoporos Int* 1997; 7:1–6.
8. **Johnell O, Kanis JA.** An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. *Osteoporos Int* 2006; 17:1726–1733. doi: 10.1007/s00198-006-0172-4.
9. **Wentz L, Liu PY, Haymes E, Ilich JZ.** Females have a greater incidence of stress fractures than males in both military and athletic populations: a systemic review. *Mil Med* 2011; 176:420–430.
10. **Tenforde AS, Barrack MT, Nattiv A, Fredericson M.** Parallels with the female athlete triad in male athletes. *Sports Med* 2016; 46:171–182. doi: 10.1007/s40279-015-0411-y.
11. **Blauwet CA, Brook EM, Tenforde AS, et al.** Low energy availability, menstrual dysfunction, and low bone mineral density in individuals with a disability: implications for the para athlete population. *Sports Med* 2017; 47(9):1697–1708. doi: 10.1007/s40279-017-0696-0.

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