

Validity of self-reported height and weight for measuring prevalence of obesity

NOORI AKHTAR-DANESH, MAHSHID DEGHAN, ANWAR T MERCHANT, JAMES A RAINEY

ABSTRACT

Objectives: To examine the validity of self-reported body mass index (BMI) in estimating the prevalence of obesity in the Canadian population, and to suggest a model for predicting actual BMI from self-reported data.

Methods: This analysis is based on 1131 participants with both self-reported and measured height and weight from the Canadian Community Health Survey, Cycle 2.2 dataset. We estimated the prevalence of obesity as well as the mean and standard deviation (SD) of BMI according to sex, age group, and measured weight classification. Multiple regression analysis was used to build a model to assess the relation between actual BMI and variables of age, sex, and self-reported BMI.

Results: The overall prevalence of obesity was 23.0% based on measured BMI, and 15.6% based on self-reported BMI. Estimated mean (SD) for self-reported and measured BMI were 25.8 (4.8) and 26.9 (5.0) kg/m², respectively. Only 74.3% of obese men and 56.2% of obese women were correctly classified as obese on the basis of self-reported measures. Females and heavier respondents showed more BMI under-reporting than others.

Conclusions: To estimate overweight and obesity in etiological and disease relationship studies, the use of measured height and weight in BMI estimation is preferable to the use of self-reported values. However, if self-reported height and weight are used in population studies, our proposed model can be used to reliably predict the actual BMI with a narrow 95% confidence interval.

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OVERWEIGHT AND OBESITY HAVE A SIGNIFICANT impact on both physical and psychological health and are important risk factors for cardiovascular disease and diabetes¹ and certain types of cancer.² Increasing obesity rates in Canada have resulted in rising health care costs and have created a substantial economic burden.³ It is therefore important to monitor population trends in overweight and obesity, from both a

health care intervention and an economic standpoint. Body mass index (BMI), calculated as weight to squared height (kg/m²), is used extensively to identify underweight, overweight, and obese individuals in large population-based studies because it is easy, reproducible, and inexpensive to use.⁴ In addition, BMI has been used in other populations to predict risk of morbidity and mortality.⁵

In large epidemiological studies and national surveys, BMI is often obtained from self-reported heights and weights rather than from measured values. The accuracy of BMI derived from self-reported height and weight (referred to as self-reported BMI in this article) has been questioned on the basis that individuals tend to overestimate their height and to underestimate their weight.⁶ Although some studies have suggested that self-reported BMI could be used in certain populations,^{7–9} many studies have reported systematic errors in self-reported BMI.^{6,10–12} Under-reporting of BMI is greater in certain groups; for instance, overweight and obese individuals tend to underestimate BMI more than people of average weight do, and women tend to underestimate BMI more than men (especially overweight or obese women).⁶ It appears that under-reporting of weight with over-reporting of height increases with age, resulting in underestimated BMI in older populations.¹¹ On the other hand, underweight individuals appear to overestimate BMI by overestimating weight.¹⁰

Under-reporting of weight may reflect psychological factors or social norms for slimness,⁶ recall bias, lack of access to a scale, and lack of recent measurements taken at home or at clinics.¹³ Perceived weight and body size appears to contribute to under-reporting of body weight in some populations.¹⁴

The prevalence of overweight and obesity in Canada has continued to rise over the past several years,^{15,16} but this trend is based mainly on self-reported height and weight. In the only Canadian study that used measured height and weight, the prevalence of obesity was about twice that found using self-reported height and weight.¹² Therefore, self-estimated prevalence of overweight and obesity in Canada may underestimate true prevalence.

Recently, the Canadian Community Health Survey, Cycle 2.2 (CCHS-2.2), collected both self-reported and measured BMI status for a population sample of 1131 Canadian adults. In this paper, we compare the prevalence of obesity based on self-reported BMI with measured BMI in the CCHS-2.2 dataset to examine the validity of self-reported BMI. We propose a model to predict actual BMI on the basis of some common available variables. CCHS-2.2 is the first Canadian large-sample study to provide the opportunity to examine this question, and this is first report that compares self-reported and measured BMI as a measure of obesity in the Canadian population as a whole.

Methods

Study population and sample size. We used the CCHS-2.2 dataset provided by Statistics Canada for analysis.¹⁷ The CCHS-2.2 is a cross-sectional survey that contains information related to health status, health care utilization, and health determinants for the Canadian population. The survey was conducted between January 2004 and January 2005 in 10 Canadian provinces and included over 35 000 individuals of all ages living in private dwellings, with 98% coverage of the target population.¹⁷ It excluded persons living in the territories or on Crown lands, institutional residents, full-time members of the Canadian Forces, and residents of certain remote regions. The CCHS-2.2 survey was based on a complex design with stratification and multiple stages of selection to ensure adequate representation of young persons (aged 15 to 24 years) and seniors (aged 65 and over). One individual per household was randomly selected. This dataset includes self-reported BMI for 7 589 adults (aged 18 years and over) and measured BMI for 12 428. Data for 1 131 individuals with both self-reported and measured BMI were used in this analysis.

We used the Canadian body weight classification system for adults to identify overweight and obese respondents.¹⁸ Respondents with a BMI less than 18.5 were classified as underweight, those with a BMI of 18.5–24.9 as normal weight, those with a BMI of 25.0–29.9 as overweight, and those with a BMI of 30 or more as obese. Because of the difficulty of accurately determining BMI during pregnancy, pregnant women were excluded from this analysis.

Statistical analysis. The sample weights provided by Statistics Canada were used in all tabulations and estimates. First, the prevalence of obesity was calculated for both self-reported and measured BMI. Then, mean and standard deviation (SD) of self-reported and measured BMI were calculated with respect to sex, age group, and actual weight classification. Multiple regression analysis was used to evaluate the relationship between measured (actual) BMI and variables of age, sex and self-reported BMI. The statistical packages SPSS 15.0 and Stats/SE 9.2 were used for the analyses.

Results

The overall prevalence of obesity was 23.0% based on the measured BMI and 15.6% based on self-reported

Table 1: Percentage of individuals with obesity by sex, age group, and actual weight group

Age group (years)	Males			Females		
	SR	MD	Diff	SR	MD	Diff
18–30	13.8	16.9	3.1	9.2	18.5	9.3
31–50	16.0	22.9	6.9	7.6	12.2	4.6
51–70	28.1	38.2	10.1	16.1	26.4	10.3
≥ 71	21.5	24.9	3.4	22.2	36.2	14.0
Total	19.1	25.4	6.3	12.2	20.6	8.4

SR = self-reported body mass index (BMI); MD = measured BMI; Diff = MD minus SR

Table 2: Mean (SD) of self-reported and measured BMI by sex, age, and actual weight class

	SR	MD	MD minus SR
Males			
Age group (years)			
18–30	25.5 (4.9)	26.0 (5.5)	0.5 (1.8)
31–50	27.2 (4.2)	28.2 (4.5)	1.0 (1.8)
51–70	28.3 (4.8)	29.2 (4.7)	0.9 (1.6)
≥ 71	27.2 (3.8)	28.0 (4.1)	0.8 (1.6)
Weight group			
Underweight	18.8 (0.8)	18.4 (0.1)	–0.4 (0.8)
Normal weight	23.0 (1.7)	23.2 (2.3)	0.2 (1.3)
Overweight	26.5 (1.7)	27.5 (2.0)	1.0 (1.6)
Obese	33.1 (4.0)	34.6 (3.9)	1.5 (2.3)
Females			
Age group (years)			
18–30	24.1 (4.6)	25.4 (5.0)	1.3 (2.2)
31–50	23.5 (4.3)	25.4 (4.2)	1.9 (2.6)
51–70	26.0 (4.9)	27.1 (5.4)	1.1 (2.1)
≥ 71	26.1 (4.6)	27.3 (5.2)	1.2 (1.8)
Weight group			
Underweight	18.7 (1.5)	17.7 (0.3)	–1.0 (1.5)
Normal weight	21.4 (2.0)	22.0 (1.8)	0.6 (1.1)
Overweight	24.9 (3.0)	26.9 (1.2)	2.0 (2.6)
Obese	31.0 (4.4)	33.6 (3.4)	2.6 (2.6)

BMI = body mass index; SR = self-reported BMI; MD = measured BMI

BMI. These rates varied between males and females (see Table 1), the largest difference occurring among females over 70 years, i.e., 22.2% for self-reported BMI and 36.2% for measured BMI. Further analysis showed that only 74.3% of obese men and 56.2% of obese women were identified as obese on the basis of their self-reported BMI. The overall estimated means (SD) of self-reported and measured BMI were 25.8 (4.8) and 26.9 (5.0), respectively. These values were 27.0 (4.7) and 27.8

(5.0) for males and 24.6 (4.7) and 26.1 (4.9) for females. In general, the mean of BMI under-reporting was 1.2 (kg/m²) (0.8 for men and 1.5 for women). Table 2 provides the estimated mean (SD) for self-reported and measured BMI on the basis of sex, age group, and actual weight class. For most age groups and weight categories, measured BMI was larger than self-reported BMI. Larger differences were noted in women and obese individuals.

Predicting actual BMI on the basis of common available variables

To evaluate and predict the relationship between the actual BMI and some common available variables, we developed a simple and reliable relation between measured BMI and variables of sex, age group, and self-reported BMI (see Table 3) using regression analysis. This model can be used effectively to predict actual BMI in most circumstances in Canada, as it is based on the findings of CCHS-2.2, a national large-sample dataset involving participants with diverse ethnicities, lifestyles and socio-economic status. When adjusted for age and self-reported BMI, the results indicate that on average women under-report 0.54 BMI (kg/m²) more than men ($p < 0.001$). The analysis also indicates that BMI under-reporting depends on the age group. In general, individuals in the age group of 31–50 years under-report about 0.60 BMI (kg/m²) compared with the reference age group of 18–30 years. The coefficient of determination for this model is $R^2 = 0.84$; therefore, it provides a reliable prediction of actual BMI based on the 4 readily accessible variables of sex, age, self-reported weight, and self-reported height. We used this model to assess the reliability of the actual BMI prediction in 8 hypothetical individuals with different combinations of self-reported BMI, sex, and age group (Table 4). The results indicate that the maximum width of the 95% confidence interval is not more than 0.1. For each combination, the mean and interquartile range (IQR) of residuals (actual BMI minus predicted BMI) for individuals in the dataset with the same sex, age group, and self-reported BMI (± 0.5) are also presented in Table 4. The residuals appear to be well distributed around a mean of zero, given that there were a limited number of participants for each combination (minimum of 4 for case 7 and 18 for case 1). These residuals, moreover, confirm the appropriateness of the model.

Figure 1 depicts the pattern of change in difference between self-reported BMI and measured BMI according to sex and age group. It is apparent that female respon-

Table 3: Regression analysis of the relation between measured BMI and sex, age, and self-reported BMI

Variable	Coefficient (β)	SE	t value	p value	95% CI for β
Constant	1.559	0.008	189.79	< 0.001	(1.542–1.575)
Sex					
Male (reference)					
Female	0.544	0.003	192.53	< 0.001	(0.539–0.550)
Age group					
18–30 years (reference)					
31–50 years	0.586	0.004	165.49	< 0.001	(0.579–0.592)
51–70 years	0.196	0.004	51.04	< 0.001	(0.188–0.203)
≥ 71 years	0.184	0.005	37.73	< 0.001	(0.175–0.194)
Self-reported BMI	0.963	0.0003	3248.69	< 0.001	(0.962–0.963)

Table 4: Prediction of 8 realizations of the independent variables in Table 3

Case number	Sex	Age group (years)	Self-reported BMI	Predicted measured BMI	95% CI for predicted BMI	Mean (IQR) of the residuals for similar participants
1	M	18–30	22	22.630	(22.628–22.632)	–0.91 (0.48)
2	F	18–30	22	23.343	(23.340–23.343)	0.05 (1.98)
3	M	31–50	24	25.203	(25.200–25.206)	–0.63 (0.53)
4	F	31–50	24	25.953	(25.943–25.963)	–1.13 (2.36)
5	M	51–70	29	29.632	(29.628–29.636)	–0.03 (1.68)
6	F	51–70	29	29.944	(29.904–29.984)	–0.08 (2.83)
7	M	≥ 71	30	30.445	(30.447–30.449)	–0.79 (2.63)
8	F	≥ 71	30	31.052	(31.045–31.059)	–0.72 (0.86)

CI = confidence interval; IQR = interquartile range

dents showed more BMI under-reporting than men. Individuals in the 31–50 year age group also showed more under-reporting than others.

Discussion

Although estimating the prevalence of overweight and obesity using self-reported height and weight might be a common practice, this analysis shows that it leads to the underestimation of actual rates. Some researchers have attempted methods to correct self-reported BMI. For example, John and colleagues⁶ asked another member of the household to report the weight and height of the respondent, but this still resulted in underestimation of BMI. Given the error in self-reported BMI from various populations, it is important to search for an appropriate method for monitoring overweight and obesity and to determine what remedy might exist to adjust the under-reported BMI.

This analysis confirms the finding by John and colleagues⁶ that under-reporting of BMI depends on the height and weight of respondents: under-reporting is directly related to weight and inversely related to height, which means that shorter individuals over-report their height and heavier individuals under-report their weight. Studies from the United States^{11,19} and the United Kingdom²⁰ showed increased under-reporting of BMI with age; this is not supported by our findings. Each of the 4 age categories in our classification showed a different effect. This discrepancy may arise from the analytical approach that we used, or from some other characteristics of the Canadian population that need to be further investigated. In addition, studies have shown that self-reported BMI is influenced by socioeconomic status, which varies internationally.¹⁹ Also, this discrepancy may be a result of the ethnicity distribution of the Canadian population.

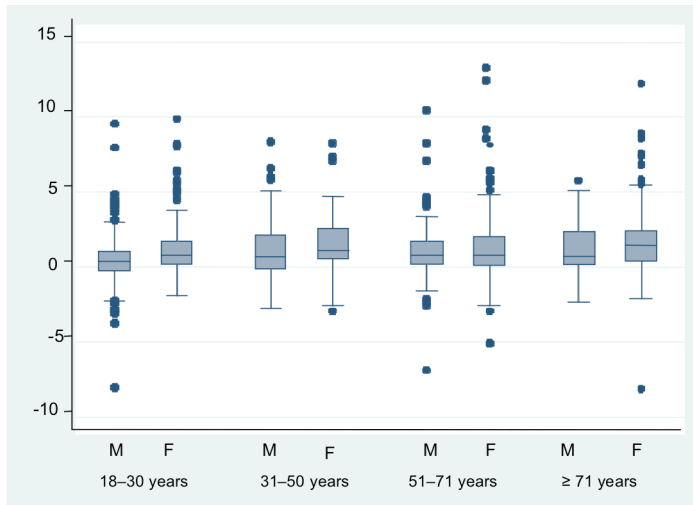


Figure 1: Difference between self-reported body mass index (BMI) and measured BMI according to sex and age group.

The majority of studies have shown that obese participants are most likely to be misclassified and that individuals with normal BMI are least likely to be incorrectly allocated to another weight class. In our analysis, over 25% of obese men and 44% of obese women were misclassified when their self-reported height and weight was used in calculating BMI. Furthermore, about 20% of overweight men and 37% of overweight women misclassified themselves as having normal weight. Allocation of overweight and obese participants to a lower BMI category would underestimate the relative risks of diseases associated with increasing BMI. Hence, results of studies calculated on the basis of self-reported weight and height should be interpreted with caution.

We found an obesity prevalence of 15.6% on the basis of self-reported BMI and 23.0% on the basis of measured BMI; this difference of 7.4% cannot be overlooked, given its implications for public health and etiologic research. These results resemble findings from some other studies;^{11,13} however, the extent of the problem seems to be larger in our analysis.

Spencer and colleagues⁹ compared the self-reported and measured height and weight of 5140 participants of the EPIC-Oxford study and found a similar systematic error of over-estimation of height and under-estimation of weight among men and women.

Overweight and obesity have substantial effects on public health and public resources, and underestimation

of overweight and obesity could mislead policy makers to overlook the extent of the problem. Most importantly, this misclassification can distort the results from etiological studies about the risk factors of overweight and obesity and underestimate the impact of obesity-related diseases.

The second objective of this analysis was to find a simple model that could reliably predict actual BMI on the basis of some available variables. We developed a model based on 4 readily accessible variables of sex, age, self-reported weight, and self-reported height that can reliably predict actual BMI ($R^2 = 0.84$). In addition, this model does not depend on variables that are less known by individuals. However, because this seems to be the first model for predicting actual BMI on the basis of such easy accessible variables, at least for Canadian population, it needs to be further validated in a separate validation dataset distinct from the one that we used to derive the prediction model.

In conclusion, to estimate overweight and obesity in etiological and disease relationship studies, the use of measured height and weight are preferable to self-reported values. However, if measured height and weight are not available in population studies, our proposed model can be used to reliably predict actual BMI with a narrow 95% confidence interval.

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