

AGE OF ONSET TRAINING BUT NOT BODY COMPOSITION IS CRUCIAL IN MENSTRUAL DYSFUNCTION IN ADOLESCENT COMPETITIVE SWIMMERS



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ABSTRACT

Introduction: In sports, an athletic body type with low body fat is the most desired. **Objective:** To estimate the prevalence of menstrual dysfunctions and identify if body composition, especially body fat and training are associated factors of menstrual dysfunctions in Brazilian adolescent competitive swimmers. **Methods:** The sample consisted of 78 female athletes, 11 – 19-year olds, from the city of Rio de Janeiro. The presence of menstrual dysfunction and training were assessed through a validated questionnaire. Body composition was measured by DXA. Statistical analyses were conducted using SPSS 17.0. **Results:** The athletes' mean age was 14.6 ± 0.2 years. Concerning the post-menarcheal athletes, 26.3% met the criteria for menstrual irregularity. Oligomenorrheic athletes started training younger than eumenorrheic ones (5.7 ± 3.1 years *versus* 7.3 ± 2.4 years, $p=0.04$), but there was no difference in relation to body composition (total body mass and body fat: 56.1 ± 6.5 kg and $26.3\% \pm 4.9$ versus 53.3 ± 6.9 kg and $25.5 \pm 6.5\%$, respectively). **Conclusion:** Age of onset of training rather than body composition is associated with menstrual dysfunctions in Brazilian competitive adolescent swimmers.

Keywords: training, menstrual cycle, body composition, athletes, adolescent.

INTRODUCTION

The female interest for physical exercise practice has increased in the last decades contributing to the spread of the participation of teenage girls in sports¹. The search for better results with additional pressure from the family and coaches is constant. Besides that, an athletic body type with low percentage of fat is considered the most desirable by these athletes^{2,3}. In this context, physiological dysfunctions which compromise physical performance of an athlete start to come out⁴.

Low percentage of fat, when combined with intense training, may lead to hypothalamic alterations which interfere in the release of the female sexual hormones. As a result, alterations in the menstrual cycle of the athlete may be identified, which lead to longer periodicity (oligomenorrhea) or absence of the menstrual cycle (amenorrhea)⁵.

Total body fat is directly related to the ovarian production of estrogen⁶. However, with exposure to restrictive diets, the body fat designated to the production of estrogen is redirected to the production of energy, causing irregularities in the estrogen synthesis and consequently, alterations in the menstrual cycle⁵. The aim of this study was to estimate the prevalence of menstrual dysfunctions and identify if body composition – especially body fat – and training are factors associated with these dysfunctions in Brazilian adolescent competitive swimmers.

METHODS

Initially, 108 athletes were selected to participate in the study. Among these, three stopped training during the research, seven were not interested in participating and 20 did not complete all the phases of the study.

Thus, a total of 78 swimmers, aged between 11-19 years were evaluated in the city of Rio de Janeiro, Brazil. In the selected age group, all swimmers who reached at least the fifth position in the ranking of their age categories in state championships in 2005 or 2006 were invited to participate in the study. The participants were investigated for a period longer than two years. Athletes with *diabetes mellitus*, pregnant and lactating, oral contraceptive users, drug users and smokers were excluded from the study.

Each athlete was asked to sign a free and clarified consent form. Athletes younger than 18 years old should request an authorization from their parents or legal tutors. This research was approved by the Ethics in Research Committee of the Clementino Fraga Filho University Hospital of the

Federal University of Rio de Janeiro, Rio de Janeiro, Brazil (under protocol number 217/05).

Total body mass (weight) was checked on a *Filizola* platform mechanical scale (São Paulo, SP, Brazil), with capacity of 150kg (precision of 100g) and stature was checked with *Personal Sanny* stadiometers (São Paulo, SP, Brazil), 2-m long (precision of 1mm). All measurements were performed with the athletes wearing only bathing suits, barefoot, not wearing any hair or body accessory.

The body composition (body fat percentage and lean body mass) was performed by dual-energy X-ray absorptiometry - DXA (Lunar Prodigy Advanced Plus, GE Lunar, Milwaukee, WI, USA). Such method is fast, non-invasive and safe for the body composition evaluation. In order to be evaluated, the athletes were at a four-hour fast and 12 hours without performing physical exercises.

The presence of menstrual dysfunctions and training were evaluated through a previously validated self-reported questionnaire⁷. Primary amenorrhea was defined as absence of menstrual flow at 16 years of age or older, or absence of pubertal development at 14 years of age or older. Likewise, secondary amenorrhea was defined as absence of menstrual flow for at least six months or for three or more consecutive menstrual cycles. Finally, oligomenorrhea was defined as menstrual cycles longer than 35 days^{8,9}.

Pubertal development was self-evaluated using the Marshall and Tanner charts¹⁰. The athletes received a set of five standardized drawings of breasts and female pubic hair stages with an explanatory text for evaluation of their own development. The description of each stage was read for the athletes and after that they were asked to select the stage which best indicated their development. This evaluation was carried out with privacy and was applied by a female researcher. This method was previously validated with this very age group¹¹.

A previous study carried out in Brazil evidenced that mean age of menarche was 12.2 ± 1.1 years for athletes and 11.6 ± 1.9 years for non-athletes⁷. For this reason, we included in this study the evaluation of 11-year old athletes. However, the swimmers who were in their first year post-menarche were not evaluated for the presence of menstrual disorders, since irregularities in menstruation naturally usually occur in that phase¹².

The central tendency and variability measurements were calculated. The Mann-Whitney test was used for the means comparison and the adopted significance level was 5% (p < 0.05). The Kaplan-Meier survival curves were obtained to estimate mean age of menarche. All analyses were carried out using the *SPSS* program, version 17.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

The 78 swimmers presented mean age of 14.6 ± 2 years. The anamnesis evidenced that the athletes started practicing swimming at 6.6 ± 2 years and that they had been practicing the sport for 8.0 ± 2 years. Generally speaking, the athletes trained for 2.2 ± 0.5 daily hours (1.5 to four daily hours and 5.8 ± 0.5 days per week – five to seven days per week).

Presence of menstrual dysfunctions was detected in 26.3% (15 out of the 78) of the athletes. There were no cases of primary or secondary amenorrhea.

Table 1 presents demographic and training data according to the presence or absence of menstrual dysfunctions. Oligomenorrheic athletes presented earlier onset of training than eumenor-

rheic ones (5.7 ± 3.1 years *versus* 7.3 ± 2.4 years, p = 0.04).

The athletes' distribution according to the pubertal development stage is presented in table 2. None athlete was classified in stage 1.

Among the athletes who participated in this study, 21.8% (17 out of 78) did not present menarche (pre-menarcheal athletes), 73.1% (57 out of 78) presented menarche (post-menarcheal athletes) and 5.1% (four out of 78) were in their first post-menarche year, and hence, were excluded from the menstrual dysfunction analysis⁹. Mean age of menarche was 12.4 ± 0.2 years.

Table 3 presents the body composition according to the menstrual cycle. Statistical differences have not been found between groups when the different body fat compartments were analysed.

Table 1. Demographic and training data in Brazilian adolescent competitive swimmers according to the presence of alterations in the menstrual cycle.

Variables	Eumenorrheic	Oligomenorrheic	p-value
Age (years)	15.3 ± 2.0	15.3 ± 1.8	0.74
Age of menarche (years)	11.8 ± 1.2	12.3 ± 1.1	0.23
Training onset (years)	7.3 ± 2.4	5.7 ± 3.1	0.04*
Time of training (years)	8.1 ± 2.8	9.6 ± 3.1	0.10
Training (hours/day)	2.3 ± 0.5	2.2 ± 0.4	0.72
Training (days/week)	5.9 ± 0.5	5.7 ± 0.6	0.19
Training (hours/week)	13.4 ± 3.3	12.2 ± 2.5	0.50

Values are presented in mean ± standard deviation (SD).

* p < 0.05, comparison using the Mann-Whitney test.

Table 2. Distribution of the pubertal development in Brazilian adolescent competitive swimmers.

Pubertal development stage	Breasts		Pubic hair	
	Mean age (years)	Frequency (%)	Mean age (years)	Frequency (%)
Stage 2	13.3 ± 1.5	19.2	13.4 ± 3.4	5.1
Stage 3	14.0 ± 1.7	44.9	13.7 ± 1.4	35.9
Stage 4	15.8 ± 1.9	29.5	14.6 ± 2.0	39.7
Stage 5	16.7 ± 2.1	6.4	16.4 ± 1.6	19.2

% – percentage.

Values are in mean ± standard deviation (SD)

Table 3. Comparative analysis of the body composition in Brazilian adolescent competitive eumenorrheic and oligomenorrheic swimmers*.

Variables	Eumenorrheic = 42)	Oligomenorrheic (n = 15)	p-value
Total body mass (kg)	56.1 ± 6.5	53.3 ± 6.9	0.15
Lean body mass (kg)	39.6 ± 4.6	38.0 ± 4.5	0.19
Total body fat (kg)	14.2 ± 3.6	13.3 ± 4.5	0.36
Total body fat (% F)	26.3 ± 4.9	25.5 ± 6.5	0.47
Arms (% F)	24.0 ± 15.1	20.7 ± 6.3	0.55
Legs (% F)	30.1 ± 5.5	30.0 ± 6.1	0.73
Trunk (% F)	26.2 ± 5.5	25.0 ± 7.6	0.43
Android (% F)	26.5 ± 6.2	25.5 ± 8.1	0.47
Gynoid (% F)	37.3 ± 4.7	36.8 ± 6.0	0.72

Values are in mean ± standard deviation (SD).

* p < 0.05, comparison using the Mann-Whitney test.

% F – body fat percentage.

DISCUSSION

Presence of menstrual dysfunction is higher in the population of athletes than in the population of non-athletes^{13,14}. This prevalence may vary between 3.4% and 66% within the population of athletes and between 2% and 5% among non-athletes¹⁵. In adolescents, the prevalence of these alterations has not been well-established yet; however, it is known that this prevalence is more common among athletes who practice in which a thin body is related to perfor-

mance, such as ballet, artistic gymnastics and long-distance run¹⁴. In the current research, 26.3% of the athletes presented some kind of menstrual dysfunction. Similar results were presented by Vigário and Oliveira¹⁶, who found menstrual alterations in 22.5% of the Brazilian adolescents who practiced synchronized swimming.

A series of studies suggest association between prevalence of irregularities in the menstrual cycle in athletes and their body composition^{13,17,18}, as well as with low percentage of body fat¹⁹. Carlberg *et al.*¹⁹ investigated the correlation between body composition and menstrual cycle in 14 athletes with menstrual dysfunctions and 28 athletes with normal cycles in different modalities. In all the analyzed parameters, including body fat percentage, the results were significantly lower in athletes with menstrual alterations, suggesting hence that this occurrence may be related to the low body fat percentage. Nevertheless, no difference has been identified in the body fat percentage among synchronized swimming athletes with or without menstrual dysfunctions²⁰. Tomten and Hostmark²¹ evaluated runners and found the same results. On the other hand, a study with 30 ballet dancers and 30 non-athletes concluded that there is a significant association between menstrual dysfunction and body fat¹⁴.

The present study does not evidence significant differences between total body mass and body fat percentage in athletes and alterations in the menstrual cycle. The fact that the study was carried out with adolescent athletes may have influenced in this result.

Brownell *et al.*²² believe that the onset of menstrual alterations may be influenced, at least partially, by the body fat distribution. According to these authors, menstrual alterations may be caused by low body fat percentage in the femoral region. Thus, these alterations would be the response from the body to save energy. In the present study, significant differences in femoral fat as well as in other parts of the body have not been observed among athletes with or without menstrual alterations.

Frisch and McArthur¹³ demonstrated that in order to keep the reproductive health and regular menstrual function steady, a minimum of 22% of body fat are necessary. These authors associated this amount of fat with the production of ovarian estrogen. In athletes with fat percentage below 22%, the production of ovarian estrogen, besides the menstrual function, would be compromised. In the present study, significant differences concerning the body fat percentage have not been observed in the analyzed groups. Such fact may suggest

that the amount of body fat *per se* is not directly associated with the regulation of the menstrual cycle in Brazilian adolescent swimmers.

It is rare to find differences in the body fat percentage among female swimmers; for this reason, alterations in the body fat are not related to improvement in performance²³. Female swimmers present body fat percentage similar to the girls in the general population^{24,25}. It is believed that in this sport the athletes need greater amount of body fat for flotation and dislocation in the water, which end up causing better results in competitions²⁶.

Besides that, other factors may be related to the presence of alterations in the menstrual cycle, as genetic predisposition, restrictive diets, eating disorders (anorexia nervosa, bulimia nervosa and their respective precursors), psychological stress, intense training routines (high intensity and volume), suppression of the reproductive hormone (estrogen and progesterone) and high blood cortisol levels^{1,3,17,22,26}. In our study, the age of the onset of training was different among swimmers with and without menstrual dysfunction.

In this study, the use of self-reported questionnaires for information on the menstrual cycle and training was a limitation. Another limitation was the lack of hormonal data, which could have aided in our interpretation of the menstrual irregularity, especially of the athletes who presented oligomenorrhea.

Torstveit *et al.*²⁷ suggested the use of a risk criterion model including questions about menstrual dysfunction for detection of disorders such as eating disorders (ED) in athletes of sports which require thinness. Moreover, in non-thin athletes the self-report of ED is suggested for the early detection of clinical eating disorders. However, extra factors not elucidated yet may be associated with the development of these alterations. Further studies with the goal to help to prevent menstrual dysfunctions in athletes should be carried out. We suggest that coaches and trainers systematically monitor adolescent athletes, contributing hence to the decrease in the prevalence of menstrual dysfunctions as well as reduction in the risk to the health of these athletes.

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REFERENCES

1. Mantoanelli G, Vitall SSM, Amâncio SMO. Amenorreia e osteoporose em adolescentes atletas. *Rev Nutr Camp* 2002;15:319-32.
2. Sevier TL. The industrial athlete. *Occup Environ Med* 2000;57:285.
3. American College of Sports Medicine. Position Stand: The female athlete triad. *Med Sci Sports Exerc* 2007;39:1-9.
4. Safran MR, Mckeag DB, VanCamp SP. Manual de Medicina Esportiva. São Paulo, Manole; 2002.
5. Pardini DP. Alterações hormonais da mulher atleta. *Arq Bras Endocrinol Metab* 2001;45:343-51.
6. Soyka L, Fairfield WP, Klibanski A. Hormonal determinants and disorders of peak bone mass children. *J Clin Endocrinol Metab* 2000;85:3951-63.
7. Oliveira FP, Bosi MLM, Vigário OS, Vieira RS. Comportamento alimentar e imagem corporal em atletas. *Rev Bras Med Esporte* 2003;9:384-56.
8. Marshall LA. Clinical evaluation of amenorrhea in active and athletic women. *Clin Sports Med* 2004;13:371-87.
9. Harel Z. Approach to the adolescent girl as she transits from irregular to regular menstrual cycles. *J Pediatr Adolesc Gynecol* 2005;18:193-200.
10. Marshall WA, Tanner JM. Variations in pattern of pubertal changes in girls. *Arch Dis Child* 1969;44:291-303.
11. Matsudo SMM, Matsudo VKR. Self-assessment and physician assessment of sexual maturation in Brazilian boys and girls: concordance and reproducibility. *Am J Hum Biol* 1994;6:451-5.
12. Beznos GW. Distúrbios menstruais. In: Coates V, França LA, Beznos GW, editors. *Medicina do adolescente*. São Paulo: Sarvier; 1993. p. 207-10.
13. Frisch RE, McArthur JW. Menstrual cycles: fatness as a determinant of minimum weight for height necessary for their maintenance or onset. *Science* 1974;185:949-51.
14. Warren MP, Shantha S. The female athlete. *Baillieres Clin Endocrinol Metab* 2000;14:37-53.
15. The American Academy of Pediatrics. Medical Concerns in the Female Athlete. *Pediatrics* 2000;106:610-3.
16. Vigário PS, Oliveira FP. Disfunções menstruais em atletas de elite. *Arq Mov* 2005;1:25-31.
17. Warren MP, Perloth NE. The effects of intense exercise on the female reproductive system. *J Endocrinol* 2001;170:3-11.
18. Costil DL, Wilmore JH. Fisiologia do esporte e do exercício. Rio de Janeiro, RJ: Guanabara Koogan S.A., 2004.
19. Carlberg KA, Buckman MT, Peake GT, Riedesel ML. Body composition of oligo/ amenorrheic athletes. *Med Sci Sports Exerc* 1983;15:215-7.
20. Ramsay R, Wolman R. Are synchronized swimmers at risk of amenorrhea? *Br J Sports Med* 2001;35:242-4.
21. Tomten SE, Hostmark AT. Energy balance in weight stable athletes with and without menstrual disorders. *Scand J Med Sci Sports* 2006;16:127-33.
22. Brownell KD, Steen N, Wilmore JH. Weight regulation practices in athletes: analysis of metabolic and health effects. *Med Sci Sports Exerc* 1987;19:546-56.
23. Tuuri G, Loftin M, Oescher J. Association of swim distance and age with body composition in adult female swimmers. *Med Sci Sports Exerc* 2002;34:2110-4.
24. Richardson MS, Beerman K, Heiss C, Schultz J. Comparison of body weight and body fat classifications of competitive school-age club swimmers. *J Am Diet Assoc* 2000;100:237-40.
25. Kjendli PL, Ingjer F, Stallman RK, Stray-Gundersen J. Factors affecting swimming economy in children and adults. *Eur J Appl Physiol* 2004;93:65-74.
26. Dusek T. Influence of high intensity training on menstrual cycle disorders in athletes. *Croat Med J* 2001;42:79-82.
27. Torstveit MK, Rosenvinge JH, Sundgot-Borgen J. Prevalence of eating disorders and the predictive power of risk models in female elite athletes: a controlled study. *Scand J Med Sci Sports* 2008;18:108-18.