

Prevalence of Female Athlete Triad Risk Factors among Division III Collegiate Athletes

ABSTRACT

BACKGROUND The female athlete triad (Triad) is composed of three interrelated components; low energy availability, menstrual dysfunction, and low bone mineral density. The Triad is known to have serious short and long term consequences on bone health. No previous studies have evaluated the prevalence of risk factors in a Division III collegiate athlete cohort.

METHODS An electronic survey was administered to 748 female athletes from two NCAA Division III schools. The questionnaire assessed risk factors for low energy availability, menstrual dysfunction, and low bone mineral density.

RESULTS Of 635 responses, 28.9% reported one risk factor, 6.1% reported two risk factors and 0.6% reported three risk factors. A total of 16.9% were at risk for intentional low energy availability, 20.6% were at risk for menstrual dysfunction, and 6.9% had a history of a stress fracture and were at risk for low bone mineral density. 24.0% of athletes with a BMI below 18.5 had elevated risk for intentional low energy availability compared to 16.0% who had a BMI above 18.5, but this relationship did not reach statistical significance ($p=0.16$).

CONCLUSION A substantial amount of female athletes (28.9%) have at least one risk factor for the female athlete triad. Further research on the short and long term effects of such risk factors is warranted to promote optimal bone health in this population.

LEVEL OF EVIDENCE Level IV, Cross sectional survey

KEYWORDS Female athlete triad, female athlete, energy availability, bone health, Triad

Over the past four decades, female sports participation has increased significantly due to the Title IX legislation, enacted in 1972. Title IX has afforded female athletes the ability to competitively play sports at the high school, collegiate, and professional level.¹ Increased female sport participation during the 1980s also led to the discovery of the relationship between eating disorders and amenorrhea. In 1992, the Task Force on Women's Issues of the American College of Sports Medicine (ACSM) coined the term, female athlete triad (or Triad), describing patients presenting with three interrelated conditions: disordered eating, irregular menstrual cycles, and reduced bone mineral density (BMD).^{2,3} Originally, the Triad was thought to predominately affect women participating in weight-dependent or judging sports, such as dance, endurance running, gymnastics, and ice skating. However, many athletes remained undiagnosed because they did not participate in one of the aforementioned sports, or did not present with all three components simultaneously.

Under the 1992 definition, the prevalence of the female athlete triad was low. A study examining Triad prevalence in 112 collegiate athletes from seven sports found that all

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three components of the Triad were present in 0.9% of athletes.⁴ A separate study found a prevalence of 1.2% among 170 high school athletes.⁵ However, the true prevalence is largely unknown due to the heterogeneity of the studies, including small sample size, nonstandard diagnostic procedures, and a wide range of level of participation or sport types studied.

The definition of the female athlete triad was modified in 2007 by the ACSM to address the shortcomings of the 1992 definition. First, the term “low energy availability” was introduced, which replaced “disordered eating” in order to recognize the consequences of both intentional and unintentional energy deficits.⁶ Energy availability is defined as energy intake (kcal) minus exercise energy expenditure (kcal), divided by kilograms of fat free mass (FFM).⁷ The threshold for low energy availability based on healthy females is 30 kcal/kg-FFM per day.⁸ The updated definition also characterized the female athlete triad as a spectrum, ranging from optimal health to disease, for three interrelated conditions: low energy availability, functional hypothalamic amenorrhea, and reduced bone mineral density.^{6,9} As a result, only one present component of the Triad was required for a diagnosis.

Studies after the 2007 ACSM position stand focus on prevalence of both individual and simultaneous Triad components. A recent systematic review reported a prevalence of all three components as high as 15.9% among a cohort of 991 athletes.¹⁰ However, individual components, such as secondary amenorrhea, are reported to be up to 60% in certain athletic populations.¹⁰ Melin et al. found that 63% of elite endurance athletes had low or reduced energy availability, 60% had menstrual dysfunction, and 45% had impaired bone health.¹¹

In 2014, the Female Athlete Triad Coalition released a consensus statement on guidelines for diagnosis and treatment of the Triad. Additionally, risk factors for the Triad were identified in order to be included in screening tools. Examples of risk factors include history of menstrual irregularities and amenorrhea, history of stress fracture, history of dieting, and pressure to lose weight.¹² Additionally, low energy availability was recognized as the driving force of menstrual dysfunction and low bone mineral density. No previous studies have examined the prevalence of risk factors for the Triad in a Division III collegiate athlete population. The aim of this study is to assess the prevalence of risk factors for low energy availability, menstrual dysfunction, and low bone mineral density among Division III female collegiate athletes across all sports disciplines.

METHODS

We administered an anonymous electronic survey to 748 female athletes from two NCAA Division III women's colleges. Student athletes who were part of a National Collegiate Athletic Association (NCAA) sports team or a college-sponsored club sport at the time of survey administration were included. The self-report questionnaire included age, class year, race, height, weight, BMI, and medical history. Participants were asked questions about eating habits, menstruation, duration of weekly exercise, and history of stress fracture. Study approval was received from the Institutional Review Board.

Data elements

Due to the nature of the self-report questionnaire, we assessed risk for intentional low energy availability by using the Eating Attitudes Test (EAT-26), which is used as a screening tool to determine risk for disordered eating.¹³ Questions are rated on a 4-point scale from 0 (never, rarely, sometimes) to 3 (always). Example items include “terrified about being overweight” and “display self-control around food”. The responses are summed, resulting in a total score that ranges from 0-78 (higher scores represent greater presence of risk for disordered eating behaviors). For this study, a score greater than or equal to 20 was considered at risk for intentional low energy availability and achieved 1 point towards the overall presence of risk factors. Risk for menstrual dysfunction was assessed by the question, “How would you describe your menstrual cycle?” The responses were multiple choice and consisted of normal (I get my period every month), which was scored as 0, menstrual irregularity or oligomenorrhea (I get my period less than every 35 days) and amenorrhea (I haven't had my period 3 months or more) with the latter two groups combined to demonstrate risk for menstrual dysfunction and were scored as 1 point towards the overall presence of risk factors.

Finally, a reported history of stress fracture was considered a risk factor for impaired bone health and was scored as 1 point towards the overall presence of risk factors. The risk factors were added, and athletes were categorized having a total risk score of 0, 1, 2, or 3.

Activity was described by both sport type and duration. The distinction between “high risk” and “low risk” sports for developing the triad was decided based upon coauthor consensus. The following sports were classified as high risk: ballet, cheerleading, cross-country, diving, equestrian, swimming, synchronized swimming, and track. The following sports were classified as low risk: basketball, crew, field hockey, ice hockey, lacrosse, rugby, skiing, soccer, softball, squash, tennis, ultimate frisbee, and volleyball. Duration was categorized as either long duration, defined as performing 5 or more hours of exercise per week, or short duration, which was considered less than 5 hours of exercise per week. Activities were then categorized by low risk/short duration, low risk/long duration, high risk /short duration, and high risk/long duration. Age was categorized as 17-18, 19, 20, and 21+. Year in school was categorized as freshman, sophomore, junior, and senior. BMI was categorized as underweight (BMI < 18.5), normal weight (18.5 ≤ BMI < 25), overweight (25 ≤ BMI < 30), and obese (BMI ≥ 30).

Statistical analysis

Each respondent was scored based on the number of Triad risk factors present on a 0-3 point scale (0 representing no presence of any risk factors and 3 indicating the most risk for the Triad based on the study parameters). Descriptive statistics were summarized as frequencies and percentages. The chi-square test was used to assess differences in proportions. Our primary analysis was the evaluation of 4-level triad risk category: 0, 1, 2, and 3. As secondary analyses, we evaluated each risk factor for each component of the Triad separately as a binary variable, i.e., risk for low energy availability vs. no risk for low energy availability, risk for low bone density vs. no risk for low bone density, and risk for menstrual dysfunction vs. no risk for menstrual dysfunction.

All statistical analyses were performed using SAS software, (Version 9.4, Cary, NC, USA), and a two-sided p-value of 0.05 or less indicated statistical significance.

RESULTS

A total of 635 student athletes took the survey, achieving a response rate of 84.9%. Of the 635 responses, 70% female athletes were Caucasian, 4% African American, 15% Asian, 5% Hispanic or Latino, and 6% as other. For year in school, 30% were freshman, 31% sophomores, 17% juniors, and 22% seniors. For BMI, 8% were categorized as underweight (BMI<18.5), 74% “normal” weight (BMI 18.5-25), 13% “overweight” (BMI 25-30), and 5% “obese” (BMI>30 ; **Table 1**). Twenty-two representative sports were included (ballet, basketball, cheerleading, crew, cross-country, diving, equestrian, field hockey, ice hockey, lacrosse, rugby, skiing, soccer, softball, squash, swimming, synchronized swimming, tennis, track and field, ultimate frisbee, and volleyball).

TABLE 1 Demographic characteristics of respondents		
	N	(%)
Race/Ethnicity (n=635)		
Caucasian	443	(70)
African American	24	(4)
Asian	93	(15)
Hispanic or Latino	34	(5)
Other	41	(6)
Year in School (n=619)		
Freshman	185	(30)
Sophomore	190	(31)
Junior	109	(17)
Senior	135	(22)
BMI (n=621)		
Underweight (BMI <18.5)	50	(8)
Normal weight (BMI 18.5-25)	458	(74)
Overweight (BMI 35-30)	82	(13)
Obese (BMI >30)	31	(5)

Overall, 28.9% of athletes had one risk factor, 6.1% had two risk factors, and 0.6% had three risk factors. For risk of individual triad components, 16.9% were at risk for intentional low energy availability by exhibiting disordered eating behaviors, 20.6% were at risk for menstrual dysfunction by reporting oligomenorrhea or amenorrhea, and 6.9% had a history of a stress fracture, placing them at risk for low bone mineral density (**Table 2**).

Twenty eight percent of the athletes who had a BMI below 18.5 were at risk for menstrual dysfunction, compared to 20% of those with a BMI above 18.5, but this difference did not reach statistical significance (p=0.22). Similar trends were seen with regards to elevated EAT-26 scores, with 24% of those with a BMI below 18.5 exhibiting risk for intentional low energy availability, as compared to 16% of those with a BMI above 18.5 (p=0.16). There was no difference between high risk or low risk sports or duration of exercise for reported history of stress fracture (p=0.069).

DISCUSSION

This is the first study to report the prevalence of Triad risk factors among Division III collegiate athletes across sports disciplines. We found that a substantial percentage of athletes (28.9%) had at least one risk factor for the Triad. This is in contrast to a previous study, which found that 78% of high school athletes presented with one or more components of the Triad.¹⁴ This difference may be attributable to heterogeneity in the populations studied with regards to age, level of competition, and also methodologies used to collect data.

TABLE 2 Prevalence of risk factors by total number and triad components			
	N	%	(95% CI)
Number of risk factors (n=621)			
One risk factor	180	28.9	(25.4-32.5)
Two risk factors	38	6.1	(4.2-8.0)
Three risk factors	4	0.6	(0.0-1.2)
Risk for specific triad components (n=621)			
Intentional low energy availability	105	16.9	(14.0-19.9)
Menstrual dysfunction	128	20.6	(17.8-24.2)
Low bone mineral density	43	6.9	(4.9-9.0)
CI = Confidence Interval			

A total of 16.9% female athletes were at risk for intentional low energy availability by reporting behaviors consistent with disordered eating, which is similar to the findings of a prior study, where 15.2% of collegiate athletes were at risk for disordered eating using the EAT-26 questionnaire.¹⁵ Due to the survey methodology, we were unable to collect formal food diaries and calculate true energy availability. Additionally, such results do not account for unintentional low energy availability, as the EAT-26 questionnaire was developed to evaluate behaviors that increase risk of disordered eating behaviors, and therefore intentional low energy availability. In the present study, 20.6% of athletes were at risk for menstrual dysfunction by reporting oligomenorrhea or amenorrhea. Such results are consistent with Thompson et al., who reported that 23% of collegiate cross-country runners experienced menstrual dysfunction.¹⁶ The results are also consistent with menstrual irregularity or dysfunction found among high school athletes, with two studies reporting that 23.5% and 19.7% of high school athletes experienced menstrual irregularity or dysfunction, respectively.^{5,17}

The most common clinical manifestation of the female athlete triad is stress fracture, since the symptoms of low energy availability and menstrual dysfunction can be difficult to clinically evaluate and diagnose. Female athletes have a 1.5-3.5 times relative risk of stress fracture compared to male athletes.¹⁸ Further, female athletes with amenorrhea are 2-4 times more at risk for developing a stress fracture than eumenorrheic females.¹⁹ The reason why stress fracture incidence is increased in female athletes is multifactorial; however, it is critical to raise the index of suspicion for the female athlete triad when encountering a stress fracture. Our results indicate that 6.9% of athletes reported a history of stress fracture. These results are lower than Beals et al., who reported 34.3% of collegiate athletes experienced bone stress injury during their collegiate career.¹⁵ There was no difference in reported stress fracture between the high risk and low risk sport groupings, indicating that all individuals remain at risk for stress fracture regardless of sport type. Although not statistically significant in the present study, previous literature indicates that low BMI is associated with an increased risk for bone stress injury and low BMD.^{20,21} Peak bone mass, defined as “the amount of bony tissue present at the end of skeletal maturation”, is accrued within the first two decades of life for females.^{22,23} Peak bone mass is a predictor for osteoporosis and fracture risk as females age.^{24,25} If symptoms of the female athlete triad are not recognized and addressed early, peak bone mass will be negatively impacted, creating long-term consequences such as decreased BMD, osteoporosis, and increased fracture risk.^{6,12}

This study does have limitations. The survey was distributed to all student athletes at two NCAA Division III women's colleges and responses were based on self-report. Regional bias could influence our results as the survey was only administered to student athletes residing in one state and results could differ if conducted on a national level. In addition, the EAT-26 questionnaire was used to assess risk for intentional low energy availability. Although less feasible, at least 3-day food diaries are the preferred method of determining energy availability in order to account for both intentional and unintentional low energy availability as indicated by the 2014 Triad Coalition consensus statement.¹² Therefore, we are likely underestimating the prevalence of low energy availability, as

we were unable to assess unintentional low energy availability. Of note, oral contraceptive pill use was not assessed and we may be underestimating the true prevalence of oligomenorrhea or amenorrhea. Due to the survey nature of the study, history of stress fracture was self-reported, and increases the risk of reporting bias. A dual x-ray absorptiometry (DXA) scan is the only way to assess bone mineral density and should be performed if an athlete demonstrates significant risk for the Triad.

Further research on the prevalence of risk factors for the Triad in collegiate athletes is necessary in order to understand the true risk for the disorder among young female athletes. The 2014 Triad Coalition consensus statement indicates that proposed screening questions in Pre-Participation Physical Evaluations (PPE) should continue to be utilized and expanded at the collegiate and high school level to determine risk for the Triad.¹² Further research on the prevalence of risk factors should be conducted at NCAA Division I, II, and III colleges or universities in order to better assess risk in this age population.

This is the first study to assess the prevalence of risk factors for the Triad among NCAA Division III female athletes. We found that a high percentage of Division III collegiate female athletes (28.9%) have at least one risk factor for the Triad. This result is concerning due to the severe consequences of the Triad if it is not diagnosed and addressed early. Bone mineral density can only be accrued for the first two decades of life in females, and begins to decline in the mid-twenties. Females who do not address Triad health factors leading to low bone mineral density in their twenties will be at an increased risk for osteoporosis and osteoporotic fractures later in life. Thus, it is crucial to educate our young female athletes about the female athlete triad and long-term consequences associated with the disorder.

CONCLUSION

While few athletes had more than two risk factors (0.6%), a significant percentage of athletes (28.9%) had at least one Triad risk factor. Subsequent studies are needed to investigate differences between NCAA divisions, since prevalence of risk factors may differ among female athletes due to level of competition and institutional support. As the Triad can have serious long-term consequences for bone health, it is important to accurately assess prevalence among susceptible populations such as collegiate athletes in order to better identify, treat, and ultimately prevent the female athlete triad.

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