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Full Length Research Paper

Validity of self-reported height and weight and factors associated with errors in self-report

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The aim of this investigation is to assess the validity of self-reported height and weight and to examine factors associated with errors in self-report. A cross-sectional study was conducted in Coimbatore, Tamil Nadu, South India, from June 20 to August 20, 2011. The study involved 389 men and 355 women aged 20 years and above. We found that self-reported height and weight were significantly correlated with measured height and weight for men and women [Pearson's correlation coefficient(r) for men and women: 0.61 and 0.44 in height, 0.91 and 0.85 in weight, 0.76 and 0.64 in body mass index (BMI), respectively]. The prevalence of obesity based on self-reported height and weight were 7.9 and 15.8% for men and women, respectively, which was slightly smaller than that based on measured data 7.7 and 19.7%, respectively. Sensitivity and specificity of obesity based on self-report for both men and women were 97, 62% in men and 89, 64% in women, respectively. Participants with higher measured BMI significantly underestimated their weight compared to those with smaller BMI. It is also observed that among both men and women with measured BMI above 18.5 kg/m^2 were likely to underestimate their weight and BMI below 18.5 kg/m^2 were likely to overestimate their weight. However, the presence of diabetes, hypertension and heart disease was not associated with the difference between measured and self-reported height and weight for both men and women. Our findings indicate that self-reported weight has an acceptable agreement with measured data, but self-reported height has only a moderate agreement with measured data. There were no significant differences by presence of chronic disease and educational level between the self-reported and measured height and weight in both men and women.

Key words: Validity, body weight, body height, self-report, obesity.

INTRODUCTION

Height and weight are most commonly used anthropometric measurements in clinical practice and research. Body mass index (BMI), which is constructed from these measurements, can be used to assess nutritional status and overall health such as obesity. A U-shaped association for BMI and mortality has been reported for older adults (Cornoni-Huntley, 1991; Wada, 2005). Obesity has also been identified as an important risk factor for many chronic diseases including cardiovascular disease, diabetes and some cancers (Lin et al., 2004; Pi-Sunyer, 1993).

Height and weight are also frequently obtained by inquiries on self administered questionnaires or during personal or telephonic interviews. Self-reported height and weight are commonly used in large epidemiological studies because it is simple, inexpensive and non-invasive for collecting data from large number of individuals and their accuracy has been investigated by several previous studies (Brener, 2003; Giacchi, 1998; Nawaz, 2001; Niedhammer, 2000; Wada, 2005). Several

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studies have shown a moderate agreement between measured and self-reported height and weight, with height generally overestimated and weight underestimated (Brener, 2003; Giacchi, 1998; Nawaz, 2001; Niedhammer, 2000). In some studies, men were found more likely to overestimate their height, and women were more likely to underestimate their weight (Brener, 2003; Niedhammer, 2000). Furthermore, these biases in reporting might influence the distribution of BMI and consequently the prevalence of obesity.

Most of the previous studies have been conducted on whites and western society in developed countries and few studies have been conducted on Asians in developing countries whose body size is different from Whites (Wada, 2005). However, these earlier studies have not associated the influence of education and income which may confound the results. The aim of the present study is to assess the validity of self-reported height and weight in an urban population in Coimbatore, India and examine factors associated with the validity of self-reported height and weight. The factors considered are age, BMI, presence of chronic diseases, education and income.

MATERIALS AND METHODS

This is a cross-sectional study, conducted from June 20 to July 20, 2011. Participants in the study are individuals aged 20 years or more and had different economic conditions. The minimum sample size calculated was 400 men and 400 women. This sample size is sufficient to detect a sensitivity of 60% for detecting overweight including obesity in adults with a precision of 5% for a confidence interval of 95% and was based on a publication by Zhou et al. (2010). The sample was selected in two stages. First stage was the selection of primary sampling unit (PSU) which were non-slum areas, selected randomly from the list of such areas in the field practice area of the Urban Health Centre of Peelamedu Samanaidu Govindaswamynaidu Institute of Medical Science and Research situated in Coimbatore, Tamil Nadu, South India, followed by the selection of households using simple random sampling within each selected PSU in the second stage. According to the National Family Health Survey Data of India, about 56% of the population belongs to the age group of 20 years and above. Based on these values, the expected numbers of subjects were estimated as 14384, in 4348 households. In order to get 800 subjects, 300 households were required to be selected. Using random numbers, 4 non-slum areas from 12 non slum areas were selected. The required number of households were selected proportionately from the 4 non-slum areas to make the design self weighting. Of the 300 households selected, 7 houses were found locked even after the third visit. In such a case, as replacement, neighbouring houses were selected. The subjects who were not able to communicate because of dialect or hearing problems and pregnant women were excluded from this investigation. Thus a total of 804 subjects were interviewed from 307 households.

For the collection of information, we conducted a household interview. The subjects were asked about their height, weight, sex, age, education level, occupation, monthly income, number of family members, medical history of hypertension, diabetes and heart disease. The anthropometric measurements included measures of body height (in cm) and weight (in kg) which were performed in an empty room with the subjects wearing light indoor clothing and no shoes. Few investigators of the study team were trained in taking anthropometric measurements and were performed in each house. Standing height was measured using a non stretchable tape suspended from the wall and was measured to the nearest 0.1 cm. Weight (in kg) was measured to the nearest 0.5 kg (using Krups weighing scale). The Institutional Human Ethics Committee approved all subjects' recruitments and data collection procedures. Oral informed consent was obtained from all the subjects.

Statistical analysis

As the validity of self-reported BMI may differ among men and women (Zhou et al., 2010), separate analyses were conducted for men and women. The differences were calculated by subtracting measured values from self-reported values in height, weight and BMI. Pearson's correlation coefficient was used for evaluating the strength of association between measured and self reported values. The difference between measured and self-reported values was compared by paired t-test. The mean absolute value of the difference is also calculated. Measured and self-reported BMI was divided in to four categorical groups (<18.5, 18.5 to 24.9, 25 to 29.9, ≥30), and kappa statistics were calculated to assess the degree of concordance. To define obesity, we used criteria recommended by the World Health Organization (WHO), that is, the subjects BMI≥ 30 kg/m^2 were considered as obese. Prevalence of obesity based on self-reported height and weight was compared with that of measured BMI. Further to assess the validity of self-reported data, we calculated the sensitivity, specificity, positive predictive value and negative predictive value using measured data as gold standard.

To examine the factors associated with the validity of self-reported height and weight, potential explanatory variables were examined. These variables included the age, BMI, education levels, socio-economic status, presence of chronic diseases such as diabetes, hypertension and heart diseases. We measured income levels based on Prasad's modified classification based on Annual Consumer Price Index (Industrial Worker) (ACPI

Table 1. Means, differences, and Pearson's correlation coefficient of measured and self reported height, weight and BMI in the study population.

Men (n=389)	**Height (cm)**	**Weight (kg)**	**BMI (kg/m^2)**
Measured value[a]	165.16 ± 7.34	64.96 ± 14.26	23.72 ± 4.51
Self-reported value[a]	164.35 ± 10.72	62.96 ± 13.66	23.38 ± 4.99
Pearson's correlation coefficient	0.612**	0.913**	0.761**
Mean difference[b]	-0.795	-1.990*	-0.335*
95% C.I	(-1.64, -0.0551)	(-2.57,-1.40)	(0.640,.0517)
Mean Absolute value of the difference[b]	5.724	4.253	2.276
95% C.I	(5.09, 6.36)	(3.81, 4.70)	(2.04, 2.51)
Women (n=355)			
Measured value[a]	152.57 ± 70.33	60.52 ± 12.21	26.02 ± 5.17
Self reported value[a]	152.44 ± 11.80	59.96 ± 12.23	24.73 ± 5.87
Pearson's correlation coefficient	.444**	0.853**	0.644**
Mean difference[b]	-.1287	-3.56*	-1.28*
95% C.I	(-1.25, 0.99)	(-4.25, -2.87)	(-1.77, -0.796)
Mean Absolute value of the difference[b]	7.131	4.771	3.338
95% C.I	(6.28, 7.97)	(4.56, 5.38)	(2.98, 3.72)

*P<0.05 **P<0.001; BMI: Body Mass Index. [a] mean±s.d. [b] A difference was obtained by subtracting measured value from self-reported value. A negative value reflects under estimating and a positive value reflects over estimating.

(IW)) for the month of May 2011 after rounding off the nearest Rs.10. For those with per capita monthly income Rs.4270 and above were classified as class 1, between Rs.2130 to 4270 were classified as class 2, Rs.1280 to 2130 were classified as class 3, Rs.3640 to 1280 were classified as class 4, finally less than Rs.640 were classified as class 5 (Kumar, 1993). The difference between self-reported and measured height and weight was used as the dependent variables. We examined the relationship between each of the explanatory variables and the dependent variable by one- way analysis of covariance using General Linear Models. Then a multivariate General Linear Model analysis was performed to estimate mean difference between self-reported and measured height and weight adjusted for age, BMI, education levels, income and chronic diseases such as diabetes, hypertension and heart disease. Alpha was set up at 0.05. All analyses were conducted using the statistical package for social sciences (SPSS), version19.0.

RESULTS

A total of 804 subjects participated in the survey; 60 participants failed to report either height or weight were excluded from the analyses, leaving 744 subjects (92.53%) in the final analyses. Individuals excluded were not significantly different in age, height and weight from those individuals included. The mean age for men and women in the final analyses was 43.3 years old (S.D: 15.33 y) and 40.19 years old (S.D: 13.40 y), respectively. There was a moderate correlation between measured and self-reported height in both men and women (Pearson's correlation coefficient (r) for men and women: 0.612 (p <0.001) and 0.444(p<0.001)). However, in the case of weight and BMI there were strong correlations between measured and self-reported values in both men and women (Pearson's correlation coefficient (r) for men and women: 0.913 (p<0.001 and .853(p<0.001) for weight, 0.761(p<0.001) and .644(p<0.001) for BMI, respectively). Although both men and women underestimated their weight (P<0.001), the mean difference was small (-1.99 kg for men and -3.56 kg for women). The difference between measured and self reported height was not statistically significant in both men and women. The mean absolute value of the difference for men and women was 5.72 and 7.13 cm for height, 4.25 and 4.77 kg for weight, 2.36 and 3.34 kg/m^2 for BMI, respectively. These findings were presented in Table 1.

It is interesting to note that, among the overweight men (BMI: 25 to 29.9 kg/m^2), 41.3% did not consider themselves as overweight and among the obese men (BMI: ≥30kg/m^2), 33% did not consider themselves as obese. While among overweight women, 45.5% did not consider themselves as overweight, and among obese women 48.5% did not consider themselves as obese. On further evaluation, when four classes of self-reported BMI were compared to their measured BMI, the Kappa value was (Kappa: 0.443, p<0.001 for men, 0.362, p<0.001 for women) (Table 2).

Table 2. Classification of participants according to measured and self reported BMI.

Measured BMI (kg/m^2)	Self-reported BMI (kg/m^2)				Kappa
	<18.5	18.5 t0 24.9	25 to 29.9	≥30	
Men (n=389)					
<18.5	30(71.4)	12(28.6)	0	0	
18.5 to 24.9	38(18.7)	141(69.5)	21(10.3)	3(1.5)	0.443
25 to 29.9	0	45(41.3)	56(51.4)	8(7.4)	(P<0.001)
≥ 30	0	0	10(33.3)	20(66.7)	
Women (n=355)					
<18.5	9(56.3)	7(43.8)	0	0	0.362
18.5 to 24.9	23(15.9)	102(70.3)	14(10.3)	6(1.5)	(P<0.001)
25 to 29.9	6(5)	49(40.5)	52(43)	14(11.6)	
≥ 30	1(1.4)	4(5.7)	29(41.4)	36(51.4)	

Values are expressed as *n*. Percentages are in parentheses, BMI: Body mass index.

Table 3. Prevalence of obesity based on measured and self-reported values and test values for the diagnosis of obesity based on self-reported values.

	Men (n=389)	Women (n=355)
Prevalence of obesity (%) based on self reported values	7.9%	15.8%
Based on measured values	7.7%	19.7%
Test values		
Sensitivity (%)	97.19	88.62
Specificity (%)	60.60	64.28
Positive predictive value (%)	96.37	92.98
Negative predictive value (%)	33.33	48.57

As shown in Table 3, the prevalence of obesity based on self-reported values for men and women was 7.9 and 15.8% respectively. These were 1.03 and 0.803 times as great as the prevalence of obesity based on measured values, which were 7.7 and 19.7%, respectively. When the measured value was taken as gold standard, specificity obtained for men and women is 60.60 and 64.28%, respectively, while sensitivity was 97.19 and 88.62% for men and women respectively. The crude and adjusted mean difference in self-reported weights is shown in Table 4. Similar analysis was done for height also (not presented). Adjusted age had a statistically significant effect for difference in weight only in men, but these associations was not observed for height in men and women. In men, under estimation of weight was found decreasing with increasing age. Adjusted BMI of both men and women was significantly associated with error in the self-reported weight, whereas for self-reported height similar relationship was found only among women. There were no significant differences by presence of chronic disease, education levels between the self-reported and measured height and weight in men and women. Household income was affected the difference between measured and self-reported values in weight on men after adjusting all other covariates but no such association was observed for height in men and women.

DISCUSSION

Our findings are consistent with results from other studies (Brener, 2003; Giacchi, 1998; Kuczmarski, 1988; Wada, 2005; Lawlor, 2002; Nakamura, 1999; Niedhammer, 2000; Spencer, 2002; Strauss, 1999) that self-reported height and weight are correlated with measured height and weight in both men and women. Self-reported and measured weight was highly correlated, but in the case of height and BMI only a moderate correlation was found, which affect obesity prevalence estimate. This shows that there is need for the awareness about the consequences of misreporting height and weight and its effect on epidemiological and clinical study in the study population.

On average, the reported weight and resultant BMI was underestimated and the difference was statistically significant. These findings were similar to those in

Table 4. Mean differences between measured and self-reported weight according to demographic and health-related factors.

	Men			Women		
		Mean difference			Mean difference	
	n	Crude	Adjusted	n	Crude	Adjusted
Age group (years old)						
20-40	191	-2.26	-2.26[a]	212	-3.52	-3.52[a]
41-60	141	-2.08	-2.08[a]	110	-3.91	-3.91[a]
60+	57	-0.825	-.824[a]	33	-2.66	-2.66[a]
		p= 0.256	p= 0.037		p= 0.632	p= 0.344
Measured BMI (kg/m^2)						
<18.5	42	0.919	0.919[b]	16	0.312	0.312[b]
18.5-24.9	203	-1.13	-1.13[b]	145	-2.71	-2.71[b]
25- 29.9	113	-3.61	-3.61[b]	124	-3.92	-3.92[b]
≥30	31	-5.59	-5.59[b]	70	-5.56	-5.56[b]
		p<0.001	p<0.001		p<0.001	p=0.001
Diabetes						
Yes	24	-1.08	-1.08[c]	27	-4.14	-4.14[c]
No	365	-2.05	-2.05[c]	328	-3.51	-3.51[c]
		p=0.434	p=0.178		p=0.635	p=0.637
Hypertension						
Yes	46	-3.27	-3.27[d]	47	-4.24	-4.24[d]
No	343	-1.81	-1.81[d]	308	-3.45	-3.45[d]
		p=0.114	p=0.135		p=0.451	p=0.364
Heart disease						
Yes	10	-1.80	-1.80[e]	7	-0.714	-0.714[e]
No	379	-1.99	-1.99[e]	348	-3.62	-3.62[e]
		p=0.917	p=0.411		p=0.252	p=0.290
Education level						
University and above	114	-1.70	-1.70[f]	97	-2.79	-2.79[f]
Up to higher secondary	275	- 2.10	-2.10[f]	258	-3.85	-3.85[f]
		p=0.537	p=0.309		p=0.179	p=0.271
Income level						
Class 1 and 2	196	-1.63	-1.63[g]	165	-3.28	-3.28[g]
Class 3,4 and 5	193	-2.34	-2.34[g]	190	-3.80	-3.80[g]
		p=0.232	p=.014		p=0.455	p=0.410

One way analysis of covariance. BMI: Body mass index. [a] Adjusted for BMI, diabetes, hypertension, heart disease, education, socio-economic status. [b] Adjusted for age, diabetes, hypertension, heart disease, education, socio-economic status. [c] Adjusted for Age, BMI, hypertension, heart disease, education, socio-economic status. [d] Adjusted for Age, BMI, diabetes, heart disease, education, socio-economic status. [e] Adjusted for age, BMI, diabetes, hypertension, education, socio-economic status. [f] Adjusted for Age, BMI, diabetes, hypertension, heart disease, socio-economic status. [g] Adjusted for age, BMI, diabetes, hypertension, heart disease, education.

previous studies in adults (Wada, 2005). But, in our study height was also underestimated, which is a conflicting result to those in previous study. In our study, the mean difference of self-reported and measured height was not statistically significant. On average self reported height and weight was -0.80 and -1.99 kg lower for men and -

0.13 and -3.56 kg for women, respectively. The difference observed in our study was quite higher than those reported in other studies (Giacchi, 1998; Wada, 2005; Niedhammer, 2000). This may be partly due to the differences in study population including household economic status and area of residence.

For women self-reported weight was 3.56 kg lighter than measured values, as a total and the difference were statistically significant. In an earlier study Engstrom et al. (2003) reviewed 34 reports on self-reported weight in women; they found that women in all 34 studies under estimated their weight. It was also suggested that the mis-reporting of weight may be influenced by the tendency to act in a socially desirable bias for women (Larson, 2000). Our results support with the findings of Engstrom et al. (2003) and it may be due to actual background characteristics of the Indian people.

As a result, our study showed that BMI based on self reported height and weight tended to be under estimated compared to BMI based on measured height and weight for both men and women and the difference between these two values was statistically significant. The prevalence of obesity with BMI ≥30 kg/m^2 based on self reported data was slightly smaller than that based on measured data. However sensitivity proved quite high, that is, almost all the subjects reported their weight as <30 kg. Substantial Kappa value suggests that only to some extent we can depend on the self-reported measure. In general, between measured and self-reported BMI we could only observe a mild agreement.

Although many previous studies have investigated the association between age and self-reporting error (Wada, 2005; Zhou et al., 2010), the results were not always concordant. This may be due to differences in age distribution among these studies. Our subjects aged 20 years and above, showed that the adjusting age was associated with difference between measured and self reported weight only in men and such association was not found with self-reported height in both men and women.

We also showed that the measured BMI biased the accuracy of self-reported weight, that is, the higher the measured BMI the more the under estimation for both men and women. Since the same trend has been observed in previous studies (Bolton-Smith, 2000; Wada, 2005; Lawlor, 2002; Nawaz, 2001; Niedhammer, 2000; Rowland, 1990; Strauss, 1999), we confirmed that the degree of obesity was one of the most important factors that bias the difference between measured and self-reported weight. Similar association was found only in women for self-reported height which conflicts in the previous studies (Bolton-Smith, 2000).

A few previous studies have reported an association between chronic disease and reporting bias in weight (Bolton-Smith, 2000; Wada, 2005). Bolton-Smith et al. (2000) indicated that men with diabetes under estimated their weight but not women. In our present study, presence of diabetes, hypertension and heart disease was not associated with any reporting bias. Future studies should examine these issues in a large number of subjects or other population. Household income was not associated with difference between the self-reported and measured value for height; but it was associated with bias for weight in men.

Our present study has several limitations. First, our study population constituted of individuals living in field practice area of our health centre. For this reason, our findings may not be generalized to other socio-economic strata. Second, we did not include physical activity in our analysis which may confound the results. Third, we have included all subjects aged 20 years and above. This include older people also who may have poorer memory due to aging, cognitive problems and even side effects of medication which may confound the results. Despite these limitations, our study has several strengths. Systematic ways of data collection by the same research assistants avoided inter observer variations. To our knowledge, there are not many studies conducted in India in this area. Additionally data on demographic background, history of chronic diseases and anthropometric measurements collected allowed us to examine the associations between socio-economic influences on self-reported height and weight.

Conclusion

The self-reported weight has an acceptable agreement with measured weight data, but self-reported height has only a moderate agreement with measured height. Thus, self-reported data could be considered for use in surveillance system and epidemiological studies with caution. Any use of self-reported height and weight from similar subjects in future research studies should be justified with supporting pilot data validating such measures.

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