

## Accuracy of Self-Reported Height and Weight to Determine Body Mass Index Among Youth

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### Abstract

**Background:** Self-reported height and weight has important economic, clinical and research value however little is known on the accuracy of self-reporting BMI among youth. Our objective was to determine the accuracy of self-reported height and weight estimates compared to measured height and weight used to determine BMI, among youth.

**Methods:** Youth ages 15-25 were recruited from primary care urban hospital clinical where a trained clinical assistant measured the participant's height and weight. The youth were asked to self-report their height and weight as part of a larger computerized survey. Continuous variables were compared using t-tests, and dichotomous variables using chi-square tests. BMI correlation was determined using Pearson's r and agreement using a weighted kappa test.

**Results:** Among 355 youth, the mean measured BMI for men: 27.3+7.0 kg/m<sup>2</sup> compared to women: 28.9+8.7 kg/m<sup>2</sup> (p=0.08). 58% of youth had an above normal BMI. There was high correlation between measured and self-reported BMI when calculated using an adjusted r<sup>2</sup>=0.84 (p<0.01). Agreement was also high between BMI categories (weighted kappa=0.88, p<0.01).

**Conclusions:** Youth can accurately self-report height and weight to derive meaningful BMI scores for BMI categorization during this important period of body transition in the life course cycle. BMI is often conceptualized as categories and the weighted kappa test is a sensitive test capturing ordinal levels of BMI categorical agreement.

### Introduction

In light of the obesity epidemic, determining unhealthy body mass index (BMI), particularly among youth is important, as there are detrimental short and long-term consequences ranging from adverse socialization and increased cardiovascular risk as they transition into adulthood [1]. One of the challenges that researchers often face is the potential trade-off in accuracy between using self-reported compared to measured height and weight to determine BMI. Although measured height and weight is considered the gold standard, it is expensive, requires trained personnel and well-maintained equipment, compared to self-reported data, which is quick, easy to obtain, and cost-effective [2]. Previous studies report overall good correlation between measured and self-reported height and weight. However subgroup analyses have observed that women and heavier youth often underestimate their weight, leading to an underestimate of the size of the target group and questioning the generalizability of this technique [2]. Even though BMI is a continuous measure it is commonly conceptualized as a categorical construct, and there are few studies comparing the agreement amongst categories. Recognizing the unique stage of youth, as they enter into a period of their lives when they take charge of their own health, the objective of this study is to report the accuracy of BMI calculations using self-report compared to measured height and weight among youth.

### Methods

The study methods have been previously published and are summarized in brief here [3]. The youth in our study were recruited from an urban hospital adolescent/young adult clinic, targeting socially disadvantaged youth that agreed to participate in a computerized survey. Upon arrival to the clinical, a trained clinical assistant measured the participant's height using a stadiometer and weight using a calibrated

scale (Scale-Tronix Model 5002, Chicago, Illinois, USA) in centimetres and kilograms, respectively. As per protocol, clinical assistants were carefully instructed to not discuss height and weight with the patient. Within the computerized survey whose primary aim was to screen and identify social problems, participants were asked to self-report their height and weight captured by the following two questions: "How tall are you without shoes on?" and "How much do you weigh without shoes on?". Participants recorded their answers in the metric system of their choice.

Eligible participants were ages 15 to 25, and were excluded if they had a learning disability, emotional instability, or lacked English skills. All patients provided written informed consent or assent and the study received institutional review board ethics approval.

The height and weight of each study participant were used to derive two BMI estimates: "self-reported BMI" and "measured BMI". BMI is described both as a linear variable and categorical variable with 5 levels; underweight <18.5 kg/m<sup>2</sup>, normal 18.5 to < 25.0 kg/m<sup>2</sup>, overweight 25

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to <30 kg/m<sup>2</sup>, obese 30 to <35 kg/m<sup>2</sup> and morbidly obese > 35 kg/m<sup>2</sup>. Continuous variables were compared using t-tests, and dichotomous variables using chi-square tests. Correlation between self-reported and measured BMI was estimated using Pearson's correlation and linear regression, and agreement was calculated using kappa and weighted kappa test. Analyses were performed using IBM SPSS 20.0®.

## Results

There were 110 (31%) men and 245 (69%) women in our study, the mean age was 18.1 ± 2.0 years, and the mean measured BMI for men was 27.3 ± 7.0 kg/m<sup>2</sup> compared to 28.9 ± 8.7 kg/m<sup>2</sup> for women (p=0.08). The prevalence of overweight BMI (≥ 25 kg/m<sup>2</sup>) is high; 58% of youth had an above normal BMI with no statistically significant differences according to gender (χ<sup>2</sup>=0.13, p=0.72), race/ethnicity (χ<sup>2</sup>=0.65, p=0.89) or age (χ<sup>2</sup>=0.11, p=0.74).

There was high correlation between measured and self-reported BMI (Pearson's r=0.92), and there was no difference in the unadjusted r<sup>2</sup> and adjusted r<sup>2</sup> (for gender, age and race/ethnicity) values (r<sup>2</sup>=0.84, p<0.01).

The kappa test revealed a moderately good level of agreement (κ=0.76, p=0.03), however the weighted kappa, which is a sensitive measure of agreement between categories, was higher between self-reported and measured BMI categories (weighted kappa=0.88, p<0.01) (Table 1). However, 16% of obese and 25% of morbidly obese patients misclassified themselves into a lower weight category. Despite overall strong agreement, there was slight variation among subgroups: men κ<sub>weighted</sub>=0.84, women κ<sub>weighted</sub>=0.90, white κ<sub>weighted</sub>=0.87, black κ<sub>weighted</sub>=0.90, Hispanic κ<sub>weighted</sub>=0.86 and other race κ<sub>weighted</sub>=0.78.

The sensitivity of self-reported BMI among normal participants was 92% and the sensitivity decreased as the BMI increased. The specificity however was over 90% for all BMI categories. The positive predictive value was lower compared to the negative predictive value among all BMI groups (Table 1).

## Discussion

Despite a high correlation (92%) between self-reported and measured BMI, the r<sup>2</sup> accounted for 84% of the variance and this value did not change when adjusted for age, gender and race, suggesting no impact according to subgroups. The weighted kappa, which treats BMI categories as ordinal using quadratic weights to differentiate between different levels of agreement based on the proximity to the

estimate, demonstrates high level of agreement between self-reported and measured BMI [4]. We were able to explain some of the variance according to gender and race/ethnicity.

Other investigators have emphasized the importance of determining what factors influence self-reporting error to allow for appropriate planning and interpretation of epidemiologic studies based on self-reported height and weight, arguing that an underestimation of weight and an overestimation of height will underestimate BMI and consequently the prevalence of obesity [5,6]. In our study, we found overall good congruence between self-reported and measured BMI when captured using linear and categorical estimates of BMI. Although the sensitivity of self-reported BMI was lower among overweight groups, the specificity, positive and negative predictive values remained high.

## Strengths and limitations

BMI accuracy between self-reported and measured BMI is often expressed as an r<sup>2</sup> value however this statistic does not accurately measure agreement or reflect the accuracy among specific categories of BMI with the sensitivity of the weighted kappa statistic. Although it is common to capture BMI among individuals younger than 18 years of age in terms of z-scores, we did not find any differences in our sensitivity analysis when we analysed this small subgroup this way (data not shown). Further, BMI z-scores are difficult to interpret and since we are interested in capturing the self-categorization of BMI and not in BMI itself per se, we felt that the categorical expression of BMI captured as kg/m<sup>2</sup> is appropriate. Although we cannot exclude the possibility, we took precautions in our protocol to avoid any direct social desirability bias in the self-reporting of BMI by instructing the clinical assistants to not share any height and weight values with the study participants. Further, study participants were asked to estimate their height and weight as part of a larger study using a branched questionnaire of over 100 questions to screen and identify social problems and participants did not know that one of the questions would involve self-report of height and weight when recruited to participate in the study.

## Conclusions

Overall youth can accurately self-report height and weight to derive meaningful BMI scores for weight categorization. BMI is often conceptualized as categories and the weighted kappa test is a sensitive test capturing ordinal levels of BMI categorical agreement.

Self-reported BMI	Measured BMI					Self-Reported Totals
	Underweight N (%)*	Normal N (%)*	Overweight N (%)*	Obese N (%)*	Morbidly obese N (%)*	
	11 (85)	5 (4)	1	0	0	17
Normal	2	126 (92)	15 (17)	1	4 (6)	148
Overweight	0	5	69(79)	13	3 (5)	90
Obese	0	0	1	40 (73)	9 (14)	50
Morbidly obese	0	1	1	1	47 (75)	50
Measured BMI Totals	13	137	87	55	63	355
<b>Kappa= 0.76, p=0.03</b>						
<b>Weighted Kappa= 0.88, p&lt;0.01</b>						
Sensitivity	0.85	0.92	0.79	0.73	0.75	
Specificity	0.98	0.90	0.92	0.97	0.99	
PPV	0.65	0.85	0.77	0.80	0.94	
NPV	0.99	0.95	0.93	0.95	0.95	

\*N=raw score  
(%)=self-reported BMI/total measured BMI category

Table 1: Agreement of Self-Reported BMI versus Measured BMI.

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## Competing Interests

We have no competing or conflicts of interest to report from any of the authors. All authors declare that we have not received any support from any organization for the submitted work; it is original and has not been submitted elsewhere. We have no financial, professional or personal conflicts of interest that could influence the submitted work.

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