Reliability between reported and measured weight and height, and influence of physical activity history on individuals who search for supervised practice of exercises

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ABSTRACT

The objective of this study was to verify the reliability between self-reported and measured weight, height and body mass index values, as well as the influence of the physical activity history on 328 individuals, 200 women (39 ± 11 years) and 128 men (35 ± 10 years) who search for the supervised practice of exercises. All individuals underwent functional evaluation that recorded self-reported and measured weight and height values. The individuals were also classified as active (those who exercised three times a week or more), a low active (those who exercised from one to two times a week), and inactive (those who did not exercise), according to the physical activity history in the last three months previously to the evaluation. The data obtained through the calculation of the intraclass correlation coefficient showed high reliability between variables reported in men (ICC ≥ 0.94) and women (ICC ≥ 0.96). The one-way analysis of variance ANOVA did not suggest any association, either isolated or combined, between the physical activities review and regularity in the error magnitude in reports from men ($p \geq 0.29$) and women ($p \geq 0.07$). According to these findings, the authors encourage weight and height report use in studies with large sampling size, regardless the physical activity level.

Key words: Epidemiology. Evaluation. Health. BMI.

INTRODUCTION

The growth of obesity as public health problem in developed and developing countries has led to an increasing need to asses weight, height and, hence, the body mass index (BMI) in epidemiological studies. The BMI, assessed through the product weight (kg) by height^{-2} (m), has been used as a valid indicator of the nutritional status of populational groups[1].

Despite being easily assessed, the weight and statute information is sometimes used through self-reported data. This is the case, for example, of studies involving a large number of individuals approached through telephone interviews or questionnaires sent by mail[2,3]. It seems to have a good reliability in this method that, however, is population specific[4-7].

The regular practice of physical exercises may be considered as one of the main factors to prevent weight gain, where the own weight control is a reason that leads individuals to exercise themselves. In addition, the physical fitness obtained through exercise reduces mortality and morbidity, even among obese individuals[8,9]. Studies assessing the physical activity level make use of the self-reported weigh and height more and more. Generally, such studies investigate the risk of chronic-degenerative diseases in some populations using the self-reported BMI in associations with other variables[10-14].

In this context, knowing the reliability of self-reports of individuals who search for the practice of supervised exercises and verifying if active individuals are more reliable their reports become important. Relevant mistakes in these people report may mislead the evaluation of the risk profile for chronic-degenerative diseases and the physical activity program that will be prescribed.

Thus, the objective of this study was to verify the reliability of self-reported weight, height and BMI through the comparison of these variables with measured values in individuals who searched for supervised practice of exercise in a sports center. Furthermore, the influence of the physical activities review on the reliability of that report was also verified.

METHODS

The sample of this study was comprised 328 individuals from 18 to 81 years old: 200 women (39 ± 11 years) and 128 men (35 ± 10 years), who searched for supervised practice of exercises in the city of Petrópolis (Rio de Janeiro). Before the start or three weeks after the beginning of their training program, the individuals underwent functional evaluation that, among other information, recorded the weight and height self-reported and measured values. The evaluations occurred between 2001 and 2002 with the objective of verifying the health status through questions regarding morbidity, cardiovascular diseases risk factors, physical activity history and physical fitness evaluation. All participants signed a term of informed consent, according to recommendations of the Resolution 196/96 – National Health Council, after approval from the ethics committee of the institution.

Weight was reported in kilograms and height in centimeters with up to one decimal place. Both variables were assessed after self-report in calibrated electronic scale with stadiometer (*Welmy*®), presenting readings of 0.1 kilogram and 0.5 centimeter for weight and height, respectively. The measurements were performed according to the Anthropometric Standardization Reference Manual[15]. Weight and height variables were collected by two independent appraisers with 10-minute intervals, so that no one could know information collected by the other. All variables were evaluated separately, according to gender.

In order to quantify the individuals' physical activities review, a questionnaire subdivided into three categories was applied: inactive (those who did not exercise for three months); a low active (those who exercised from one to two times a week) and active

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(those who exercised three times a week or more in the last three months with duration of 20 minutes per session).

The difference between self-reported and measured weight and height was considered as the report error. Negative values represent underestimation, while positive values, overestimation. The concordance between reported and measured variables, once it deals about continuous variables, was assessed through the intraclass correlation coefficient (ICC)[16]; which was estimated by using information regarding to the mean squares obtained after two-way analysis of variance, considering the observer as a random factor; in other words, considering a variance, even minimal, between appraisers.

The calculation of the ICC used is shown in chart 1.

CHART 1
Calculation of the intraclass correlation coefficient (ICC) used in the present study

ICC = δ^2 individuals ÷ (δ^2 individuals + δ^2 appraisers + δ^2 error)

δ^2 individuals	(Mean square of results from individuals – mean square of residuals) ÷ number of appraisers
δ^2 appraisers	(Mean square of results from appraisers – mean square of residuals) ÷ number of individuals
δ^2 error	Mean square of residuals

The difference between self-reported and measured variables or the report error was also evaluated through methodology proposed by Bland and Altman[17]. This methodology consists of a graphic arrangement of intra-individual differences (reported x measured) in function of the intra-individual averages ([reported + measured] ÷ 2). Thus, it could also be evaluated if the report error was constant (homoscedastic) or if it changed according to the absolute value of the intra-individual averages, what would indicate presence of heteroscedasticity. Ideally, the report error is expected to be independent of the variables' absolute value; in other words, the report error magnitude is expected to be independent from the magnitude of the individual's weight, height or BMI.

The Bland-Altman curve was also used with the objective of verifying possible outliers. Three concordance limits of 95% (CL 95%) were calculated to aid in this analysis and were calculated through the average difference between the reported and measured ± standard deviation of differences multiplied by 1.96. In case some error equivalent to two upper or lower CL 95% was found, the ICC could be recalculated with the exclusion of these discrepant values.

In the evaluation of the influence of the physical activity level on the weight and height report, the one-way ANOVA was used. To do so, the variable analyzed was the absolute difference between reported and measured variable. The descriptive statistics was used in the sample characterization. The software *Stata*™ (*Standard Edition 8.0*) was used for the entire data analysis, considering $p < 0.05$ as significance level.

RESULTS

Table 1 shows the descriptive data regarding weight, height and BMI, both reported and measured for all subjects and the CL 95%. Through these values, we can observe only a slight difference between the averages of reported and measured values, what suggests a high concordance for all variables in men and women. With the objective of corroborating this finding, the ICC calculation was performed (table 2). The data obtained showed high reliability between all variables assessed in men. On the other hand, the reliability of reported height in women, was not low, but presented a lower coefficient than the other variables.

TABLE 1
Weight, height, body mass index (BMI), average differences and concordance limits of 95% (CL 95%) between self-reported and measured variables in the sample studied

Variables	Reported (average ± sd)	Measured (average ± sd)	Average differences*	CL 95%
Men				
Weight (kg)	79.8 ± 15.2	79.6 ± 15.2	0.2	–5.1 ↔ +4.5
Height (m)	1.77 ± 0.08	1.76 ± 0.08	0.01	0.02 ↔ +0.03
BMI ($kg.m^{-2}$)	25.8 ± 3.37	25.8 ± 3.35	0	–1.88 ↔ +1.93
Women				
Weight (kg)	62.7 ± 11.1	62.8 ± 11.5	–0.1	–3.0 ↔ +3.0
Height (m)	1.62 ± 0.07	1.61 ± 0.07	0.01	–0.04 ↔ +0.04
BMI ($kg.m^{-2}$)	23.9 ± 3.93	24.1 ± 4.27	–0.2	–1.58 ↔ +1.80

* average difference = reported value – measured value.

TABLE 2
Intraclass correlation coefficient (ICC) between self-reported and measured weight, height and body mass index (BMI)

Variables	ICC
Men	
Weight (kg)	0.979
Height (m)	0.964
BMI ($kg.m^{-2}$)	0.941
Women	
Weight (kg)	0.981
Height (m)	0.963*
BMI ($kg.m^{-2}$)	0.964†

* This value was obtained when the ICC calculation occurred after the exclusion of two outliers present in the sample. The ICC value before this procedure was of 0.926.
† This value was obtained when the ICC calculation occurred after the exclusion of two outliers present in the sample. The ICC value before this procedure was of 0.958.

Figures 1 to 6 present the application of the Bland-Altman methodology[17] for variables height, weight and BMI for both men and women. Through the observation of the curves, no heteroscedastic behavior is clear. In the case of the variable weight in men (figure 4), a weight underestimation tendency is verified (more data below zero), and it is not evident that this difference increases with the body weight.

With regard to the observation of outliers, only a few values are found above CL 95%. However, in figure 2, with regard to the women's height, two individuals overestimated their height above 8 cm, what characterizes an error twice as higher than the upper CL 95% (table 1).

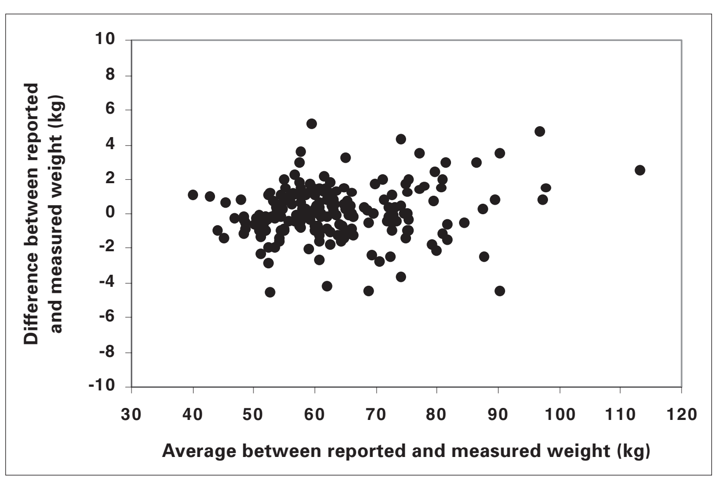

***Fig. 1** – Difference between reported and measured weight (report error) in function of the average between reported and measured weight in women*

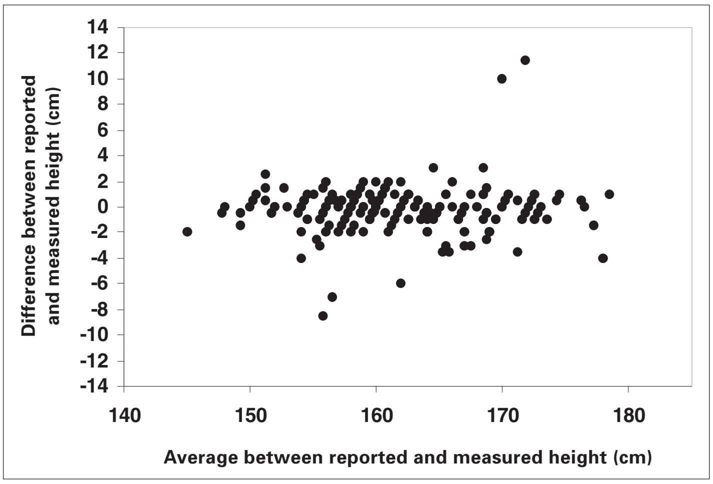

***Fig. 2** – Difference between reported and measured height (report error) in function of the average between reported and measured height in women*

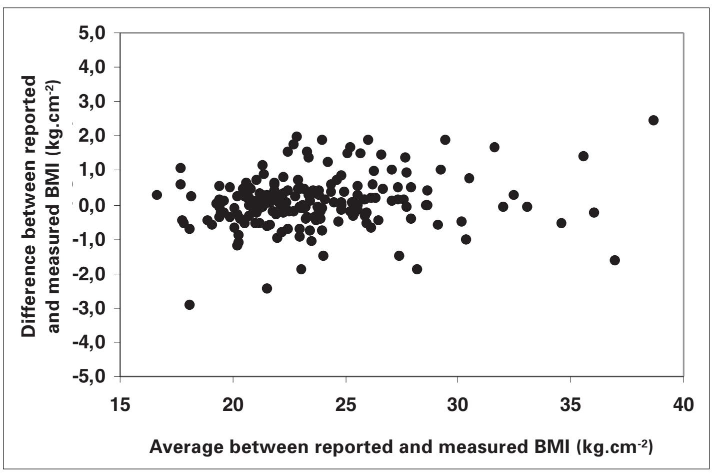

***Fig. 3** – Difference between reported and measured body mass index (report error) in function of the average between reported and measured BMI in women*

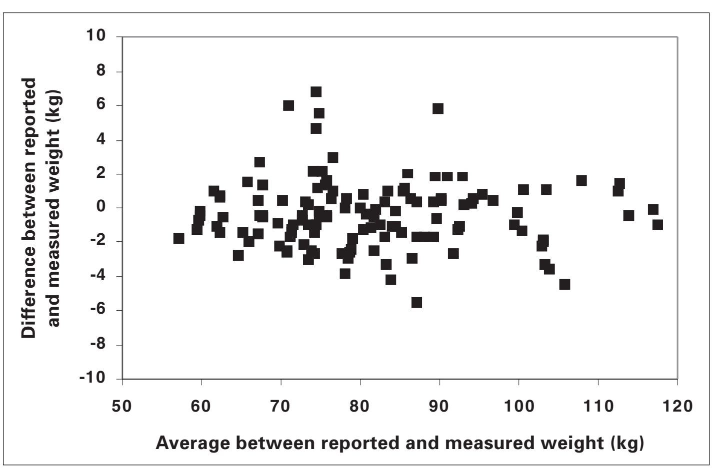

***Fig. 4** – Difference between reported and measured weight (report error) in function of the average between reported and measured weight in men*

Not coincidently, the variable height in women was the one presenting the lowest ICC (table 2). As defined in the methodology, the ICC with the exclusion of the discrepant values was recalculated, and this new value increased from 0.926 to 0.963. The removal of these two values also affected the ICC in relation to the women's BMI, which increased from 0.958 to 0.964.

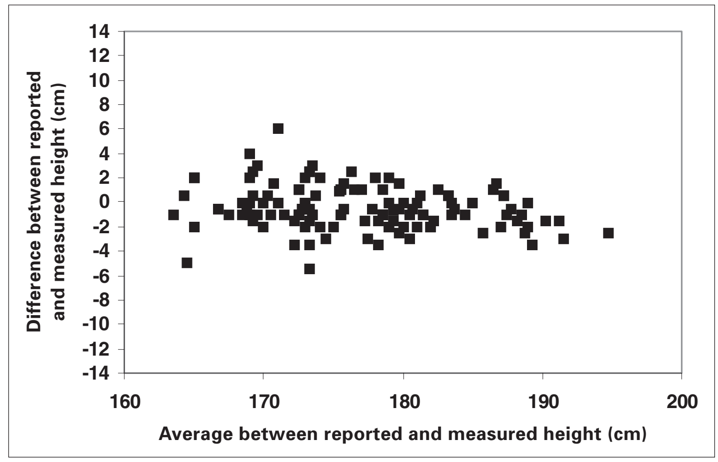

***Fig. 5** – Difference between reported and measured height (report error) in function of the average between reported and measured height in men*

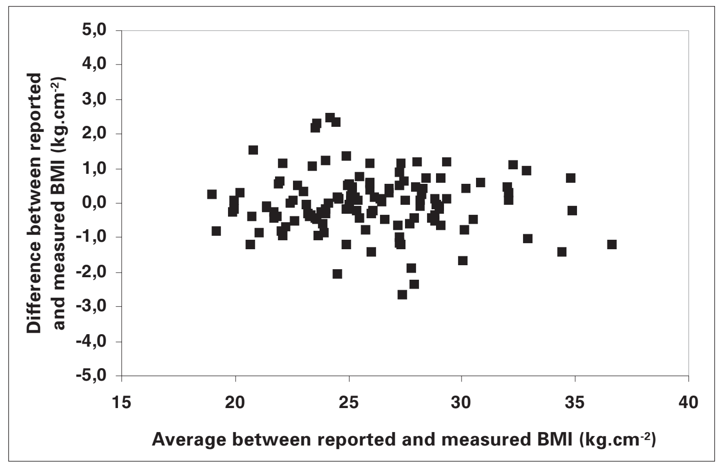

***Fig. 6** – Difference between reported and measured body mass index (report error) in function of the average between reported and measured BMI in men*

Table 3 presents data with regard to the absolute and relative frequencies of the physical activity level in men and women. The results, obtained from the analysis of variance ANOVA, did not suggest any association, isolated or combined, between the regular practice of physical exercises and the reports' error magnitude of men and women (table 4).

TABLE 3
Physical activity level in men and women in the three months before evaluations

Physical activity level	Men (n = 128)	Women (n = 200)
Inactive*	65 (50.8%)	126 (63%)
A low active†	25 (19.5%)	16 (8%)
Active‡	28 (29.7%)	58 (29%)

* None physical activity.
† Physical activity once to twice a week during 20 minutes or more.
‡ Physical activity three times a week or more during 20 minutes or more.

TABLE 4
Influence of the physical activity level on the report error in men and women according to the one-way ANOVA

Variables	Men	Women
Weight	p = 0.29	p = 0.07
Height	p = 0.73	p = 0.61
BMI	p = 0.41	p = 0.48

DISCUSSION

The concern of deepening questions regarding the reliability of weight and height reports in individuals who seek the supervised practice of exercises was remarkable in this study. Although the findings presented are in agreement with those from other studies[6,18] with regard to the magnitude of the difference between reported and measured variables (less than 1 cm for height and 0.5 kg for weight for both genders), some approaches used here are different from those previously used.

For example, in the study of Chor *et al.*[6], the authors attempted not only to test the reliability of each variable for men and women separately, but also to observe if the report error depended on the variable magnitude. In this purpose, the Bland-Altman curves were calculated separately by gender and variable reported. We believe that, when this procedure is not performed, the verification of specific details of each gender becomes difficult, especially heteroscedastic behaviors. A clear example of this difficulty may be seen in a recent study by Fonseca *et al.*[19], who verified the validity of the weight and statute report information in relation to values measured in university attendants.

No heteroscedastic behavior was verified in the present study for weight, height and BMI. One of the factors that may have influenced it was the fact that the sample used was not composed of many overweighed people, what could have impaired a more detailed observation.

Still in relation to the study of Chor *et al.*[6], the error in the height report was considered as insignificant. Thus, both the ICC and the Bland-Altman curves were not calculated. In the present study, we showed that the height error should be considered, so that the ICC had to be recalculated in the case of women. Besides, we believe that the new ICC calculation is justified, once these values were quite discrepant (reports of 10 and 12 cm more than the actual height).

The fact that the individuals who participated in the study of Chor *et al.*[6] knew that their reports would be compared with measurements before they had been questioned may explain the fact that higher ICC values were found, when compared with values from our study. An example may be the so high ICC for height.

The other study from which we differ with regard to the data treatment strategy was that by Araújo and Araújo[18]. These authors used the Pearson correlation instead of the ICC calculation. We recommend the use of the ICC, once correlation analysis would be effective to verify the association of variables, but not the reliability. A good example is the correlation between Celsius and Fahrenheit degrees for temperature, as reported by Holiday *et al.*[20]. Although this correlation is perfect ($r = 1.0$), the ICC would be small, once the difference between the two values is too big.

CONCLUSION

The increasing divulgation of the physical activity benefits for weight control and health improvement in several national programs, such as the governmental Health Policies program[21], may lead to higher concern with body weight by those who search for the practice of physical activities. Furthermore, theses types of programs seem to encourage the performance of new populational studies that would include the use of reported variables such as physical activity level, weight, height and, hence, BMI.

According to our findings, we encourage the use of the weight and height reports in large sampling size studies, regardless the physical activity level, once this variable does not seem to influence the report. However, further research must be conducted in order to verify the reliability of the reported weight and even the influence of the physical activity level in men and women previously classified as overweighed and/or obese.

Other important aspect is that our sample involved individuals whose age range reflects most people who search for the supervised practice of exercises in sports centers, including few elders. However, the number of elders seeking to maintain themselves active is increasing, what reinforces the importance of future investigations also in older populations.

All the authors declared there is not any potential conflict of interests regarding this article.

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