

Commentary

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## Commentary: Preventing the Triad/RED-S by Educating on Variables Affecting Development in Female Adolescent Athletes

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### Article Info

#### Article Notes

Received: January 20, 2022

Accepted: April 20, 2022

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#### Keywords

Adolescent  
Female  
Athlete  
Triad  
Sleep debt  
Bone  
Holistic  
Preventative  
RED-S

Adolescent female athletes experience health challenges impacting not only athletic performance, but bone growth and development<sup>1,2</sup>. Factors related to the female athlete triad (FAT), growth/developmental demands and external factors such as diet and decreased sleep<sup>3</sup> place additional pressures on development. Our recent review described the physiological processes that occur during sleep and highlighted variables impacting sleep debt, many of which are related to the daily life and training demands experienced by female adolescent swimmers and gymnasts<sup>4</sup>. The evidence supporting the impact of these variables including blue light emission during screen time, social media and caffeine intake were detailed in our review<sup>4</sup>. Understanding these variables can lead to a holistic, preventative approach to care from an integrative treatment team encompassing pediatricians, pediatric and adult orthopedic physicians, and pediatric and adult allied health practitioners for athletes exhibiting the risk factors for FAT. Practitioner, coach, parent, and athlete education on the FAT, sleep, and early sport specialization, could lead to its prevention. The purpose of this commentary is to promote discussion and question how these variables may play a role in identifying, treating and preventing FAT.

### Considerations on the female athlete triad and sleep

Hallmarks of the FAT include: (a) menstrual dysfunction, (b) low energy availability and (c) decreased bone mineral density (BMD)<sup>5</sup>. Competitive female adolescent athletes expend high amounts of energy training for their sport(s). Without proper energy intake, a central component of the triad, the physiological processes for female growth and bone development may become disrupted<sup>5</sup>. Sleep affects energy expenditure. Research in sleep deprived adults quantified an increase in energy expenditure after 1 night of missed sleep and provided evidence for sleep leading to energy conservation<sup>6</sup>. More recently, the hormonal implications of sleep loss<sup>7</sup>, specifically during the pubertal period<sup>8</sup>, has been recognized. Could increased energy expenditure from lost sleep compound with existing low energy availability and physiological energy needs for growth in female adolescent athletes? If so, would sleep debt over time have a similar impact? Considering our review highlighted current factors leading to a decrease in sleep in adolescence<sup>4</sup>, additional empirical evidence is needed for pre-pubertal female adolescent athletes connecting sleep debt, energy availability, and bone development in specific sports with different physical demands. However, in the interim, addressing sleep hygiene in female adolescent athletes is a low-risk intervention that may improve the energy deficiency. Although

our review specifically discussed female gymnasts and swimmers, addressing sleep hygiene with all athletes will be movement toward preventative efforts.

### **Contributing variable of early sport specialization and female adolescent athletes**

Research reflects the growing trend toward early sport specialization in pre-adolescent and adolescent athletes<sup>9-12</sup> as there is a perceived notion that specialization may improve prospects in their sport<sup>13</sup>. Female adolescent athletes are no exception, and this early specialization coincides with critical points during growth and development. In one study, high school athletes reported a higher prevalence of sports injury if engaged with early sport specialization<sup>10</sup>. Female athletes have the added concern of menarche related difficulties that may adversely impact bone<sup>11</sup>. This may serve as an opportunity for clinicians to screen and identify potential risk factors for FAT and intervene. Future research from a clinical research vantage point, including the experience and observations of orthopedic specialists, may contribute to the progression of research in this area.

### **FAT and RED-S?**

The clinical relevance of the FAT has been investigated extensively in the evidenced based medical literature since 1992<sup>14</sup>. Since this time, scientific strides have allowed clinicians and athletes to better understand the triad. The unique women's health feature to the triad for female adolescent athletes is menstrual dysfunction. With the advent of the 2014 International Olympic Committee (IOC) consensus statement, a new term emerged, Relative Energy Deficiency in Sport (RED-S)<sup>15</sup>. In Mountjoy's paper, RED-S is described as a broader term to encompass physiological dysfunction from energy deficiency in multiple organ systems, while still acknowledging and citing evidence of the triad<sup>15</sup>.

After the IOC consensus statement, there was a cautionary refutation of the RED-S terminology<sup>16</sup>. In the same timeline, a FAT consensus statement for athletes emerged which highlights: (a) a treatment model, (b) FAT risk assessment tool for physicians, and (c) a clearance and return to play assessment<sup>17</sup>. Since the FAT has been empirically investigated, and well documented, the usage of the triad terminology is supported<sup>18</sup>. In 2022, researchers have elucidated a differentiation of models in the literature for the FAT, Male athlete triad (MAT), and RED-S<sup>19</sup>. This differentiation of models is critical for highlighting the differences between male and female health.

### **A holistic approach to adolescent female athlete care**

While the FAT is growing in recognition, not all practitioners may be aware of FAT or the impact of high energy training, lack of sleep and poor nutrition on

the young female athlete<sup>20</sup>. When a patient presents with an overuse injury, the management of that injury typically becomes the focus of care. Commonly, there are both intrinsic and extrinsic factors contributing to the overuse injury that might be overlooked. At a minimum, screening for FAT should be done when a young female athlete is seen in an orthopedic office for an injury. For early intervention to prevent FAT, screening should be completed at any encounter with health care providers, school nurses, pediatricians and coaches who are aware of the athlete's intense training schedule. Kroschus et al. studied 370 school nurses regarding their knowledge of the FAT, only 19% identified all three components of the triad. When asked about proactively working with coaches on preventative measures, 25% indicated that they did<sup>21</sup>. Working with coaches preventatively is an area that could be improved to help avoid the FAT. Curry et al. surveyed 931 physicians among various specialties finding that only 51% were knowledgeable and felt comfortable referring the athletes for further assessment and treatment<sup>22</sup>. The authors conclude that increased awareness of the FAT would be beneficial in screening and referral. Similarly, 85% of coaches surveyed were not knowledgeable of the FAT nor were able to identify components of the FAT<sup>23</sup>. These studies indicate a lack of awareness and screening for FAT, thus, increasing knowledge and prescreening for FAT risk factors would be beneficial to the athletes. In fact, educating the athletes and families/care givers will be beneficial to mitigate FAT before it occurs.

### **Conclusion**

Who should assist with habits, routines, and role adjustments for athletes? Ideally, it is healthcare providers, school nurses, coaches, parents and the athletes themselves using a preventative approach. They should be made aware of the variables that can lead to FAT/RED-S so that the athlete, parent, and coaches make a commitment to good sleep habits, sound nutrition, and reasonable training schedules. The competitive nature of these athletes requires that habits be established early on in their specialization.

Although prevention is optimal, we are not there yet. Research informs us that 16-60% of young women had a least one component of FAT and therefore recommends screening and early referral<sup>20</sup>. Young athletes seen in primary care and orthopedic offices as well as by coaches and school nurses who have symptoms of dysmenorrhea, low body weight and bone stress should be screened for weight, menstrual function, and bone health. A comprehensive, holistic approach to these risk factors can be obtained by referring these young athletes to physician specialists such as endocrinologists, sports medicine specialists and allied health practitioners who work with athletes such as nutritionists, dietitians, occupational/physical therapists, athletic trainers, social workers and

psychologists dependent upon the need. Parents, coaches, and athletes should be included in the care team.

Our narrative literature review<sup>4</sup> highlights contemporary variables influencing sleep and physiological processes associated with FAT in adolescent female athletes. As these variables impact this generation of athletes, along with sport specialization at earlier ages, it will be imperative to utilize a communicative holistic approach to care, taking into consideration the daily routines and habits of young adolescent female athletes. Updated public health data related to sleep may also assist athletes, coaches, parents and health care multidisciplinary teams to understand how sleep debt may be impacting young athletes in a critical time of growth and development.

### Conflict of Interest

The authors report no conflicts of interest.

### Funding

No funding was received for this work.

### References

1. Ackerman KE, Misra M. Bone health and the female athlete triad in adolescent athletes. *Phys Sportsmed.* 2011; 39(1): 131-141. doi:10.3810/psm.2011.02.1871
2. 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. doi:10.2147/OAJSM.S100026
3. Lo HM, Leung JHY, Chau GKY, et al. Factors affecting sleep quality among adolescent athletes. *Sports Nutr Ther.* 2017; 2: 123. doi:10.4172/2473-6449.1000123
4. Bartholomew J, Gilligan C, Spence A. Contemporary variables that impact sleep and development in female adolescent swimmers and gymnasts. *Sports Med – Open.* 2021; 7(57): 1-11. doi:10.1186/s40798-021-00331-9
5. Nattiv A, Loucks AB, Manore MM, et al. American College of Sports Medicine. American College of Sports Medicine position stand. The female athlete triad. *Med Sci Sports Exerc.* 2007; 39(10): 1867-82.
6. Jung CM, Melanson EL, Frydendall EJ, et al. Energy expenditure during sleep, sleep deprivation and sleep following sleep deprivation in adult humans. *J Physiol.* 2011; 589(Pt 1): 235-244. doi:10.1113/jphysiol.2010.197517
7. O'Donnell S, Beaven CM, Driller MW. From pillow to podium: A review on understanding sleep for elite athletes. *Nat Sci Sleep.* 2018; 10: 243-253. doi:10.2147/NSS.S158598
8. Shaw ND, Butler JP, McKinney SM, et al. Insights into puberty: the relationship between sleep stages and pulsatile LH secretion. *J Clin Endocrinol Metab.* 2012; 97(11): E2055-E2062. doi:10.1210/jc.2012-2692
9. Jayanthi N, Pinkham C, Dugas L, et al. Sports specialization in young athletes: Evidence-based recommendations. *Sports Health.* 2013; 5(3): 251-257. doi:10.1177/1941738112464626
10. Buckley PS, Bishop M, Kane P, et al. Early single-sport specialization: A survey of 3090 high school, collegiate, and professional athletes. *Orthop J Sports Med.* 2017; 5(7): 2325967117703944.11.
11. Brenner JS and AAP Council on Sports Medicine And Fitness. Sports specialization and intensive training in young athletes. *Pediatrics.* 2016; 138(3): e20162148.
12. Hayano T, Plummer H, Oliver G, et al. Early sport specialization in the adolescent female athlete. *Ann Joint.* 2021. <http://dx.doi.org/10.21037/aoj-2020-sri-06>
13. Brooks MA, Post EG, Trigsted SM, et al. Knowledge, attitudes, and beliefs of youth club athletes toward sport specialization and sport participation. *Orthop J Sports Med.* 2018; 6(5): 2325967118769836. doi:10.1177/2325967118769836
14. Slater J, Brown R, McLay-Cooke R, et al. Low energy availability in exercising women: Historical perspectives and future directions. *Sports Med.* 2017; 47(2): 207-220. doi:10.1007/s40279-016-0583-0
15. 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. doi:10.1136/bjsports-2014-093502
16. De Souza MJ, Williams NI, Nattiv A, et al. Misunderstanding the Female Athlete Triad: Refuting the IOC consensus statement on Relative Energy Deficiency in Sport (RED-S). *Br J Sports Med.* 2014; 48(20): 1461-1465. doi:10.1136/bjsports-2014-093958
17. 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. doi:10.1136/bjsports-2013-093218
18. Williams NI, Koltun KJ, Strock NCA, et al. Female Athlete Triad and Relative Energy Deficiency in Sport: A focus on scientific rigor. *Exerc Sport Sci Rev.* 2019; 47(4): 197-205. doi:10.1249/JES.0000000000000200
19. De Souza MJ, Strock NCA, Ricker EA, et al. The path towards progress: A critical review to advance the science of the Female and Male Athlete Triad and Relative Energy Deficiency in Sport. *Sports Med.* 2022; 52(1): 13-23. doi:10.1007/s40279-021-01568-w
20. Mehta J, Thompson B, Kling JM. The female athlete triad: It takes a team. *Cleve Clin J Med.* 2018; 85(4): 313-320. doi:10.3949/ccjm.85a.16137
21. Kroshus E, Fischer AN, Nichols JF. Assessing the awareness and behaviors of U.S. high school nurses with respect to the Female Athlete Triad. *J Sch Nurs.* 2015; 31(4): 272-279. doi:10.1177/1059840514563760
22. Curry EJ, Logan C, Ackerman K, et al. Female Athlete Triad awareness among multispecialty physicians. *Sports Med Open.* 2015; 1(1): 38. doi:10.1186/s40798-015-0037-
23. Mukherjee S, Chand V, Wong XX, et al. Perceptions, awareness and knowledge of the Female Athlete Triad amongst coaches – Are we meeting the expectations for athlete safety? *Inter J of Sports Science & Coaching.* 2016; 11(4): 545-551. doi:10.1177/1747954116654781