The validity of self-reported vs. measured body weight and height and the effect of self-perception

Mehmet Enes Gokler[1], Necati Bugrul[1], Ahu Ozturk Sarı[2], Selma Metintas[1]

[1]Department of Public Health, Medical Faculty, Eskisehir Osmangazi University, Eskisehir, Turkey
[2]Department of Public Health, Medical Faculty, Cukurova University, Adana, Turkey

Submitted: 18 March 2015
Accepted: 28 October 2015

Arch Med Sci 2018; 14, 1: 174–181
DOI: 10.5114/aoms.2016.61401

Corresponding author:
Mehmet Enes Gokler PhD
Department
of Public Health
Medical Faculty
Eskisehir Osmangazi
University
26600 Eskisehir, Turkey
Phone: +90 05054435782
E-mail: enesgokler@gmail.com

Abstract

Introduction: The objective was to assess the validity of self-reported body weight and height and the possible influence of self-perception of body mass index (BMI) status on the actual BMI during the adolescent period.
Material and methods: This cross sectional study was conducted on 3918 high school students. Accurate BMI perception occurred when the student's self-perception of their BMI status did not differ from their actual BMI based on measured height and weight. Agreement between the measured and self-reported body height and weight and BMI values was determined using the Bland-Altman metod. To determine the effects of "a good level of agreement", hierarchical logistic regression models were used.
Results: Among male students who reported their BMI in the normal region, 2.8% were measured as overweight while 0.6% of them were measured as obese. For females in the same group, these percentages were 1.3% and 0.4% respectively. Among male students who perceived their BMI in the normal region, 8.5% were measured as overweight while 0.4% of them were measured as obese. For females these percentages were 25.6% and 1.8% respectively. According to logistic regression analysis, residence and accurate BMI perception were significantly associated with "good agreement" ($p \leq 0.001$).
Conclusions: The results of this study demonstrated that in determining obesity and overweight statuses, non-accurate weight perception is a potential risk for students.

Key words: validity, self-reported, weight, height, self-perception.

Introduction

Globally, approximately 170 million children under the age of 18 are estimated to be overweight, with higher incidences occurring in countries with moderate and high income levels. However, the rate of increase in obesity is much higher in countries with low and moderate income levels [1]. Obesity during the adolescent period is known to be mainly associated with cardiovascular system diseases, such as hypertension, dyslipidaemia and type 2 diabetes, and to significantly increase morbidity and mortality [2–4]. In addition, obesity or overweight during the adolescent period is also associated with low self-esteem, stigma and depression [5]. Because 80% of obese adolescents will also be obese during adulthood, great efforts should be made to reduce obesity, particularly in this age group [6].

In most countries, obesity control programs are included in school health programs. The ultimate goal of obesity control programs is to reduce body mass index (BMI). Therefore, it is important to obtain reliable BMI values before and after the implementation of these programs. Body mass index can be calculated using either self-reported or measured body weight and height values. Although the self-reporting of values represents a practical and low-cost method that enables the study of larger populations, the reliability of self-reported vs. measured values is a matter of debate [7]. The reliability and validity of the self-reporting method have been found to vary with gender, age, race and ethnicity [7, 8]. On the other hand, individuals' perceptions of themselves have been suggested to be key factors affecting the validity of self-reported body weight and height values [9]. Although the self-perception of adolescents is also closely related to the content of school obesity control programs, there are a limited number of studies that have evaluated this relationship. Additionally, demonstrating the validity of self-reporting body weight and height effects is very useful in epidemiology and longitudinal follow-up of large cohorts [8].

Childhood obesity control programs have been recently initiated in developing countries. Importantly, in the literature, there are no large-scale studies based on non-US and non-European samples of adolescents evaluating the reliability and validity of self-reported vs. measured body weight and height values in the calculation of BMI, which are used to assess the efficiency of obesity control programs. Therefore, the present study aimed to assess the reliability and validity of self-reported vs. measured body weight and height values and the effects of self-perception during the adolescent period.

The validity of self-reported body weight and height and the possible influence of self-perception of BMI status on the actual BMI during the adolescent period were evaluated.

Material and methods

Participants

This cross sectional study was conducted on a sample of high school students from rural and urban settlement areas of Eskişehir Province between March 2012 and February 2013. Eskisehir, the city in which the study was conducted, is located in central Anatolia to the west of Ankara, which is the capital city. A total of approximately 40,000 high school students were residing in Eskisehir at the time of the study.

One district from each of the rural and urban areas of Eskisehir was selected. Schools in these districts were stratified according to their education programs. Schools were selected from each stratum (vocational high schools and Anatolian high schools) in proportion to the number of students in each school. A total of 3918 students (2870 (73%) from urban areas and 1048 (27%) from rural areas) from 16 schools were included in this study. Permission for this study was obtained from the managers of the educational institutions and from the local ethics committee (approval number: 11/06.12.2012).

The detailed protocol for the study and the questionnaire were obtained from the previous Health Behaviour in School-aged Children study [10]. Questions about sociodemographic characteristics, cardiovascular risk factors (physical activity, diet and smoking), self-reported body weight and height and bodily self-perception were asked to the students. To assess self-reported body weight and height, they were asked, "What is your body weight/height?". To assess perceived BMI, they were asked, "What do you think about your BMI?" and were asked to choose one of the following answers: "underweight", "normal", "overweight" or "obese". Because few students (1%) chose "underweight" and the study was focused on obesity, the groups of students who chose the answers "underweight" and "normal" were integrated. Accurate BMI perception occurs when the students' perception of their BMI status does not differ from their actual BMI based on measured height and weight. After administering the questionnaire, students' body weight and height were measured and recorded. Weight and height were measured with the individuals wearing light clothing and no shoes, and measurements were performed using sensitive instruments.

Height was classified in three group as < 15^{th} percentile, 15^{th} to 85^{th} percentile, and > 85^{th} percentile according to the WHO [11]. Two BMI values were calculated for each individual using the self-reported and measured body weight and height values, which were assessed according to the reference values of the WHO [11].

Physical activity was measured using questions on four different aspects as follows: physical activity at school, physical activity during recreation time, physical activity while traveling to school and physical resting time. Low activity was defined as < 600 MET-min. Inappropriate use of computer/TV was defined as using either or both of these items for 4 h or more daily. Students who reported having smoked at least one cigarette per day for one month or longer were categorized as smokers.

Statistical analysis

Differences between the measured and self-reported anthropometric parameters were assessed

by the *t* test for the dependent variables, and the effect size of the inter-group differences was assessed using Cohen's *d* coefficient, for which an effect size of approximately 0.20 was considered a "small" effect, that of approximately 0.50 was a "medium" effect and 0.80 represented a "large" effect [12].

The McNemar-Bowker χ^2 test was used to compare the self-reported and measured anthropometric parameters in determining obesity and overweight statuses.

Agreement between the measured and self-reported body height and weight and BMI values was determined using the Bland-Altman method. The variable obtained for the difference between the self-reported and measured anthropometric parameters was plotted against the average of the self-reported and measured values. The 95% confidence interval (CI) for the agreement variable was calculated by adding/subtracting a standard deviation (SD) of 1.96 to/from the average difference. The level of agreement was classified as good (within –1/1 SD), moderate (within –1/–1.96 SD and 1/1.96 SD) or poor (lower than –1.96 SD or higher than 1.96 SD).

The dependent variable for multivariate logistic regression analysis was "a good level of agreement" for the difference between self-reported and measured BMI values (within –1/1 SD). To determine the effect of "a good level of agreement", hierarchical logistic regression models were used. Variables found significant in the bivariate analysis and potential confounders included in the hierarchical logistic regression models were centered. Hierarchical logistic regression models were stepwise. The first step examined the null model of overall probability of good agreement without adjustment for covariates, where β_0 is an overall random effect that accounts for differences between facilities (i.e., the intercept was allowed to vary randomly by residence). The second and third step included residence-level variables to determine which variables were significantly associated with good level of agreement.

Results

The study group consisted of 3918 high school students. Of them, 1874 (47.8%) were male, and 2044 (52.2%) were female. The ages of the participants ranged from 14 to 18 years.

The self-reported body height and weight and BMI values calculated from the self-reported values were significantly lower than the measured parameters except for the higher self-reported body height in the girls (for each, $p < 0.001$). The average differences between the self-reported and measured parameters were higher for body weight and BMI in the male students ($p = 0.04$ and $p < 0.001$, respectively) and for body height in the females ($p < 0.001$) (Table I). However, the effect size of this difference according to Cohen's *d* coefficient is quite small (< 0.20). Among male students who reported their height in the normal region, 3.8% were measured as shorter while 6.1% of them were measured as taller. For females in the same group, these percentages were 5.2% and

Table I. Averages of reported vs. measured height, weight and BMI values and their differences according to gender

Parameter	Average of measured values: $\bar{x}$ (SD)	Average of reported values: $\bar{x}$ (SD)	Average of reported – measured values differences: $\bar{x}$ (SD)	Cohen's *d* coefficient
Male (*n* = 1874):				
Weight [kg]	64.4 (12.7)	63.5 (12.7)	–0.9 (4.3)*	0.070
Height [cm]	172.8 (8.3)	172.1 (8.7)	–0.8 (4.0)*	0.082
BMI [kg/m^2]	21.5 (3.6)	21.4 (3.6)	–0.1 (1.6)*	0.027
Female (*n* = 2044):				
Weight [kg]	56.9 (10.8)	55.8 (10.2)	–1.2 (3.8)*	0.104
Height [cm]	162.0 (6.4)	162.3 (6.6)	0.2 (3.3)**	–0.046
BMI [kg/m^2]	21.7 (3.8)	21.2 (3.5)	–0.5 (1.7)*	0.136
Total (*n* = 3918):				
Weight [kg]	60.5 (12.3)	59.5 (12.1)	–1.0 (4.0)*	0.081
Height [cm]	167.2 (9.2)	167.0 (9.1)	–0.2 (3.7)*	0.021
BMI [kg/m^2]	21.6 (3.7)	21.3 (3.6)	–0.3 (1.7)*	0.082

**p ≤ 0.001 and **p ≤ 0.002.*

2.2% respectively. Among male students who reported their height in the shorter region, 28.0% were measured as normal while 0.6% of them were measured as taller. For females in the same group, these percentages were 30.0% and 1.7% respectively. Among male students who reported their height in the taller region, 0.4% were measured as shorter while 13.0% of them were measured as normal. For females in the same group, these percentages were 0.4% and 26.1% respectively.

The BMI classifications calculated from the self-reported vs. measured parameters were not different in the males, while the obesity prevalence was higher when the BMI was calculated from the self-reported values ($p < 0.001$). The BMI classification determined by the self-perception of body weight was significantly different from that calculated according to the self-reported values for both the male and female students. Figure 1 shows self-reported BMI status by gender and measured BMI, and Figure 2 shows the perceived BMI status by gender and measured BMI.

Among male students who reported their BMI in the normal region, 2.8% were measured as overweight while 0.6% of them were measured as obese. For females in the same group, these percentages were 1.3% and 0.4% respectively. Among male students who perceived their BMI in the nor-

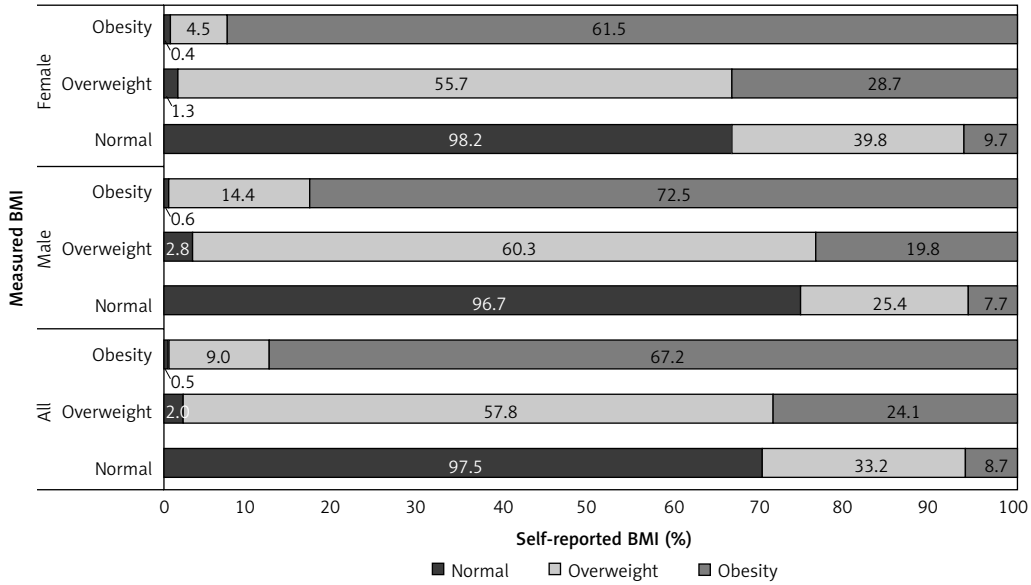

Figure 1. Self-reported BMI status by gender and measured BMI. Male $\chi^2_{\text{McNemar-Bowker test}} = 6.188$, $p = 0.103$; and female $\chi^2_{\text{McNemar-Bowker test}} = 85.586$, $p < 0.001$; and all $\chi^2_{\text{McNemar-Bowker test}} = 68.932$, $p < 0.001$

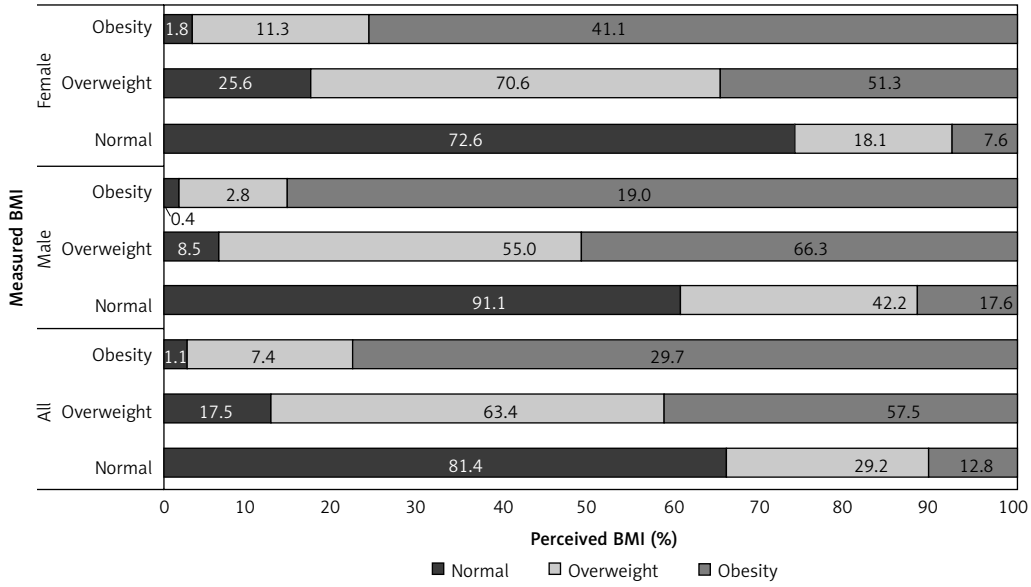

Figure 2. Perceived BMI status by gender and measured BMI. Male $\chi^2_{\text{McNemar-Bowker test}} = 143.838$, $p < 0.001$; and female $\chi^2_{\text{McNemar-Bowker test}} = 338.043$, $p < 0.001$; and all $\chi^2_{\text{McNemar-Bowker test}} = 391.703$, $p < 0.001$

mal region, 8.5% were measured as overweight while 0.4% of them were measured as obese. For females in the same group, these percentages were 25.6% and 1.8% respectively.

According to the Bland-Altman method, the agreement between the BMI values calculated from the self-reported and measured values were good in 82.1% and 81.7%, moderate in 14.0% and 13.9%, and poor in 3.9% and 4.4% of the males and females, respectively. The Bland-Altman plot of the differences versus the averages of the reported and measured weight, height and BMI values are shown in Figure 3.

Good agreement of self-reported and measured BMI values according to the Bland-Altman method was used as a dependent variable for multivariate logistic regression analysis. There was no association between "good agreement" and age, gender or individual risk factors, such as smoking and physical inactivity, while it was significantly associated with residence and accurate BMI perception. Associations of the good agreement of self-reported and measured BMI values and the variables using a hierarchical logistic regression analysis model are presented in Table II.

Discussion

Overall, our objectives were: (i) to examine the validity of self-reported vs. measured body weight and height values and (ii) to determine the effects of BMI self-perception. The results showed that inaccurate BMI perception is a potential risk in determining obesity and overweight status.

Using self-reported body weight and height values for determining and following up BMI in adolescents would be more practical for healthcare professionals. Population-specific reliability and validity of this method and associated factors should be determined.

Some studies have reported an adequate level of reliability for BMI values calculated from self-reported body height and weight values [13–16]. These studies have mainly correlated or compared average differences between self-reported and measured anthropometric parameters. There are many studies examining the reliability of self-reported body weight and height values in children and adolescents [13–16]. Although most studies on body height have reported higher values for self-reported parameters, some studies have reported a lower value or no difference [14, 17]. On the other hand, self-reported body weight values are generally underestimated [13, 16, 17]. In particular, males have been found to overestimate body height, and females have been found to underestimate body weight, resulting in a bias towards underestimated BMI values in both cases [15, 17, 18].

In this study, the average difference between the self-reported and measured body height and

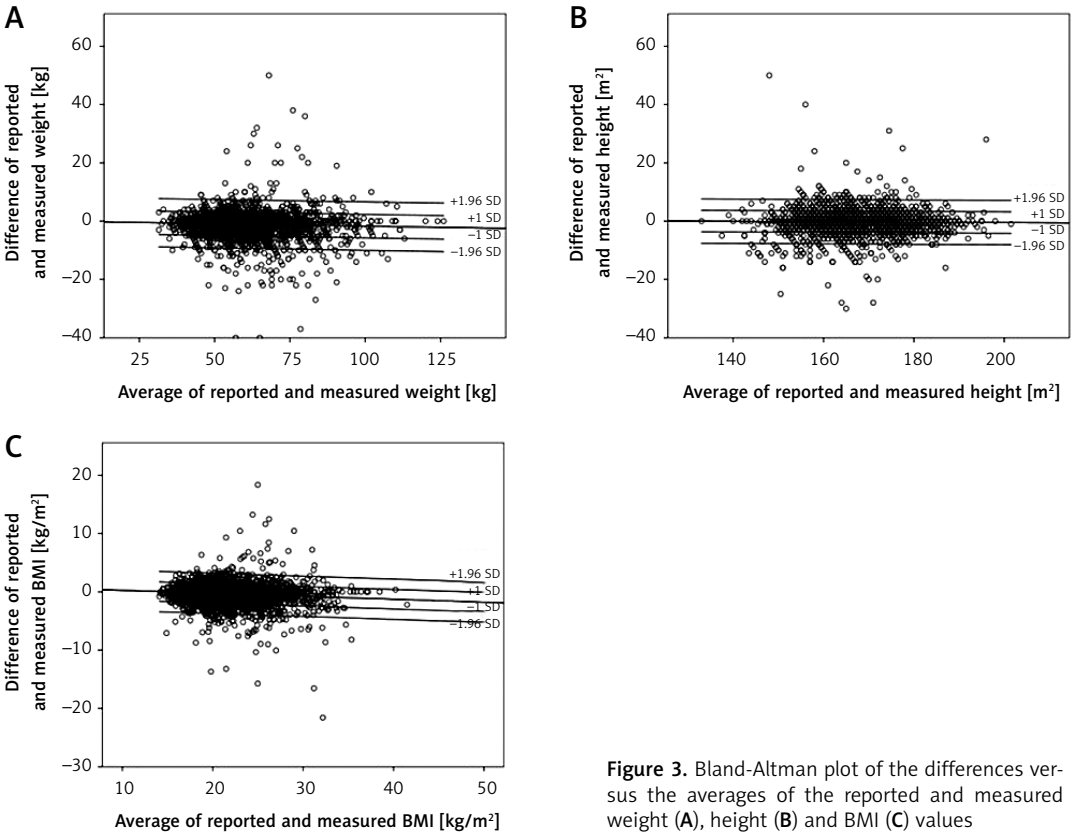

Figure 3. Bland-Altman plot of the differences versus the averages of the reported and measured weight (**A**), height (**B**) and BMI (**C**) values

Table II. Associations of the good agreement of self-reported and measured BMI values and the variables using a hierarchical logistic regression analysis model

Parameter	Good agreement *n* (%)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Gender:				
Male	1525 (81.2)	0.98 (0.83–1.16)	0.91 (0.756–1.07)	0.90 (0.76–1.08)
Female	1646 (81.7)			
Age group:				
14–15	1454 (80.0)	0.87 (0.75–1.01)	0.88 (0.76–1.03)	0.86 (0.74–1.01)
16–17	1590 (83.3)			
> 18	127 (86.4)			
Residence:				
Rural	910 (90.7)	2.57 (2.04–3.25)*	2.54 (2.01–3.21)*	2.51 (1.98–3.17)*
Urban	2261 (78.8)			
Accurate BMI perception:				
Normal	2221 (84.3)	–	1.45 (1.27–1.66)*	1.45 (1.26–1.66)*
Overweight	813 (77.4)			
Obesity	137 (73.3)			
Smoking:				
Nonsmoker	2821 (81.9)	–	–	1.21 (0.92–1.59)
Smoker	335 (81.1)			
Physical activity:				
Good	1049 (83.4)	–	–	1.05 (0.92–1.18)
Middle	1556 (81.0)			
Good	556 (81.6)			

*$p \leq 0.001$.

weight values was calculated. The results of this study suggest that males are likely to underestimate their body weight and height, while females tend to underestimate their body weight and overestimate their body height. On the other hand, BMI was found to be under-calculated for both sexes. The coefficient of variation for the average difference (Cohen's *d*) was quite low. However, many interventional obesity studies have evaluated differences between pre-intervention and post-intervention periods and have assessed the per cent change in BMI. Obesity prevention programs have reduced average BMI by only 0.05 kg/m^2 [19]. Thus, the use of self-reported values rather than measured values in the calculation of BMI does not have any impact on the limited effects of obesity prevention programs.

Categorical assignment of obesity and overweight can be performed using cut-off values and BMI values. Categorical data transformation that using self-reported values suggests that approximately half of obese and overweight individuals are overlooked [5, 8, 17]. In our study, we found that approximately one in three obese individuals had discordance between their self-reported and measured values. Moreover, the disagreement between the self-reported and measured anthropometric parameters was higher in the females than the males.

Bodily self-perception was in significant disagreement with the BMI values calculated from the measured parameters for both the females and males. With regard to bodily perception, 17.6% and 63.3% of obese male adolescents classified themselves as normal and overweight, respectively, while 42.2% of overweight male adolescents classified themselves as normal. On the other hand, 7.6% and 51.3% of the female adolescents classified themselves as normal and overweight, respectively, while 18.1% of overweight female adolescents classified themselves as normal. Therefore, approximately one in five obese male adolescents, but only 2 in 5 female obese adolescents, perceived their body accurately.

In contrast with previous studies, the biases between self-reported and measured anthropometric parameters were assessed using a "good agreement" variable determined by the Bland-Altman method as the dependent factor. Recent studies have suggested that the assessment of validity is more important than the assessment of reliability and that the Bland-Altman method is useful for this purpose [8, 20]. The 68% CI was calculated by adding and subtracting one SD to the average difference as determined by the Bland-Altman method for the self-reported and measured values. Because the "good agreement" variable was considered to be more suitable in terms of demonstrating the impact of a method on producing changes in obesity control programs, the analysis was based on this variable, which was also used to calculate bias.

The final results of multivariate analysis demonstrated that the factors associated with bias include living in an urban areas and bodily misperception.

Weight perception is a major component of body image, and misperception of weight may have adverse effects on nutritional behaviors [21]. Body image is an individual's perception, attitudes and experiences about his/her body. Large-scale studies of the relationship between perceived body weight and self-reported body weight, body height and BMI values in students began with the HBSC study, which evaluated the relationship of self-reported BMI with weight perception and weight loss attempts in male and female college students from 22 countries in Europe, Asia and the US, suggesting significant discrepancies between countries [22]. In addition, the relationships between bodily perception and self-reported body weight and height have been evaluated in college students from seven European countries, including Turkey [9]. The major limitation of these studies was the fact that perception was associated with the BMI calculated from the self-reported anthropometric parameters, leading to a failure to assess the impact of perception on actual BMI in depth.

The major advantage of the present study is that it compared bodily perception in adolescents from Turkey with BMI values calculated from measured values and not from self-reported values. In addition, our findings suggest that bodily perception is associated with BMI calculated from self-reported body weight and height values.

This study was a cross-sectional study, and perceived body weight was found to be closely associated with actual, measured BMI. Future prospective studies should aim to elucidate this finding.

In conclusion, the results of this study demonstrate the potential risks of erroneous weight perception in determining obesity and overweight statuses.Considering that increased numbers of young people are likely to reside in city centers in the future, emergency action plans are needed. In this regard, the first step of school obesity control programs should include the promotion of a healthy body image among students. Moreover, emphasis should be placed on the importance of knowing accurate body weight and height measurements and having an accurate bodily perception with realistic targets in adolescents.

Conflict of interest

The authors declare no conflict of interest.

References

1. De Onis M, Blossner M, Borghi E. Global prevalence and trends of overweight and obesity among preschool children. Am J Clin Nutr 2010; 92: 1257-64.
2. Karakas P, Bozkir MG. Anthropometric indices in relation to overweight and obesity among Turkish medical students. Arch Med Sci 2012; 8: 209-13.
3. Kyriazis I, Rekleiti M, Saridi M, et al. Prevalence of obesity in children aged 6-12 years in Greece: nutritional behaviour and physical activity. Arch Med Sci 2012; 8: 859-64.
4. Elgar FJ, Roberts C, Tudor-Smith C, Moore L. Validity of self-reported height and weight and predictors of bias in adolescents. J Adolesc Health 2005; 37: 371-5.
5. Kelishadi R, Marashinia F, Heshmat R, et al. First report on body image and weight control in a nationally representative sample of a pediatric population in the Middle East and North Africa: the CASPIAN-III study. Arch Med Sci 2013; 9: 210-7.
6. Daniels SR. The consequences of childhood overweight and obesity. The Future of Children/Center for the Future of Children, the David and Lucile Packard Foundation 2006; 16: 47-67.
7. Sherry B, Jefferds ME, Grummer-Strawn LM. Accuracy of adolescent self-report of height and weight in assessing overweight status: a literature review. Arch Pediatr Adolesc Med 2013; 161: 1154-61.
8. Zhou X, Dibley MJ, Cheng Y, Ouyang X, Yan H. Validity of self-reported weight, height and resultant body mass index in Chinese adolescents and factors associated with errors in self-reports. BMC Public Health 2010; 10: 190.
9. Mikolajczyk RT, Maxwell AE, El Ansari W, Stock C, Petkeviciene J, Guillen-Grima F. Relationship between perceived body weight and body mass index based on self-reported height and weight among university students: a cross-sectional study in seven European countries. BMC Public Health 2010; 10: 40.
10. Roberts C, Freeman J, Samdal O, et al. The Health Behaviour in School-aged Children (HBSC) study: methodological developments and current tensions. Int J Public Health 2009; 54 Suppl. 2: 140-50.
11. Who Multicentre Growth Reference Study G, de Onis M. WHO Child Growth Standards based on length/height, weight and age. Acta Pædiatrica 2006; 95: 76-85.
12. Cohen J. Statistical power analysis for the behavioral sciences. Hillsdale NJ. L. Erlbaum Associates 1998.
13. Yoshitake N, Okuda M, Sasaki S, Kunitsugu I, Hobara T. Validity of self-reported body mass index of Japanese children and adolescents. Pediatr Int 2012; 54: 397-401.

14. Brettschneider AK, Rosario AS, Ellert U. Validity and predictors of BMI derived from self-reported height and weight among 11- to 17-year-old German adolescents from the KiGGS study. BMC Research Notes 2011; 4: 414.
15. Strauss RS. Comparison of measured and self-reported weight and height in a cross-sectional sample of young adolescents. Int J Obes Relat Metabol Disord 1999; 23: 904-8.
16. Sarafrazi N, Hughes JP, Borrud L, et al. Perception of weight status in U.S. children and adolescents aged 8-15 years, 2005-2012. NCHS data brief, no 158. Hyattsville, MD: National Center for Health Statistics 2014.
17. Brener ND, McManus T, Galuska DA, Lowry R, Wechsler H. Reliability and validity of self-reported height and weight among high school students. J Adolesc Health 2003; 32: 281-7.
18. Rasmussen F, Eriksson M, Nordquist T. Bias in height and weight reported by Swedish adolescents and relations to body dissatisfaction: the COMPASS study. Eur J Clin Nutr 2007; 61: 870-6.
19. Harris KC, Kuramoto LK, Schulzer M, Retallack JE. Effect of school-based physical activity interventions on body mass index in children: a meta-analysis. CMAJ 2009; 180: 719-26.
20. Altman DG, Bland J. Measurement in medicine: the analysis of method comparison studies. Statistician 1983; 32: 307-17.
21. Dorosty AR, Mehdikhani S, Sotoudeh G, Rahimi A, Koohdani F, Tehrani P. Perception of weight and health status among women working at Health Centres of Tehran. J Health Popul Nutr 2014; 32: 58-67.
22. Wardle J, Haase AM, Steptoe A. Body image and weight control in young adults: international comparisons in university students from 22 countries. Int J Obes 2006; 30: 644-51.