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Disordered eating among adolescent female swimmers: Dietary, biochemical, and body composition factors

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ABSTRACT

Objective: To verify associations among body composition, biochemical parameters, and food intake in adolescent female swimmers with and without disordered eating (DE).
Methods: Seventy-seven athletes 11 to 19 y old from clubs in Rio de Janeiro, Brazil were studied. DE was assessed through three questionnaires (Eating Attitudes Test-26; Bulimic Investigatory Test, Edinburgh; and Body Shape Questionnaire), body composition by dual-energy x-ray absorptiometry, and food intake by a 3-d diet record. Biochemical parameters related to iron, folic acid, and vitamin B12 were analyzed. The Fisher exact test, Mann–Whitney test, and the Spearman coefficient were calculated.
Results: DE was found in 44.2% of the sample. DE-positive compared with DE-negative athletes presented greater body fat percentage (11–14 y: 27.5% versus 23.4%, $P = 0.023$; 15–19 y: 30.2% versus 24.1%, $P = 0.006$) and fat mass (11–14 y: 13.8 versus 10.3 kg, $P = 0.010$; 15–19 y: 17.0 versus 13.2 kg, $P = 0.027$). In relation to food intake, DE-positive athletes presented lower protein consumption in the 11- to 14-y-old group and lower calcium intake adequacy in the 15- to 19-y-old group. Most other dietary parameters showed a low adequacy of consumption, with no difference between athletes with and without DE. Four DE-positive athletes presented anemia or iron deficiency.
Conclusion: DE-positive compared with DE-negative athletes presented a higher percentage of body fat and fat mass, lower protein consumption in the 11- to 14-y-old group, and lower calcium intake adequacy in the 15- to 19-y-old group. Greater attention should be given to the nutritional state of these athletes, considering the number of adolescents with anemia and an inadequate dietary intake.

Introduction

Disordered eating (DE), a component of the female athlete triad, refers to a group of abnormal eating behaviors such as restrictive eating, fasting, frequently skipping meals, the use of diet pills, laxatives, diuretics, or enemas, overeating, binge eating, and purging (vomiting) [1]. DE may be detected by self-report scales [2]. In many cases, people with DE develop a clinical mental disorder recognized as an eating disorder that includes anorexia nervosa and bulimia nervosa [3].

Athletes, as a group with distinctive characteristics, constitute a unique population among those considered as being at greater risk of DE [1]. It is known that 95% of DE cases affecting this group occur in women, 90% of whom are 25 y old or younger [4].

Studies that have assessed the presence of the female athlete triad have shown that DE is the most prevalent component and seems to be the factor that triggers this syndrome [5–8], because it is instigated by energy restriction or by excessive exercise, whether voluntary or based on the recommendations of trainers and coaches. Athletes and trainers often believe that decreases in body mass and body fat will improve athletic performance [9].

As a rule, weight loss in athletes is desired to improve physical performance [1], but a drastic decrease in the consumption of energy and nutrients promotes mineral deficiencies and other adverse health effects [10,11].

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Because of the increase in the number of women involved in sports and the high prevalence of DE in female athletes, the aim of this study was to verify the associations among dietary, biochemical, and body composition factors in adolescent female swimmers with and without DE from the city of Rio de Janeiro, Brazil.

Materials and methods

This was an analytic cross-sectional study including 77 adolescent female swimmers 11 to 19 y old. All swimmer athletes from clubs located in the city of Rio de Janeiro who had reached the fifth-ranking position in the state championships in 2005 or 2006 were invited to participate in this study. Participants were investigated over 2 y.

Athletes who self-reported having diabetes mellitus and those who used oral contraceptives were excluded from the study. The data were gathered through self-report using a pretested questionnaire that inquired about personal information, training, menstrual cycle, bone health, nutritional data, and medication use [12].

This protocol was approved by the ethics committee of the Clementino Fraga Filho University Hospital at the Federal University of Rio de Janeiro. An informed consent was signed by all participants and their parents/guardians.

Evaluation of pubertal development

Pubertal stage was self-assessed using diagrams from Marshall and Tanner [13]. After the placard presentation, each athlete was requested to indicate the picture with the secondary sexual characteristics that best resembled their own developmental stage. This evaluation had been previously validated for use in this age group [14].

Evaluation of disordered eating

Three tests were selected to evaluate the presence of DE. The Eating Attitudes Test-26 evaluates eating behaviors related to anorexia nervosa [15], the Bulimic Investigatory Test, Edinburgh, allows for the identification of bulimic episodes [16], and the Body Shape Questionnaire evaluates the subjects' dissatisfaction with their body image and measures their degree of concern with their body image [17]. The analysis methodology of each test was previously described [8].

The athletes who tested positive in at least one of the tests were considered DE positive.

Evaluation of food intake

All participants completed a 3-d diet record of non-consecutive days, including a weekend day. These records were completed by the athletes after a previous orientation by the researcher including the days to be registered [18]. Foods were expressed in household measurements. These data were collected and analyzed by only one researcher.

The household measurements were converted to grams and milliliters for a quantitative analysis of energy and nutrient intake by the Programa de Apoio à Nutrição, NutWin (Nutrition Support Program, Federal University of São Paulo, São Paulo, Brazil). Foods and preparations not included in the database provided by the program were included with the help of a complementary nutritional information table or based on information contained on the labels of the industrialized products.

The dietary analyses included energy (kilocalories per kilogram of fat-free mass per day), protein (grams of body mass per kilogram per day), carbohydrates (grams of body mass per kilogram per day), fat (percentage of energy consumption), calcium (milligrams per day), iron (milligrams per day), folate (micrograms per day), vitamin B12 (micrograms per day), zinc (milligrams per day), and vitamin C (milligrams per day). The recommendations of the American College of Sports Medicine [1] were observed for energetic consumption and the recommendations of the American Dietetic Association [19] for the macronutrients. The dietary reference intakes [20–23], considering the values of the estimated average requirement, was applied for the micronutrients.

Anthropometric and body composition evaluations

To measure body mass, a FILIZOLA mechanical platform scale (150-kg capacity, 100-g resolution; São Paulo, Brazil) was used, and a Personal Sanny stadiometer (200-cm capacity, 1-mm graduations; São Paulo, Brazil) was used to measure stature. All measurements were conducted with the athletes in swimsuits and without any footwear or accessories.

Body composition (fat mass, percentage of body fat, and fat-free mass) was assessed by dual-energy x-ray absorptiometry (Lunar Prodigy Plus Advanced, GE Lunar, Milwaukee, WI, USA). To perform this test, the athletes underwent a 4-h fast and abstained from physical training for 12 h; therefore, it also allowed for an evaluation of the swimmers' body composition.

Biochemical parameters

All blood samples were collected by technicians from a biochemical research laboratory. To perform this test, the athletes underwent an 8-h fast and abstained from physical training for 12 h.

Blood samples were analyzed for different biochemical parameters. In the integral blood, evaluations were conducted for hematocrit using the conventional capillary technique (Ultramicro, Beckman International Division, Fullerton, California, USA) by centrifugation, and for hemoglobin using the cyanmethemoglobin method with a commercial kit (Bioclin, Belo Horizonte, Brazil). The intra-assay coefficient of variation (CV) was 2.9%. The quantification of serum iron levels was performed with an endpoint reaction using a manual application of the acetate-Ferrozine buffer method. The intra- and interassay CVs were 3.9% and 4.9%, respectively. The concentration of ferritin was measured using a radioimmunoassay kit (Diagnostic Products Corporation, Los Angeles, CA, USA). The intra- and interassay CVs were 5.6% and 6.1%, respectively. Transferrin saturation capacity was assessed by an automated colorimetric method (Kit Merck, Rio de Janeiro, Rio de Janeiro, Brazil). Total iron-binding capacity from the serum was determined using the Tris-Ferrozine buffer direct method using the IBC Liquiform reagent from Labtest (Lagoa Santa, Minas Gerais, Brazil). Plasma concentrations of folic acid and vitamin B12 were measured by a Dualcount (Diagnostic Products Corporation Corporate Offices, Los Angeles, California, USA)[57] commercial kit using the dilution of radioisotopes. Intra- and interassay CVs were 6.1% and 9.2% for folic acid and 6.6% and 8.9% for vitamin B12.

To be classified as iron deficient, the athletes had to meet, simultaneously, the following criteria: serum ferritin lower than 12 g/mL, transferrin saturation percentage lower than 16%, and total iron-binding capacity higher than 428 μg/mL. Moreover, when hemoglobin concentrations were below 12 g/dL, the athletes were classified as anemic [24]; and when serum concentrations of vitamin B12 were below 243 pg/mL and those of folic acid below 3.1 ng/mL, the athletes were classified as having megaloblastic anemia.

Statistical analysis

The Mann–Whitney test was used to verify statistical differences among all the variables studied and the Fisher exact test was used for the analysis of frequency. Spearman coefficients between food intake and biochemical measurements were calculated. The level of significance adopted was lower than 5% ($P < 0.05$). Analyses were performed in SPSS 13.0 (SPSS Inc., Chicago, IL, USA).

Results

One hundred five athletes were eligible to be included in the study. Of those, 3 stopped training during the study, 7 were not interested in participating, and 18 did not complete all phases of the study, totaling a sample loss of 26.6% ($n = 28$). Seventy-seven adolescent female swimmers participated in the study.

Regarding DE, 44.2% ($n = 34$) of the sample presented positivity for at least one of the tests applied. The mean age did not differ between the groups (14.8 ± 2 y old for DE-positive athletes versus 14.5 ± 2 y old for the DE-negative athletes, $P = 0.648$).

After a separate evaluation of each test, it was possible to observe positive results of 7.8% ($n = 6$) in the Eating Attitudes Test-26, 22.1% ($n = 17$) in the Bulimic Investigatory Test, Edinburgh, and 36.4% ($n = 28$) in the Body Shape Questionnaire. None of the athletes presented high severity on the Bulimic Investigatory Test, Edinburgh. One athlete presented positivity on all tests. When analyzed according to age strata, no significant difference was observed between the groups (Table 1).

Regarding the methods used for weight loss, 14.3% ($n = 11$) reported having fasted for an entire day at least once and 3.9% ($n = 3$) reported doing it once in a while. Purging once in a while was reported by 3.9% ($n = 3$) of the athletes. The occasional use of laxatives and diuretics was reported by 1.3% ($n = 1$), and 1.3% ($n = 1$) reported using them daily.

There was a significant difference between the development of pubic hair in athletes 11 to 14 y old with and without DE (Table 2). No athlete was classified as being in stage 1 of development.