

# Can secondary school students' self-reported measures of height and weight be trusted? An effect size approach

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**Background:** Self-reported measures of height and weight are a cost-effective alternative to direct measures in large-scale studies. This study was designed to examine the accuracy of adolescent students' self-reported height and weight taking into consideration the magnitude of the differences. **Methods:** Self-reported height and weight were taken from 300 secondary public schools students. Participants' actual height and weight were subsequently verified. Body mass index (BMI; kg/m<sup>2</sup>) was calculated separately from reported and from actual measures. Adolescents' whose measured BMI was above the 85th percentile were characterized as 'at risk for overweight/obese'. **Results:** There was no gender effect on the discrepancy between reported and actual measures. Overall adolescents significantly underestimated their weight and BMI. Although correlation coefficients were high, eta-square ( $\eta^2$ ) values indicate large bias for weight (0.36) and BMI (0.31). 'At risk for overweight/obese' individuals underestimated their weight and BMI to a greater extent than their 'normal weight' counterparts. **Conclusions:** The magnitude of the discrepancies call into question the accuracy of self-reported weight and consequently the estimated BMI. Correlation coefficients did not provide any valuable information about the discrepancy between the self-reported and actual measures. A better understanding of the validity of self-reported height and weight could be reached if interpretation of the results is based on both statistical significance and magnitude of the differences.

**Keywords:** adolescents, body mass index, Greece, reproducibility of results

Existing research evidence indicates that childhood and adolescent obesity is linked to adulthood obesity.<sup>1–3</sup> Therefore, identification and surveillance of overweight or obese children and adolescents are major concerns in public health. For practical and economic reasons in epidemiological studies and clinical research self-reports of weight and height are frequently used in place of actual measurement. Based on these reports the body mass index (BMI) is calculated (weight in kilograms/height in metres<sup>2</sup>), which is subsequently used to screen for overweight or obese individuals. BMI is an easily calculated index, correlates with subcutaneous and total body fat and has been recommended as the best simple method to evaluate obesity.<sup>2</sup>

Numerous studies have examined the accuracy of adolescents' self-reported height and weight with inconsistent findings. For example, although several authors concluded that gender did not influence the patterns of accuracy in self-reported measures, others reported gender differences, that is, girls tended to underreport their weight to a greater degree than boys.<sup>2,4</sup> Another controversial issue is the direction of biases. Most studies suggest that adolescents tend to understate their weight and overstate their height. However, there is also evidence for no significant height bias<sup>2</sup> as well as height underestimation.<sup>4</sup> The only notable consistent finding is the systematic understating of self-reported weight, which is greater for heavier children compared with lighter children.<sup>4–9</sup>

The vast majority of the existing literature on the validity of self-reported height and weight has used correlational analysis and/or statistical significance tests to interpret empirical

research results. The use of correlational analysis as an index of validity has been frequently criticized.<sup>10–12</sup> This statistic has been designed to investigate the bivariate relationship of two variables representing different measurement classes (interclass correlation). Furthermore, sources of systematic variance (bias) cannot be assessed in Pearson's *r*. This means that correlation coefficient is insensitive to any possible differences in the means and variances of raw data.

On the other hand several authors seem to agree that interpretation of the differences should not be solely based on the derived significance level. Inferential statistics apart from establishing significance should also assess the meaningfulness of the results.<sup>13–15</sup> Some indicator of the strength of association among variables is necessary, especially in epidemiological or large-scale surveys where because of the large sample size small or trivial differences might be declared significant.<sup>14</sup> Thus, to overcome this shortcoming it has been suggested that effect sizes should be calculated and reported along with significance levels.

Validity studies of self-reported height and weight have mainly been conducted in northern America and Australia. Limited research findings exist for European countries and for Greece, in particular. Recent evidence seems to suggest that BMI values may vary among different ethnic groups.<sup>16</sup> These differences might result in greater inaccuracy for ethnic or race groups with higher BMI values.<sup>10,11,17</sup> As far as Greece is concerned, Karayiannis *et al.*<sup>18</sup> found that the prevalence of overweight and obesity in a nationwide representative sample of Greek school-aged children and adolescents was lower than most Western countries. Therefore the patterns of height and weight accuracy of Greek adolescents might be different from their Western peers.

The purpose of the present study was to examine the accuracy of adolescent students' self-reported height, weight, and BMI estimated from these reports. Interpretation of the results would be based both on statistical significance and magnitude of the differences.

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## Methods

### Participants

A convenience sample of 300 middle-school and high-school students participated in the study. Students were recruited from six schools in the urban area of Trikala in Greece. Their mean age was 15.79 years ( $SD = 1.33$ ). One hundred and forty-one were males and 159 were females. Prior to the study permission from the school principal was obtained and parental consent was secured.

### Procedure

The study was conducted on two separate days. During the first visit at the schools, students reported their demographic information, height, and weight. Participants were unaware that their actual height and weight would be subsequently verified. On the second visit at the schools, students were weighted on an electronic scale to the nearest 0.2 kg and had their height measured to the nearest centimetre. The electronic scale was standardized against a SECA Beam Balance 710. Prior to measurement students were asked to remove their shoes and heavy outer clothing.

### Statistical analysis

Descriptive statistics were used to calculate means and standard deviations. Student's paired  $t$ -test was employed to examine differences between self-reported and measured values. The alpha level was set at 0.05. Among the several types of effect size the eta-square ( $\eta^2$ ) was employed to evaluate the meaningfulness of the differences.  $\eta^2$  denotes the proportion of the total variance attributed to an effect (independent factor).  $\eta^2$  values of 0.01–0.03, 0.06–0.09, and  $>0.14$  indicate a small, medium, and large effect, respectively.<sup>13,15</sup>

## Results

Biases in self-reported measures (height, weight, and BMI based on self-reported values) were calculated by subtracting the actual measures. Independent  $t$ -test analysis showed no gender differences for height ( $t_{298} = -1.66$ ,  $P = 0.097$ ,  $n^2 = 0.009$ ), weight

( $t_{298} = 0.046$ ,  $P = 0.964$ ,  $n^2 = 0.001$ ), and BMI ( $t_{298} = 1.53$ ,  $P = 0.127$ ,  $n^2 = 0.008$ ).

Comparison between self-reported and actual measures revealed significant differences, except height for male secondary students (table 1).  $\eta^2$  values indicated a small effect for height and large effects for weight and BMI. Overall, secondary students underestimated their weight by 2.13 kg ( $SD = 2.84$ ) and their BMI by 0.87 kg/m<sup>2</sup> ( $SD = 1.29$ ).

Next, based on the norms provided by Rosner and his colleagues,<sup>2</sup> students having BMI values above the 85th percentile were characterized as 'at risk for overweight or obese'. Fifty-seven participants yielded BMI values above the 85th percentile, representing 19% of the total sample.

Re-examination of the differences between self-reported and measured values separately for students 'at risk for overweight or obese' indicated higher  $\eta^2$  values than for the 'normal weight' students. These differences were more prominent for the weight and the BMI.

## Discussion

This study was undertaken to examine the accuracy of self-reported height and weight of secondary students taking into consideration the effect size of the differences. Our finding justified that approach and suggested that interpretation of the biases depending solely on the significance level might be misleading. For example, although there was a significant bias in height,  $\eta^2$  values indicate that this difference was trivial. On the contrary, the biases in both weight and BMI, apart from being statistically significant, were also meaningful, as indicated by the sizes of the differences. Thus, a better understanding of the discrepancy between self-reported and actual measures of height and weight can be reached if future studies calculate and report some indicator of the strength of association among variables.

A comment should be made regarding the utility of the Pearson correlation coefficient. Numerous studies used Pearson's  $r$  to make inferences about the validity of self-reported height and weight.<sup>1,17,19</sup> For example, Brener *et al.*<sup>17</sup> concluded that '... the high correlations between self-reported and measured height, weight and BMI suggest that self-reported height and weight are valid proxy measures for measured values...' (p. 287). However, in the present study this statistic

**Table 1** Comparisons between self-reported and measured height, weight, and BMI

	Self-reported M (SD)	Measured M (SD)	d (SD)	r	$\eta^2$
Total sample (n = 300)					
Height (cm)	169.8 (9.48)	169.3 (9.30)*	0.48 (2.90)	0.97	0.027
Weight (kg)	62.45 (12.10)	64.59 (12.65)*	-2.13 (2.84)	0.95	0.361
BMI (kg/m <sup>2</sup> )	21.53 (3.04)	22.40 (3.36)*	-0.87 (1.29)	0.92	0.314
Males (n = 141)					
Height (cm)	175.2 (9.25)	175.0 (8.62) <sup>ns</sup>	-0.18 (3.25)	0.94	0.003
Weight (kg)	68.21 (12.10)	70.33 (12.33)*	-2.12 (3.00)	0.97	0.335
BMI (kg/m <sup>2</sup> )	22.08 (2.74)	22.84 (2.93)*	-0.75(1.30)	0.90	0.251
Females (n = 159)					
Height (cm)	165.0 (6.70)	164.2 (6.54)*	0.74 (2.54)	0.93	0.079
Weight (kg)	57.35 (9.56)	59.49 (10.61)*	-2.14 (2.71)	0.97	0.387
BMI (kg/m <sup>2</sup> )	21.03 (3.22)	22.02 (3.66)*	-0.98 (1.28)	0.94	0.372

Note: \* $P < 0.01$ ,  $ns$  = non significant,  $\eta^2$  = eta-square,  $r$  = Pearson correlation coefficient,  $d$  = difference between self-reported and actual measures

**Table 2** Eta-square values for the differences between self-reported and actual measures for the 'normal weight' and the 'at risk for overweight or obese' students

	Normal weight (n = 243)	Overweight/obese (n = 57)
Height (cm)	0.015	0.129
Weight (kg)	0.335	0.545
BMI (kg/m <sup>2</sup> )	0.227	0.523

did not provide any valuable information about the discrepancy between self-reported and actual measures. Its value was exceptionally high regardless of significant or non-significant differences and meaningful or trivial effect sizes. Thus, researchers should not rely on correlation coefficient to make inferences about the validity of the reported measures.

Gender was not associated with discrepancies in height, weight, and BMI. This finding is in accordance with some previously published reports.<sup>7,9,20</sup> Discrepancies in self-reported height by Greek secondary students were either trivial (for the total sample and females) or non-significant (for males). No significant differences for height were found for American-Indian adolescents<sup>20</sup> and for white girls.<sup>19</sup> On the other hand biases in weight were significant and of considerable size. The overall mean difference of weight (2.13 kg) is comparable with that of previously published studies (2.0 and 2.5 kg).<sup>9,20,21</sup>

The bias in weight seemed to influence the accuracy of estimated BMI from reported measures towards lower values. Similar conclusions have been reported in literature.<sup>6,11,12,17,20,21</sup> Thus, there is a need to identify the sources of this bias in order to reduce the discrepancy between self-reported and measured weight. Identified sources of bias can be entered into adequate models (e.g. liner, exponential) as explanatory variables along with reported measures. The derived functions can then be applied to minimize the bias.

Several factors have been examined as responsible for this discrepancy (e.g. sex, race/ethnicity, socioeconomic status, daily exercise, time since menarche, parent's educational level).<sup>5,12</sup> One potentially relevant factor, which has not attracted the research interest, is social desirability and especially the social norms for thinness. In a recent study, Larson<sup>22</sup> found that social desirability correlated with females' self-reported weight in a small adult sample. Although social desirability has been speculated as an important factor in understanding differences between reported and actual measures in youth,<sup>4,9,17</sup> no such study has been conducted. Another possible factor might associate with the elapsed period since the last weight measurement.<sup>9,10</sup> Indeed it is rational to expect more accurate reports for shorter elapsed periods of time than longer ones. Future studies should address the above issues.

Calculation of the effect sizes separate for 'normal weight' students and their 'overweight/obese' peers revealed that the magnitude of the differences was greater for the latter group (table 2). This finding compares well with other available reports on adolescents<sup>4-9</sup> and suggest that the actual body size is associated with the magnitude of the discrepancy between self-reported and actual weight. Researchers should expect greater discrepancies for overweight or obese adolescents than normal weight counterparts.

The present study was not free of limitations. There are two limitations with respect to the sample enrolled. First, the study was school based and consequently it did not include adolescents who, for various reasons, do not attend school (e.g. they work or they are members of the gipsy community). One might

argue that the prevalence of overweight and obesity in this out-of-school-youth differs from secondary school students, a fact that may have an impact on the perceptions of weight and height and result in different patterns of accuracy. Second, a convenient, relatively small sample was used. However, the prevalence of overweight or obese adolescents was within the reported confidence intervals for Greek school-aged children from urban areas derived from a nationally representative sample.<sup>18</sup> This fact might indicate that the size of the sample did not introduce significant level of bias. Despite the speculated resemblance of the current sample to the nationwide representative cohort, generalization of the results might not be appropriate.

In conclusion, our findings suggest that there is appreciable bias in reported weight in adolescent Greek boys and girls as indicated by the  $\eta^2$  values. Bias in reported weight resulted in bias in the estimated BMI from the students' reports. Gender was not associated with the biases. Reporting the effect size of the examined differences might have important implications for the appropriate interpretation of such data.

### Key points

- This study examined the accuracy of adolescents' self-reported height and weight taking into consideration the magnitude of the differences.
- Significant biases were not always accompanied by meaningful differences.
- Our finding suggested that interpretation of the biases depending solely on the significance level might be misleading.
- Reporting the effect size of self-reported measures might have important implications for the appropriate interpretation of such data.

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