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Determinants of menstrual dysfunction in the female athlete triad: A cross-sectional study in Italian athletes.

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A R T I C L E I N F O

Keywords:
Female athlete triad
Menstrual dysfunction
Risk factors
Prevention

A B S T R A C T

Background: In 1992 the American College of Sports Medicine first described the Female Athlete Triad. The Triad is a metabolic injury involving three distinct clinical traits: low energy availability, with possible eating disorder, low bone mineral density and menstrual dysfunction (MD). Although the estimated prevalence of the Triad is low (1.2 %), single factors are common in female athletes, at all competitive levels and ages. Even though the Triad was described over two decades ago, the interrelation of the three diagnostics components is still debated: additional evidence is required to improve the multidisciplinary treatment approach for this complex condition. MD is one of the first signs of energy impairment. The present study aims at investigating MD determinants and predictors in female athletes, to allow an early diagnosis of the Triad and to implement adequate preventive strategies.

Materials and methods: An original structured questionnaire was composed to detect the presence of MD risk factors. Included participants were active female athletes within reproductive age range (15–40 years old). Anthropometric parameters and training-related factors, possibly affecting the regularity of the menstrual cycle, were investigated.

Results: Respondents were 288 female athletes. Among them, 73.3 % were under 25 years of age; 6.6 % resulted underweight; 30.6 % reported to follow a meal plan/diet and 13.9 % declared to be a smoker. Lean sports were practiced by 30.6 % of responders. Body-weight congruence was detected in in 79.9 % of participants, whereas overestimation of body image was found in 16.3 % of athletes. Irregular menstrual cycle, a possible MD predictor, was present in 33.0 % of athletes, with 41.1 % practicing some lean sport ($p = 0.007$). Also, overestimation of body image suggested an increased risk of menstrual irregularity ($p = 0.001$). BMI <18.5 or BMI >30 could also act as risk factor, although significance was not fully obtained ($p = 0.053$). Overall, practice of lean sports and overestimation of body image appeared good determinants of increased menstrual irregularity (AOR 2.02 and 3.83, respectively).

Conclusions: Menstrual irregularity in female athletes can be considered an early predictor of MD: risk is further increased in athletes of lean sports and reporting an overestimation of self-perceived body image. Screenings and awareness programs should specifically address female athletes, because of their vulnerable-group profile. In order to define a standardized at-risk profile for Triad onset and sequelae likelihood, evaluation of menstrual regularity should especially be considered, in conjunction with the assessment of other indicators of energy availability (e.g. TEE, lean and fat mass, BMC). Testing for sport-derived stress and disordered eating attitudes is also recommended. Preventive strategy should involve the proactive engagement of sport clubs and periodic competitive sport medical assessment.

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1. Introduction

Along with the notable health benefits provided by physical exercise, unique physiologic and behavioral responses of women to athletic activity have been identified and investigated during the last decades (Javed et al., 2013). Female athletes exposed to intensive training and associated psychological stress, as well as to strict dietary restraints, are prone to develop reproductive dysfunction and bone pathology (Roupas & Georgopoulos, 2011). The Female Athlete Triad (triad) is a metabolic injury that can be observed in physically active girls and women. The classic definition contains three parameters: low energy availability (LEA), with or without eating disorder (ED); low bone mineral density (BMD) and menstrual dysfunction (MD) (Daily & Stumbo, 2018). However, the latest conception of the condition is that of a spectrum, ranging from a pre-triad (i.e. experiencing 1 or 2 of the above characteristics) to the full three-parameters complying triad (Javed et al., 2013).

Although the estimated prevalence of the triad is low (1.2 %), single components are common in female athletes at all competitive levels and ages (i.e. 23.5 % MD; 18.2 % disordered patterns of eating; 4.1 % low BMD) (Javed et al., 2013). Notably, prevalence of the triad among lean sport athletes (i.e. disciplines emphasizing weight categories or aesthetics, such as ballet, gymnastics) is 2–3 times higher than in non-lean sports (Nattiv et al., 2007).

Among the three clinical entities of the Triad, MD share a peculiar bond with LEA. MD includes abnormal menstrual bleeding patterns along with other physiological alterations, e.g. anomalous pain (dysmenorrhea) and enhanced premenstrual syndrome. In addition, a subclinical form of MD can also occur with no perceptible symptoms, although in presence of ovarian dysfunction (i.e. anovulatory cycle, luteal phase deficiency) (Ravi et al., 2021). The mechanism laying behind MD is complex. Regular menstrual cycles occur when the hypothalamic gonadotropin-releasing hormone (GnRH) properly regulates the secretion of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) from the pituitary gland, ensuring the release of adequate levels of estrogen from the ovary. During times of prolonged metabolic LEA, primary physiologic mechanisms need to be maintained and thus the hypothalamic-pituitary function is altered (Gibbs et al., 2011). Consistently, athletes with MD or amenorrhea present changes in the metabolic milieu, such as increased growth hormone, ghrelin, and peptide YY levels and low leptin and insulin-like growth factor 1. The result is an “energy conservation status” in which secondary physiologic processes, such as menstrual cycles, are compromised (Laughlin & Yen, 1997; Misra, 2012; Scheid & De Souza, 2010; Vescovi et al., 2008).

Psychogenic stressors may also contribute to MD by affecting the Hypothalamic-Pituitary-Ovarian (HPO) axis, although they should not be seen as unrelated from physical/metabolic stress, since both components are concurrently present and act synergistically rather than in isolation (Pauli & Berga, 2010). For instance, studies conducted under hypnosis found that anger from humiliating experiences leads to increased prolactin (PRL) secretion, while cortisol was associated with surprise and intimidation (Levine & Muneyyirci-Delale, 2018). PRL influences the gonads either directly or indirectly. It decreases sensitivity of LH and FSH receptors in the gonads. Moreover, the indirect effect is exerted by a reduction of GnRH secretion. In detail, its pulsatile secretion result inhibited through stimulation of the opioid system. Consequently, suppressed LH and FSH secretion inhibits ovulation (Bouilly et al., 2012; Capozzi et al., 2015).

In addition, to further highlight the complexity and juxtaposition of interactions, although athleticism usually has beneficial effects on the skeletal system, female athletes with LEA and MD showed lower BMD than eumenorrheic athletes and non-athletic controls (Jonnalagadda et al., 2004; Mazziotti et al., 2011). Last, conditions associated with low BMD during adolescence and young adulthood are concerning both as immediate increase in fracture risk and perspective impaired bone health (Ackerman et al., 2011).

Menstrual irregularity is one of the first signs of energy impairment and can be considered as an early predictor of full MD. Additional determinants can influence its occurrence: identification of factors, causes and habits that favor MD in female athletes is therefore essential, both for an early diagnosis of the triad and for to implement prevention programs. In the present study, we recruited a sample of Italian female athletes aged 15–40 years old and administered a questionnaire to investigate the possible role of menstrual irregularity, which temporally precedes the onset of MD, as an early predictor for the early interception of Triad cases. Furthermore, the present study aimed at collecting evidence on other MD determinants, amidst anthropometric parameters and training-related factors, to identify factors to be prioritized, in the context of a multidisciplinary preventive approach.

2. Materials and methods

An original structured questionnaire was composed. Several validated questionnaires are described in literature, e.g. Eating Disorder Examination Questionnaire (EDE-Q) (Aardoom et al., 2012); Low Energy Availability in Females Questionnaire (LEAF-Q) (Łuszczki et al., 2021); Brief Eating Disorder in Athletes (BEDA-Q) (Martinsen et al., 2014). However, they mostly aim at the evaluation of symptoms to support the diagnostic process, but they were not designed to detect the presence of risk factors, as the present study intended. The questionnaire was disseminated online, targeting athletes of local branches affiliated to the main Italian National sport federations (e.g. FIGC, FIP, FIR, FIDAL), following the non-probability approach of *snow-ball* sampling. Included participants were active female athletes within reproductive age range (i.e. 15-49 years old). Minimum sample size ($n = 162$) was calculated with Epi Info™ StatCalc Build 7.2.6. free tool (Dean et al., 2011), with the following settings: expected frequency of the Triad in the general population = 1.2 % (Javed et al., 2013), acceptable margin of error = 5 %; confidence level = 95 %.

No ethical approval was required for the present research, since investigators exclusively registered fully anonymised data.

Investigated variables included: age; height and weight (for BMI calculation); sport discipline; number of training sessions per week; mean duration of each training session; self-perception of body image; smoking habit; diet style; use of nutritional supplements; perception of competitiveness. Menstrual irregularity was assessed in terms of self-reported abnormal bleeding patterns (e.g. amenorrhea, oligomenorrhea) and considered a MD risk predictor.

Sport disciplines were binomially classified in lean and non-lean sports, according to reference criteria (Mancine et al., 2020). The perception of competitiveness was assessed with a dedicated item, in which a 10-point Likert scale was used. Self-perception of body image was also assessed with a specific question. Body Weight Congruence (BWC) refers to the correct perception of body weight in comparison with its actual value: it was assessed combining BMI and self-perceived body image, which was classified into 3 categories (agreement, underestimation, and overestimation), as in Moehlecke et al. (2020).

Official BMI categories for the identification, evaluation, and treatment of overweight and obesity in adults were adopted for BMI, presenting the following thresholds: BMI $<$18.5 Underweight; 18.5–24.9 Normal weight; 25–29.9 Overweight; $\geq$30 Obesity (Jonnalagadda et al., 2004).

Differences between women with regular and irregular menstrual cycle for all variables investigated were assessed with non-parametric Fisher's Exact test and p-values were reported. Subsequently, a binary logistic regression analysis was performed to identify potential predictors of menstrual irregularity, adjusting for age, BMI, smoking habit, diet style, use of nutritional supplements number of training sessions per week; mean duration of each training session; practice of a lean sport, perception of competitiveness; self-perception of body image. Adjusted odds-ratios (AOR) and relative 95 % confidence intervals were reported. All statistical analyses were conducted with IBM SPSS version 29.0.

3. Results

The present study recruited 288 female athletes (Table 1). Focusing on possible MD general risk factors, salient data are hereby presented. Among responders, 73.3 % were under 25 years of age; 80.9 % had a normal weight; 6.6 % were underweight and 12.5 % had a ≥25 BMI. Moreover, 30.6 % reported adhering to a meal plan/diet and 13.9 % of them declared to be a smoker. Investigation of nutritional habits highlighted how 30.6 % of athletes were following a specific diet and 44.4 % reported using food supplements.

Lean sports were practiced by 30.6 % of responders. Other sport-related items showed that 60.8 % of athletes train 3 to 4 times per week, mostly with <2 h sessions (78.3 %). There was agreement with the self-perceived body image in 79.9 % of participants. Overestimation of body image was found in 16.3 % of the athletes.

Responders were then stratified after the self-reported regularity/irregularity of their menstrual cycle (Table 2), as early predictor of full MD. An irregular menstrual cycle was present in 33.0 % of athletes, with 41.1 % of them practicing some lean sport (p-value = 0.007). Moreover, overestimation of body image (p-value = 0.001) suggested an increased chance of menstrual irregularity. Having either a BMI <18.5 (underweight) or BMI >30 (overweight) could also act as risk factor, although significance was not fully obtained (p-value = 0.053).

In detail, the specific condition of BMI ≥30 could favor an increase of menstrual irregularity, in comparison with congruous weight athletes (OR 1.42), although without reaching significance (Table 3). On the other hand, practice of lean sports restituted a 2.02 OR, thus suggesting a significant increased risk for menstrual irregularity. Also, female athletes presenting an overestimation of their body image seem exposed to a particularly enhanced risk (OR 3.83).

4. Discussion

The aim of the present study was to identify the possible role of menstrual irregularity alongside other behavioral, anthropometric, and sport-related parameters in a sample of Italian female athletes. Menstrual irregularity represents an early warning as it usually temporally precedes the onset of full MD. In our sample, 33.0 % of athletes self-reported some menstrual cycle irregularity. Among athletes reporting menstrual irregularity, 41.1 % practiced a lean sport (p-value 0.007). Coherently, training for lean sports was found to significantly increase the risk of developing menstrual irregularity (AOR 2.02, p-value 0.018) in comparison with athletes of non-lean sport disciplines.

In literature, irregular menstruation is estimated to range from 2 % to 5 % of the general population, and up to 66 % among female athletes (Romm et al., 2010). It is well-documented how intense exercise can impact menstrual function in several ways, from delayed menarche to clinical and subclinical presentations of MD, such as menstrual irregularity. Oligomenorrhea is defined as menstrual cycles occurring at intervals longer than 35 days, and secondary amenorrhea is defined as the absence of menstrual cycles for more than 3 months in a previously menstruating woman. These disorders occur over 12 % of female athletes and prevalence is even higher in lean sports such as ballet (i.e. up to 79 %) (Carlberg et al., 1983; Practice Committee of the American Society for Reproductive Medicine, 2004).

Although being a good MD predictor, diagnosing menstrual irregularity in young athletes could be challenging, since oligomenorrhea is normally present in 65 % of girls during their first year after menarche (Legro et al., 2000). However, primary amenorrhea (i.e. lack of menstruation by the age of 15 years) does specifically affect athletes (Beals & Manore, 2002). Notably, in a study of 425 collegiate athletes, 7.4 % overall and 22.2 % within aesthetic sports (e.g. cheerleading, diving, and gymnastics) had not menstruated by the age of 16, as opposed to 1 % in the general population (Chumlea et al., 2003).

In the present study, length and frequence of training sessions did not reveal statistical correlation with menstrual irregularity. However, it

Table 1
Sample description: main characteristics of recruited female athletes are presented, reporting both absolute number of responders and respective percentage.

Variable		n	%
Age	under 25	211	73.3 %
	over 25	77	26.7 %
BMI	Normal weight (18,5–-24,9)	233	80.9 %
	Underweight (<18,5)	19	6.6 %
	Overweight/Obesity (≥25)	36	12.5 %
Tobacco smoke		40	13.9 %
On diet/meal plan		88	30.6 %
Nutritional supplements		128	44.4 %
Lean sport athletes		88	30.6 %
Training sessions per week	<2 days	54	18.8 %
	3–4 days	175	60.8 %
	>5 days	59	20.5 %
Length of single training session	<2 h hours	226	78.3 %
	≥2 h hours	62	21.7 %
Perceived competitiveness (0–-10 scale; reporting mean and SD)		7.2	2.3
Self-perceived body image	Agreement	230	79.9 %
	Underestimation	11	3.8 %
	Overestimation	47	16.3 %
Total		288	

Table 2
Menstrual cycle regularity of participants. Distribution of investigated variables *per*per regularity of menstrual cycle. Fisher's exact test p-value reported in the last column.

		Menstrual cycle				p-value
		Regular (n = 193; 67.0 %)		Irregular (n = 95; 33.0 %)		
		n	%	n	%	
Age	under 25	136	70.5 %	75	78.9 %	0.120
	over 25	57	29.5 %	20	21.1 %	
BMI	Normal weight (18,5–24.9)	159	82.4 %	74	77.9 %	0.053
	Underweight (<18.5)	8	4.1 %	11	11.6 %	
	Overweight/ Obesity (≥25)	26	13.5 %	10	10.5 %	
Tobacco smoke	No	164	85.0 %	84	88.4 %	0.417
	Yes	29	15.0 %	11	11.6 %	
On diet/meal plan	No	130	67.4 %	70	73.7 %	0.261
	Yes	63	32.6 %	25	26.3 %	
Nutritional supplements	No	106	54.9 %	54	56.8 %	0.730
	Yes	87	45.1 %	41	43.2 %	
Training sessions per week	<2 days	39	20.2 %	15	15.8 %	0.601
	3–4 days	117	60.6 %	58	61.1 %	
	>5 days	37	19.2 %	22	23.2 %	
Length of single training session	<2 h hours	152	78.8 %	74	77.9 %	0.919
	≥2 h hours	41	21.2 %	21	22.1 %	
Lean sport	No	144	74.6 %	56	58.9 %	**0.007***
	Yes	49	25.4 %	39	41.1 %	
Perceived competitiveness (0–10 scale; reporting mean and SD)		7,2	2.4	7.2	2.2	0.396
Self-perceived body image	Agreement	163	84.5 %	67	70.5 %	**0.001***
	Underestimation	9	4.7 %	2	2.1 %	
	Overestimation	21	10.9 %	26	27.4 %	

*p < 0,05

Table 3
Binary logistic regression. AOR and relative 95%CI are reported for the investigated outcome "irregularity of menstrual cycle".

		AOR	95 % C.I.		p-value
			Lower	Upper	
Age	reference value Under 25				
Over 25		0.69	0.36	1.35	0.281
BMI	Normal weight (18,5–-24,9)				
Underweight (<18,5)		1.03	0.33	3.23	0.956
Overweight/Obesity (≥25)		1.42	0.57	3.51	0.452
Tobacco smoke		0.99	0.45	2.18	0.984
Diet/meal plan		0.76	0.40	1.45	0.405
Nutritional supplements		1.01	0.58	1.78	0.965
Training sessions per week	>2 days				
3–4 days		1.53	0.70	3.34	0.288
> 5 days		1.62	0.60	4.39	0.341
Length of training session	<2 h hours				
≥ 2 h hours		1.13	0.57	2.22	0.724
Lean sport		**2.02**	**1.13**	**3.62**	**0.018**
Perceived competitiveness (0–-10 scale)		0,98	0.86	1.11	0.726
Body image	Agreement				
Underestimation		0.41	0.08	2.19	0.297
Overestimation		**3.83**	**1.74**	**8.46**	**0.001**

should be noted that participants engaged in more than two sessions per week, with training length exceeding 2 h, were roughly only one-fifth of the sample. However, previous studies reported how training duration in runners correlated with MD, with prevalence of amenorrhea increasing from 3 % to 60 %, as training distance increased from 10 to more than 100 Km per week (Sanborn et al., 1982). To further assess the role of training-derived metabolic and psychogenic stressors, future studies should aim at recruiting a wider number of athletes reporting the abovementioned training characteristics, resolving a limit posed by the sample recruited for the present study.

MD is intimately linked to LEA, since in times of limited energy availability, metabolic resources are shunted to prioritize survival processes, e.g. thermoregulation, cellular maintenance and locomotion (Wade et al., 1996; Wade & Schneider, 1992). Actually, metabolic and endocrine adaptations start to occur within normal physiological ranges and represent expected adjustments to transitory LEA. In fact, even mild to modest reductions in energy availability, without appreciable reductions in body weight, can result in significant MD induction (Beitins et al., 1991; Bullen et al., 1985; Lieberman et al., 2018; Loucks & Heath, 1994; Loucks & Thuma, 2003; Williams et al., 2001, 2015).

In our sample, among athletes that reported menstrual cycle irregularity, 11.6 % were underweight; 10.5 % overweight and 77.9 % had a normal weight BMI. Borderline significance (p-value = 0.053) was achieved for BMI and menstrual irregularity, possibly suggesting how outermost BMI values could act as risk predictors. Although we didn't collect specific data on energy impairment, it can be fairly assumed that LEA concerns athletes with BMI<18.5 and especially those undertaking long (i.e. ≥2 h) training sessions.

LEA is often considered a negative balance between daily energy intake (i.e. the total caloric intake of a person per day) and total energy expenditure (TEE) (Javed et al., 2013). However, reported variability in individual susceptibility to MD calls for more in-depth assessment of the actual informativeness of energy availability levels in female athletes. On the whole, a dose–response continuum between energy availability and menstrual irregularities emerges: when energy availability decreases, the likelihood of menstrual irregularities increases. To this purpose, BMI monitoring instead of repeated and more complex calorimetric and anthropometric measurements could allow a simple, yet indirect, evaluation of daily energy intake and, thus, a measure of MD risk.

Definition of body image is given as "*the picture we have in our minds of the size, shape and form of our bodies, and our feelings concerning characteristics and our constituent body parts*" (Slade, 1994). Body image disturbance (BID) is a reported criterion for the diagnosis of EDs. Nevertheless, BID is not limited to ED subjects but can concern athletes as well. A study conducted in dancers and body builders revealed that BID is quite common, independently of their BMI and prevalence of ED. Some level of misperception is also present in most ballet dancers and bodybuilders not suffering from proper BID (Ravaldi et al., 2003, 2006). In addition, it was documented how girls perceive themselves as being "too fat" more frequently than boys: prevalence of such perception seems to increase with age. (Zaborskis et al., 2008).

Coherently, our BWC data support the evidence that BID indeed results magnified in female lean sports athletes (i.e. 30.6 % of total responders and 41.1 % of athletes with menstrual irregularity), with 16.3 % of them overestimating their body image. When considering athletes with menstrual irregularity, overestimation of body image was found in 27.4 % (p-value = 0,001). Also, along with overestimation of body image, risk for development of menstrual irregularity is significantly enhanced (AOR 3.83).

From a broader perspective, sports are thought to exert a positive influence on body image perception in children. However, literature reveals that self-satisfaction of body image can change over time. A study on gymnasts found that pre-menarcheal phase is crucial for the onset of BID (Amato et al., 2021). In the study, one-third of both athletes and coaches acknowledged that experiencing normal, female pubescent development is usually perceived as a disadvantage. In addition, gymnasts, coaches, and other sport personnel often hold the belief that lower percentage of body fat mass results in enhanced athletic performance, especially in lean sports. The discussed statistics are rather disturbing, as they suggest how BID and other symptoms of the Female Athlete Triad can be considered as normal, and therefore, ignored. Interestingly, even with a more "body image friendly" training climate (e.g. improved attitudes, beliefs, and behaviors of influential adults), no changes were found in body satisfaction nor in the level of internalization of the thinness ideal, although athletes perceived a reduction in pressure-for-thinness from their sports clubs (Amato et al., 2021; Buchholz et al., 2008).

Another current limitation is the absence of information on participants' level of education. The link between lower education attainment and poorer health outcomes has been increasingly supported by evidence (Bertoncello et al., 2018). This study also cannot exclude education as a potential confounding factor. In fact, while some studies have failed to establish a clear correlation between the number of years spent in formal education and the onset of BID (Kuck et al., 2022), other research has indicated that lower levels of education among both adolescents (Lee et al., 2021) and even their parents are associated with body image concerns (Som & Mukhopadhyay, 2015).

Nevertheless, detection of altered BWC perception among female athletes seems a reliable indicator for the assessment of Triad onset risk, especially if juxtaposed to menstrual irregularity. Consequently, screenings and awareness programs should encompass evaluation of BID and/or BWC.

A perspective that deserves to be further investigated derives from the lack of data about BMD and bone fracture history. Literature describes how prolonged MD and LEA increase the risk of low BMD, the last clinical trait of the Triad. Caloric restriction and weight fluctuations have been associated with bone loss (De Souza & Williams, 2005; Kadel et al., 1992), with a 10 % decrease in body weight resulting in a 1–2% loss in BMD (Andersen et al., 1997; Compston et al., 1992). Chronic amenorrhea causes further decline in BMD and negates the benefits of exercise on skeletal health, as reported in several studies comparing

BMD and bone microarchitecture among amenorrheic athletes, eumenorrheic athletes, and nonathletes (Ackerman et al., 2011; Andersen et al., 1997; Beals & Manore, 2002; Bennell et al., 1996; Compston et al., 1992; Drinkwater et al., 1990; Nattiv et al., 2000). Moreover, other studies describe how the combination of amenorrhea and demanding workouts increases the likelihood of stress fractures, with one study reporting that 100 % of amenorrheic ballet dancers who practiced >5 h/day sustained at least one stress fracture (Kadel et al., 1992).

Further assessments should encompass the administration of an improved questionnaire, with items addressing the above topics, alongside dual-energy X-ray absorptiometry (DXA) testing on participating athletes. To this purpose, we suggest BMD measurement at different sites, whilst considering the differential influence of different sport disciplines. For instance, although world-class rhythmic gymnasts show high MD prevalence, they present a paradoxical improvement in bone health at weight-bearing sites. The high mechanical load generated by intense training, in fact, seems to counterbalance the negative effects of prolonged MD on bone mass acquisition (Christo et al., 2008; Maïmoun et al., 2013; Robinson et al., 2009).

At any rate, adopting a preventive perspective, we propose that early detection of Triad cases should rely mostly on precocious determinants (e.g. menstrual irregularity, altered BWC), since low BMD occurs only secondary in timing to both MD and LEA.

5. Conclusion and perspectives

Overall, we propose that among female athletes, especially for those practicing lean-sports, evaluation of menstrual regularity, BMI and BWC should be periodically evaluated, in conjunction with the assessment of other minor risk indicators (e.g. perceived sport-derived stressors, bone-fracture history). Moreover, attitudinal testing for DE should be encompassed too to outline a standardized at-risk profile for Triad onset and sequelae likelihood. Such an investigation could benefit from the proactive engagement of sports clubs and/or be coupled to the periodic competitive sport medical examination. On the whole, we support the goal of developing good and reliable strategies for the early detection of at-risk profiles, in order to prevent and promptly recognize and treat the Female Athlete Triad with a multidisciplinary approach.

CRediT authorship contribution statement

Irene Amoruso: Supervision, Conceptualization. **Marco Fonzo:** Formal analysis, Data curation. **Anna Barro:** Writing – original draft, Investigation, Conceptualization. **Claudia Scardina:** Writing – original draft, Conceptualization. **Francesca Titton:** Writing – review & editing, Resources, Project administration, Conceptualization. **Chiara Bertoncello:** Writing – review & editing, Validation, Supervision, Resources. **Tatjana Baldovin:** Visualization, Supervision, Resources, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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