Validity of self-reported weight and stature in adolescents from *Cuiabá*, Central-Western Brazil

Validade de peso e estatura autorreferidos em adolescentes de Cuiabá, Região Centro-Oeste do Brasil

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ABSTRACT

Objective

This study assessed the agreement between self-reported and measured weight and stature in adolescents.

Methods

Ninety-seven students from public and private high schools of *Cuiabá*, in the state of *Mato Grosso*, Brazil (14 to 19 years old), were examined to assess the validity of self-reported weight and stature. The adolescents reported their weight and stature, which were subsequently measured by standard procedures. The body mass index was calculated from both self-reported and measured data. Weight status was classified according to body mass index Z-score and World Health Organization criteria. The differences between the self-reported and measured means were tested by the Student's paired *t*-test. Weighted Kappa's coefficient of agreement was used to assess the variations in weight status categorization using informed and measured data. Agreement between measurements was assessed by the Bland-Altman method and intraclass correlation coefficient.

Results

The means of self-reported and measured weights (p=0.30), statures (p=0.76) and body mass index (p=0.47) were not significantly different. There was high agreement between self-reported and measured measurements according to intraclass correlation coefficient (weight: r=0.99; stature: r=0.96; body mass index: r=0.97) and the mean agreements estimated by the Bland-Altman method were 99% for weight and 100% for stature.

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Conclusion

Given the excellent agreement with measured data, self-reported weight and stature are considered valid to be used in epidemiological studies on adolescents of *Cuiabá*, *Mato Grosso*, Brazil.

Indexing terms: Agreement. Anthropometry. Body mass index. Intraclass correlation coefficient. Nutritional status.

RESUMO

Objetivo

Avaliar a concordância entre as medidas de peso e estatura autorreferidas e aferidas em adolescentes.

Métodos

Noventa e sete estudantes de 14 a 19 anos de idade do ensino médio público e privado de Cuiabá, (Mato Grosso) foram examinados a fim de se avaliar a validade de medidas de peso e estatura autorreferidas. Os adolescentes referiram o peso e a estatura e, na sequência, as respectivas medidas foram aferidas com base em procedimentos padronizados. O índice de massa corporal foi determinado a partir das medidas estimadas e aferidas. O status de peso foi classificado com base no escore-Z do índice de massa corporal segundo proposta da Organização Mundial da Saúde. Utilizou-se o teste t de Student pareado para avaliar as diferenças entre as médias das medidas autorreferidas e aferidas. O coeficiente de concordância Kappa ponderado foi utilizado para se avaliarem as variações na categorização do status de peso estimado a partir de medidas informadas e aferidas. A concordância entre as medidas foi avaliada pelo método de Bland-Altman e pelo coeficiente de correlação intraclasse.

Resultados

Não se observaram diferenças entre as médias das medidas autorreferidas e aferidas de peso (p=0,30), estatura (p=0,76) e índice de massa corporal (p=0,47). Houve elevada concordância entre as medidas autorreferidas e aferidas de acordo com o coeficiente de correlação intraclasse (peso: r=0,99; estatura: r=0,96; índice de massa corporal; r=0,97) e segundo o método de Bland-Altman (concordância média: peso=99%; estatura=100%).

Conclusão

Dada a excelente concordância com as medidas aferidas, o peso e a estatura autorreferidos são considerados válidos para serem utilizados em estudos epidemiológicos com adolescentes de Cuiabá.

Termos de indexação: *Concordância. Antropometria. Índice de massa corporal. Coeficiente de correlação intraclasse. Estado nutricional.*

INTRODUCTION

Obesity in childhood and adolescence is a risk factor for the early development of metabolic complications[1], in addition to being strongly related with excess weight in adulthood[2]. Hence, the monitoring of overweight and obesity indicators in children and adolescents is critically important in public health.

Body Mass Index (BMI=weight/stature^2) is widely used for the nutritional assessment of adolescents in epidemiological studies[3] because weight and stature are relatively easy to measure with simple and low-cost equipment. However, situations in which anthropometric measurements are unfeasible are not uncommon, whether because of costs or logistics[4]. Thus, self-reported information has been used as a proxy of measured data in epidemiological surveys that assess adolescents' nutritional status[5-12].

However, different study designs, sample characteristics, statistical analysis techniques, and socio-cultural factors may cause divergences in studies evaluating the agreement between the measured and self-reported weights and statures of adolescents. So it may not be possible to extrapolate the self-reported and measured agreement found for one population to other groups, especially if they live in distinct geographical and cultural environments[9].

The objective of this study was to assess the agreement between self-reported and measured weights and statures used in the nutritional assessment of adolescents in a school-based study carried out in *Cuiabá* (MT), Brazil[13].

METHODS

A cross-sectional study was performed with a sample of 97 students aged 14 to 19 years from a state public high school, a federal public high school, and a private high school of *Cuiabá*, the capital of the state of *Mato Grosso*, in Central-Western Brazil. The sample size was estimated using an equation appropriate for validation studies (Equation 1)[14]:

$$n = \left[\frac{(Z_\alpha + Z_\beta)}{C}\right]^2 + 3$$

Where:

n = total number of individuals required for the validation;

Z_α = standard deviation for α;

Z_β = standard deviation for β and;

$C = 0.5 * \left[\frac{\ln(1+r)}{\ln(1-r)}\right]$, where r is the expected correlation coefficient and *ln*, the natural logarithm.

Therefore, to estimate a correlation coefficient of at least 0.80, with statistical power of 95% (β=0.05; Z_β=1.65), and significance level of 99% (α=0.01; Z_α=2.33), approximately 16 adolescents would be required for the study. Considering the possibility of non-response bias, the sample size was increased by 30%, totaling 21 adolescents.

Having as base the sample selected for a school-based cross-sectional study carried out in the same city[13], three classes were randomly selected, one from each of the sample strata (state public schools, federal public school, and private schools) and all students in each selected class were examined.

All adolescents and/or their parents or legal guardians signed an Informed Consent Form confirming their agreement to participate in the study. The study was approved by the Research Ethics Committee of *Hospital Universitário Júlio Müller*, of *Universidade Federal do Mato Grosso* under protocol number 459/CEP-HUJM/07. Data collection was also authorized by the schools' principals.

The adolescents were asked to inform their weight (kg) and stature (m) and were subsequently measured. Weight was measured using an electronic scale (Tanita, model UM-080) with accuracy of 0.1kg and capacity of 150.0kg. Stature was measured by means of a portable stadiometer (Sanny, *São Paulo*, Brazil) with accuracy of 1mm and total length of 210cm. The measurements were done as recommended by the Brazilian Ministry of Health[15]. The adolescents were asked to take off their shoes, use light clothes, and stand upright with the head in the Frankfort plane. Stature was measured twice admitting a maximum difference of 0.5cm between the measurements and the mean of the two measurements was used in the analyses. The weight status of the adolescents was classified according to BMI Z-score as proposed by the World Health Organization[16] (Table 1).

The statistical analyses were performed by the Statistical Package for the Social Sciences version 19.0. The continuous variables were tested by the Kolmogorov-Smirnov test to verify the normality of the distributions. The difference between self-reported and measured data was calculated by subtracting the measured from the self-reported data. The paired Student's *t*-test was used for comparing the self-reported and measured weight, stature, and BMI means. Analysis of Variance (ANOVA) was used for assessing the differences according to type of school.

The weighted Kappa coefficient of agreement was used for estimating the

Table 1. Criteria used for classifying the weight status of the adolescents*.

Cut-offs to body mass index Z-score	Weight status
Z-score <-2 standard deviations	Underweight
-2 standard deviations ≤ Z-score ≤ +1 standard deviation	Normal weight
+1 standard deviation < Z-score ≤ +2 standard deviations	Overweight
Z-score >+2 standard deviations	Obesity

Note: *Based on the World Health Organization proposal.

agreement between self-reported (BMI calculated from self-reported data) and measured (BMI calculated from measured data) weight status (underweight, normal weight, overweight, and obesity). The following limits determined the degree of agreement: 0.00 to 0.20=slight agreement; 0.21 to 0.40=fair agreement; 0.41 to 0.60=moderate agreement; 0.61 to 0.80=substantial agreement; and 0.81 to 1.00=almost perfect agreement[17]. Additionally, the proportion of adolescents categorized in the same weight status category (exact agreement), adjacent categories (adjacent agreement) and opposite categories (disagreement) according to the two measurements (self-reported and measured) was determined.

The Intraclass Correlation Coefficients (ICC) and respective 95% Confidence Intervals (95%CI) were estimated to evaluate the agreement between self-reported and measured data. The ICC estimates the proportion of the total variability that can be attributable to the variability between individuals; it is considered high when greater than 0.75[18].

The self-reported and measured weights and statures were transformed into their logarithms to apply the Bland-Altman method[19], and the mean agreement and Limits Of Agreement (LOA) were estimated. The mean agreement is represented by the mean difference between self-reported and measured data. The LOA provide an interval that contains 95% of the individual differences between the two data. The lower and upper LOA are estimated by: [mean difference ± (1.96 x the standard deviation of the differences between the measurements)]. As the analyzed data were log transformed, both the mean agreement and LOA are expressed in percentages, since the exponential of a difference is a ratio (x100).

Additionally, simple linear regression models were performed, having the differences between the measures as dependent variables and the means as independent variables[20]. In this analysis, the regression coefficient (β) is expected to be close to zero and not statistically significant, showing that the agreement between the two measurements is not influenced by their magnitude.

RESULTS

The study included 97 adolescents with a mean age of 16 years (standard deviation=1 year); 59% were boys, 35% studied in the federal public high school, 34% in a state public high school, and 31% in a private high school (data not shown).

Weight, stature, and BMI distributions were symmetric (p>0.05; Kolmogorov-Smirnov test). There were no significant differences between self-reported and measured weight (p=0.30), stature (p=0.76), and BMI (p=0.47) means (Table 2) and the ICCs between those measures were high (>0.90) for all gender, age, and type of school strata (Table 3). Additionally, the self-reported and measured weight, stature, and BMI means did not differ according to gender (p=0.21; p=0.06 and p=0.94, respectively) or age (p=0.33; p=0.26 and p=0.79, respectively) (data not shown).

There was perfect agreement between the weight status categories estimated from self-reported and measured data (kappa=0.85; 95%CI 0.77; 0.93): underweight (3% *vs*. 3%), normal weight (71% *vs*. 74%), overweight (19% *vs*. 12%), and obesity (7% *vs*. 10%). Thus, the exact agreement between the categories of weight status was of 86% and the exact agreement plus the adjacent agreement was 100% (data not shown).

According to the Bland-Altman method[19], weight and stature mean agreements were 99% (LOA=89% and 112%) and 100% (LOA=96% and 104%), respectively. The agreement between

Table 2. Mean and standard deviation of measured and self-reported weights, statures, and body mass indices of the adolescents (n=97). *Cuiabá* (MT), Brazil, 2008.

Self-reported anthropometric measures	All		Boys		Girls	
	M	SD	M	SD	M	SD
Weight (kg)						
Self-reported	61.4	13.8	66.3	15.1	54.5	7.5
Measured	61.8	13.9	67.0	15.0	54.3	7.5
Self-reported *minus* measured weight	-0.4	3.4	-0.7	3.5	-0.2	3.2
p value*	0.30		0.13		0.76	
Stature (m)						
Self-reported	1.69	0.1	1.73	0.06	1.62	0.1
Measured	1.69	0.1	1.74	0.06	1.61	0.1
Self-reported *minus* measured stature	-0.001	0.03	-0.01	0.03	-0.01	0.03
p value*	0.76		0.19		0.14	
BMI (kg/m²)						
Self-reported	21.5	4.0	22.0	4.4	20.8	3.1
Measured	21.6	4.0	22.1	4.5	20.9	3.1
BMI calculated from self-reported data *minus* BMI calculated from measured data	-0.1	1.4	-0.1	1.6	-0.1	1.2
p value*	0.47		0.59		0.64	

Note: *Paired Student's *t*-test. M: Mean; SD: Standard Deviation; BMI: Body Mass Index.

Table 3. Intraclass correlation coefficient between self-reported and measured weights, statures, and body mass indices according to gender, age, and type of school (n=97). *Cuiabá* (MT), Brazil, 2008.

Adolescents' characteristics	Weight		Stature		BMI	
	ICC	95%CI	ICC	95%CI	ICC	95%CI
All	0.99	0.98-0.99	0.96	0.94-0.98	0.97	0.95-0.98
Gender						
Male	0.99	0.98-0.99	0.91	0.85-0.95	0.97	0.95-0.98
Female	0.95	0.91-0.97	0.94	0.89-0.97	0.96	0.92-0.98
Age (years)						
14 - 16	0.99	0.98-0.99	0.96	0.94-0.98	0.97	0.95-0.98
17 - 19	0.98	0.97-0.99	0.97	0.93-0.98	0.96	0.92-0.98
Type of high school						
State	0.98	0.96-0.99	0.97	0.95-0.99	0.97	0.93-0.98
Federal	0.98	0.97-0.99	0.97	0.94-0.99	0.97	0.94-0.98
Private	0.99	0.98-0.99	0.95	0.90-0.98	0.96	0.92-0.98

Note: 95%CI: 95% Confidence Intervals; ICC: Intraclass Correlation Coefficient; BMI: Body Mass Index.

Table 4. Mean agreement and Limits Of Agreement (LOA) of the measured and self-reported weights and statures of adolescents (n=97). *Cuiabá* (MT), Brazil, 2008.

Anthropometric measures	Mean agreement (%)	LOA**	β***	*p* value****
*Weight (kg)**				
All	99	89; 112	0.001	0.98
Boys	99	89; 110	0.033	0.35
Girls	100	89; 113	-0.017	0.82
*Stature (m)**				
All	100	96; 104	-0.049	0.21
Boys	100	96; 104	0.081	0.32
Girls	100	97; 104	-0.086	0.26

Note: *Data were log-transformed for the agreement analysis; **LOA determined as mean difference ± 1.96 x standard deviation of the differences; ***Slope of the differences between the methods regressed on the averages of the methods. (H_0: β=0; α=0.05); ****Statistical significance of β.

the self-reported and measured data did not vary with data magnitude for weight (β=0.001; *p*=0.98) or stature (β=-0.049; *p*=0.21). Similar results were obtained for the adolescents stratified by gender (Table 4).

DISCUSSION

This study evaluated self-reported weight and stature, considered valid for use in epidemiological studies with adolescents from *Cuiabá* (MT), Brazil. High school students of *Cuiabá* (MT), Brazil were able to report reliable weight and stature measures, which were highly concordant with measured weight and stature according to various statistical procedures used for assessing agreement.

In the present study, there were no statistical differences between the boys' and girls' mean self-reported and measured weights, statures, and BMI. Similar results were obtained by Wang *et al*.[5] while studying Australian adolescents; nevertheless, the agreement between self-reported and measured weights and statures of different populations may diverge, especially among adolescents. Analogous studies have shown that adolescents tend to underestimate weight and overestimate stature when reporting anthropometric data, resulting in underestimated BMI. Fonseca *et al*.[11] assessed the agreement between BMI calculated from self-reported and measured weights and statures in Portuguese adolescents and found that, on average, weight was underestimated by -0.99kg, stature was overestimated by 0.70cm, and BMI was underestimated by -0.55kg/m^2. Comparable results were obtained by Zhou *et al*.[12] who found that Chinese adolescents underestimated their weight by -2.35kg and overestimated their stature by 1.36cm; consequently, BMI was underestimated by -1.23kg/m^2. Farias-Júnior[9] also found that, on average, boys from *Florianópolis* (SC) (Southern Brazil) underestimated their weight by -0.26kg and girls, by -0.87kg (*p*=0.02). Conversely, those boys overestimated their stature by 0.08cm and girls, by 0.92cm (*p*=0.01)[9]. Brug *et al*.[8] assessed Dutch adolescents (13 to 19 years old) and found that both boys and girls overestimated their weight; nevertheless, overestimation of weight was higher among girls than among boys.

The high agreement between weight status evaluated from self-reported weight and stature, and weight status analyzed from measured weight and stature indicates that self-reported measurements can be used in epidemiological studies that assess the weight status of adolescents from *Cuiabá* (MT), as seen in other studies[7,9,11]. Yet, these results differ from those observed by other authors. Brener *et al*.[6] assessed adolescents from the district of Columbia and found that the overweight prevalence was underestimated when the classification of weight status relied on BMI calculated from self-reported weight and stature. Zhou *et al*.[12] concluded that

weight and stature reported by Chinese adolescents should be used with caution, considering the sensitivity of self-reported measurements for detecting overweight (56%) in spite of the estimated high weighted Kappa coefficients (weight=0.859; stature=0.906; BMI=0.754).

In this study, the accuracy of adolescents' self-reported weight and stature (and estimated BMI) was not affected by their ages, similar to the findings of Farias-Júnior[9] when Southern Brazilian adolescents were evaluated. However, it should be pointed out that the present study only included adolescents aged 14 years or more, which may have favored the results, since Himes *et al*.[7] observed that the accuracy of self-reported weight and stature increased with age among adolescents from Minnesota aged 12 to 18 years.

In the present study, the agreement between self-reported and measured weights and statures according to ICC was high. These results are similar to those found by Farias-Júnior[9], who reported ICCs of 0.96, 0.95 and 0.94 for weight, stature and BMI, respectively. On the other hand, Zhou *et al*.[12] found slightly lower ICCs: 0.85 (weight), 0.90 (stature), and 0.80 (BMI). Other studies with adolescents that estimated the Pearson's correlation coefficients also found high correlations between self-reported and measured data[6,7,11].

The slight differences observed between the self-reported and measured weights and statures may stem from the fact that the adolescents reported their data considering a measurement made in the past. Thus, information about the last occasion that the adolescent had his/her weight and stature measured may be useful in this type of study as a confounder to be controlled.

Even though Page *et al*.[21] reported that adolescents may measure their weight and stature frequently because of their excessive concern with body image and hope for a "perfect body," a characteristic of the contemporary Western society[9], anthropometric variables may not be measured as often as desirable among adolescents, which, coupled with their fast growth, may cause them to have outdated information about their weight and stature[9,22].

In this study, the sample size far exceeded that required for generalizing the results for high school adolescents from *Cuiabá* (MT). Moreover, the fact that the studied adolescents were probabilistically selected using a school-based study sample minimizes the chance of selection bias and optimizes the sample's representativeness.

CONCLUSION

Comparing the study results with those of similar studies with adolescents living in different locations indicates the need of studies assessing the accuracy of self-reported weight and stature prior to the use of these measures. Identifying the characteristics associated with differences in self-reported weight and stature helps to reduce information bias and enhance the quality of adolescents' weight status classification.

When financial or logistic restrictions prevent the measurement of weight and stature, self-reported measures can be used as a valid alternative to calculate the BMI of adolescents from *Cuiabá* (MT), Brazil. Therefore, the present results support the hypothesis that BMI calculated from self-reported weight and stature may be used in epidemiological and surveillance studies assessing the weight status of high school adolescents in this city.

COLLABORATORS

PRM RODRIGUES participated in the study design and development, statistical analysis, and data interpretation, outlining and writing the article. RMV GONÇALVES-SILVA participated in the study design and coordination, and article outline and critical revision. RA PEREIRA participated in the study design, data analysis and interpretation, and critical revision of the article. All authors read and approved the final version.

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