ORIGINAL ARTICLE

Body composition parameters can better predict body size dissatisfaction than body mass index in children and adolescents

Rejane Rosaria Grecco Dos Santos[1] · Gabriele Carra Forte[1] · Eduardo Mundstock[1,6] ·
Marina Azambuja Amaral[2] · Carolina Gomes da Silveira[1,7] · Fernanda Chaves Amantéa[3] ·
Julia Frota Variani[3] · Linda Booij[4] · Rita Mattiello[5]

Abstract

Purpose Recent studies suggest that body mass index is not a reliable enough measurement for body composition in individuals, particularly in older and younger people. However, most research on body image has used the body mass index (BMI) as a physiological predictor of body satisfaction, particularly in children. The aim of this study was to investigate whether body composition is a better predictor of body size dissatisfaction in children than BMI.

Methods This is a cross-sectional study. Healthy children and adolescents aged 5–19 years, sex male and female, were recruited using a convenience sample in Brazil. BMI was measured according to the international standardization method and body composition was measured by bioelectrical impedance analysis (BIA) with a portable device model (BIA InBodyS10 multi-frequency, USA). Body size dissatisfaction was assessed using the Kakeshita's Figure Rating Scale for Brazilian Children. Data were analyzed with logistic regression analysis.

Results A total of 547 participants were evaluated, including 54% females and 67% Caucasian, with a mean age of 11.4 ± 3.8 years. The mean BMI was 20.5 ± 4.6 kg/m^2, and the mean percentages of fat and lean mass were $23.01 \pm 10.59\%$ and $72.84 \pm 10.03\%$, respectively. In the multivariable model, only body composition was significantly associated with body size dissatisfaction (odds ratio: 1.849 (1.085–3.149, $p = 0.024$) and 1.828 (1.043–3.202, $p = 0.035$), respectively).

Conclusions Body composition measures can better predict body size dissatisfaction in children and adolescents than BMI. This result may be relevant for the design of future studies on physiological indicators and body satisfaction.

Level of evidence Level V, cross-sectional study

Keywords Body composition · Body mass index · Body size dissatisfaction · Pediatric

✉ Rita Mattiello
rita.mattiello@pucrs.br

1 Programa de Pós-graduação em Pediatria e Saúde da Criança, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil

2 Programa de Pós-graduação em Medicina e Ciências da Saúde da Pontifícia Universidade Católica do Rio Grande do Sul e Centro Universitário Ritter dos Reis-UniRitter, Porto Alegre, Brazil

3 Escola de Medicina, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil

4 Department of Psychology, Concordia University & CHU Sainte-Justine, University of Montreal, Montreal, Canada

5 Programa de Pós-graduação em Pediatria e Saúde da Criança, Pontifícia Universidade Católica do Rio Grande do Sul e Programa de Pós-graduação em Medicina e Ciências da Saúde, Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Avenida Ipiranga 6690, second floor, Porto Alegre, RS 90610-000, Brazil

6 Secretaria de Educação Esporte e Lazer, Programa Esporte e Saúde em Canela(PESC), Prefeitura de Canela, Brazil

7 Faculdade de Nutrição, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

Introduction

Body image is a complex and multidimensional psychological concept that includes perceptual, cognitive, attitudinal, and behavioral factors [1]. Body dissatisfaction is a component of the attitudinal dimension and refers to the negative subjective assessment of one's body [1]. Studies have demonstrated that body dissatisfaction has increased in the past decade, especially among young children [2, 3]. This is an important health concern, given the broad psychological consequences such as dietary restraint, eating disorders, and depression [1, 4–6].

Most research on body image has used the body mass index (BMI) as a physiological predictor of body satisfaction, particularly in children [3, 5–8]. However, BMI may overestimate fatness in children who are shorter or who have higher muscle mass, and may underestimate adiposity in those with reduced muscle mass [9]. Individuals with increased lean body mass can be classified as overweight when using BMI, while individuals with a high percentage of fat mass can be classified as having normal weight [10]. Studies have shown that at or above risk for overweight and overweight according BMI percentiles, childhood cardiovascular health status is negatively affected and future health can be compromised [9, 11, 12].

Few studies have investigated how body composition can predict body size dissatisfaction. Body composition is considered as an important predictor in different clinical scenarios. For example, lower lean mass is a good prognostic factor predicting mortality in patients with sarcopenia [13] and cancer [14]. On the other hand, higher fat mass percentage is a predictor of disease severity, for instance in cardiovascular disease [15], nonalcoholic fatty liver disease [16] and cancer [17]. However, the number of studies investigating the association between body size dissatisfaction and body composition, particularly with fat free mass is relatively limited. Studies that reported measurements of the body composition used the skinfold thickness [18–22]. These measures can also underestimate or overestimate fat mass and have a large variability due to low inter-rater reliability [23]. One of the different methods to assess body composition is bioelectrical impedance analysis (BIA). This is a portable, noninvasive, fast, and relatively inexpensive method for assessing body composition [24, 25]. Bioimpedance body composition parameters has already been associated with several health outcomes morbidity and mortality [26].

Body size dissatisfaction have also been linked with engaging in unhealthy weight-control behaviors among overweight and obese children [1]. Several instruments for the study of the perception of body image have been developed. The silhouetted figure scales have many advantages:

they are relatively simple and easy to administer and do not require sophisticated equipment. The Kakeshita's scale was developed in 2009 and has been useful instrument for clinical and epidemiological research involving body image perception of Brazilian adults and children. Thus, the aim of the present study is to investigate whether body composition parameters can be a better predictor than BMI for body image dissatisfaction in children and adolescents.

Material and methods

Setting and participants

Healthy community-dwelling individuals aged 5–19 years, of both sexes, were recruited using a convenience sample. Children and adolescents were considered healthy if they did not report a diagnosis of chronic disease and did not use medication continually. Data were collected in public and private schools, and events across the Rio Grande do Sul Cities, South of Brazil. Recruitment occurred through word of mouth.

Exclusion criteria were contraindications to BIA, such as diseases affecting the electrical resistance of the skin, pregnancy, having an implanted pacemaker or cardioverter defibrillator, and having an amputation or using prosthesis/orthosis.

The study was approved by the Ethics Committee at the Pontifícia Universidade Católica do Rio Grande do Sul, Brazil (Decision number 48270515.3.1001.5336/2015) and has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. Consent was obtained from children's parents or guardians prior to study participation. An assent form was read and explained to the children/adolescents, and their signature was obtained prior to participation.

Body mass index (BMI)

To assess nutritional status by BMI, participants were weighed and measured according to the standardization of the International Society for the Advancement of Kinantropometry [27]. Participants wore as little clothing as possible and no shoes during the measurements. Weight was measured using a calibrated digital scale (Charder MS6121 model, Brazil) with a capacity of 200 kg and accuracy of 100 g. Repeated measurements were taken until the same weight value was obtained twice. Height was assessed using a metal stadiometer (Cescorf, Brazil) affixed on a vertical bar with an adjustable headpiece. The individuals were instructed to stand with bare feet, arms along the body and head in the Frankfort horizontal plane [28].

BMI (kg/m^2) was computed, and the BMI-for-age Z score values were obtained using the software AnthroPlus V.1.0.2 from the World Health Organization [29]. All participants were classified according to the standard cutoffs recommended by the WHO [30]. These cutoffs classify BMI as low for age (BMI $< Z$ score -2); normal weight (BMI $\geq Z$ score -2 and $< Z$ score $+1$); overweight (BMI $\geq Z$ score $+1$ and $< Z$ score $+2$), and obesity (BMI $\geq Z$ score $+2$).

Body composition

Body composition was measured by bioelectrical impedance analysis (BIA) with a portable device model (BIA InBodyS10 multi-frequency, USA) with applied current of 100 µA (1 KHz), 500 µA (5, 5, 50, 250, 500 and 1000 kHz) with power supply of 100–240 VAC, 50/60 Hz, 1.2 A was used. The hand electrodes were attached to the thumb and middle finger of each hand. The foot electrodes were positioned between anklebone and heel. The test procedure was conducted according to the manufacturer's instructions, the participants wiped the bottoms of their feet with a proprietary electrolyte tissue before standing on the electrodes on the scale platforms of the respective analyzers [31]. The participants followed the recommendations to perform the test according to the recommendations of the BIA guidelines. BIA parameters assessed in this study were percent of body fat and percent of fat-free mass.

The participants' fat percentage was classified according to the standard cutoffs recommended by Lohman [32]: high fat mass $\geq 25\%$ for boys and high body fat $\geq 32\%$ for girls and the classifications consisting of two categories: satisfied and dissatisfied [33].

Outcome

Body size dissatisfaction

Body size dissatisfaction was measured using the Figure Rating Scale for Brazilian Children developed by Kakeshita et al. [33], which calculates the discrepancy between respondents perceived body size and their ideal body size. This scale contains 11 male and female silhouettes that correspond to real intervals of BMI for classification of the subjects ranging from the smallest (BMI of 12 kg/m^2) to the largest silhouette (BMI of 29 kg/m^2). Each successive figure represents a constant increase in BMI of 1.7 kg/m^2 compared to the previous figure. The interviewers asked the children to select the figure that best represents their perceived and ideal body shapes, with possible dissatisfaction scores ranging from -11 to $+11$. Answers with a score of zero (from choosing the same silhouette) indicate body satisfaction. The interviewers asked the participants to identify the figure with the body most similar to their own (actual BMI), and after that to indicate the figure

(cards) showing the body they would like to have (desired BMI). Body dissatisfaction was estimated by subtracting the desired BMI from the actual BMI ("desired" minus "actual"). When the result was zero, the participants were considered to be satisfied with their body image.

The measurements were carried out by a team of trained evaluators following the established standards for the performance of the exams and the application of the questionnaires. Participants and their family completed standardized self-report questionnaire for the collection of demographic and socioeconomic data, which included the following information: age, sex, family income, ethnicity (Caucasian, African American, Asian descendent, and Hispanic).

All participants answered the questionnaires in the presence of only the interviewer. The researchers who carried out the questionnaires and performed the analysis and classifications were blinded to the results of the BIA.

Study design and sample size

The study design was cross-sectional. The logistic regression model sample size was calculated a-priori considering the following parameter values: slope $= 0.03$, $\alpha = 0.05$, power $= 0.90$, and standard deviation residual $= 0.5$. Thus, the total required number of participants was 294. The strategy chosen was the inclusion of at least 300 participants, considering we would adjust the analysis by sex and age group, and evaluate the outcome of body perception. The sample size was calculated using G*power 3.1.9.4.

Statistical methods

Descriptive statistics were used to summarize the data. We conducted logistic regression analyses to estimate the association between BMI, body composition, and body size dissatisfaction, as well as possible confounder variables age $=$ continuous variable, years, ethnicity $=$ Caucasians and others (African American, Asian descendent, and Hispanic), and sex $=$ male and female.

Initially, all covariates that presented $p < 0.20$ were included in the multivariate model. The next step was the individual exclusion of covariates that presented critical p values (values that were not significant). This step was repeated until all variables remaining in the model presented $p < 0.05$.

All analyses were performed using the Statistical Package for Social Sciences (SPSS) v.17 (SPSS Inc, Chicago, IL).

Results

A total of 547 participants were evaluated, including 188 (34.4%) children and 359 (65.6%) adolescents with a mean age ($\pm$ SD) of 11.4 ± 3.8 years. Of these, 296 (54.1%) were

females and 325 (66.6%) identified as Caucasian. The mean BMI was 20.5 ± 4.6 kg/m^2, and 314 (59%) participants were classified as normal weight, 112 (21.1%) were overweight, and 106 (19.9%) were obese. The average fat and lean mass percentages were $23.01 \pm 10.59\%$ and $72.84 \pm 10.03\%$, respectively. There were 44 (30.2%) boys and 78 (27.5%) girls were classified as having excess fat mass percentage.

Dissatisfaction with body size was presented in 363 (76.3%) participants, with 230 (48.3%) participants desiring a thinner figure and 133 (27.9%) desiring a larger figure, and there were no statistical differences in regard to age and sex. About 30% of boys selected silhouette 5 as ideal (Fig. 1a), and about 20% of girls selected silhouettes 3, 4, and 5 as ideal (Fig. 1b).

In our univariate model, BMI and body composition parameters were associated with body size dissatisfaction. In the multivariate model (including both BMI and body composition), only body composition was significantly associated with body size dissatisfaction, with increases in the measure of percentage of fat mass and lean body mass corresponding to increased dissatisfaction odds ratio: 1.85 (1.08–3.14, $p = 0.024$) and 1.83 (1.04–3.20, $p = 0.035$), respectively. We then tested with hierarchical regression analyses whether sex moderated the observed associations. For each key predictor (BMI, percentage of fat mass or lean body mass), the analysis was done in 3 subsequent steps. In the first step, the key predictors of investigation were entered (BMI, percentage of fat mass or lean body mass), followed by the moderator variable (sex) in step 2 and lastly the interaction term (key predictor by sex) in step 3. Results on the association between BMI or the body composition measures and body size dissatisfaction were similar to the univariate analyses without the inclusion of sex. In all three subsequent analyses, there was no main effect of sex ($p > 0.46$). There were also no interaction effects between the key predictor variables and sex ($p > 0.31$), indicating that sex did not further moderate our findings.

Considering the participants' age range, we also tested whether the BMI Z score was associated with body size dissatisfaction, but it was not ($p = 0.52$).

Discussion

We found that BMI was not a determinant of body size dissatisfaction, whereas body composition (i.e., fat mass and lean body mass percentage) were predictors. The probability of dissatisfaction among children and adolescents with greater fat mass was similar to dissatisfaction with the larger lean body mass. One explanation is that participants restrict their assessment of body image to "being bigger" and "being fatter" in the images. Although BMI is used to evaluate the anthropometric nutritional status of individuals, it does not take into account the amounts of fat and lean body mass. For example, children who have increased lean mass due to sports are more likely to have better outcomes in relation to morbidity and mortality [29–31], even if their image appears to be larger than the body size considered ideal for a given
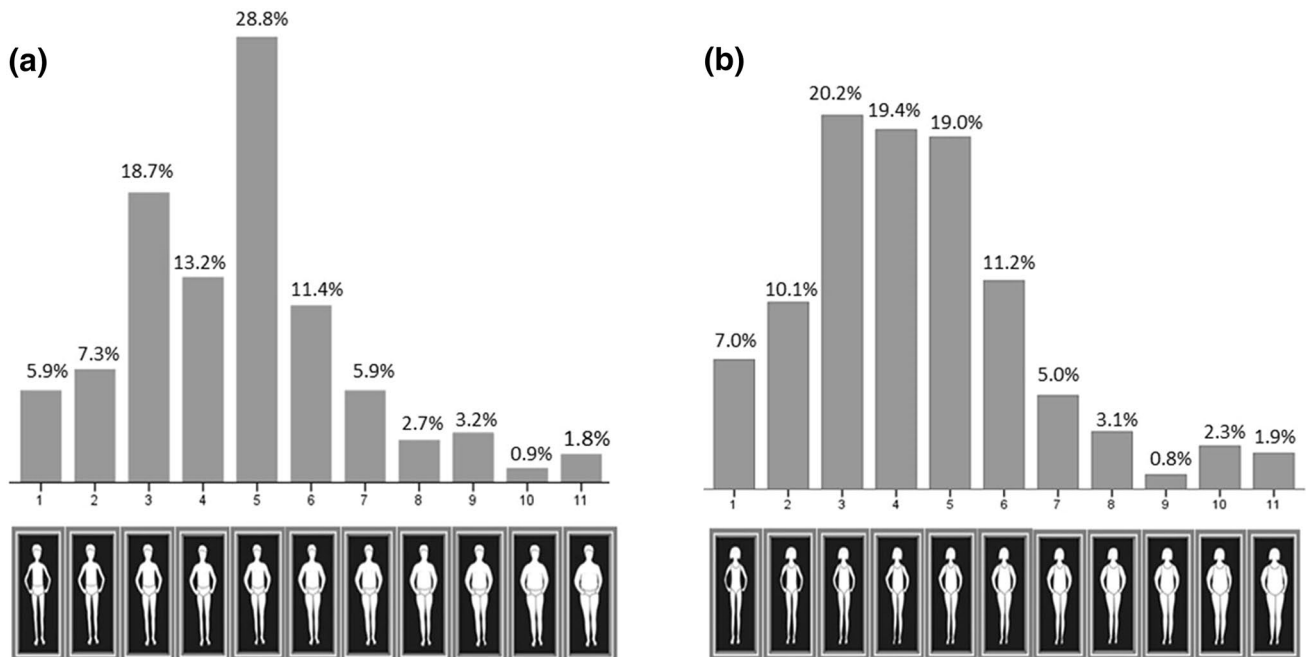
Fig. 1 Silhouette considered as ideal body size in boys (**a**) and girls (**b**)

culture. Being dissatisfied with body size can contribute to risk for various forms of mental health problems, including bulimia nervosa and anorexia nervosa, even if dissatisfaction is motivated by increased muscle mass. Thus, the evaluation of body composition is fundamentally important when evaluating body image satisfaction.

Similar to our results were found in a study with 256 university students, but body composition was measured from the sum of five skinfold thickness measurements [19]. Others studies that evaluated body composition by skinfold thickness observed that both BMI and fat mass percentage appeared to be indicators of body size dissatisfaction [8, 20–22]. However, most studies included only adolescents [20–22], and the body composition was evaluated by one skinfold thickness measurement at the triceps [22] or the sum of two skinfold thickness measurements at the triceps and subscapularis or at the triceps and calf [8, 20, 21]. Underestimation or overestimation of fat mass by skinfold equations has been shown in other studies with the different populations, independent of nutritional studies [34–36]. In this context, it is important to evaluate the body composition by accurate methods such as multifrequency bioimpedance.

We observed a high prevalence of body size dissatisfaction without differences regarding sex, age and ethnicity among the children. The high prevalence of body size dissatisfaction found in this study was similar to the results obtained in others studies, particularly among adolescents [8, 37, 38]. However, the present findings suggest that dissatisfaction may develop in very young children. One possible explanation is how children and adolescents perceive their bodies. In our study, despite around 60% of the participants being classified as having normal weight, dissatisfaction was observed in almost 80%. Furthermore, the analysis of body composition values showed a shift of the percentage fat mass and the lean body mass from the normal values (20 and 70%, respectively).

Recent studies showed that children of both sexes do not make accurate judgments regarding average body size, which points to considerable biases of perception. Research has shown an association between eutrophic child and negative body image, which may be attributed to discrepancies from one's perceived ideal body [39–41]. In general, children and adolescents emphasized a strong preference for a thinner or normal body sizes and an aversion of overweight and obese body sizes. We found no significant differences in sex and the images selected as ideal, although more girls selected leaner images as an ideal body than boys [4]. As highlighted by the literature, adolescent girls are often concerned with a "drive for thinness" and "body dissatisfaction".

Ethnicity is an important factor to consider, which could the values attributed to the body image of children and adolescents [6, 42]. Western culture predominantly endorses an ultrathin ideal body as attractive for women, while a muscular and slender body is considered ideal for men. A thin body size is predominant among actresses and singers with thin ideal bodies, that is often perceived by girls as having "perfect bodies" [43]. On the other hand, in non-Western ethnicities, traditionally, a body image of being "full figured" may still predominate [43–46]. The present study was conducted in a Brazilian population, who generally internalize the Western thin-body ideal and may be more vulnerable to negative body size and dissatisfaction with one's body. However, we did not find any association with ethnicity and body size in our sample.

This study has several limitations. First, the study was conducted solely in the south part of Brazil, but we included participants from different ethnicities and different levels of socioeconomically status. We also included participants living in the more urban and rural areas to have a better representation of the sample. Second, the validated silhouette drawings are directly associated with bidimensional linear forms, which may imply flaws in total body representation. The scale can have a no detectable variation between one figure and another, but it is one of the most widely used validated methods to assess body image in Brazilian children and has been constantly considered a good instrument. The high prevalence rates of body image dissatisfaction as observed in the present study along with the recently reported high prevalence rates of disordered eating behaviors in another Brazilian community sample [47] highlight the relevance to further develop and validate other measures of body size dissatisfaction that can be used in Brazilian (Portuguese speaking) community samples.

Furthermore, this study did not differentiate the level of dissatisfaction by a larger or smaller body in the association with the variables of body composition and BMI, as the number of people wishing larger body was relatively small and may confound with other variables such as sex.

Finally, we do not consider other variables that may influence this type of association such as the presence of a clinical depression. As far as we know, this is the first study to evaluate the association between body size satisfaction and body composition in a large sample among young children and adolescents. One of the important contributions of this study is the evaluation of body composition by multifrequency BIA versus proxy measures such as BMI. Other advantages are the inclusion of young children and adolescents and the large, ethnically diverse sample. Nevertheless, the limitations should not be ignored.

In conclusion, we found that body composition measures can predict body size dissatisfaction. Thus, the present findings clearly indicate the importance of evaluating body composition in young children and adolescents as a reference parameter for body size dissatisfaction. This result may be relevant for clinical practice and future studies on physiological indicators and body satisfaction.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study was approved by the Ethics Committee of the Pontifícia Universidade Católica do Rio Grande do Sul, Brazil, under approval number 2.187.802.

Informed consent All adult participants provided written informed consent. In the case of minors, consent was obtained from their parents or guardians. An assent form was read and explained to the children/adolescents, and their signature was then collected.

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