Sport Sciences for Health (2024) 20:933–941
https://doi.org/10.1007/s11332-024-01182-z

RESEARCH

Rhythmic gymnastics, is a healthy or a deleterious sport for the athletes? An exploratory study on eating disorders in southern Italy

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Received: 24 October 2023 / Accepted: 7 February 2024 / Published online: 13 March 2024
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Abstract

Background The practice of sports is not always associated with the concept of health. Rhythmic gymnastics often witnesses athletes adopting unhealthy eating habits. This may lead to eating disorders.

Aims This study aims to evaluate a sample of rhythmic gymnasts from Southern Italy in terms of eating habits, eating disorders, and menstrual cycles disorders.

Methods Girls under 19 years of age who practice rhythmic gymnastics answered two questionnaires: the Eating Attitudes Test-26 (EAT-26); and the Bulimic Investigatory Test Edinburgh (BITE). An health questionnaire was also proposed.

Results The participants had a mean body mass index of 17.9 ± 2.2 kg/m^2; 33.33% of the gymnasts reported a score ≥ 20 in the EAT, indicating a possible eating disorder. On the BITE Symptom subscale, 6.7% of the gymnasts had a score between 10 and 19 (abnormal eating habits); 10% scored ≥ 20 (highly disordered eating possible binge eating). Some gymnasts presented altered menstrual cycle.

Conclusion the findings emphasize the need for special attention to eating disorders, menstrual alteration, and education among rhythmic gymnasts. Coaches and team managers should institute monitoring and preventive measures to address these issues as athletes transition into adulthood.

Keywords Sport · Rhythmic gymnastics · Eating disorder · Aesthetic sport · Adolescence · Diet

Introduction

Eating disorders, including anorexia nervosa, bulimia nervosa, and binge eating, can have severe consequences if left untreated. Without intervention, these disorders may lead to long-term health issues and increase mortality [1–3]. Therefore it is fundamental to prevent them. Athletes are at risk of eating disorders [4], especially in sports where practitioners need a specific body composition or body shape for the best performance [5]. Female athletes often exhibit perfectionist tendencies, and they are particularly susceptible to eating disorders [6–8]. Statistics suggest that elite athletes, show a high prevalence of eating disorders compared to the general population [9, 10]. This is especially the case in sports that emphasize leanness or low body weight, or in which aesthetics is considered a fundamental element for the result [11–13]. Gymnastics is one such sport with a high prevalence of eating disorders and attitudes [14]. Athletes in this sport are often elite from childhood to the end of adolescence [15]. Peak performance usually occurs between 12 and 18 years old [16]. Many elite gymnasts are minute with low body fat composition [17]. It is still not clear if the body shape is due to the sport selection or the sport practice [18].

Whitin gymnastics sport, rhythmic gymnastics athletes generally present low body mass and fat percentage and higher height; artistic gymnasts generally have low body mass and fat, but they are relatively short. Consequently, the ratio weight-height of the rhythmic gymnasts is more unfavorable [17–20] with an impact on the body mass index (BMI). Elite rhythmic gymnasts undergo intensive training routines from a very young age with physical and psychological stress [21]. These athletes present a deterioration of the energy balance with energy deprivation [22]. This puts

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rhythmic gymnasts at health risk. Generally, elite rhythmic gymnasts present nutrient deficiencies and poor sleep quality [23].

Another important aspect to consider is related to the alteration of the menstrual cycle. A review highlights that rhythmic gymnastics carries the highest risk of primary amenorrhea [24]. For secondary amenorrhea, rhythmic gymnastics is the third sport with the higher risk after cycling and triathlon [24]. About oligomenorrehaea, the discipline with the higher risk is boxing followed by rhythmic gymnastics [24]. From the review of Gimunova and colleagues [24] it is clear how this aestetic sport is highgly at risk of menstrual alteration. A review stated how functional hypothalamic amenorrea could be caused from the set of low body weigth, low energy, and/or increased stress [25]. In a study of professional rhythmic gymansts, a high prevalence of premenstrual syndrome and premenstrual dysphoric disorders, was noted [26]. These alterations increase the risk of acute and chronic cardiac, skeletal (such as osteoporosis), psychological, and reproductive problems [25, 27].

Rhythmic gymnastics is an Olympic specialty. In the international contests, it is only for women. It is considered an aesthetic sport forcing these athletes to assume behaviors to be extremily thin but physically competitive. The elite gymnasts, followed by experts and medical doctors, are examples for younger gymnasts. Non-elite athletes, usually non followed by experts, improve their diet and physical routines to be like their idols. Furthermore, these athletes obtain peak performances during adolescence [28]. This period of life is characterized by body and psychological stress [21] increasing the health risks. Considering all these aspects, the purpose of this study was to investigate whether and how often eating disorders and menstrual cycle alterations occur in female athletes who practice rhythmic gymnasts at a competitive level in Sicily.

Methods

Study design

Local sports club managers were contacted by email or telephone to understand their availability to participate in the study. Before collecting data, both participants and their parents/legal guardians were fully informed about the study's purpose due to the ethical difficulties and dangers of the topic for the athletes [29]. They provided their written informed consent. The protocol, the risks, and benefits of being part of the present study, and the data treatment modalities (confidentiality and anonymity of the athlete) were described. The participants could withdraw at any time. No compensation was provided to athletes or clubs. Procedures were approved by the Local Ethics Review Committee of the Research Center on Motor Activities (CRAM), University of Catania (Protocol Number: Protocol n.: CRAM-030-2023, 15/03/2023). The study followed the principles of the Declaration of Helsinki.

After the preliminary screening, the eligible participants answered an online questionnaire. They provided anthropometric information, their sports history; menstrual cycle; alimentary habits, and drugs use. Furthermore, two online questionnaires were proposed to study the presence of food disorders: the Eating Attitudes Test-26 (EAT-26) and the Bulimic Investigatory Test Edinburgh (BITE). All questionnaires were sent through Google Modules. Participants were asked to answer correctly.

Sample

Eligibility criteria. Only female athletes practicing rhythmic gymnastics were included in the study if they were under 19 years of age, healthy, and had an experience of at least three years. Rhythmics gymnasts had to compete in competitions. They were included only if the consent for participation form was obtained; and if they completed the questionnaires. Exclusion criteria consisted of participants with recent injuries or under particular (physical or psychological) treatments. The initial sample consisted of 45 participants. The mean age of the study participants was 14.2 ± 2.3 years. The athletes practiced this sport for a minimum of 3 years with a mean of 7.8 ± 2.9 years of experience competing in local, regional, and national competitions.

General health questionnaire

The health questionnaire consisted of sub-scales: (1) personal information (date of birth, self-reported height, and body weigth). Indirectly was extrapolated the BMI by dividing the body weigth (kilograms) by height (meters squared). The World Obesity BMI cut-offs [30] were applied for the classification of weight status as underweight (17.9 and below), norm weight (range 18–24.9), or overweight (above 25); (2) training history, including the number of training session per week, hours of training per day, and age of training experience; and (3) menstrual history, with questions related to the age of menarche, and the menstrual cycle absence or irregularity. In the questionnaire, it was stated that: (a) primary amenorrhea is no menstruation above 15 years old; (b) secondary amenorrhea is no menstruation for 3 months in the post-menarche period (in the absence of pregnancy); (c) oligomenorrhea is menstrual cycle over 35 days apart, with 4–9 periods in the past year. Other questions were about the use of contraceptives or drugs.

Eating attitudes test-26

The EAT-26 is a self-report questionnaire that studies the psychological profile and the characteristics and symptoms of eating disorders [31]. It was created in 1976 and it is composed of 26 questions with 6 possible answers [31]. For each question, there is a score that ranges from 0 to 3 where 0 is never, seldom, and sometimes; 1 is often; 2 is usually, and 3 is always. For question 25 "I like to try new processed foods" the scores are the opposite where 0 is always and 3 is never. The final score is the sum of the values from 0 to 78. Twenty is the cut-off: a value above 20 indicates the presence of eating disorders, if confirmed with other diagnosis and more specific methods. The questionnaire consists of three subscales: dieting, bulimia food preoccupation, and oral control sections [32]. The EAT-26 Italian version was adopted in this study [33].

Bulimic investigatory test Edinburgh

The first manuscript with the BITE was published in 1987 [34]. In the paper of Henderson et al. [34] it is clearly stated how this questionnaire is easy to administer, acceptable, and simple to score. It is also valid and reliable [35], also in students [36]. As the previous questionnaire, also this is self-explanatory. It is composed of 33 items and requires about 10 min for its compilation [34]. In this study, it was adopted the validated Italian version [37]. Below is the description of the questionnaire [34]:

-items form 2 scales: the symptom scale (30 items) to evaluate the presence of symptoms related to bulimia. The severity scale (3 items) to evaluate the severity defined by the frequency of binge eating and purging behaviors. It is a useful instrument to detect people with symptoms of bulimia or binge-eating disorders;

-questions 1, 13, 21, 23 and 31 require a "no" answer while the other 25 items require a "yes". The maximum score is 30 because questions (6, 7 and 27) have not to be counted. A score of 20 or more is considered high (compared to the possible presence of eating disorders). A medium score (unusual eating pattern) is in the range of 10–19 (a score between 15–19 requires an interview to better understand the situation). A score below 10 is low (normal range);

-items 6, 7 and 27 are part of the severity scale. A score of 5 or higher suggests clinically relevant bulimic symptoms. A score of 10 or higher indicates a high degree of severity. A score above the threshold on the severity scale but within the normal range on the symptom scale disqualifies the diagnosis of bulimia nervosa;

-the final total score is given by the sum of the two subscale scores. A total score of or above 25 indicates a possible case of eating disorders.

Statistical analysis

The normality of data was evaluated through the Shapiro–Wilk test performed with normality accepted if α set at 0.05. Data were evaluated through descriptive statistics (means, standard deviations, and percentages). Pearson's correlation coefficient I was performed to detect linear associations between the EAT-26 score and the BITE with the variables age, body weigth, height, BMI, years of experience, frequency a week, and hours a week. Furthermore, Pearson's correlation coefficient (r) was performed to study the correlation between BMI and years of experience, frequency a week, and hours a week. Significance was accepted with $p < 0.05$. The statistical analysis was performed through the program Jamovi software (The Jamovi project, 2022. *Jamovi* Version 2.3 [Computer Software]. Retrieved from https://www.jamovi.org).

Results

The mean of workouts per week was 4.5 ± 0.9 times, with a total of 15 ± 7.1 h.

The mean BMI of the population examined was 17.9 ± 2.2 kg/m^2. 52.28% of female athletes presented a normal BMI, while 47.72% of participants had a BMI below the recommended limit of 18 kg/m^2. Of the athletes underweight, 76.19% were mildly underweight (between 17.9 and 15), and 23.81% were severely thin (equal to or below 14.9).

Sexual health

Most (90.1%) of the athletes presented secondary sexual characteristics. A 17-year-old athlete started to present secondary sexual characteristics at the age of 16 years, her BMI was 16.7 kg/m^2 while an 18-year-old athlete presented the characteristics at the age of 15 years (BMI of 20 kg/m^2). 68.18% declared that they just presented the menarche. Of these last girls, 51.72% presented a regular menstrual cycle (every 24–35 days); 27.59% presented an irregular menstrual cycle (the interval between 2 cycles was variable); 17.24% presented amenorrhea (absence of menstruation from at least 3 months); and 3.45% presented polymenorrhagia (bleeding before 24 days). Only 2 athletes who presented amenorrhea presented a BMI under 18 kg/m^2. 29.54% of the athletes had a delay or an early period given an important sporting competition.

Two athletes indicated taking the pill or other hormonal preparations. One of them took a drug indicated for menstrual cycle disorders, dysmenorrhea, and premenstrual syndrome. Three gymnasts reported having gynecological problems, including polycystic ovaries, heavy bleeding, and amenorrhea.

Diet routine

Related to the diet, only one gymnast reported that she followed a strict diet, despite this she presented a BMI of 17.04 kg/m^2 which defines the athlete as underweight.

Of our sample, 20.45% reported that they eat the recommended 5 meals a day. Two athletes affirmed to have only two meals a day. 45.45% had 4 meals a day while the 29.55% had 3 meals a day. More details about the diet routine are presented in Table 1.

Eating attitudes test-26

Of the sample of 44 participants only 30 answered all questions of the EAT-26: the percentage below is in the proportion of the 30 questionnaires considered in the analysis. The results of the EAT-26 show that 33.33% of the gymnasts participating in the study scored ≥ 20, which indicates the possible presence of an eating disorder. The remaining participants obtained a mean value of 13.4 ± 15. One gymnast achieved high and worrying scores (71). Table 2 provides the percentage of the athletes' answers to the EAT-26 questionnaire.

Bulimic investigatory test, Edinburgh

Of the sample of 44 participants, 30 answered all questions of the BITE. The percentage below is in proportion to the 30 questionnaires considered in the analysis. The results of the "Symptom Scale" subscale show that 6.7% of the gymnasts obtained a score between 10 and 19, which is indicative of abnormal eating habits. Another 10% of gymnasts scored ≥ 20, indicating a highly disordered eating pattern and the presence of binge eating. The mean of the scores obtained by the remaining study group is 7.1 ± 6.6.

As regard "the "Severity"Scale" , the scores obtained do not indicate the presence of bulimic symptoms, except for a gymnast with a score ≥ 10, an indication of a high degree of severity.

The sum of the scores obtained on the two scales shows that three gymnasts scored ≥ 25, which reveals the presence of possible binges. Table 3 provides the percentages of the symptom scale.

Statistical analysis results

The analysis with Pearson's correlation test detected a significance between the BMI and the age of the participants ($r = 0.585$; $p < 0.001$); and with experience ($r = 0.480$; $p = 0.008$). A negative correlation was detected between the BMI and the number of days a week of training ($r = -0.224$; $p = 0.243$) and the hours a week ($r = -0.069$; $p = 0.723$).

The analysis with Pearson's correlation test detected no statistically significant correlation between EAT-26 and all the variables. It was noted a negative correlation with the BMI ($r = -0.118$; $p = 0.541$) and the highest correlation with age ($r = 0.254$; $p = 0.186$).

Pearson's correlation analysis detected a statistically significant correlation between the BITE symptom scale ($r = 0.413$; $p = 0.026$); the severity scale ($r = 0.376$, $p = 0.045$), and the total score ($r = 0.432$; $p = 0.019$) with the variable "experience". An important negative correlation was detected between the BITE symptom scale ($r = -0.059$; $p = 0.761$), the BITE severity scale ($r = -143$; $p = 0.459$), and the BITE total score ($r = -0.083$; $p = 0.667$) with the days a week. Detailed information is in Table 4.

Table 1 The diet routine of the athletes examined in the study

Question	Yes	Sometimes	No	Other information: number of athletes
Do you have a good breakfast?	28 63.6%	10 22.7%	6 13.7%	
I feel hungry during the day	17 38.6%	19 43.2%	8 18.2%	
I eat meat	35 79.5%	8 18.2%	1 2.3%	Less than 25% of meat in the diet: 12 About 50% of meat in the diet: 19 About 75% of meat in the diet: 6 More the 90% of meat in the diet: 7
I eat vegetable	37 84.1%	5 11.4%	2 4.5%	Few times a week: 6 Several times a week: 10 At least once a day: 27 / never: 1
I eat fruit	39 88.6%	3 6.9%	2 4.5%	Few times a week: 4 Several times a week: 18 At least once a day: 30 / never: 2
I eat sweets	26 59.1%	16 36.4%	2 4.5%	Few times a week: 18 Several times a week: 8 At least once a day: 14 / never: 3

Table 2 Percentage of the athletes' answers to the EAT-26 questionnaire

Question	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)
You have a terrible fear of gaining weight	29.4	20.6	14.7	5.9	5.9	23.5
When i am hungry i avoid eating	52.9	5.9	23.5	5.9	0	11.8
I think about food with concern	50	14.7	5.9	11.8	8.8	8.8
Many times i have eaten with enormous voracity feeling unable to stop	64.7	17.6	5.9	8.8	0	2.9
I have a habit of chopping food	47.1	20.6	11.8	0	5.9	14.7
I pay close attention to the caloric value of the foods i eat	52.9	8.8	17.6	2.9	11.8	5.9
I especially avoid foods with a high carbohydrate content (bread, pasta, sweets)	50	11.8	11.8	11.8	8.8	5.9
I feel that others would like me to eat more	38.2	17.6	14.7	8.8	2.9	17.6
I sometimes throw up after eating	82.3	11.8	0	2.9	2.9	0
I feel very guilty after eating	61.8	8.8	0	11.8	8.8	8.8
The desire to be more subtle torments me	44.1	11.8	0	11.8	14.7	17.6
I undergo intense physical exercises to burn calories	52.9	11.8	8.8	14.7	5.9	5.9
Others think I'm too thin	29.4	14.7	20.6	11.8	11.8	11.8
I worry about having fat on my body	38.2	11.8	8.8	5.9	14.7	20.6
I take longer than others to eat	26.5	20.6	20.6	8.8	2.9	20.6
I avoid sweet foods	35.3	26.5	17.6	14.7	0	5.9
I eat diet foods	44.1	20.6	20.6	5.9	0	8.8
I feel that food dominates my life	61.8	2.9	5.9	14.7	8.8	5.9
I like to show great self-control towards food and dominate hunger	41.2	17.6	8.8	11.8	5.9	14.7
I feel others pressuring me to eat	44.1	17.6	14.7	5.9	5.9	11.8
I spend too much time and too much thought on food	58.8	2.9	8.8	5.9	14.7	8.8
I despair if i eat sweets	61.8	8.8	17.6	5.9	0	5.9
I engage in diet programs	58.8	11.8	11.8	8.8	5.9	5.9
I like my stomach to be empty	61.8	5.9	17.6	0	5.9	8.8
I have the urge to vomit after eating	70.6	14.7	2.9	2.9	2.9	5.9
I like to try new processed foods	17.6	23.5	35.3	5.9	0	17.6

0: never; 1: sometimes, rarely; 2: seldom; 3: sometimes; 4: often; 5: usually; 6: always

Discussion

This study aimed to assess the prevalence and frequency of eating disorders and menstrual cycle alterations among female athletes competing in rhythmic gymnastics. The findings suggest that 33.33% of the athletes present a risk of eating disorders according to EAT-26 and 10% according to BITE. To confirm the results, their mean BMI was 17.9 kg/m^2 with most of the participants were underweight. Only 51.72% of our sample presented a regular menstrual cycle and 20.45% reached the recommended 5 meals a day. The findings indicate that our sample is assuming wrong eating habits. Eating disorders may be attributed to various factors, including individual personality traits, an early start in the sport, rigorous training regimens, the occurrence of injuries, coaching practices, and the adoption of unhealthy eating habits. [7, 38]. Taking into account the age of this group is crucial. Adolescence is marked by susceptibility, emotional challenges, and significant transformations in physical, psychological, and social aspects [39].

The idea of aesthetic sports, in which physical appearance is associated with better performance [40, 41], brings athletes to pursue thinness. The average BMI in our sample was 17.9 ± 2.2 kg/m^2, aligning with findings from prior investigations. Donti al [42]. examined international level gymnasts. They presented a BMI of 17.0 ± 2.0 kg/m^2, while recreational level gymnasts averaged 19.5 ± 3.9 kg/m^2. Similarly, in the study of Kontele et al. 2021 [43] the BMI was of 19 ± 2.45 kg/m^2. A negative correlation was noted between BMI and EAT-26 ($r = -0.118$). Highlighting the problems in diet habits was also the number of daily meals: only 20.45% of our sample reached the 5 recommended daily meals. This is similar to other studies, in which 22.81% was reached [42]. To support the finding, a study on the diet habits of a Greek population, detected that most of their sample not followed the Mediterranean diet [43]. As suggested in the study, coaches should be involved in an educational process where the body weight has to remain within certain limits [43]. Ideally, the nutritional intervention should be personalized and proposed

Table 3 Symptom scale percentage responses

Question	Yes (%)	No (%)
1. Do you have a regular food pattern?	55.2	44.8
2. Do you follow a strict diet?	24.1	75.9
3. Do you feel like a failure if you stop the diet once?	24.1	75.9
4. Do you count calories from everything you eat even when you're not on a diet?	13.8	86.2
5. Do you ever fast for a whole day?	3.4	96.6
6. Does your way of eating seriously disrupt your life?	17.2	82.8
7. Would you say that food dominates your life?	27.6	72.4
8. Do you ever eat until a physical discomfort stops you?	31	69
9. Are there times when you only think about food?	44.8	55.2
10. Do you eat sensibly in front of others and then hide in private?	17.2	82.8
11. Can you always stop eating whenever you want?	75.9	24.1
12. Do you feel strong urges to eat continuously?	13.8	86.2
13. When you feel anxious do you tend to eat a lot?	17.2	82.8
14. Does the thought of gaining weight terrify you?	37.9	62.1
15. Do you ever eat large amounts of food quickly?	24.1	75.9
16. Are you ashamed of your eating habits?	27.6	72.4
17. Do you worry that you have no control over how much you eat?	24.1	75.9
18. Do you turn to food for comfort?	20.7	79.3
19. Are you able to leave food on your plate after a meal?	72.4	27.6
20. Do you deceive other people about how much you eat?	31	69
21. Does your hunger determine how much you eat?	55.2	44.8
22. Do you ever binge on large amounts of food?	17.2	82.8
23. If yes, do these binges make you feel miserable?	13.8	86.2
24. If you binge, is it only when you are alone?	27.6	72.4
25. Would you do anything to satisfy your urge to binge?	6.9	93.1
26. Do you ever feel very guilty if you eat too much?	41.4	58.6
27. Do you ever eat in secret?	41.4	58.6
28. Are your eating habits what you consider normal?	69	31
29. Do you consider yourself a compulsive eater?	3.4	96.6
30. Does your weight fluctuate more than 2 kg in a week?	3.4	96.6

Table 4 Statistical results after Pearson's correlation analysis

	Age	Body weight	Height	BMI	Experience	Days a week	Hours a week
Eating attitudes test-26							
r di Pearson	0.253	0.045	0.225	− 0.118	0.084	0.097	0.150
valore *p*	0.186	0.817	0.241	0.541	0.664	0.617	0.437
Bulimic investigatory test, Edinburgh, symptom scale							
r di Pearson	0.173	− 0.016	− 0.037	− 0.000	0.413	− 0.059	0.157
valore *p*	0.371	0.933	0.850	1.000	0.026	0.761	0.416
Bulimic investigatory test, Edinburgh, severity scale							
r di Pearson	0.232	0.076	0.112	0.004	0.376	− 0.143	0.058
valore *p*	0.225	0.694	0.563	0.983	0.045	0.459	0.765
Bulimic investigatory test, Edinburgh							
r di Pearson	0.199	0.005	− 0.003	0.001	0.432	− 0.083	0.144
valore *p*	0.301	0.979	0.987	0.996	0.019	0.667	0.457

BMI body mass index

throughout the year, only in this way it is possible to prevent underweight and overweight status [43].

It was previously highlighted that weight is not the only or ideal indicator of eating disorders [44], in rhythmic gymnasts as well [45]. Coaches and physicians should monitor the risk of menstrual disorders. The occurrence of this typology of problem could be associated with health problems [24]. Between the girls that presented menarche, only 51.72% presented a regular cycle similar to 48.72% in the study of Donti et al. [42]. A similar trend was detected before the competition, in our sample 29.54% presented alteration, in the sample of Donti et al. [42] the number was 28.1%. This information is important to understand the health of the athletes. The medical staff should monitor them and the parents should be educated to recognize the main symptoms to prevent the health-related risks [7]. The medical team should systematic screen and intervene if necessary with a multidisciplinary intervention (physician, psychologist, and nutritionist) [5]. Consequently, the growth and maturation of the athletes should also be monitored, assuring the appropriate energy and nutrient availability [46] to adequately prevent issues. In our sample, 33.33% of participants presented higher values than the cut-off of 20 in the EAT-26 suggesting a risk of eating disorders. Similarly (32.35% of the sample) was in the study by Donti et el. [42]. Differently, Kontele et al. detected only 12.3% of high-level and 7.4% of noncompetitive athletes who scored 20 or higher in the EAT-26 [47]. It is to highlight that in the study of Kontele et al. [43] the sample was mixed (artistic and rhythmic gymnasts), and the authors reported that the majority of underweight athletes were rhythmic gymnasts. The EAT-26 presented the highest correlation with age ($r = 0.254$), this could be explained by the independence reached growing. Data collected through the BITE show that 10.34% obtained a score of ≥ 20 and 6.9% scored ≥ 25 on the "Symptom Scale". These values are higher than the country's average detected in other studies done [42]. A finding [42, 43] that we did not consider was the level of the athletes: the higher the level of the athletes is, the higher is the risk of presenting eating disorders. In this study, this variable was not directly analyzed but a moderate negative correlation was detected between the BMI and the number of days a week of training ($r = -0.224$) and the hours a week ($r = -0.069$). A comparable trend was also between the BITE symptom scale ($r = 0.413$), the severity scale ($r = 0.376$), and the total score ($r = 0.432$) with the years of experience. Therefore, our results are consistent with the literature [42], confirming that the years of practice can facilitate eating disorders.

Study limitations

This study has a relatively small number of participants. Furthermore, it was not possible to conduct face-to-face interviews with the study participants. Everything was carried out electronically. Despite online survey are an interesting option to study different topics, the literature suggests a need to validate and study the repeatability of online questionnaires [48]. The questionnaire about their diet routine has been standardized as much as possible with multiple choice answers. However, a diary to collect daily information could have been a better solution. It would obtain more detailed information and reduce possible response bias. Other possible response bias related to the health questionnaire were correlated to the answers given for the use of contraceptives or drugs. Even if it was everything anonymous, we cannot be sure of the answers given by the participants. About the EAT-26 and the BITE we are quite confident of the answers given for their simplicity and generic information collected. Another important limitation, considering the important number of adolescents presenting eating disorders [49], it was the lack of a control group. One last limitation is related to the lack of data about their physical routine outside the training routine. The possible participation in other discipline could be an unconsidered counfunding factor. The results significantly depend on the participants' subjective self-assessment and accuracy in answering.

Conclusions

In summary, the study revealed that a sample of Southern Italy experienced rhythmic gymnasts exhibit low BMI. They experience irregular menstrual cycles influenced by competition-related stress. They also face a heightened risk of eating disorders, as indicated by the EAT-26 and BITE questionnaire results. These findings underscore the need for more frequent monitoring. They also call for targeted interventions to mitigate the impact of eating disorders.

Author contributions G.M., S.A. and L.P. provided the rationale of the study. L.P. and S.A. performed the data analysis. L.P. and M.S. and B.T. wrote the main manuscript text. G.M. and S.A. reviewed the manuscript. All authors approved the final version of the manuscript.

Funding Open access funding provided by Università degli Studi di Catania within the CRUI-CARE Agreement. No funding was received.

Data availability Data are shared upon request to the corresponding author. All data are included in the manuscript.

Declarations

Conflict of interest The authors report there are no competing interests to declare.

Ethical approval The ethical approval was agreed by the Local Ethics Review Committee of the Research Center on Motor Activities

(CRAM), University of Catania (Protocol Number: Protocol n.: CRAM-030-2023, 15/03/2023).

Informed consent All participant signed the consent forms in this regards.

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