Self-Reported Weight and Height for Evaluating Obesity Control Programs

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***Objectives*: To assess the adequacy of self-reported weight and height as indicators for BMI in community-based obesity control programs. *Methods*: Self-reported and measured weight and height and calculated BMI in 6979 adults were assessed using analysis of covariance. *Results*: Prevalence of obesity (BMI $\geq$25kg/m^2) and overweight (25-29.9kg/m^2) was lower using self-reported values by 3.2% and 5.0%, respectively. Females underreported BMI more than males did; and older subjects, more than younger subjects. *Conclusions*: Self-reported weight and height measurements may be used for the evaluation of community-based obesity control programs with the application of correction factors. This will minimize costs associated with physical measurements.**

***Key words*: self-reported weight, height and BMI, measured weight, height and BMI, obesity-control programs evaluation**

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Many countries have reported increases in the prevalence of over weight and obesity among all age-groups.[1-3] Data from the United States show the percentage of obese adults has increased from 15% in 1980 to 32.2% in 2004.[3] Similarly, in Australia the prevalence of obesity among adults has risen from 7.1% in 1980[4] to 25% in 2008.[5]

Overweight and obesity are associated with numerous medical conditions and linked to increases in morbidity and mortality.[6] Such medical conditions include type 2 diabetes, cardiovascular disease, stroke, osteoarthritis, some cancers, sleep apnoea, respiratory disease, and musculoskeletal problems as well as the exacerbation of these conditions when they exist.[7-10]

In response to this global obesity epidemic, there has been a concomitant increase in prevention research where the aim is to prevent further increase of overweight and obesity among selected target groups.[11] Many of these obesity control programs use measures of obesity, both measured waist circumference and self-reported weight and height, to determine body mass index (BMI) as an indicator of weight status.[2] An increasing number of studies are using the waist circumference[12-15] and waist-to-hip ratio[16-20] due to their superior ability in predicting cardiovascular mortality and morbidity. However, self-reported weight and height to allow estimation of BMI is

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still a favored measure as it can be collected with little effort and at low cost,[2] and the procedure for measuring weight and height has been standardised for some time. BMI is calculated from body weight and height measures: 25.0–29.9 kg/m^2 are classified as overweight, and those over 30.0 kg/m^2 are classified as obese.

Mixed literature exists considering the accuracy of using self-reported weight and height, with some authorities suggesting that measured rather than self-reported weight and height may be desirable to minimize error.[21-23] Others[24,25] indicate that self-reported weight and height indicators of BMI are reasonably accurate for the assessment of the prevalence of overweight/obesity.

Researchers submitting proposals for funding for community-based obesity control programs are faced with a dilemma. Some reviewers generally favor measured data when assessing research grant applications, and there is concern that applications that use self-reported measures may be rated at a lower level. Hence, on one hand, the rigor of obesity-control program applications often appears to be enhanced when measured rather than self-reported weight and height are proposed. On the other hand, there are lower costs and less subject burden, along with higher recruitment success and reduced attrition when the latter are used.[2,11]

The literature indicates that for self-reported measures, there is in general a relatively small underreporting of body weight and overestimation of height.[24,26] Though the differences are relatively small, it can have important implications for research studies such as weight-loss programs that use specific BMI criteria for enrollment.[22] These are usually clinical studies that might have relatively small sample sizes, where the participants have close contact with a health facility and where the researchers are interested in very small changes in weight and BMI.[13,14] Hence, in this circumstance, measured weight and height are preferable.

With respect to large community-based obesity control programs, it is very costly to measure weight and height of participants.[2] This is especially so where special measuring centers have to be established or where researchers / program evaluators have to travel to participants' homes to take the measurements. It is much more economical to use self-reports.[2]

There can be substantial subject burden associated with measured weight and height compared to self-reported measures. Subject burden due to measurement demands contributes significantly to recruitment refusals and program attrition.[2,11] Participants may be more likely to agree to be involved when demands on their time are minimized. Similarly, attrition is minimized.[2] This is particularly so for control group subjects, who may be expected to provide substantial time commitment to measurements, but with none of the potential benefits that accrue for intervention group subjects. It might be argued that any limitations imposed by self-report are compensated by securing suitable control or comparison groups, which Swinburn et al[23] suggest as one of 3 components needed for "high-quality evaluations" of obesity control programs.

This paper examines the accuracy of self-reported weight and height versus physical measures as indicators for BMI. Based on the data of 6979 Australian adults, this paper suggests that self-report of weight and height as indicators of BMI have adequate accuracy and may be used with caution in community-based obesity control programs. Further, we discuss the calculation and procedures for using a correction error adjustment to enhance its accuracy, and we also present the cut-points for self-reported obesity to predict measured obesity at high levels of sensitivity and specificity.

METHODS

The third Australian Risk Factor Prevalence Study[27] conducted in 1989 by the National Heart Foundation of Australia recruited residents aged 20-69 years, registered on the Commonwealth electoral rolls of December 1988, from 9 metropolitan cities across Australia: North Sydney, South Sydney, Melbourne, Brisbane, Adelaide, Darwin, Hobart, Perth, and Canberra.[28] Subjects were chosen by systematic sampling of sex and 5-year age-groups. Representative samples of 1500 subjects from each catchment area were invited to a local survey center after an overnight fast. A total of 15,164 people were selected from the electoral rolls wherein 2694 were no longer living at the specified address. Of the remaining 12,470 potential respondents, 9309 attended, which accounts to a response rate of 74.7%. As reflected by place of birth, the majority of the respondents (93%) were European descent (including Australia, United Kingdom , and Europe). Asian and African descendents accounted for 5%. Survey methods are described in detail by Boyle et al,[29] Bennett and Magnus,[28] and Welborn et al.[17] The questionnaires collected information on the demographic and physical characteristics, health, and associate behavior of people aged 20-69 years. Self-reported weight and height information was collected, and weight and height were also measured by survey staff as part of the physical examination. Height was measured to the nearest centimeter and weight to the nearest 0.1 kg. The subjects were measured in socks, stockings, or bare feet and light street clothing, with no coats or sweaters.

Statistical Analysis

The error in self-reporting is calculated as the difference between the self-reported values and measured values of weight, height, and BMI. The association of the error in self-reporting with the measured value was assessed using Pearson's correlation and linear regression for weight, height, and BMI measurements (Figure 1).[30] The country of birth was used as a surrogate for ethnicity and was grouped into regions as described in the Australian Risk Factor Prevalence Study Management Committee.[27]

Sensitivity and specificity were calculated to assess the ability of self-reported measurements to predict measured BMI $\geq$30 kg/m^2 (Table 2) for the overall group and for each of the subgroups (gender, age-group, birthplace category). McNemar test was used to compare self-reported and measured values for BMI $\geq$30 kg/m^2 due to the presence of matched pairs and the variables being statistically dependent. The 95% confidence interval for the true difference of proportions, which quantifies the error in obesity prevalence due to self-reporting, was calculated using a Wald confidence interval. The agreement between the self-reported BMI and measured BMI for obese subjects was assessed using kappa, a coefficient that takes a value of 1 when there is perfect agreement and 0 when there is no agreement.[31]

The differences (or error) between self-reported values of weight, height, and BMI and their respective measured values were analyzed using analysis of covariance. The model assessed the effects of gender, age-group, and ethnicity and their interactions to explain the error associated with self-reporting, after adjusting for the respective measured value. Measured value was used as a covariate because error in reporting was associated with the size of the measure. Data were analyzed using SPSS Version 17, and P-values <0.05 were considered as statistically significant.

Cut-points for self-reported BMI at desired levels of sensitivity to predict measured BMI $\geq$25 kg/m^2 and BMI $\geq$30 kg/m^2 were calculated using receiver operating characteristic (ROC) curves (Table 3), and the associated level of specificity reported.[32] Sample sizes were computed for determining the adjustment to self-reported BMI to estimate measured BMI at varying levels of precision or error at the 95% confidence level (Table 4) using the standard deviations of the difference for the various age-groups.

RESULTS

The baseline characteristics, obesity classification based on self-reported and measured values together with the errors in self-reporting (Self-reported – Measured value), are summarized in Table 1.

About 75% of 9279 subjects from the NHF Risk Factor Prevalence Study[27] had valid self-reported weights and heights. The percentage of subjects that were classified as obese (BMI $\geq$30 kg/m^2) based on self-reported values was 8.2%, compared to 11.4% based on measured values of weight and height. Generally, female subjects underreported their weights and males overreported their heights in the study group. The overall mean overestimation of height and underestimation of weight were relatively small, but individual differences can vary considerably.

Figure 1 represents the self-reporting errors for (a) BMI (b) weight , and (c) height plotted against their respective measured values for the overall sample.

The self-reporting errors in relation to weight and height measurement can be sizeable. Self-reporting errors on BMI were linearly related to the measured value (P<0.0005) with a predicted underreporting error of 0.087 for every increase in 1kg/m^2 in BMI measured

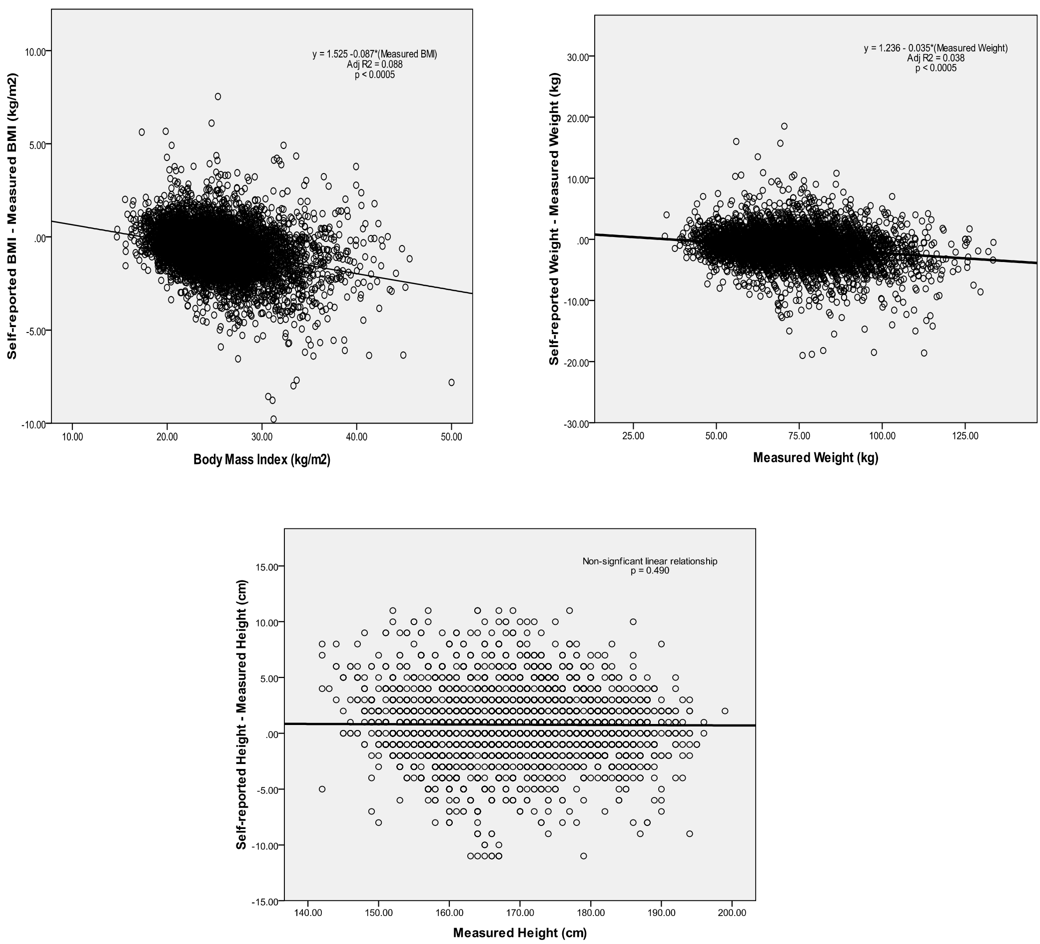
Table 1
Characteristics of NHF Study Subjects With Self-Reported and Measured Weight and Height[a]

	Males (n=3585)	Females (n=3394)	Total (n=6979)
Age (years)	44.0 ± 13.2	43.2 ± 13	43.6 ± 13.1
Age in 10-year Groupings			
20 - 29 years	17.1%	17.9%	17.5%
30 - 39 years	24.3%	26.8%	25.5%
40 - 49 years	26.0%	24.5%	25.3%
50 - 59 years	16.5%	16.7%	16.6%
60 - 69 years	16.0%	14.1%	15.1%
Australia or Overseas Born Indicator			
Born in Australia	71.0%	74.6%	72.8%
Born overseas	29.0%	25.4%	27.2%
Birthplace Category			
Australia	71.0%	74.6%	72.8%
United Kingdom and Ireland	11.5%	10.1%	10.8%
Northern Europe	4.6%	4.3%	4.4%
Southern Europe	5.3%	4.0%	4.7%
Asia	4.3%	4.0%	4.2%
Africa	1.3%	0.7%	1%
United States of America	0.1%	0.1%	0.1%
Canada	0.2%	0.1%	0.1%
Other Australasia	1.5%	1.4%	1.5%
Other American Countries	0.2%	0.4%	0.3%
Pacific Islands	0.1%	0.2%	0.1%
Weight Measured (kg)	79.6 ± 12.2	64.7 ± 12.1	72.4 ± 14.2
Height Measured (cm)	175.5 ± 6.9	162.2 ± 6.3	169.0 ± 9.4
Body Mass Index Measured (kg/m²)	25.8 ± 3.5	24.6 ± 4.5	25.2 ± 4.1
BMI (measured) Categories			
< 25 kg/m²	43.3%	62.8%	52.8%
≥ 25 and < 30 kg/m²	45.3%	25.8%	35.8%
≥ 30 kg/m²	11.4%	11.4%	11.4%
Weight Self-reported (kg)	78.4 ± 11.7	63.3 ± 11.8	71.1 ± 14
Height Self-reported (cm)	176.6 ± 7	162.7 ± 6.5	169.8 ± 9.7
Body Mass Index Self-reported (kg/m²)	25.1 ± 3.4	23.9 ± 4.3	24.5 ± 3.9
BMI (self-reported) Categories			
< 25 kg/m²	53.0%	69.4%	61.0%
≥ 25 and < 30 kg/m²	39.2%	22.0%	30.8%
≥ 30 kg/m²	7.8%	8.6%	8.2%
Difference between Weights (kg) (self-reported - measured)	-1.2 ± 2.8	-1.4 ± 2.2	-1.3 ± 2.5
Difference between Heights (cm) (self-reported - measured)	1.1 ± 2.5	0.4 ± 2.5	0.8 ± 2.6
Difference between BMIs (kg/m2) (self-reported - measured)	-0.7 ± 1.2	-0.7 ± 1.2	-0.7 ± 1.2

Note.
a Continuous data represented as mean ± 1 standard deviation and categorical data as percentages.

value. Hence, subjects with a BMI of 20kg/m² underestimated their BMI by 0.215 kg/m², whereas those with a BMI of 30kg/m² underestimated their BMI by 1.085 kg/m². The linear relationship between weight self-reporting error and measured weight was statistically significant ($P<0.0005$), with a mean increased underreporting error of 0.35 kg for every 10 kg increase in weight. There was,

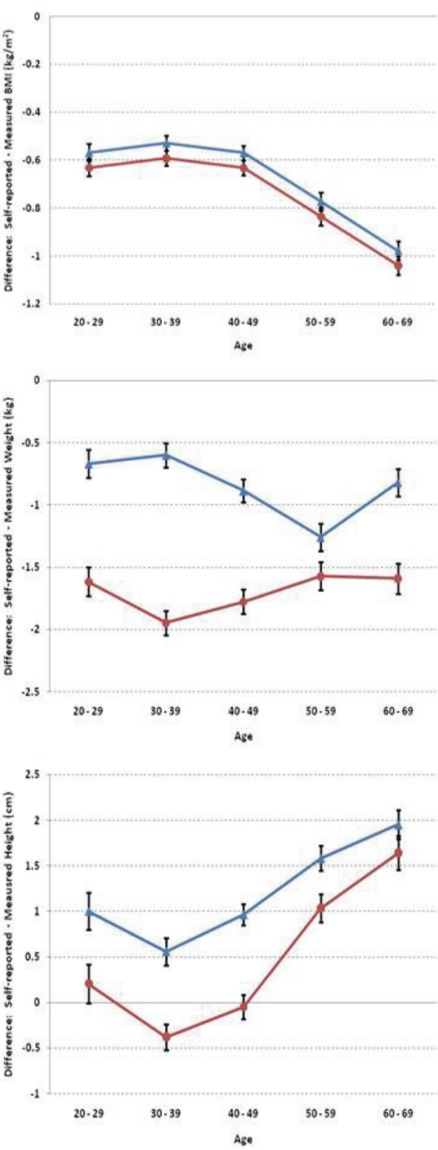
Figure 1
Plot Differences Between Self-reported and Measured (a) BMI (kg/m^2), (b) Weight (kg), and (c) Height (cm) Against Their Respective Measured Value



however, no significant linear relationship between self-reporting error on height against measured height values (P=0.490).

In the analysis of covariance, after adjusting for measured BMI, the gender and age-group of subjects had significant independent effects on the BMI self-reporting error. Males underreported their BMI by -0.683 ± 0.02 kg/m^2 and females by -0.745 ± 0.02 kg/m^2. The mean difference in the self-reporting errors for males and females was significant: 0.063 ± 0.028 kg/m^2 (P=0.026). The effect of age-group was also significant (P<0.005). Older subjects in the study underreported their BMI more than younger subjects did. BMI self-reporting errors for subjects in the age-groups 20 – 29 years, 30 – 39 years , and 40 – 49 years were significantly less than both 50 – 59 years and 60 – 69 years. The underreporting errors for subjects

Figure 2
Profile Plot Differences (mean ± se) Between Self-reported and Measured (a) BMI, (b) Weight, and (c) Height for Gender by Age-group[a]



Note.
Males are represented by triangles top line) and females by circles (bottom line).

less than 50 years was on average 0.6 kg/m², for 50 – 59 years was 0.8 kg/m², and for 60-69 years was 1 kg/m². Gender by age-group interaction was nonsignificant (P=0.799) for differences between self-reported BMI and measured BMI (Figure 2a). BMI self-reporting errors for the different ethnic groups were not significantly different (P=0.206). The interaction between age-group and ethnicity was nonsignificant (P=0.189), and the interaction between gender and ethnicity was also nonsignificant (P=0.2). Interestingly, younger (20 – 29 years) southern Europeans in the study underreported their BMI more than the other ethnic groups. Ethnic groups were also not significantly different (P>0.05) from one another.

The self-reporting errors for weight were also adjusted for their measured weight in the analysis of covariance to assess the effects of gender, age-group, and ethnicity and their interactions. Females underreported their weights by 1.7 ± 0.07 kg, and males underreported their weights by 0.8 ± 0.06 kg. The mean difference (0.9 ± 0.07 kg) in self-reporting error between females and males was significantly different (P<0.0005). The interaction between gender and age-group was significant for self-reported weight errors (P=0.002), with younger female subjects underreporting significantly more than younger male subjects (Figure 2b). At older ages, the differences between males and female were not significantly different. Weight self-reporting errors for the different ethnic groups were not significantly different (P=0.576). The interaction between age-group and ethnicity was nonsignificant (P=0.858), and that between gender and ethnicity was also nonsignificant (P=0.831).

Self-reporting height errors, after adjusting for measured height in the analysis of covariance, were significantly associated with gender, age-group, and ethnicity. Males overreported their heights by 1.2 ± 0.08 cm; and females overreported their height by 0.5 ± 0.09 cm; and although the difference was less than 1cm (0.7 ± 0.1cm), it was statistically significant (P<0.005). Overreporting of heights was significantly greater (P<0.0005) at older ages. The interaction between gender and age-group interaction was significant (P=0.004), with younger males overreporting their heights compared to younger females (Figure 2c).

Table 2
The Assessment of Self-Reported Obesity to Predict Measured Obesity (BMI ≥ 30 kg/m²) for All Subjects and Subjects in the Various Subgroups

	Sensitivity for BMI ≥ 30	Specificity for BMI ≥ 30	Kappa	McNemar P-value	Self-Reported Obesity	Measured Obesity	Difference in Obesity Prevalence
MALES							
All Ages	61.10%	99.1%	0.698	<0.0005	7.8%	11.4%	-3.6% (-4.3% to -2.9%)
Age-Group							
20 - 29 yrs	58.3%	99.7%	0.698	0.002	3.8%	5.9%	-2.1% (-3.4% to -0.8%)
30 - 39 yrs	71.8%	98.9%	0.764	0.029	7.5%	8.9%	-1.5% (-2.7% to -0.2%)
40 - 49 yrs	60.9%	98.9%	0.691	<0.0005	9.3%	13.7%	-4.4% (-6.0% to -2.8%)
50 - 59 yrs	61.5%	98.6%	0.687	<0.0005	11.1%	16.2%	-5.1% (-7.2% to -2.9%)
60 - 69 yrs	50.7%	99.4%	0.621	<0.0005	6.8%	12.4%	-5.6% (-7.6% to -3.5%)
Country of Birth							
Australia	61.0%	99.1%	0.700	<0.0005	8.2%	12.2%	-4.0% (-4.9% to -3.1%)
UK and Ireland	66.7%	99.5%	0.754	0.039	5.3%	7.3%	-1.9% (-3.6% to -0.3%)
Northern Europe	60.0%	99.3%	0.698	0.125	6.1%	9.1%	-3.0% (-6.1% to 0.1%)
Southern Europe	57.5%	95.3%	0.582	0.064	15.8%	21.1%	-5.3% (-10.3% to -0.3%)
Asia	60.0%	100.0%	0.744	0.500	1.9%	3.2%	-1.3% (-3.1% to 0.5%)
FEMALES							
All Ages	72.70%	99.60%	0.807	<0.0005	8.6%	11.4%	-2.7% (-3.3% to -2.1%)
Age-Group							
20 - 29 yrs	86.5%	100.0%	0.923	0.063	5.3%	6.1%	-0.8% (-1.5% to -0.1%)
30 - 39 yrs	79.1%	99.6%	0.854	0.001	8.3%	10.0%	-1.8% (-2.8% to -0.8%)
40 - 49 yrs	65.1%	99.2%	0.733	<0.0005	7.2%	10.0%	-2.8% (-4.1% to -1.4%)
50 - 59 yrs	72.2%	99.4%	0.793	<0.0005	12.9%	17.1%	-4.2% (-6.1% to -2.4%)
60 - 69 yrs	67.5%	99.7%	0.770	<0.0005	11.1%	16.2%	-5.0% (-7.1% to -3.0%)
Country of Birth							
Australia	72.4%	99.6%	0.808	<0.0005	8.3%	11.0%	-2.7% (-3.4% to -2%)
UK and Ireland	73.9%	99.3%	0.806	0.013	10.5%	13.4%	-2.9% (-5% to -0.8%)
Northern Europe	81.0%	100.0%	0.879	0.125	11.7%	14.5%	-2.8% (-5.4% to -0.1%)
Southern Europe	70.8%	99.1%	0.775	0.070	13.3%	17.8%	-4.4% (-8.5% to -0.4%)
Asia	50.0%	99.2%	0.597	0.375	3.6%	5.8%	-2.2% (-5.4% to 1.0%)
OVERALL							
All Ages	66.80%	99.3%	0.752	<0.0005	8.2%	11.4%	-3.2% (-3.7% to -2.7%)
Age-Group							
20 - 29 yrs	72.6%	99.8%	0.819	<0.0005	4.5%	6.0%	-1.5% (-2.2% to -0.7%)
30 - 39 yrs	75.7%	99.3%	0.812	<0.0005	7.9%	9.5%	-1.6% (-2.4% to -0.8%)
40 - 49 yrs	62.6%	99.0%	0.709	<0.0005	8.3%	11.9%	-3.6% (-4.7% to -2.6%)
50 - 59 yrs	66.8%	99.0%	0.741	<0.0005	12.0%	16.7%	-4.7% (-6.1% to -3.2%)
60 - 69 yrs	59.5%	99.6%	0.701	<0.0005	8.8%	14.1%	-5.3% (-6.8% to -3.9%)
Country of Birth							
Australia	66.4%	99.4%	0.753	<0.0005	8.2%	11.6%	-3.4% (-3.9% to -2.8%)
UK and Ireland	71.1%	99.4%	0.787	0.001	7.7%	10.1%	-2.4% (-3.7% to -1.1%)
Northern Europe	72.2%	99.6%	0.806	0.012	8.7%	11.6%	-2.9% (-5.0% to -0.8%)
Southern Europe	62.5%	96.9%	0.656	0.007	14.8%	19.7%	-4.9% (-8.3% to -1.6%)
Asia	53.8%	99.6%	0.655	0.125	2.7%	4.5%	-1.7% (-3.5% to 0.1%)

At older ages, males were not significantly different from females in overreporting heights. Ethnic groups were significantly different (P=0.034), but all the differences between the groups were small in magnitude (mean difference less than 0.6 cm).

Self-reported obesity (BMI ≥30 kg/m²) was highly specific (≥99%) and was of moderate sensitivity (range: 61.1% to

Table 3
Cut-Points for BMI Calculated From Self-Reported Weight and Height Values to Predict Measured BMI ≥ 25 kg/m² and BMI ≥ 30 kg/m² at Various Levels of Sensitivity and Specificity[a]

	70% sensitivity	80% sensitivity	90% sensitivity	95% sensitivity
Male[a] BMI ≥ 25 kg/m²				
All Ages	25.5 (98%)	25.0 (96%)	24.3 (88%)	23.8 (80%)
Age-Groups				
20 - 29 yrs	25.2 (98%)	24.9 (96%)	24.3 (91%)	23.9 (85%)
30 - 39 yrs	25.2 (98%)	25.0 (95%)	24.6 (89%)	24.0 (77%)
40 - 49 yrs	25.6 (98%)	25.1 (96%)	24.4 (89%)	23.8 (77%)
50 - 59 yrs	25.6 (98%)	25.1 (97%)	24.1 (86%)	23.4 (69%)
60 - 69 yrs	25.3 (99%)	24.8 (97%)	24.0 (86%)	23.8 (83%)
Female[a] BMI ≥ 25 kg/m²				
All Ages	25.6 (99%)	24.9 (98%)	24.2 (94%)	23.7 (88%)
Age-Groups				
20 - 29 yrs	25.8 (99%)	24.9 (98%)	24.4 (96%)	23.8 (89%)
30 - 39 yrs	25.7 (99%)	25.1 (98%)	24.3 (95%)	23.8 (91%)
40 - 49 yrs	25.7 (99%)	25.0 (98%)	24.6 (96%)	23.9 (89%)
50 - 59 yrs	25.6 (100%)	24.9 (98%)	24.3 (96%)	24.0 (89%)
60 - 69 yrs	25.1 (98%)	24.5 (96%)	23.8 (91%)	23.5 (86%)
Male[a] BMI ≥ 30 kg/m²				
All Ages	29.5 (98%)	29.1 (97%)	28.4 (94%)	27.8 (90%)
Age-Groups				
20 - 29 yrs	29.8 (99%)	29.3 (98%)	27.1 (92%)	26.0 (85%)
30 - 39 yrs	30.1 (99%)	29.4 (97%)	29.0 (97%)	28.4 (95%)
40 - 49 yrs	29.6 (98%)	29.2 (96%)	28.7 (94%)	28.2 (91%)
50 - 59 yrs	29.4 (97%)	29.1 (96%)	28.1 (91%)	27.7 (88%)
60 - 69 yrs	29.0 (97%)	28.4 (96%)	28.1 (94%)	27.5 (89%)
Female[a] BMI ≥ 30 kg/m²				
All Ages	30.4 (99%)	29.4 (99%)	28.5 (98%)	27.9 (95%)
Age-Groups				
20 - 29 yrs	31.6 (100%)	30.8(100%)	29.8 (100%)	28.4 (98%)
30 - 39 yrs	30.7 (100%)	29.7 (99%)	29.0 (99%)	28.2 (97%)
40 - 49 yrs	29.7 (99%)	29.1 (99%)	28.3 (97%)	27.8 (96%)
50 - 59 yrs	30.1 (99%)	29.6 (99%)	28.6 (97%)	27.7 (92%)
60 - 69 yrs	29.8 (100%)	28.7 (99%)	28.0 (96%)	27.5 (93%)

Note.
a Levels of specificity shown in brackets.

72.7%) in detecting measured obesity in males, females , and the overall study group (Table 2).

Kappa, a chance-corrected measure of agreement, showed substantial to excellent levels of agreement (range: 0.698 to 0.807) between self-reported and measured obesity. The error of self-reporting obesity prevalence was 3.2% lower in the overall group (3.6% lower in males and

2.7% lower in females). The corresponding measures calculated for the subgroups were more variable due to the lower number of subjects. The McNemar test, to assess the difference in obesity prevalence as a result of using the self-reported height and weight, was very significant ($P<0.0005$) in both the males and females subgroups and in the overall group.

In order to predict measured BMI $\geq$25 kg/m^2 and BMI $\geq$30 kg/m^2 from self-reported weight and height, cut-points for self-reported BMI at desired levels of sensitivity were determined (Table 3) for the males, females , and the age subgroups.

Sample sizes for determining the adjustment to self-reported BMI to estimate measured BMI at varying levels of precision or error (± 0.1, ± 0.15, ± 0.2, ± 0.25, ± 0.3 kg/m^2) at the 95% confidence level are presented in Table 4. Larger sample sizes are required to determine the adjustment at higher precision levels.

Table 4
Sample Size Required for Determining the Adjustment to BMI Calculated From Self-Reported Weight and Height Values to Estimate Measured BMI at Various Levels of Precision[a]

	Precision (± kg/m2)[a]				
Age-Group	0.1	0.15	0.2	0.25	0.3
20 - 39 yrs	468	210	119	77	55
40 - 49 yrs	556	249	141	91	64
50 - 69 yrs	650	291	165	107	75

Note.
a Precision at 95% level of confidence.

DISCUSSION

The results from this study concur with recent reviews on self-reported measures assessing weight, height, and BMI. There is a general overreporting for height and underreporting for weight and of BMI, with a variation in reporting for men and women.[2]

The overall mean overestimation of height and underestimation of weight in this study were relatively small, but some individual differences varied considerably. A study by Dekkers et al[25] with similar findings suggested self-reported weight and height as indicators of BMI are reasonably accurate to assess prevalence of overweight or obese populations although self-reported anthropometric measures can be biased.

The relationship between self-report error and measured weight was linear, with underreporting of 0.35 kg for every 10 kg increase in weight. That is, the greater the BMI, the greater the underreporting of weight. A systematic review by Gorber et al[2] indicated that such a relationship is widely reported. Nawaz et al[22] also documented a similar result. Their sample of obese women who sought weight-loss assistance underreported their weight and overreported their height.

Our data showed significant gender difference in weight self-reporting, with larger underreporting by females compared to males. There was also a significant gender difference in height self-reporting, with larger overreporting by males compared to females. This was also age related. Similar results are reported in other studies.[2,21]

There was a significant gender difference in BMI self-report, with larger underreport by females. Males underreported their BMI by -0.683 ± 0.02 kg/m^2 and females by -0.745 ± 0.02 kg/m^2. Gorber et al[2] concur with this result with underestimation of weight being less in larger national surveys, and by males, and greater in small samples especially of obese women.

Self-reported obesity (BMI $\geq$ 30 kg/m^2) was highly specific ($\geq$99%) and was of moderate sensitivity (range: 61.1% to 72.7%) in detecting measured obesity in males, females, and the overall study group. Due to the underreporting of weights and possible overreporting of heights, it is important for a researcher to determine the cut-point on self-reported values so as to effectively identify subjects for recruitment into overweight / obesity studies with measured BMI $\geq$ 25 kg/m^2 and BMI $\geq$ 30 kg/m^2 respectively, with high levels of both sensitivity and specificity. Gorber et al [2] agree that it may be possible to use correction factors for self-reported data when direct measurement is not feasible. They suggest this would entail adequate reporting by subgroups of gender, age, education, and ethnicity. Based on our data, for both males and females, a BMI $\geq$ 28.4 kg/m^2 calculated from self-reported weight and height is recommended to target obese subjects at high levels of both sensitivity ($\geq$ 90%) and specificity ($\geq$ 90%) over all age-groups. To identify overweight and obese subjects (BMI $\geq$25 kg/m^2), a BMI $\geq$24.2 kg/m^2 cut-point calculated from self-reported weight and height is required for high sensitivity and specificity (both $\geq$90%).

The application of such a correction factor when recruiting participants into obesity control programs or research may help reduce inappropriate recruitment, eg, recruiting people who are really in a higher BMI category than the selection criteria stipulate, and may provide more accurate baseline measures and posttest measures for intervention programs.

CONCLUSIONS: Implications for Public Health

From a public health perspective, we recommend careful usage of self-reported weight and height for obesity prevalence estimates. The application of a correction factor may be adequate to improve such estimates, especially considering the same degree of underreporting is likely to have occurred at prior reporting periods.

Further, care is recommended when using self-reported weight and height as a basis for recruiting participants into obesity control programs where the selection criteria include BMI. There is likely to be a significant percentage of participants who do not meet the criteria due to underreporting of weight and over reporting of height. Because BMI is underreported, the application of correction factors may help reduce the inappropriate recruitment of subjects.

It appears that self-reported weight and height can be considered a reasonably accurate measure where BMI is monitored as part of obesity-control program evaluations and where there are concerns about subject measurement burden or budget limitations. Comparison groups should be employed in such evaluations. This will further negate likely reporting biases in that any under- or overreporting is very likely to be of the same magnitude as that from the intervention group and at all measurement periods (eg, baseline, midprogram, postprogram, follow-up). In addition a reliability check might encompass measured weight and height of a sample of the participants at one of the measurement points, eg, at baseline. The sample size for this check at the desired level of precision can be determined from Table 4.

Our findings suggest, for different subgroups of age and ethnicity, the difference in obesity prevalence in males is 3.6% lower (range: 1.3% to 5.6%) when self-reported rather than measured obesity is used; and in females, the difference is 2.7% (range: 0.8% to 5%). In the overall group, the prevalence is lower using self-reported values by 3.2% (range: 1.5% to 5.3%). Hence, self-reported weight and height could be considered a satisfactory measure, across different age-groups and ethnicity, for evaluating community-based obesity control programs. ■

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