Validity of self-reported weight and height and the body mass index within the "Pró-saúde" study

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Body weight. Body height. Body mass index. Validity. Sensitivity and specificity. Obesity. Questionnaires. Sectional study.

Abstract

Objective
Evaluate the validity of self-reported weight and height and the body mass index (BMI).
Methods
A study was made of 3,713 employees of a public university in Rio de Janeiro, in which they were participants in Phase 1 of a longitudinal study. Information was obtained through a self-administered questionnaire, and measurements were carried out after its application. Student's paired t-test, Bland & Altman's graphs and the intraclass correlation coefficient (ICC) were utilized to evaluate the differences between the measured and the reported parameters. The sensitivity and specificity of the various BMI categories were estimated.
Results
There was high agreement between the measured and reported weights (ICC=0.977) and heights (ICC=0.943). The BMI sensitivity, in its various categories, was around 80%, and the specificity was close to 92%. There was a slight and uniform tendency toward self-reported weight underestimation and self-reported height overestimation in both sexes.
Conclusions
Self-reported and measured weight and height information had good agreement and validity. In similar populations, when few resources are available, it is possible to use self-reported data instead of actual measurements.

INTRODUCTION

Self-reported weight and height have been utilized in epidemiological studies mainly with the aims of economizing on resources and simplifying field work.[5] According to the results from some studies, these are valid indicators with acceptable validity levels, even among obese individuals (who might present a greater tendency towards underestimation of weight) and among groups with low levels of schooling.[12,19,21] According to Bolton-Smith et al[3] (2000), self-reported weight and height also appear to adequate for monitoring the prevalence of obesity in the population.

Nevertheless, self-reported weight and height present limitations, as do most measurements. Le Marchand et al[11] (1988) and Ramalle-Gómara et al[15] (1997) emphasized that, despite finding high agreement between self-reported information and direct measurement in their study populations, there is a tendency to underestimate weight values and overestimate height values. Moreover, the prevalence of obesity among populations, as estimated from self-reported weight and height information, may be underestimated, especially among women and elderly individuals.[1,8,16] Thus, the validity of self-reported information may vary according to gender or age, and also according to the socio-economic conditions of the groups studied.

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According to Jeffery[7] (1996), individuals of lower socioeconomic level generally have less access to information on their own weight and, for this reason, their information would be less accurate. Boström & Diderichsen[4] (1997), in a study performed in Stockholm, observed that, among men of lower socioeconomic level, estimates of the prevalence of overweight and obesity presented a greater degree of overestimation than among men of higher socioeconomic level.

Underestimated weight is generally observed more markedly among women, and overestimated height more markedly among men.[13,20] With regard to age, studies suggest that the more elderly generally present the greatest differences between self-reported and measured values.[8,23]

In addition to the characteristics of the population, the data collection strategy may also influence the validity of the information on weights and heights. Data collection by means of self-administered questionnaires implies a greater possibility of the occurrence of the "flat slope" syndrome (underestimation of high weight values and overestimation of low weight values) than when the information is collected in the presence of interviewers.[9,10]

In Brazil, the validity of information relating to weight and height has been little studied. Some investigations have suggested that such information has high validity, especially among population groups with high levels of schooling and greater access to healthcare services, with sensitivity values of around 80% and specificity of 97%.[5,18] Even so, in a study by Schmidt et al[18] (1993) performed among the urban population of Porto Alegre, men tended to overestimate their weights and women to underestimate them. On the other hand, in a study by Chor et al[5] (1999) among employees of a state bank in Rio de Janeiro, men with weights of 80 kg or more tended to supply underestimated values. With regard to height, the differences between self-reported and measured values found in that study were insignificant.

Thus, because of the scarcity of studies among the Brazilian adult population, the present study had the objective of evaluating the validity of information relating to weight and height and the body mass index (BMI).

METHODS

Study population

This was a validity study that formed part of the "Pró-saúde" study, which is a longitudinal investigation among active employees within the permanent staff of a public university in Rio de Janeiro who were on technical-administrative career paths. The population for this study was selected, during the first data collection phase, from among an overall total of 4,614 employees. Those who had been seconded to other institutions or were on prolonged leaves of absence that were unrelated to health (166 employees) were considered to be ineligible. Thus, there were 4,448 eligible employees, of whom 4,030 (91%) answered the questionnaire.

For analysis purposes, four employees were excluded because they were over 70 years old, six because of pregnancy and 307 because some information was missing (any of the measured or self-reported weight or height values). Consequently, the population for the present study consisted of 3,713 employees (92% of those who answered the questionnaire).

Data collection

The self-reported data were obtained by means of a self-administered questionnaire that had previously been tested in five pretest stages and one pilot study. The data collection was accomplished between August and October 1999. The questionnaire was applied in auditoriums of the university during working hours, and it took an average of around 40 minutes to fill out. The employees participating in the study had assistance from a team trained in the application of the questionnaire and measurement of weights and heights.

Measured weights and heights

After the filling out of the questionnaire, the employees' weights were measured using portable electronic balances of Kratos-Cas brand, Linea model, with a capacity of up to 150 kg and precision of 50 g. The balance was placed on a flat floor surface and the employee was weighed without shoes, jacket or objects in pockets. The measurement was recorded in kilograms.

Heights were measured using a measuring tape of non-elastic material, with a capacity of up to 150 cm and precision of 1 cm. The tape was attached to a wall without a skirting board with the aid of a plumb line, at a height of 50 cm from the floor. Heights were measured with the subject in an erect position with the arms hanging, the feet together and the heels against the wall. A wooden set-square was utilized in the measurement, placed flat against the top of the head.

Data analysis

Before entering the data, a double independent review of all the questionnaires was performed. The data entry was performed in duplicate, independently, using the Epi Info software, version 6.0. The data evaluation was done in two stages: automatic checking for invalid data and analysis of the internal consistency of the responses. The SPSS software, version 11.0, was utilized in the data analysis.

For the identification of errors and systematic differentiation patterns between the measured and self-reported values, the methodology proposed by Bland & Altman[2] (1986) was proposed. This consists of graphically presenting the differences in the measured and self-reported values in relation to the averages of these values. To obtain a summary measurement of the agreement between the two sources of information (measured and self-reported), the intraclass correlation coefficient (ICC) was utilized. This estimates the proportion of the total variability observed that is attributable to variability between the individuals. In the comparison between the averages for measurements and self-reporting of weights and heights, and for the BMI, the variables were divided into quartiles, in which the standard was the measured values. The difference between the measured and self-reported values was estimated for each gender, within each quartile, in conformity with the above definition. Thus, the negative differences represented overestimated self-reported values and positive differences represented underestimated self-reported values. Student's paired t test was utilized for testing the differences between the averages (from measurements and self-reporting) of weight and height, and for the BMI, according to quartiles based on the measurements.

To estimate the sensitivity and specificity of the BMI, which was calculated from the self-reported values of body weight and height, the BMI was classified according to the bands suggested by the World Health Organization[22] (WHO, 1998). Thus, in the present study, the following categories were utilized: low or adequate weight (BMI<25 kg/m^2, with only 1.5% with BMI<18.5 kg/m^2); pre-obese or overweight (25.0≤BMI≤29.9 kg/m^2) and obese (BMI≥30.0 kg/m^2).

In addition to gender and age, variations in sensitivity and specificity according to markers of socioeconomic conditions were also analyzed. The per capita household income in numbers of minimum salaries was calculated from the midpoint of the self-reported net income category, divided by the number of persons living on this income. The result was divided by the value of the minimum salary (MS) in force at the time of the survey (136 reais) and categorized into quintiles: 1st quintile (0-1.83 MS); 2nd quintile (1.84-3.22 MS); 3rd quintile (3.23-5.06 MS); 4th quintile (5.07-6.74 MS); and 5th quintile (≥6.75 MS). The level of schooling attained was classified as elementary or less, high school, or college and beyond.

RESULTS

The employees' ages ranged from 22 to 70 years. Around 74% of the population was concentrated in the age group from 30 to 49 years, while only 2.4% were between 60 and 70 years old. With regard to level of schooling, 40% of the employees had studied at college or beyond, while 23% had attained elementary or less. The household income was greater than 3.2 minimum salaries for 56% of the employees.

There was a high agreement between the measured and self-reported weights (ICC=0.977; 95% CI: 0.975-0.978). There was greater agreement among the women (ICC=0.975; 95% CI: 0.973-0.977) than among the men (ICC=0.969; 95% CI: 0.966-0.972). There was no statistically significant difference between the measured and self-reported values, in relation to the other characteristics studied (age, schooling, income and BMI categories), with the ICC ranging from 0.946 to 0.984. With regard to height, high agreement was also observed between the measured and self-reported values, with an ICC of 0.943 (95% CI: 0.939-0.946). Statistically significant differences were found between the age groups of <30 years (ICC=0.961; 95% CI: 0.953-0.968) and 60 to 70 years (ICC=0.861; 95% CI: 0.794-0.906); between the lowest and the higher two levels of schooling attained: elementary or less (ICC=0.875; 95% CI: 0.857-0.889), high school (ICC=0.954; 95% CI: 0.949-0.958) and college and beyond (ICC=0.972; 95% CI: 0.969-0.975). There was no statistically significant difference between the measured and self-reported values, in relation to the other characteristics studied (gender, income and BMI categories), with the ICC ranging from 0.861 to 0.972.

Figure 1 shows that there were only small differences between the measured and self-reported weights, considering that the majority of the points are located close to the horizontal line that represents zero difference. In comparing the concentrations of points above and below the horizontal line, a tendency towards underestimation of the self-reported weight can be observed (greater concentration of points above the horizontal line). No difference in the pattern was identified between men and women, or between employees of lesser or greater average weight. With regard to stature (Figure 2), an even smaller distancing of the points from the horizontal line can be observed. The concentration of negative points indicates overestimation of the self-reported height values among men and women. The women presented a slightly greater frequency of more highly overestimated val-

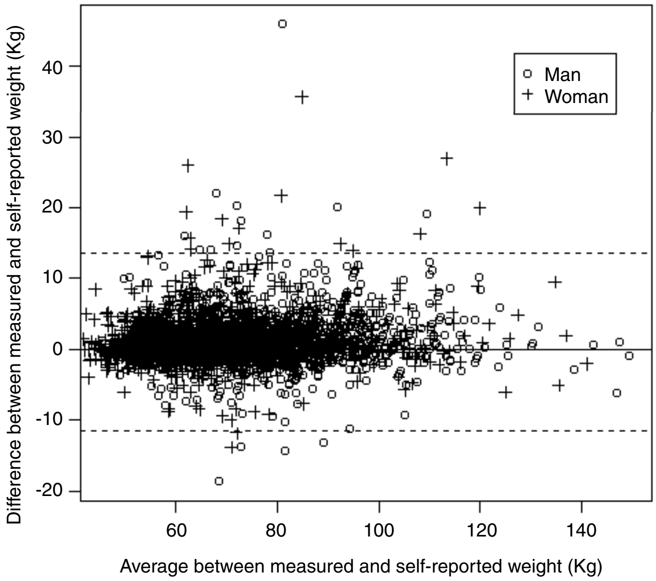

Figure 1 - Differences between measured and self-reported weight according to weight averages, by gender.

ues than did the men.

Table 1 presents the differences between the averages from measurement and self-reporting of weight and height, and the BMI, according to the measured quartiles for each of these. The estimated averages for self-reported weight were underestimated in all quartiles. This underestimation became progressively greater through the quartiles, reaching 1.6 kg among men and 2.4 kg among women in the 4th quartile. In the same way, the proportion of the difference in relation to measured weight also became progressively greater from the 1st to the 4th quartile. In this, the difference between the averages for measured and self-report weights reached 2.5% of the average for the measured weight among women, compared with 0.94% in the 1st quartile. In comparing the averages from the measured and self-reported heights, there was a small overestimation in the self-reporting among men and women, except among the tallest ones (4th quartile). There was underestimation of the BMI calculated from the self-reported values, and a tendency similar to what was seen for the weight was observed: the difference increased from the 1st to the 4th quartile. In percentage terms, the degree of error in the values self-reported by the women was greater than in values from the men for the weight, height and BMI, although this degree or error was small in all cases (between -0.10% and 2.75%).

The sensitivity values for the self-reported BMI were generally high (Table 2). The validity of the information diminished with increasing BMI, especially among the men. With regard to the age groups, the lowest value for sensitivity was found among employees over 50 years old who were classified as obese. Considering each BMI category, there were no significant differences according to per capita household income categories. There was also a reduction in sensitivity values when comparing those classified in the "low or adequate weight" category (95.7) with those in the overweight (76.6) and obese (75.2) categories.

Table 2 also presents the specificity values according to the BMI categories. The values ranged from 86 to 98% and, in all the subgroups, there was an increase in the specificity with increased BMI. Thus, the rate of false positives was very small among the obese individuals (around 2%). In addition to this general pattern, a diminution of the specificity with increased age was observed among overweight individuals, and an increase in specificity at the highest levels of schooling among the overweight and obese individuals. In the overweight category, a decline in specificity was observed with increased age, which was not observed in the other categories.

DISCUSSION

The results from the present study indicate that the self-reported information is valid, both for weight and for height.

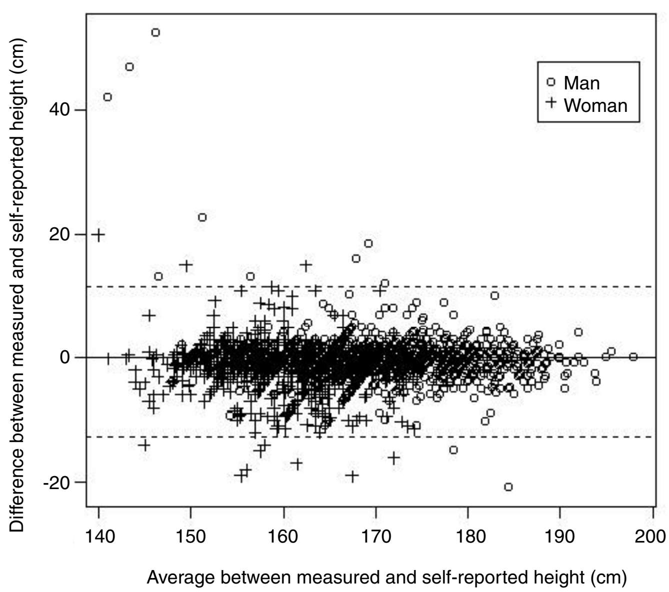

Figure 2 – Differences between measured and self-reported height according to height averages, by gender.

Table 1 – Averages for weight, height and body mass index according to quartiles from measurement, and absolute and relative differences between measurement and self-reporting.

	Men							Women						
	N	Q_1	Q_2	Q_3	Q_4	Total	SD*	N	Q_1	Q_2	Q_3	Q_4	Total	SD*
Weight (kg)	1,699							2,078						
Average from measurement (W_a)		56.5	66.0	74.9	92.2	78.51	14.18		54.7	65.1	74.2	92.6	66.25	13.58
Average from self-reporting (W_i)		56.7	65.6	73.9	90.6	77.50	13.95		54.2	63.9	72.6	90.2	65.11	13.20
Difference ($W_d= W_a - W_i$)		-0.13	0.38**	0.98**	1.59**	1.02**	3.49		0.52**	1.09**	1.65**	2.39**	1.14**	2.98
% difference ($100W_d/W_a$)		-0.26	0.66	1.31	1.68	1.20	4.35		0.94	1.67	2.23	2.52	1.59	4.07
Height (cm)	1,721							2,075						
Average from measurement (H_a)		156.2	162.9	169.1	178.0	172.8	7.04		154.7	162.2	168.2	175.5	160.14	6.39
Average from self-reporting (H_i)		157.5	163.6	169.3	178.0	172.9	7.54		155.9	163.3	168.9	175.4	161.19	6.76
Difference ($H_d=H_a - H_i$)		-1.29**	-0.59	-0.23	0	-0.18**	3.22		-1.21**	-1.06**	-0.80**	0.12	-1.05**	2.95
% difference ($100H_d/H_a$)		-0.83	-0.32	-0.14	0	-0.10	1.89		-0.79	-0.65	-0.48	0.06	-0.66	1.89
BMI (kg/m^2)	1,682							2,030						
Average from measurement (B_a)		21.0	24.1	26.8	31.6	26.25	4.14		20.9	24.1	26.8	33.1	25.79	5.11
Average from self-reported (I_i)		20.9	23.9	26.4	30.9	25.89	4.18		20.7	23.5	26.0	31.5	25.02	4.85
Difference ($B_d= B_A - B_i$)		0.04	0.20**	0.39**	0.75**	0.37**	1.59		0.31**	0.56**	0.82**	1.55**	0.77**	1.61
% difference ($100B_d/B_a$)		0.14	0.86	1.45	2.34	1.27	5.98		1.45	2.33	3.07	4.63	2.75	5.50

BMI = body mass index
*SD = standard deviation
**Significant differences according to Student's paired t test ($p<0.05$)
Q_{1-4} = quartiles defined from measurement
W_a, H_a, B_a = averages from measurement
W_i, H_i, B_i = averages from self-reporting
W_d, H_d, B_d = differences between the averages from measurement and self-reporting.

The graphical comparison between the two sources of data suggests a slight tendency towards underestimation of weight and overestimation of height, among both women and men. This tendency is not accentuated among the individuals of greater weight or lesser height. These results were different to those found in other investigations, in which a tendency towards greater underestimation of weight among individuals of greatest weight and greater overestimation of height among the smallest individuals was shown.[5,12]

The agreement between the self-reported and measured weight and height was high in our study: ICC=0.977 for weight and ICC=0.943 for height. The average difference between the two sources was 1.09 kg (standard deviation: SD=3.20 kg) for the weight and 0.65 cm (SD=3.10 cm) for the height. Moreover, only 13% of the population presented a difference of greater than or equal to 4 Kg between the self-reporting and measurement. This result is the same as observed by Schmidt et al[18] (1993), and little more than what was found by Jalkanen et al[6] (1987) in Finland (11%).

The tendency towards underestimation of weight was similar for men and women. This result is similar to what was found by Chor et al[5] (1999), and different from other authors, who observed underestimation of weight only among women, and overestimation among men.[18,20]

With regard to height, the magnitude of the overestimation was also small (0.65 cm), while it was greater among the women (1.05 cm) than among the men (0.17 cm). This result differs from other studies, which found overestimation of the same magnitude for men and women,[13] or greater overestimation among men.[14,16] It is possible that in our population, with a large proportion of young women in administrative positions, the standards of physical appearance exercise a greater influence among them than among the men.

From the small differences found between the self-reporting and measurement, the effect of the self-reporting on the BMI estimation was insignificant. These results are consistent with those described by other authors.[3,5,18,21]

In the analysis of the validity of the BMI calculated from the self-reported values of body weight and height, high sensitivity and specificity values were observed. The sensitivity values of around 80% and specificity of close to 92% indicate that most of the employees correctly self-reported their weight and height. For the individuals classified as obese according to the measurement, the specificity values from the self-reporting were around 98%, a figure that is similar to findings from other studies.[3,14,18,19] The sensitivity values were around 75%, similar to values found in the United States (74%)[14] and much higher than values found in Spain (57%)[1] and Sweden (55-61%).[4] Among the individuals classified as obese, the sensitivity estimates were over 70% for all the subgroups studied, with the exception of the employees of more than 50 years old (69.5%). The sensitivity and specificity varied markedly when the individuals were classified as obese

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Table 2 – Sensitivity and specificity of the BMI (body mass index) categories from self-reporting,* compared with the BMI categories from measurement** (gold standard), according to sociodemographic characteristics.

Characteristics of the population	Sensitivity Overweight N	%	95% CI	Sensitivity Obese N	%	95% CI	Specificity Overweight N	%	95% CI	Specificity Obese N	%	95% CI
Sex												
Male	599	81.8	78.8-84.6	216	78.5	73.2-83.3	856	90.1	88.0-91.9	1,376	97.8	96.9-98.5
Female	433	70.4	66.6-73.9	244	72.4	67.3-77.1	1,291	91.2	89.6-92.7	1,675	98.9	98.3-99.4
Age group												
<30	95	72.5	64.0-79.9	33	82.5	67.2-92.7	305	95.9	93.1-97.8	406	99.3	97.9-99.8
30-39	394	79.4	75.6-82.9	154	79.4	72.9-84.8	891	92.9	91.1-94.4	1,248	98.9	98.1-99.4
40-49	398	76.0	72.1-79.6	184	73.6	67.7-78.9	685	87.8	85.3-90.0	1,031	97.8	96.7-98.6
50-70	145	74.0	67.3-80.0	89	69.5	60.8-77.4	269	87.3	83.1-90.8	366	97.3	95.2-98.7
Schooling attained												
Elementary or less	237	72.7	62.5-77.5	144	73.5	66.7-79.5	411	85.6	82.2-88.6	589	96.6	94.8-97.9
High school	398	78.2	74.3-81.7	169	73.2	66.9-78.8	743	89.5	87.2-91.5	1,090	98.4	97.4-99.0
College or beyond	391	77.4	73.5-81.0	143	79.0	72.3-84.7	977	94.1	92.5-95.5	1,352	99.3	98.6-99.7
Per capita income***												
1º quintile	166	77.9	71.8-83.3	67	78.8	68.6-86.9	273	91.0	87.2-93.9	424	99.1	97.6-99.7
2º quintile	280	75.9	71.2-80.2	118	71.5	63.9-78.3	590	88.9	86.4-91.3	850	98.1	96.9-98.8
3º quintile	194	75.5	69.8-80.6	78	78.0	68.6-85.7	373	92.3	89.3-94.7	550	98.0	96.5-99.0
4º quintile	163	77.6	71.4-83.1	84	78.5	69.5-85.9	375	92.1	89.1-94.6	502	98.4	96.9-99.3
5º quintile	182	77.8	71.9-82.9	83	78.3	69.2-85.7	399	92.8	89.9-95.0	551	98.7	97.4-99.5
Total	1,032	76.6	74.3-78.8	460	75.2	71.5-78.5	2,147	90.8	89.5-91.9	3,051	98.4	97.9-98.8

* BMI calculated from self-reporting of weight and height
** BMI calculated from measurement of weight and height
***1st quintile (0-1.83 MS), 2nd quintile (1.84-3.22 MS), 3rd quintile (3.23-5.06 MS), 4th quintile (5.07-6.74 MS) and 5th quintile (≥6.75 MS), where MS= minimum salaries.

and were less influenced by the other characteristics studied (gender, age and socioeconomic conditions). Even so, among the BMI categories, no large differences between the measurement and self-reporting were found. Among the women classified as obese, 19.9% underestimated their weight, while among the men this proportion was 21.1%. In the same way, only 3% of the women and 8% of the men classified as having low weight overestimated in their self-reporting. These results differ from what was found by Rowland[17] (1990), who reported a greater proportion of obese women (31%) and smaller proportion of obese men (14%) who underestimated in their self-reporting of their weight. This author also found a much higher proportion (18%) of men classified as having low weight who overestimated in their self-reporting.

In the present study, there are potential sources of error in the high percentages of blank or invalid responses and in the knowledge of the objectives of the study among part of the population. The missing self-reported and measured data in our study together totaled 8%. However, the participants did not know the objective of comparing the self-reported and measured data at the time of filling out the questionnaire. Thus, it is believed that this source of error was unimportant.

One of the limitations of the present study is the impossibility of extrapolating its results to the general population, since it only includes an employed population that was selected for employment by public competition. The study may, however, indicate that self-reported information on weight and height may be of good quality in similar populations (for example, strata of urban workers). In the case of such groups, despite the need for estimates of sensitivity and specificity in sub-samples, the evidence from Brazilian studies has been accumulating indications of high sensitivity and specificity for self-reported information.

From these results, it can be concluded that self-reported information on weight and height presents good agreement and validity when compared with their respective measurements. Thus, as was suggested by Chor et al,[5] it is possible to utilize self-reported weights and heights instead of measured values in similar populations, when economizing on resources is important for accomplishing the study.

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