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A study evaluating the prevalence of female athlete triad and its risk factors among elite athletes and non-athletes

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Abstract. Research has found that females are at risk of developing the female athlete triad at any level of activity. The incidence of risk of female athlete triad in various sports has not been well documented and limited evidences are postulated for the same among Indian population. So, the purpose of the study is to evaluate the risk of female athlete triad among elite female athletes of various sports. *Material and* Method. The subjects of this study were 200 athletes of various sports, and 100 non-athletes without any orthopedic, respiratory or cardiovascular system problems. The instruments used in this study included the EAT-26, menstrual cycle history questionnaire, osteoporosis questionnaire, and time spent in exercise questionnaire. All female athlete participants were given the surveys on field after their scheduled conditioning time. The non-athletes were given the surveys in their class. All participants, athletes and non-athletes, were instructed to take the surveys home and complete them in private. The surveys were then picked up by the researcher a week later at the same location the surveys were administered. *Results***.** For a female being at risk of disordered eating, menstrual cycle dysfunction, or osteoporosis it was found: out of the 200 athletes and 100 athletes, 49 & 21 were at risk of disordered eating, 48 & 6 had irregular menstrual cycles, and 51 & 18 were at risk of osteoporosis respectively. The prevalence rate of the triad was 3.5% in the athletic population as there were 7 participants who had all the three components of female athlete triad. *Conclusion*. The presence of the risk factors of female athlete triad was found in the both the groups hence, educating the females about the risk factors has the potential to prevent several components, therefore, improving health and averting long-term complications.
Key words: *female athletes, amenorrhea, disordered eating, osteoporosis, lean sports.*

Introduction

As the numbers of female athletes are increasing and their involvement in sports escalates, it is important to understand the factors which lead to female athlete triad (1). The three distinct and interrelated conditions are low energy availability with or without disordered eating, menstrual dysfunction and low bone mineral density (2). The risk of developing one or more components of the triad is not only common in elite athletes but also in physically active girls and women (3). For some female athletes driven to excel, serious commitment to their chosen sport may increase the risk of developing the syndrome (4). Each disorder is of significant medical concern individually, but all the components synergize to develop a greater potential for serious negative impact on health (5).

Energy availability is the amount of energy available to the body after energy is used for training and activity to carry out normal physiological processes (6). Characteristics like maladaptive eating and weight control behaviours and attitudes lead to disordered eating in athletes. The changes in eating patterns that occur in relation to a stressful event, an illness, in preparation for athletic competition, or personal appearance, can stimulate disordered eating (5). The American Psychiatric Association (APA) recognizes three eating disorders; Anorexia Nervosa (AN) characterized by a refusal to maintain a minimally normal body weight, bulimia nervosa (BN) characterized by repeated episodes of binge eating, followed by inappropriate compensatory behaviors such as self-induced vomiting; misuse of laxatives, diuretics, or other medications; fasting; or excessive exercise and eating disorder not otherwise specified (EDNOS) for those disorders that do not fall within the other two (6).

According to the American College of Sports Medicine (ACSM), there are some sports in which performance is subjectively graded and pre-pubertal body habitus favors success (dance, figure skating, gymnastics), endurance sports favoring participants who have a low body weight (distance running, cycling and cross-country

skiing), in which body contour-revealing clothing is worn for competition (volleyball, basketball, swimming and running), using weight categories for participation (wrestling, horse racing, martial arts, and rowing), are at a greater risk for developing one or more components of the female athlete triad (**7**).

An unbalanced diet, inadequate caloric intake relative to exercise level and excessive training may predispose females to menstrual abnormalities including amenorrhea (1). Amenorrhea is the absence of one's menstrual cycle for 3-6 months or no menstrual cycle till the age of 16 years (3). As the physical and emotional stress levels are high in athletes, it may be considered as a feedback mechanism from increased secretion of endorphins or cortisol, or both but the exact cause is still unknown (8). Amenorrhea decreases bone mineral density when bone growth should be forming, increases the risk of stress fractures, brachial artery endothelial dysfunction, potentially osteoporosis in post-menopausal years (9).

The third component of the Female athlete triad is osteoporosis which refers to premature bone loss and inadequate bone formation, resulting in low BMD, micro architectural deterioration, increased skeletal fragility, and increased risk of stress fractures (10). Intrinsic causes of osteoporosis are late menarche, amenorrhea and early menopause (11). The modifiable risk factors include estrogen and calcium deficiencies, certain medical conditions, a sedentary lifestyle, smoking, consumption of excessive alcohol and amount of salt intake (12). Intense exercise combined with inadequate food consumption is likely to lead to premature osteoporosis.

Athletes often desire to change their body composition according to the requirement of their sport. On the basis of body composition the sports are divided into lean (ex; gymnastics, synchronized and competitive swimming and varsity crew) and non- lean (ex; softball, ice hockey, soccer and basketball). Some sports promote leanness as part of the success factor, which in turn likely promotes dieting behaviors (10).

The main aims of this study are to determine the prevalence and risk the demographic at risk of female athlete triad among elite athletes and non-athletes and to investigate the difference among athletes participating in the lean sports and the non-lean sports.

Material and method

Two hundred healthy elite athletes (age 20.19 ± 2.11 years old, height 163 ± 6 cm, body weight 51.59 ± 6.19 kg) were randomly selected from Guru Nanak Dev University, Amritsar, India. The athletes were categorized as follows: hockey players (40), runners (40), gymnasts (40), football players (40), basketball players (40) and hundred non-athletes (age 21.9 ± 2.28 years old, height 162 ± 5 cm, body weight 54.73 ± 7.89 kg) were also included. They gave their informed consent to serve as subjects in the study. The procedure and benefits of the study were explained to the participants before signing the informed consent form and starting the test. The study was approved by the Institutional Ethics Committee of Faculty of Sports Medicine and Physiotherapy, Guru Nanak Dev University, Amritsar.

The study inclusion criteria included the following: subjects agreed with the purpose of this study and athletes using oral contraceptives were excluded from the study as use of oral contraceptive is known to regulate the menstrual cycle.

The questionnaire was given and explained to the subjects. First questionnaire, i.e., EAT-26 (Garner et al. 1982) consists of 26 questions and five behavioral questions with the first 26 questions divided into three subscales. The three subscales are dieting, bulimia and food preoccupation, and oral control. A self-administered questionnaire was used to assess age, weight, height and subjects were asked about the amount of time the participants spent in exercise. They were asked the number to days per week they spend in exercise to a point where they break a sweat, and the amount of time they spend in exercise per day. The Menstrual History Questionnaire was a modified version of the Gynecological/Menstrual History section of the Student-Athlete Health Questionnaire from Ball State University to assess the risk for menstrual dysfunction associated with sport due to the lack of valid and reliable instruments available to measure these constructs (4). The fourth questionnaire was the Osteoporosis Risk Questionnaire. This questionnaire was an adapted version of a questionnaire by The Osteoporosis Evaluation Program University Hospital, Syracuse, New York.

Descriptive statistics were given as the mean±SD. Chi-square method was performed to evaluate relationships between nominal variables and Student's t test was used for continuous variables.

Spearman correlation was used to find out the relationship among different variables. All significant differences reported were at $p < 0.05$ (Version 20, SPSS, Inc., Chicago, IL).

Results

By determining the frequency for a female being at risk of disordered eating, menstrual cycle dysfunction, or osteoporosis it was found: out of the 200 athletes, 49 were at risk of disordered eating, 48 had irregular menstrual cycles, and 51 were at risk of osteoporosis, while out of 100 non-athletes 21 were at risk of disordered eating, 6 had irregular menstrual cycle and 18 were at risk of osteoporosis. The prevalence rate of female at risk was 3.5% in athlete population as there were 7 participants who had all the three components of triad.

Significant difference was found between athletes and non-athletes in menstrual cycle irregularities χ^2 (N=300)=13.440, whereas significant difference between athletes of lean and non-lean sports was found in risk of eating disorder χ^2 (N=200) =15.949 in menstrual cycle irregularities χ^2 (N=200) =13.440 and marginal difference in osteoporosis risk χ^2 (N=300) =13.440. For athletes and non-athletes, a significant result for age, BMI, weight, osteoporosis risk and hours of their workout per week was there. Whereas for lean and non-lean sports showed significant results for age, disordered eating, exercise hours per week, weight at $p<0.05$. In non-athletes it was seen that risk of disordered eating and physical activity they do is highly correlated to BMI (r =0.316, 0.294 respectively).

A Spearman correlation was done on each component of the female athlete triad and we found a significant correlation between menstrual cycle dysfunction and exercise hours ($r = 0.401$, $p = 0.01$) and disordered eating ($r = 0.385$, $p = 0.01$) among basketball players, menstrual cycle dysfunction and osteoporosis ($r = 0.321$, $p = .043$) and ($r = 0.433$, $p = 0.005$) among hockey players and runners respectively, exercise hours and disordered eating ($r = 0.337$, $p = 0.034$) among football players. There were no significant differences found between the components of gymnasts leading to risk of the female athlete triad.

Table I. Distribution of anthropometric variables of athletes & non-athletes among subject population

Variables	Athletes (Mean ± SD)	Non-athletes (Mean ± SD)
Age (yr)	20.49 ± 2.11	21.94 ± 2.28
Height (m)	1.63 ± 0.06	1.62 ± 0.05
Weight (kg)	51.59 ± 6.19	54.73 ± 7.89
BMI (kg/m^2)	19.52 ± 2.12	20.95 ± 3.09

Table II. Distribution of anthropometric variables of various sports among athletic population (mean±SD)

Variables	Basketball	Football	Hockey	Runners	Gymnasts
Age (yr)	19.6±1.32	20.62±1.92	19.70±1.76	21.85±2.43	20.65±2.21
Height (m)	1.65±.06	1.61±.04	1.62±.06	1.62±.06	1.62±.05
Weight (kg)	52.37±5.21	53.37±5.29	50.02±6.03	52.65±6.70	49.53±6.85
BMI (kg/m^2)	19.19±1.74	20.51±1.83	19.02±2.02	19.88±2.32	18.96±2.28

Table III. Significant data of different variables among athletes, non-athletes and lean and non-lean sports

Variables	Disordered Eating			Amenorrhea			Osteoporosis		
	%	χ^2	p	%	χ^2	p	%	χ^2	p
Athletes (N = 200)	24.5	0.282	0.596	24	13.44	0.000	25.5	1.175	0.19
Non-athletes (N = 100	21			6			18		
Lean (N =80)	40	15.949	0.000	13.7	13.44	0.000	17.5	3.817	0.051
Non-lean (N = 120)	14.2			30.8			30.8		

Above table represents the significant difference of amenorrhea among athletes and non-athletes and lean and non-lean sports group, also there is significant difference of disordered eating, marginal significant difference of osteoporosis among lean and non-lean sports at $p<0.05$.

Table IV. Correlation between different variables among various sports and non-athletes

Variables		BMI	DE	MC	OSTEO	EXC	Sports
MC	r		0.385			0.401	Basketball
	p		0.014			0.01	
EXC	r		0.337				Football
	p		0.034				
MC	r				0.321		Hockey
	p				0.043		
OSTEO	r			0.433			Runners
	p			0.005			
BMI	r		0.316			0.294	Non-athletes
	p		0.001			0.003	

Above table represents the correlated variables among various sports and non-athlete at $p<0.05$
Here, BMI = Body mass index, DE = disordered Eating, MC = Menstrual cycle irregularities, OSTEO = Osteoporosis risk, EXC = Exercise hours per week.

Discussion

The athletic population was found to be at risk of the female athlete triad. The results are not consistent with those found by Thompson & Gabriel (2004) in their study of 37 athletes and 18 non-athletes. They found the female athlete triad in both the female athletes and the female non-athletes (13). Female athletes reported 24.5% at risk for disordered eating, 24% with risk of osteoporosis, and 25.5% with menstrual cycle dysfunction. As for the non-athletes it was reported that 21% were at risk for disordered eating, 18% were at risk of osteoporosis, and 6% had menstrual cycle dysfunction. Present study found that athletic group having all the components of the female athlete triad with 3.5%. The results are consistent with Norway (2005) the prevalence reported was higher (4%) as compared to that reported in the Vardar *et al.,* (2005) study, the prevalence rate of the female athlete triad was 1.36% in study population (9).

Quah *et al.,* (2009) found that subjects who were at risk of suffering from the female athlete triad were more likely to be from the lean sports, particularly gymnastics (12). In this study the results are not exactly same as the suffering population includes 4 from non-lean sports while 3 from lean sports. A possible reason for the results could be as there were only two varsity athletic teams; runners and gymnasts which are classified as lean so there were only 80 lean athletes and 120 non-lean athletes in the final sample of the present study.

The current study also found female athletes to have a higher percentage of menstrual cycle dysfunction compared to non-athletes and there was statistical significance found between female athletes and female non-athletes. Interestingly, the two groups were not very similar with athletes having 24% and non-athletes having 6% of the participants with menstrual cycle dysfunction. The results found in the current study with athletes at a greater risk are similar to those found by Hopkinson and Lock, (2004). They found 42.9% of athletes and 13.4% non-athletes with irregular periods (3). Thompson and Gabrial, (2004) also found similar results with 33.4% of athletes and 16.7% of non-athletes with menstrual cycle dysfunction in their study. The reason for menstrual cycle dysfunction is not known for some females but many variables may contribute to this dysfunction (13).

We found a significant correlation between menstrual cycle dysfunction and exercise hours and disordered eating amongst basketball players that were consistent with the results of Williams & colleagues, (2006) and they found that female athletes who experienced irregular menses had a significantly higher risk of an eating disorder when compared with athletes with regular menses (14). Malinauskas *et al*., (2007) conducted a study of 115 female college students and the relationships between physical activity, disordered eating risk, and anthropometric measurements (16). They found that the women with low physical activity levels had the greatest body dissatisfaction and body fat. These two factors were found to be 71-74% predictive of psychological disordered eating risk and same

correlation was found amongst football players. Menstrual cycle dysfunction and osteoporosis were found to be associated which was same as Morgenthal, (2002) evidence that athletes who experience amenorrhea have lower bone mineral density than eumenorrheic athletes (16). There were no significant differences found between the components of the female athlete triad amongst gymnasts. Nevertheless, it has been established young female amenorrheic athletes in high impact sports may have site-specific beneficial effects on bone mineral density in gymnasts Slemenda & Johnson, (1993) (8).

Conclusion

In conclusion, based on the prevalence of multiple female athlete triad risk factors, athlete education and monitoring of the risk factors by athletic staff is paramount to the long term health and well-being of the athletes. This study found both female athletes and female non-athletes to have health concerns related to their gender. Lean athletes were found to be at greater risk for disordered eating too. Risk of menstrual cycle dysfunction and osteoporosis was found to be greater in the athletes who did not participate in lean sports Athlete education should focus on what a normal menstrual cycle is, the causes of dysfunction, and long term consequences of dysfunction. The athletes should be educated on healthy eating practices to achieve appropriate levels of caloric intake.

There were several limitations to the study. Firstly, the athletes were not determined according to their energy availability status. Secondly, the athletes completed the questionnaires at different times of their athletic training for the sport (i.e., in season, out of season), which may also impact the prevalence of disordered eating and menstrual dysfunction. Thirdly, bone mineral density was not directly measured.

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