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ORIGINAL ARTICLE

VALIDITY OF SELF-REPORTED WEIGHT AND HEIGHT FOR THE DIAGNOSIS OF THE NUTRITIONAL STATE IN ADOLESCENTS

VALIDADE DO PESO E ESTATURA REFERIDOS PARA O DIAGNÓSTICO DO ESTADO NUTRICIONAL EM ADOLESCENTES

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ABSTRACT
The objective of this study was to analyze the validity of self-reported measurements of weight and height for the diagnosis of the nutritional status of adolescents. This is a cross-sectional school-based study conducted with 989 students aged between 12 and 18 years old. Information about weight and height were collected through a questionnaire and the measurements were obtained later. It was found an underestimation in relation to the weight and an overestimation in relation to the height, in both sexes ($p<0.05$). The self-reported body mass index (BMI) was overestimated in boys (0.2 kg/m^2) and underestimated in girls (- 0.3 kg/m^2). The nutritional status influenced significantly the errors on the self-reported BMI ($p<0.05$). In adolescents with low weight there was an overestimation of the self-reported BMI and, in individuals with overweight/obesity there was an underestimation ($p<0.05$). Thus, the use of said measurements of weight and height in adolescents is valid for eutrophic adolescents, but it has to be carefully applied in adolescents with overweight/obesity, taking into consideration that they underestimate the prevalence of overweight/obesity.
Keywords: Nutritional status. Body Mass Index Adolescent.

INTRODUCTION

The high prevalence of overweight/obesity in various age groups characterizes the moment of nutritional epidemiological transition the country is experiencing (GIGANTE et al., 2003; BATISTA FILHO; RISSIN, 2003; VEIGA et al., 2004). There is a great interest in the diagnosis and monitoring of cases of overweight/obesity in adolescents, due to its high incidence rate and its close relationship with health problems (VIEIRA et al., 2007; CHU et al., 1998).

The diagnosis of cases of overweight/obesity is commonly made through anthropometric measurements. The body mass index (BMI), which is obtained by dividing weight in kilograms by height in meters square, is the internationally accepted calculation to make this diagnosis (COLE et al., 2000; CONDE; MONTEIRO, 2006).

In the search for greater applicability in population studies and simplification of the field work, saving resource and reducing the time of data collection, some authors, more frequently, have been using self-reported weight and height measurements to determine the BMI, replacing the measured measurements (SHERRY et al., 2007; MADDAH, 2010; SANTANA et al., 2009).

Nevertheless, the use of self-reported measurements in adolescents is not a consensus in the scientific literature (SHERRY et al., 2007). While some studies have shown a strong correlation among self-reported weight, height and BMI (BRENER et al., 2003; ELGAR et al., 2005; FONSECA et al., 2010), others show that self-reported measurements differ significantly from measured measurements (WANG et al., 2002; ZHOU et al., 2010; VRIENDT et al., 2009). According to the latter authors, the

underestimation of the body weight and the overestimation of the height are factors that can contribute to a lower accuracy in the calculation of BMI from self-reported measurements.

In Brazil, only two studies related to the topic investigated the validity of self-reported measurements in adolescents: FARIAS JÚNIOR, 2007, and ENES et al., 2009. In the first one, conducted with adolescents, it was observed that self-reported measurements can be used as a form of approximating the measurements, but their authors point out that in girls aged between 16 and 18 there may be a significant underestimation of the self-reported BMI. In the other study, it was observed low validity of self-reported measurements of weight and height.

Thus, it is observed that is not clear in the literature the validity of using self-reported weight, height and BMI for the diagnosis of overweight/obesity in adolescents. In view of this, the present study aims to analyze the validity of self-reported measurements of weight and height in adolescents, verify the influence of sex, age and nutritional status variables on the errors of the self-reported body mass index and compare the cases of overweight/obesity calculated through the BMI with the chaos in which this data was reported by the adolescents.

METHODS

This is a cross-sectional school-based study (N = 6,597) conducted in the public schools of Ponta Grossa city, Paraná state, Brazil. Individuals of both sexes, enrolled in urban schools, who were in daytime high school, were part of the study.

Sampling was constructed by the proportional stratified method in two stages. Initially, all public schools were listed and grouped according to their geographic location (north, south, east, west and center). Then, nine schools were selected, by adopting stratification by geographical region, which ensured the representation of geographical areas of the city in the sample. The number of selected classes in each school was set to achieve a representative percentage of its geographical area in relation to the city as a whole.

To calculate the size of the sample, this study took into consideration the incidence of overweight/obesity of 20% in adolescents (ABRANTES et al., 2002), confidence interval of 95%, error of 3.0 percentage points, design effect of 1.5 and an increase of 10% for losses/refusals. The minimum sample size was estimated at 1,068 individuals. All students who were in class on the day of collection and who was responsible for them had authorized their participation were considered eligible. As for the adopted exclusion criterion, the present study did not count with: students older than 19 years-old; pregnant adolescents and adolescents whose responsible refused to sign the informed consent. With these criteria, the final sample consisted of 1,150 individuals, aged between 14 to 18 years. Out of this total, 14.1% did not report their height and 7.2% stopped reporting their body weight. Finally, the sample consisted of 989 subjects who had complete data.

The data collection occurred on a weekday. Initially, the researchers gave the informed consent (IC) and the next day the students who wished to participate in the study filled, supervised by the researchers, a questionnaire that requested information on sex, age and self-reported weight and height of the participant. Later, the students were taken to the room physical assessment, where the body weight and height were measured according to the procedures of the World Health Organization (1995). It was used a digital scale, Plenna brand, with resolution of 100 grams and a wall-mounted stadiometer, with a resolution of 1 cm. The data collection was carried out by two researchers

trained to perform the measurements.

From the self-reported and measured measurements of weight and height they calculated the values of self-reported and measured body mass index (BMI). For classification of cases of underweight, overweight and obesity the normative table proposed by Conde and Monteiro (2006), which takes into account sex and age, was adopted.

For the data analysis, initially, the descriptive statistics was used to characterize the sample and, subsequently, it was established the difference among the self-reported and measured measurements (error = self-reported measurement minus measured measurement), in which negative values are related to the underestimation for the self-reported variable.

The paired t test was used to compare the mean error among the self-reported and measured measurements of weight, height and BMI. For comparison of the mean error between the sexes the t test for independent samples was used. The intraclass correlation coefficient was used in order to verify the correlation among the self-reported and measured information. The Bland and Altmann's graphical analysis (1986) was used to analyze the configuration of the variability among the self-reported and measured measurements of BMI.

Finally, the prevalence of overweight/obesity estimated by self-reported and measured BMI was compared through the McNemar's test of proportions and, for the diagnosis of overweight/obesity, the values of sensitivity and specificity and the Kappa index of the self-reported BMI were calculated. The statistical and graphical calculations were developed by using SPSS 10.0 and MedCalc programs, adopting a significance level of $p < 0.05$.

This study was approved by the Ethics and Research Committee Involving Humans of the State University of Ponta Grossa - Paraná (protocol 40/07), in accordance with the Resolution 196/96 of the National Health Council.

RESULTS

A total of 989 students of both sexes were assessed, out of whom 58.4% were female and with an average age of 15.8 ± 1.19 years. Table 1 presents the mean values and the differences among the self-reported and measured measurements stratified per sex. The weight was statistically underestimated in both sexes ($p < 0.05$). Among boys there was a higher underestimation of values of weight in relation to the girls (0.5 kg vs. 0.2 kg, $p < .05$).

As for the height, overestimation was observed in both sexes: the boys reported height 1.5 cm higher than the measured average. In the girls, this value was also overestimated, but to a lesser magnitude (0.5 cm).

The body mass index presented statistical differences ($p < 0.05$) between the self-reported and measured measurements in both sexes. There was no difference ($p > 0.05$) between the errors in relation to the sexes (0.2 kg/m^2 vs. -0.3 kg/m^2).

Table 1 - Mean values, standard deviation, mean error and intraclass correlation coefficient (ICC) between the self-reported and measured measurements of weight, height and body mass index in adolescents.

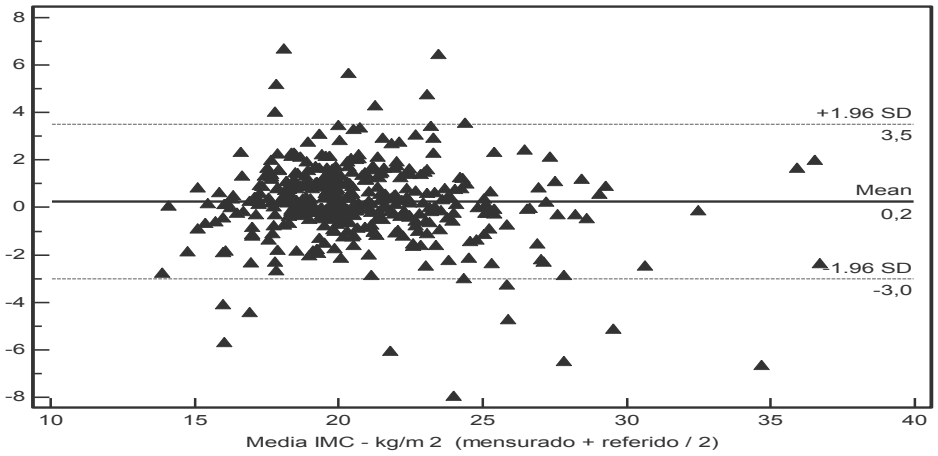
Variables	Self reported	Measured	Error	ICC	$CI_{95\%}$
Boys					
Weight (kg)	61,7±11,6	62,2±12,5	- 0,5 *	0,92**	0,91-0,94
Height (cm)	173,2±7,4	171,7±8,	1,5 *	0,82**	0,72-0,84
BMI (kg/m^2)	20,9±3,3	20,7±3,6	0,2 *	0,87**	0,85-0,90
Girls					
Weight (kg)	54,1±8,9	54,3±10,8	- 0,2 *	0,96**	0,95-0,96
Height (cm)	162,2±6,7	161,7±6,7	0,5 *	0,84**	0,82-0,87
BMI (kg/m^2)	20,5±2,9	20,8±3,7	- 0,3 *	0,90**	0,88-0,92

Error: self-reported measurement minus measured measurement; ICC: intraclass correlation coefficient. IC95%: confidence interval. *p<0.05. **p<0.01

The intraclass correlation coefficients between the self-reported and measured measurements were all statistically significant (p <0.01), ranging from 0.82 (CI95% = 0.72 - 0.84) and 0.96 (CI95% = 0 0.95 - 0, 96). The height, in both sexes, was the variable that had the lowest intraclass correlation coefficient.

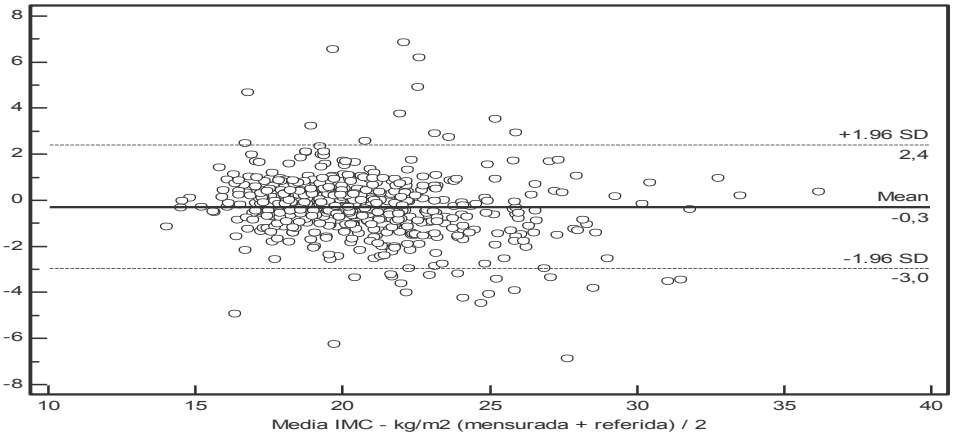
The analysis of the differences allows confirming the tendency of overestimation of the self-reported BMI in the boys (Figure 1) and underestimation of the self-reported BMI in the girls (Figure 2). There was a higher concentration of errors down the zero point, demonstrating a mean error of 0.2 kg/m^2 (CI95% = -3.0 kg/m^2, 3.5 kg/m^2) among the boys, and mean error of - 0.3 kg/m^2 (CI95% = -3.0 kg/m^2, 2.4 kg/m^2) among the girls.

Adopting arbitrarily the error value of 2kg as correct (error=zero), it can be noted that for the measurement of weight 41.6% of the boys and 23.7% of the girls presented errors superior to 2kg; as for the height, 52.7% of the boys and 46.6% of the girls reported their height with an error superior to 2cm (data not presented).



Error (self-reported - measured) Mean BMI - kg / m^2 (measured + self-reported / 2)

Figure 1 - Analysis of the residual scores between the self-reported and measured BMI for boys. The solid line represents the mean error and the dotted line represents the confidence interval (95%).



Error (self-reported-measured) Mean BMI - kg / m^2 (measured + self-reported / 2)

Figure 2 - Analysis of the residual scores between the self-reported and measured BMI for girls. The solid line represents the mean error and the dotted line represents the confidence interval (95%).

In Table 2 it is noted that individuals with low weight, overweight and obesity of both sexes presented measurements of error that are statistically different ($p < 0.05$), and adolescents with low weight overestimated the reported BMI ($p < 0.05$), while individuals with overweight and obesity significantly underestimated these values ($p < .05$).

Table 2 - Values of mean error, intraclass correlation coefficient (ICC) and confidence interval (CI) of the self-reported body mass index, in relation to the nutritional status of the adolescents.

Sexo	Nutritional status	n	Mean Error ±	ICC	IC (95%)
Boys					
	Low weight	3	2,54*	0,86	0,84-0,90
	Eutrophic	339	0,44	0,96	0,94-0,99
	Overweight	37	- 0,98*	0,90	0,87-0,94
	Obese	16	- 1,70*	0,91	0,86-0,93
Girls					
	Low weight	25	0,79*	0,85	0,81-0,89
	Eutrophic	429	- 0,13	0,97	0,92-0,99
	Overweight	77	- 1,50*	0,89	0,83-0,94
	Obese	21	- 1,89*	0,88	0,81-0,91

* it differs statistically ($p<0.05$) in relation to the measured measurement *paired t test.*
mean errors: mean of the difference between the self-reported and measured values.

Figures 3 and 4 display the values of prevalence of overweight, obesity and overweight/obesity for both sexes, comparing the measured values with the self-reported values. In general, the boys underestimated the excess of weight (overweight / obesity) by 4.2 percentage points, showing statistical differences ($p < 0.05$); however, when analyzing only cases of obesity, this value becomes non-significant significant ($p < 0.05$), since the boys underestimated obesity by 1.3 percentage points in comparison with the self-reported measurement ($p < 0.05$).

Regarding the girls, there was a significant underestimation ($p < 0.05$) in all analyzed cases. There was an underestimation of 3.2% of overweight and 2.2% of obesity, which corresponds to an underestimation of 5.4 percentage points in the incidence of excess of weight (overweight / obesity) when using the self-reported measures to calculate the

BMI .

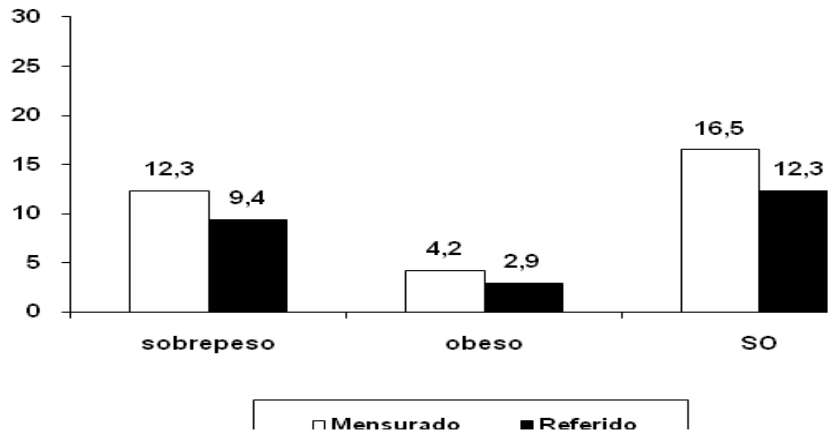


Figure 3 - Prevalence of overweight and obesity in boys in relation to the self-reported and measured measurements. OOb overweight/obese

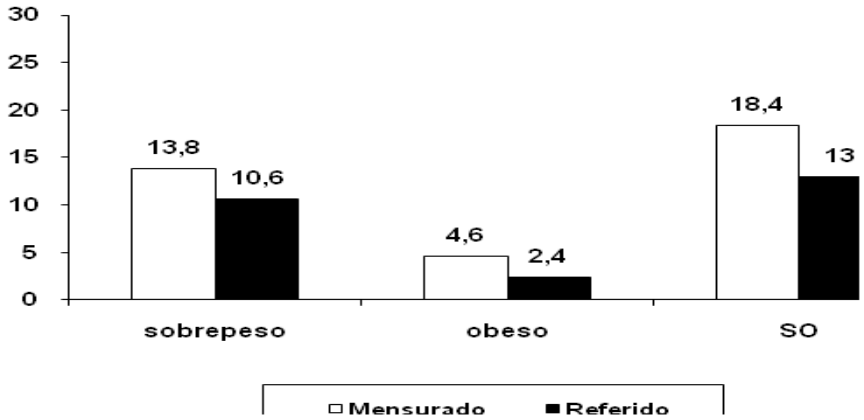


Figure 4 - Prevalence of overweight and obesity in girls in relation to the self-reported and measured measurements. OOb overweight/obese

From the prevalenceof overweight / obesity, sensitivity and specificity were calculated for the incidences estimated from the values of self-reported BMI (Table 3). There was a high correlation in the calculation of the nutritional status, which ranged from 94% (kappa = 77, p <0.001) in boys and 92.4% (kappa = 0.74, p <0.001) in girls. Sensitivity was high for both sexes, with values of 95.5% and 97.5% for boys and girls, respectively. For the specificity higher values were found for males (86%) in comparison with females (70,5%).

Table 3 - Relative values (%) of sensitivity, specificity, negative predictive value and positive predictive value of the self-reported BMI for the diagnosis of overweight / obesity in adolescents.

Sex	Sensitivity	Specificity	False negative	False positive	Kappa*
Boys	95.5	86	2.1	3.8	0.77
Girls	97.5	70.5	5.6	2.0	0.74

*p<0.001. For the classification of the cases with overweight/obesity (OOb), this study adopted the cutoff points established by Conde e Monteiro (2006).

DISCUSSION

It is important to highlight that the present study has investigated the validity of self-reported measurements of weight and height in a sample of adolescent students of the urban area, of the daytime; thus, the results may be different when analyzed in adolescents who do not study or live in rural areas.

The cases of non-reported weight and height are also noteworthy. It was observed that a good portion of the adolescents reported not knowing their height (14.1%) or weight (7.2%). This fact suggests that studies that use the self-reported measurement should consider an additional value to the sample in order to minimize the effect of possible sample losses, although it is understood that these losses did not affect the results, because the sample calculation has considered a loss of 10% of the cases, a value close to what has been found.

In Brazil, most of the samples of the studies related to the topic of the validity of self-reported measurements of weight, height and BMI are composed of adults and / or elders (FONSECA et al., 2004; SILVEIRA et al., 2005; RECH et al., 2008). In the search for evidence that informed the validity of these self-reported anthropometric measurements in Brazilian adolescents, only the studies by Farias Junior (2007) and Enes et al have been found. (2009).

In general, the results found in the present study indicate that adolescents, when inform their anthropometric measurements, present a trend of underestimation of weight and overestimation of height, corroborating the evidence pointed out in the literature (BRENER et al., 2003; FARIAS JÚNIOR, 2007; FONSECA et al., 2010), although some studies have reported that adolescents of both sexes underestimate their height (STRAUSS, 1999; ENES et al., 2009) and others report that only boys can overestimate this measurement (ABALKHAIL et al., 2002), leaving a confused relationship between self-reported and measured measurements.

The magnitude of the differences of the self-reported measurements was more pronounced in the boys. These results are not in agreement with other findings (HIMES et al., 2005; GIACCHI et al., 1998), in which we observed it was observed a higher mean error for girls ($p < .05$). In other studies it is observed a greater difference of height (ELGAR et al., 2005) and weight (DAVIS; GERGEN, 1994) among boys, a factor evidenced in the present study.

Based on the self-reported measurements of weight and height, the self-reported BMI was calculated, also presenting a difference in relation to the measured measurement in both sexes ($p < 0.05$). Variations between the self-reported and measured measurements are expected, since the measurements are performed in a standardized manner, with the supervision of a trained assessor and specific and calibrated equipment, while the self-reported measurement corresponds to the adolescent's own information and its data are extracted from a collection carried out with subjective procedures; however, the aim is to investigate to what extent this subjective estimation is valid for the diagnosis of the nutritional status in adolescent populations.

There was a significant correlation ($p < 0.05$) between the self-reported and measured measurements in all the analyzed variables, which demonstrates a relationship between them, a fact already shown in other studies (STRAUSS, 1999; HIMES et al., 2005; ZHOU et al., 2010); however, regarding the variation of errors it is demonstrated a tendency of underestimation of the self-reported BMI in girls and a small overestimation in boys. Furthermore, only 58.4% of the boys and 76.3% of the girls presented errors inferior to 2 kg in weight, while for height was observed error inferior to 2 cm in 47.3% of the

boys and 53.4% of the girls, results inferior to those found by Farias Junior (2007) in a study with adolescents, except for the weight in girls. In this study it is indicated that 65% (63% for males and 67% for females) of the sample reported the weight with a difference of up to 2kg, while in relation to height, 62% of the boys and 59% of the girls presented an error inferior to 2cm.

From the exposed results, it is evident that the use of the self-reported measurements should be used with caution in adolescents. Some scientific evidence observed that adolescents who are overweight and obese inform weight below its real value and height above the measured measurement (DAVIS; GERGEN, 1994; HAUCK et al., 1995; ABALKHAIL et al., 2002; SHERRY et al., 2007), which agrees with the results found in this study.

In the investigation of Branco et al. (2006) high levels of dissatisfaction with body image were evidenced among adolescents, observing a significant association among these levels of dissatisfaction and the nutritional status, as well as greater dissatisfaction in individuals with overweight and obesity. These data show that the youth population cares intensely about their body image and point to a deliberate underestimation of weight and overestimation of height in the pursuit of the ideal body.

The underestimation of weight, associated with the overestimation of height, led to significant errors in the calculation of the self-reported BMI ($p < 0.05$). These errors have promoted different estimations of prevalence of overweight, obesity and overweight / obesity, when comparing the self-reported BMI with the measured BMI. Overweight, obesity and overweight / obesity was underestimated by 2.9%, 1.3% and 4.2%, respectively, in boys. Among girls these incidences were also underestimated. Overweight / obesity was underestimated by 5.4% when using the self-reported BMI. These results corroborate the findings of Elgar et al. (2005), which found prevalence based on self-reported measurements of 13.9% for overweight and to 2.8% for obesity, and, according to the measured measurements, 18.7% present overweight and 4.4% were obese. Broadly speaking, the self-reported measurements led to an underestimation of overweight by 4.8% and obesity by 1.6%.

The repercussion of this underestimation in the incidence of overweight / obesity present two important points: 1) - prevalence studies that use self-reported measurements should consider that these figures may be underestimated; and 2) - individual diagnosis should not use self-reported measurements because, as has been shown, among boys the tendency is that 2.1% adolescents with overweight / obesity are classified as eutrophic and 3.8% are considered with overweight / obese, when in fact they are not. Among the girls, these values are also remarkable, because, with the use of the self-reported measurement, 5.6% no longer had the diagnosis of overweight / obesity and 2.0% had misdiagnosis of overweight / obese.

CONCLUSION

Thus, it is observed that gaps are found in the literature when analyzing the validity of self-reported measurements of weight, height and BMI in adolescents; therefore, it is of great importance to conduct future studies that seek to assess the power of these variables. In this way, the exposed data in the present study allow us to conclude that the use of self-reported measurements of weight and height for studies of prevalence of overweight / obesity among adolescents promotes considerable errors in determining this incidence, causing underestimation of their actual values, on average, by 4.2% among boys and 5.4% among girls. Nevertheless, eutrophic

adolescents presented valid values for all variables, suggesting that nutritional status influences significantly the errors of the measurements.

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