

ACCURACY OF SELF-REPORTED MEASURES OF HEIGHT AND WEIGHT IN CHILDREN AND ADOLESCENTS

PRECISÃO DE MEDIDAS DE AUTO-AVALIAÇÃO DA ALTURA E PESO EM CRIANÇAS E ADOLESCENTES

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Resumo

Objectivos: São dois os objectivos do presente estudo: determinar a validade do IMC auto-reportado, utilizando o IMC calculado a partir do peso e altura medidas como a medida padrão, e investigar se o grau de concordância é influenciado por variáveis tais como, idade, género, ano de escolaridade, e

imagem corporal.

Métodos: A amostra é constituída por 719 estudantes com média etária de 13,6 anos de idade, e foi estratificada por sexo, e escolaridade, do sexto e oitavo ano de escolaridade em escolas regulares. Estes alunos responderam a um questionário baseado no comportamento de saúde em crianças em idade escolar (HBSC/OMS – www.hbsc.org). Este questionário implica responder a várias outras perguntas sobre imagem corporal. O peso e altura tanto auto-reportados como medidos foram obtidos

Resultados: A prevalência de excesso de peso com base em dados auto-reportados não é significativamente diferente da prevalência de excesso de peso com base nos dados medidos. No entanto, os adolescentes que se consideravam como tendo excesso de peso ao escolher sua auto-imagem percebida num conjunto de imagens, apresentaram uma tendência a subestimar o IMC.

Conclusão: Estes resultados confirmam conclusões anteriores que afirmam que o IMC (Índice de Massa Corporal) com base nas medidas auto-reportadas de peso e altura não é totalmente preciso para estimar o IMC a nível clínico e individual. No entanto, as medidas auto-reportadas de IMC podem ser utilizadas como uma ferramenta simples e válida para as estimativas de IMC de excesso peso e de obesidade em estudos epidemiológicos.

Palavras-chave: altura; imagem corporal; índice de massa corporal; excesso de peso; obesidade; peso.

Abstract

Objectives: The aim of the current study is twofold: to determine the validity of self-reported BMI using BMI calculated from measured weight and height as the standard measurement; and to investigate if the degree of agreement is influenced by potential variables such as, age, gender, school grade, and body image.

Methods: A sample of 719 students (mean age = 13.6 years) stratified by grade and gender, attending sixth and eighth grades in regular schools, answered a questionnaire based on the Health Behaviour in School-aged Children (HBSC) survey. This questionnaire implies answering several other questions regarding body image. Self-reported and measured weight and height were obtained.

Results: The prevalence of overweight based on self-reported data is not significantly different from the prevalence of overweight based on the measured data. However, adolescents who considered themselves as having extreme “overweight” when choosing their perceived self-image in a set of pictures, tended to underestimate their Body Mass Index (BMI).

Conclusion: These findings confirm that BMI based on self-reported weight and height is not totally accurate for BMI estimation at an individual clinical level. Nevertheless, self-reported BMI may be used as a simple and valid tool for BMI estimation of overweight and obesity in epidemiological studies.

Keywords: body image; body mass index; height; obesity; overweight; weight.

Introduction

Questionnaires on a large scale often use measures of self-reported height and weight. Such self-report measures are a fast and low cost practical method, for which accuracy has been demonstrated, especially in adults (Shapiro & Anderson, 2003). Large scale studies have also been conducted with children and adolescents, such as the Health Behaviour of School-Aged Children (HBSC) study, suggested that on the whole self-reported measures tend to underestimate body mass index (BMI) (Elgar *et al.*, 2005 & Fonseca *et al.*, 2010).

Gorber (2010) conducted a systematic review to examine the empirical evidence regarding the agreement between objective (measured) and subjective (reported) measures in assessing height, weight and body mass index (BMI). This review included five electronic databases and considered studies of adult populations over the age of 18. Overall, the data showed under-reporting for weight and BMI and over-reporting for height, although there was considerable individual variability.

Concerning adolescents, another study using HBSC Portuguese data revealed that the prevalence of normal weight, overweight, and obesity based on self-report, when compared to measured values was not significantly different considering both gender and age groups (Fonseca *et al.*, 2010). However self-reported weight and height tended to be underestimated, both by girls and boys.

While some studies suggested that both girls and boys underestimate their weight and height (Elgar *et al.*, 2005 & Hills, 2002,), others (Betz *et al.*, 1994) claim that girls have a greater tendency to under-report their weight when compared to boys. Other authors (Cortez *et al.*, 1999) found that the measured BMI was significantly higher than self-reported BMI and depended on age, suggesting that underestimation can be higher in younger populations than in older ones.

Although self-reported measures of height and weight regarding adolescents seem not to be extremely valid if the aim is an individual clinical intervention, it appears that it can be used to estimate overweight from a population perspective (Fonseca *et al.*, 2010). As prevalence of overweight is not significantly different using both methods, the use of self-reported measures is a faster, economic, and efficient mean to monitor the problems of overweight and obesity in young people, as well as to intervene from a adolescent population universal prevention point of view.

It is also interesting to understand if self-reported height and weight is a mere product of adolescents' lack of information, or if it can be influenced by their body self-perception, that is, if the way adolescents perceive themselves as more or less thin, as estimated by their choice within a set of same sex human pictures gradually increasing their weight influences their estimation of weight and height. For this purpose, it was proposed the use of a set of drawings of males and females bodies, representing a scale of seven bodies from extremely thin to extremely overweight, to assess body self-perception (Collins, 1991; Fonseca & Matos., 2005).

The objective of this study is twofold: a) to determine the validity of self-reported BMI using BMI calculated from measured body weight and height as the standard measurement; and b) to investigate if the degree of agreement is influenced by potential variables, such as age, gender, school grade, and body image perception, assessed by identification/choice of one body image from a set of seven pictures displaying bodies from thin to overweight.

Methods

Selection and description of the sample

The sample selected for this study is limited to a geographic area of the centre of Portugal, mainland and was composed by 719 students of both genders who attend sixth (220 students, 138 male and 82 female), eighth (223 students, 111 male and 112 female), and tenth grades (276, 115 male and 161 female), in three secondary regular school. Participants were randomly selected and the number of students per grade was proportional to the total number of school students per grade.

This sample was stratified into six groups: the sixth grade females; the sixth grade males; the eighth grade females; the eighth grade males; the tenth grade females; and the tenth grade males. The average of the ages of the sample is 13.7 years old, ranging from 10 to 19 years old.

Instruments and equipment

Questionnaire

The main instrument used in this study was a questionnaire based on the survey of the Health Behaviour in School-aged Children (HBSC), using as reference the research protocol of 2001/2002 (Currie et al,2002; Matos et al , 2003).

The first part of the questionnaire consists of four questions regarding demographics, age, gender, and grade. The second part of the questionnaire consists of focused specific questions:

- 1) The perception of height: What is your weight without clothes, at the moment?" with answers prompted in kilograms; The perception of weight: "What is your height without shoes, at the moment?", with answers given in meters..
- 2) The perception of Body Image:
 - 2.1) Physical Appearance was measured by answering the question "Do you think that your body is...". Participants chose the appropriate option from 1- Thin; 2- Ideal; and 3- Fat.
 - 2.2) Going on a diet: Students answered the question "Are you going on a diet?" using the following options: 1- "No, I'm not, my weight is fine"; 2- "No, I'm not but I should lose weight"; 3- "No, I'm not because I

need to gain weight”; and 4- “Yes, I am”.

- 2.3) Body Pictures: seven pictures were presented to the students representing girls and boys. These seven pictures were displayed in order from the slimmest image, to the most overweight one. Students were asked to choose the image that better fitted them at the time. These seven pictures were based on previous research studies (Collins, 1991; Fonseca & Matos, 2005), which demonstrated a strong agreement between self-reported BMI and picture choice.

Direct instruments of measurement

Weight was measured using a digital scale (Dina Home Medica PP8160) to the nearest 0.5 kg. Participants wore light clothes and no shoes. Height was measured (Seca Bodymeter 208) and recorded to the nearest 0.5 cm, with the participants standing without shoes, feet together, and head in the Frankfurt horizontal plan. BMI (weight in kg divided by the height in squared meters) was calculated using self-reported and measured weight and height. All the anthropometric measurements were performed by the same researcher, the first author of this work, using identical protocols.

Experimental procedures

The questionnaire, as well as the participants’ measurement of height and weight was performed during physical education classes.

Letters were written to the coordinators of the physical education departments of the three mentioned schools. They were informed about the aims and features related to the questionnaires, as well as weight and height measurements. Participation was dependent on informed consent and anonymity was assured.

Students filled in the questionnaire in the classroom, without knowing that they would have their height and weight measured subsequently. After finishing this task, they went to the physical education teachers’ room, holding their questionnaire. Height and weight were then measured. The values of these measurements were registered in red ink, next to the values that were given by the students: “What is your weight without clothes, at the moment?” and “What is your height without shoes, at the moment?”, assuring therefore an anonymous procedure.

Statistical analysis

SPSS version 15.0 for windows (SPSS, Chicago IL USA) was used for data management and statistical analysis. Overweight and obese adolescents were identified using age and gender-specific international cut-off points. These were

based on average percentiles estimated to pass through BMI values of 25 and 30 kg/m² respectively, at the age of 18 (Cole *et al.*, 2000) for both self-reported and measured BMI. The prevalence of normal-weight, overweight, and obesity using self-reported and measured BMI was calculated and a chi-square test Yates' correction for continuity was applied to compare the prevalence of obesity when using self-reported or measured BMI. Differences between self-reported and measured values were calculated by paired student T-tests, while an independent sample T-test was used to compare variables between genders. Linear regression analysis was performed to assess the accuracy of self-reported BMI in predicting measured BMI using the whole sample (boys and girls). In an initial moment a gender by self-reported BMI was included as a predictor variable. If a non-significant contribution of gender by self-reported BMI (interaction term) was not found, regression analysis would be conducted using the whole sample (boys and girls) to test the accuracy of self-reported BMI in predicting measured BMI. Slope and intercept were tested to find if the regression line differed from identity. Agreement between self-reported and measured BMI was assessed using the Bland-Altman method (Bland *et al.*, 1986), a widely used technique to compare methods for assessing body composition (Silva *et al.*, 2006 & Sardinha *et al.*, 2003.). Bivariate correlations were conducted to test if the difference between self-reported BMI and measured BMI were related with the mean of the two measurements for boys and girls. Additionally, multiple regression analysis was used to test the effect of potential variables, such as gender, school grade, age, body image and main effects, and also interactions between these variables on the "between-measurement differences" of self-reported and measured BMI.

Results

Descriptive statistics on measured and self-reported weight, height, and BMI are shown in Table 1.

Table 1. Descriptive statistics on measured and self-reported weight, height, and BMI

	Boys	Girls	Total
	Mean ± SD	Mean ± SD	Mean ± SD
N	360	353	713
Age (y)	13.4±1.7 ^a	13.8±1.7	13.6±1.7
Self-reported Height (m)	1.62±0.12 ^a	1.58±0.09	1.60±1.10
Measured Height (m)	1.62±0.11 ^a	1.58±0.08	1.59±1.02
Height Differences (m)	0.01±0.05 ^b	0.00±0.06	0.01±0.05 ^b

Self-reported Weight (kg)	53.7±12.9 ^a	52.2±10.3	52.9±10.7
Measured Weight (kg)	55.3±13.4 ^a	53.8±10.4	54.6±12.0
Weight Differences (kg)	-1.6±4.4 ^b	-1.7±4.0 ^b	-1.6±4.2 ^b
Self-reported BMI (kg/m ²)	20.4±3.8	20.8±3.6	20.6±3.7
Measured BMI (kg/m ²)	21.0±3.7 ^a	21.6±3.6	21.3±3.7
BMI differences(kg/m ²)	-0.62±2.05 ^b	-0.82±2.13 ^b	0.72±2.09 ^b

Abbreviations: BMI- body mass index; N- number of subjects; SD- standard deviation.

^a Significant difference between males and females ($p < 0.05$); ^b Significantly different from 0 ($p < 0.05$).

On average when compared to measured values, adolescents tended to report low body weight values ($p < 0.001$). The self-reported weight values were significantly lower than the measured weight both in girls ($p < 0.001$) and boys ($p < 0.001$). The self-reported height was significantly higher than the measured height in the entire sample and for boys ($p = 0.003$), but not for girls ($p = 0.152$). The self-reported BMI based on self-reported data was lower when compared to BMI based on measured data in the whole sample ($p = 0.001$) and among girls ($p < 0.001$) and boys ($p < 0.001$).

The prevalence of overweight and obesity based on self-report data (18.9% and 5.3%, respectively), compared to measured values (22.6% and 7.2%), was not significantly different (respectively $p = 0.100$, and $p = 0.177$).

Accuracy of self-reported BMI versus measured BMI

A multiple regression analysis including the whole sample was used to examine if gender and an interaction between gender and self-reported BMI showed any contribution in addition to self-reported BMI alone, in predicting measured BMI. Since in the model, the interaction of gender with self-reported BMI did not make a significant contribution to explain the measured BMI ($p = 0.984$) in addition to the self-reported BMI alone, the model was developed with the whole sample to investigate the accuracy of reported BMI on estimating measured BMI.

Reported BMI explains approximately 70,2% ($r^2 = 0.702$) of the variance in measured BMI with a standard error of measurement of approximately 2 kg/m². The left panel of Figure 1 illustrates the regression between self-reported and measured BMI. The regression line differs from line of identity, that is, the intercept ($\beta = 4.139$) differs from 0 and the slope ($\beta = 0.834$) differs from 1 ($p < 0.05$).

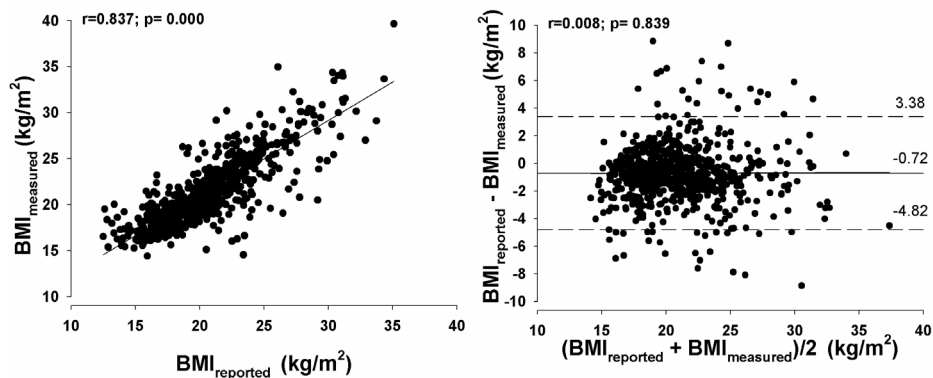


Figure 1 – Left Panel: Regression of self-reported BMI on measured BMI; Right Panel: Agreement between self-reported BMI and measured BMI. The solid line represents the mean differences between both BMI measurements with the mean of both measurements. The dashed lines represent 95% limits of agreement (± 1.96 SD). The trend line represents the association between the differences of the methods and the mean of both measurements.

Agreement between measurements

The right panel of Figure 1 illustrates the agreement between methods. The 95% confidence intervals indicate that individual variability between these two measurements varied between -4.8 to 3.4 kg/m^2 with a mean bias of -0.7 kg/m^2 . No correlation was found between the difference of the measurements or the mean of both measurements. These results indicate that the differences were not related to the magnitude of the BMI ($r=0.008$; $p=0.839$).

We further examined if gender, grade attendance, age, body image, and interactions between these variables were associated to the differences of the measurements. The results indicated that the agreement between methods is affected by the main effect of the variable body image which reported how adolescents perceived themselves (1-thin, 2-ideal, 3-fat). The beta coefficient is negative ($\beta = -0.454$; $p < 0.001$) which means that the adolescents who reported to be fat tend to underestimate BMI, as illustrated in Figure 2.

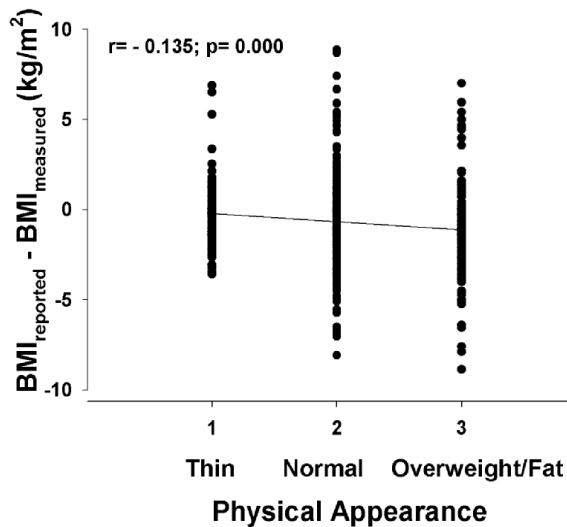


Figure 2 - Regression between BMI differences and the variable body image, representing the way adolescents perceive themselves as thin, normal, and fat.

Discussion

The results obtained in this study show that both boys and girls tended to under-report their weight values. This trend confirms previous findings (Elgar *et al.*, 2005 & Fonseca *et al.*, 2010). However, it contradicts the work of Betz *et al.*, (1994), as their results indicate that girls did not under-report their weight. According to the present study, boys show significant differences between self-reported and measured height. The boys' values of self-reported height tend to be higher than the measured values. Conversely, Cortez *et al.*, (1999) found that the measured BMI was significantly higher than the reported BMI, and these differences were related to age. Other reviews conducted on adult population (Gorber *et al.*, 2007) showed under-reporting values for weight and BMI and over-reporting for height, and highlighted the large individual variability.

This study shows that the prevalence of obesity based on self-reported data is not significantly different from the prevalence of obesity based on the measured data. Larger limits of agreement were found for boys, indicating a higher variability of self-reported BMI in estimating measured BMI.

These results are once again confirmed by others using an adolescent population (e.g., Fonseca *et al.*, 2010) and contradicting studies by several authors claiming that self-reported data contributed significantly to the underestimation of overweight and obesity prevalence (e.g., Elgar *et al.*, 2005).

However, there is a fact never mentioned before in studies proposing to compare self-reported height and weight with measurements by an external technician using specific procedures. The self-reported questionnaire asked for “weight without clothes” but typically external measurement allows “light clothes”. They might also have individual typical routines that may help lowering weight (e.g. checking their weight every morning, before breakfast, without clothes and using the bathroom scale). These methodological issues may impact the validity of self-reported data when compared to an external measuring, after school lunch, with light clothes. It is therefore recommended that those sources of variability and bias are controlled in future studies.

Finally, it was found that adolescents who considered themselves “overweight” choosing their image in a set of seven pictures, tended to underestimate their BMI, which is also confirmed in many studies that associate the self-reported data to body image.

These results extend previous findings that BMI based on self-reported weight and height is not totally accurate for BMI estimation at a clinical individual level. Nevertheless, self-reported BMI may be used as a simple and valid tool for BMI estimates of overweight and obesity in epidemiological studies, that claim for immediate and universal preventive interventions, namely at school and community levels.

References

- Betz NE, Mintz L, Speakmon G. Gender differences in the accuracy of self-reported weight. *Sex Roles* 1994; 30(7-8): 543-552.
- Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986; 8476: 307-310.
- Cole T, Bellizzi M, Flegal K, Dietz W. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; 320: 1240-1243.
- Collins ME. Body figure perceptions and preferences among preadolescent children. *Int J Eat Disord* 1991; 10: 208-217.
- Cortez C, Anderson SL, Boushet C J, Welshimer, KJ. The accuracy of body mass index for classifying Overweight using self-reported Measurements in Human. *J Am Diet Ass* 1999; 99(9):A29.
- Currie C, Smith RB W, Smith R (2001). HBSC, a WHO cross national study: Research protocol for the 2001/2002 survey. Copenhagen: WHO.
- Elgar F, Roberts C, TudorSmith C, Moore L. Validity of Self-reported Height and Weight and Predictors of Bias in Adolescents. *J Adol Health* 2005; 37(5): 371-375.
- Fonseca H, Matos MG. Perception of overweight and obesity among Portuguese adolescents: an overview of associated factors. *Eur J Pub Health* 2005; 15(3): 323-328.
- Fonseca H, Silva AM, Matos MG, Esteves I, Costa P, Guerra A, Gomes-Pedro J.

- Validity of BMI based on self-reported weight and height in adolescents. *Acta Paediatrica* 2010; 99: 83-88.
- Gorber S, Tremblay M, Moher D, Gorber B. Diagnostic in Obesity Comorbidities A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obesity Reviews* 2007; 8:307-326.
- Hills AP. A comparison of Self-reported and Measured Height, Weight and BMI in Australian Adolescents. *Aust N Z Public Health* 2002; 26: 473-478.
- Matos MG, Equipa do Projecto Aventura Social (2003). A saúde dos adolescentes portugueses -Quatro anos depois (The health of Portuguese adolescents - four years after). Lisboa: CDI/ FMH.
- Sardinha LB, Silva AM, Teixeira PJ. Usefulness of age-adjusted equations to estimate body fat with air displacement plethysmography in male adolescent athletes. *Acta Diabetologica* 2003; 40(1): 58-63.
- Shapiro JR, Anderson DA, The effects of restraint gender and body mass index on the accuracy of self-reported weight. *Int J Eat Desord* 2003; 34(1): 177-180.
- Silva AM, Minderico CS, Teixeira PJ, Pietrobelli A, Sardinha LB. Body fat measurement in adolescent athletes: multicompartiment molecular model comparison. *Eur J Clin Nutr* 2006; 60: 955-964.