Validity of self-reported weight and height among Saudi school children and adolescents

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ABSTRACT

Objectives: To explore the relationship between self-reported weight and height to actual weight and height in a cross-sectional representative sample of school students in Jeddah City, Kingdom of Saudi Arabia and its relation to selected socio-economic and socio-demographic factors. Also to evaluate the validity of self-reported weight and height measurements.

Methods: Data was collected from a sample of Saudi school students in Jeddah City, KSA from 42 boys' schools and 42 girls' schools during the month of April 2000. Data collection was carried out by an in-person interview to collect sociodemographic and self-reported weight and height, as well as, actual measurement of weight and height. Body mass index was classified according to age and genders into underweight (<15th percentile), normal weight (≥15th percentile to <85th percentile), overweight (≥85th percentile to <95th percentile) and obesity (≥95th percentile). Validity of self-reported obesity, as compared to measured body mass index, was assessed.

Results: A total of 2,860 Saudi school students were enrolled in the study with an age range from 9 to 21 years (mean=13.9, standard deviation=2.8). Overweight was reported in 13.4% and obesity in 13.5% of school students. Overweight and obesity were more marked among those of at least 13 years of age, male of high social class and students with highly educated mothers. Slightly above half of the school children were unaware of their weight and height giving an unknown body mass index in approximately 60% of cases. Among the remaining 40% who reported their weight and height, underestimation of weight was around 2.7 kg and was mainly among girls, in 16-21 year old group, high socio-economic class and born from educated mothers. Overestimation of height by 4cm was reported mainly among the overweight, obese, girls, those with at least 16 years of age. Sensitivity of determining obesity by reported weight and height was low especially among girls and those of at least 16-years of age while specificity was more among boys than girls and improved by increase in age.

Conclusion: Our results display the inaccuracy of self-reported weight and height in tracking obesity in our youth population. These results also emphasize the need for community and school based programs for preventing and reducing obesity in school age through improving the nutritional status awareness, diet habits and life style in order to ensure health and longevity.

Keywords: Obesity, children, adolescence, self-reported weight and height, validity.

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Overweight and obesity are major public health concerns as they may act as predictors for a variety of diseases. Overweight children have an increased risk of adult obesity that increases with the age of the child and the severity of the overweight.[1] It was estimated that 27% of the overweight whom

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they were one to 5 years old, 41-43% were 6 to 9 years old and 80-86% were 10 to 13 years old have remained overweight as adults.[2-4] Overweight and obese children are in future at increased risk of morbidity and mortality related to a wide range of chronic diseases as coronary heart diseases, hypertension, hyperlipidemia, respiratory diseases, diabetes mellitus, gall bladder diseases, stress, orthopedic disorders and some types of cancers.[5-6] In national surveys of youth behavior, self-reported weight and height are often utilized in place of actual measurement. In the United States of America (USA), the Youth Risk and Behavior Surveillance Study (YRBSS),[7] the National Longitudinal Study of Adolescent Health[8] and the National Health Interview Surveys (NHIS)[9] rely on self-reported weight and height in order to assess the impact of body weight on adolescent self-esteem, dieting and overall health. Despite the evidence that self-reported weight and height might be nearly as accurate as the measured one,[9-13] some studies have yielded inaccurate measurements among certain populations with age and sex influence on self- reported measurements.[14-16] In adults, the correlation between actual and reported height and weight typically range between 0.96 and 0.99.[9,17,18] Brooks-Gunn et al[19] reported correlations between actual and reported height and weight ranging from 0.77 and 0.98 in a small group of young adolescents from a well-educated, high-income community.[19] However, self-reports may reflect actual cultural biases resulting in differing accuracy among sexes and ages. The correlation between actual and reported height and weight in a cross-sectional survey of children and adolescents in Kingdom of Saudi Arabia (KSA) has not been studied. The present study was undertaken to determine the validity of self-reported weight and height, as compared to measured ones, in estimating obesity in young population. The aim of this study is to estimate the magnitude by which population surveys in adolescent population in KSA, which collect self-reported weight and height data conducted in future may under-estimate or over-estimate the prevalence of obesity.

Methods.

Study population. Jeddah City is one of the largest cities in KSA with a population of 2.1 million and a total of 692 governmental schools and 327 private schools, around half for boys and half for girls.

Sample selection. The sample was selected by stratified sampling technique with proportional allocation to type of school (governmental or private) and educational level, and 42 schools for boys and 42 schools for girls were chosen. One class from each educational level in the selected schools was chosen at random. All students in the selected classes present during the survey period were considered. Only questionnaires for students of Saudi nationality were considered for this study and a participation rate of around 99% was attained.

Data collection. Data was collected during April 2000 by medical students in King Abdul-Aziz University, Medical School, Jeddah, KSA, trained on interviewing skills, and directly supervised by the medical staff in the Department of Community Medicine. Data was collected by an in-person interview using a structured questionnaire, which included information on socio-demographic factors and self-reported anthropometric measurement, also by direct measurements of weight and height. The weight was measured without shoes and with light clothes using Seca (model 777) personal scale to the nearest 0.1 kg and the height was taken without shoes using standard measuring tape to nearest 0.1 cm. Equipment were recaliberated between each measurement. The measured body mass index (BMI) was calculated as the measured weight in kg/ (measured height in m)^2, while the self reported BMI was calculated as the self reported weight in kg)/(self reported height in m)^2. The measured and self reported BMI were classified according to age and gender into, underweight (<15th percentile), normal weight (≥15th percentile to <85th percentile), overweight (≥85th percentile to <95th percentile) and obese (≥95th percentile). The reference of BMI percentiles were derived from the first National Health and Nutrition Examination Survey (NHANES).[20] This definition is in accordance with recommendation of the expert committee on clinical guidelines for overweight in adolescence[21] and World Health Organization (WHO) expert committee in overweight.[22] Sensitivity and specificity were calculated to estimate the validity of BMI by self-reported measurements as compared to the measured one. Mothers' education level was classified into low (no school, primary and attended intermediate school), middle (completed intermediate and secondary schools) and high (attended or completed college and with higher education). No school category was combined with primary and attended intermediate school to assure uniformity of the frequency distributions in each educational level. Type of school was used as a proxy measure for socio-economic status (SES). Socio-economic status was defined as high for private school students and low for governmental school students. Since there were only Saudi population selected into the study this classification would be valid to a large extent. There was also a high correlation (Spearman's Rank correlation coefficient = 0.92) between the type of school and maternal educational level.

Data entry and analysis. Data entry and analysis were carried out using SPSS for windows version 9.0. Chi-square test was used to detect significant difference in proportion in an independent sample. Paired t-test was used to detect significant differences between 2 paired means. Correlation

coefficients were calculated using linear correlation (Pearson's correlation coefficient).

Results. A total of 2,860 Saudi school children and adolescents were enrolled in the study. Their age ranged from 9 to 21 years with mean age of 13.9 years (standard deviation = 2.8). There were (**Table 1**) 49.1% boys and 50.9% girls. Measured BMI exceeding 85th percentile was detected in 769 students (26.9%) of which 50.3% exceeded the 95th percentile. There were 11.1% of students classified as high socio-economic class and 14.7% of students classified as students born from mothers reached high level of education. Overweight (**Table 2**) was mainly marked among those of at least 13 years of age while obesity was more marked in the 13-15 years age group. Boys were more underweight and overweight than girls ($p<0.01$). Students with high socioeconomic status were more overweight and obese than those with low socio-economic status ($p<0.01$). Children born from mothers with higher educational level were both more overweight and obese than offspring of low educated mothers ($p<0.01$). Approximately 1% of students reported a weight over 18 kg different from their actual weight and one percent of students reported a height over 20 cm different from their actual height and both were excluded from the study. Then in the remaining sample 48% of them were not aware of their current weight and 57% of them did not know their actual height giving unknown self-reported weight and height of 59.2%. These were mainly in the 9-12 age group. Awareness of weight and height did not differ by different levels of measured BMI or by socioeconomic status but differ by maternal education as students born to low educated mothers were more unaware of there height and weight (**Table 3**). Among the 1,167 school children and adolescents who represent 40.8% of the sample who knew their current weight and height, classification of overweight and obesity by actual measurements were detected in 300 (25.7%) of whom 148 (49.3%) were obese. Similar to the distribution of overweight and obesity in the whole original sample, 2860. By Self-reported weight and height measures, 291 students (24.9%) of study sample were overweight and obese of whom 121 (41.6%) were obese. Self- reported weight was within 2 kg of actual weight in 45% of students and within 5 kg of actual weight in 77%. Self-reported height was within 4 cm of actual height in 41% of students and within 8 cm of actual height in 70%. As shown in **Table 4**, there was an average significant underestimation of weight by 2.7 kg and overestimation of height by 4 cm. Underestimation of weight was reported by obese girls, in 6-21 year old group, in those with high socio-economic class and born from highly educated mothers. Overestimation of height was mainly reported by

Table 1 - Characteristics of school students in Jeddah, KSA.

Students characteristics	N (%)
Total N of students	2860 (100)
Age (years)	
9-≤12	1059 (37)
13-≤15	934 (32.7)
16-21	867 (30.3)
Sex	
Boys	1403 (49.1)
Girls	1457 (50.9)
Measured BMI	
Underweight	706 (24.7)
Normal	1385 (48.4)
Overweight	382 (13.4)
Obese	387 (13.5)
Socio-economic status	
Low	2542 (88.9)
High	318 (11.1)
Mothers' education	
Low	1593 (55.7)
Middle	846 (29.6)
High	421 (14.7)

N - number, BMI - body mass index, KSA - Kingdom of Saudi Arabia

Table 2 - Distribution of BMI by age, sex, socio-economic status and mothers' educational level among school students in Jeddah, KSA.

Students characteristics	Under-weight	Normal	Over-weight	Obese
	N (%)	N (%)	N (%)	N (%)
Age (years)				
9-≤12 (N=1059)	285 (26.9)	521 (49.2)	125 (11.8)	128 (12.1)
13-≤15 (N=934)	217 (23.2)	449 (48.1)	128 (13.7)	140 (15)
16-21 (N=867)	204 (23.5)	415 (47.9)	129 (14.9)	119 (13.7)
Sex*				
Boys (N=1403)	410 (29.2)	596 (42.5)	200 (14.3)	197 (14)
Girls (N=1457)	296 (20.3)	789 (54.2)	182 (12.5)	190 (13)
Socio-economic status				
Low (N=2542)	664 (26.1)	1220 (48)	327 (12.9)	331 (13)
High (N=318)	42 (13.2)	165 (51.9)	55 (17.3)	56 (17.6)
Mothers' education*				
Low (N=1593)	474 (29.8)	748 (47)	188 (11.8)	183 (11.5)
Middle (N=846)	171 (20.2)	425 (50.2)	117 (13.8)	133 (15.7)
High (N=421)	61 (14.5)	212 (50.4)	77 (18.3)	71 (16.9)

N - number, * $p<0.01$, BMI - body mass index, KSA - Kingdom of Saudi Arabia

Table 3 - Distribution of school students by awareness of actual weight and height in Jeddah, KSA.

Students characteristics	Self-reported weight and height	
	Known N (%)	Unknown N (%)
Students (N=2860)	1167 (40.8)	1693 (59.2)
Age (years)*		
9-≤12 (N=1059)	70 (6.6)	989 (93.4)
13-≤15 (N=934)	320 (34.3)	614 (65.7)
16-21 (N=867)	777 (89.6)	90 (10.4)
Sex		
Boys (N=1403)	594 (42.3)	809 (57.7)
Girls (N=1457)	573 (39.3)	884 (60.7)
Measured BMI		
Underweight (N=706)	298 (42.2)	408 (57.8)
Normal (N=1385)	569 (41.1)	816 (58.9)
Overweight (N=382)	152 (39.8)	230 (60.2)
Obese (N=387)	148 (38.2)	239 (61.8)
Socio-economic status		
Low (N=2542)	980 (38.6)	1562 (61.4)
High (N=318)	189 (59.4)	129 (40.6)
Mothers' education		
Low (N=1593)	490 (30.8)	1103 (69.2)
Middle (N=846)	421 (49.8)	425 (50.2)
High (N=421)	256 (60.8)	165 (39.2)

* p<0.001, N - number, BMI - body mass index, KSA - Kingdom of Saudi Arabia

Table 5 - Correlation between reported and actual weight and height among school students in Jeddah, KSA.

Students characteristics	Actual weight versus reported weight r	Actual height versus reported height r
Students	0.90	0.72
Age (years)		
9-≤12 (N=70)	0.92	0.82
13-≤15 (N=320)	0.89	0.73
16-21 (N=771)	0.82*	0.62*
Sex		
Boys (N=594)	0.89	0.64
Girls (N=573)	0.83†	0.67

* p<0.01: age group 16-21 years versus 9-12 years; age group 16-21 years versus 13-15 years,
† - p<0.01: boys versus girls,
N - number, KSA - Kingdom of Saudi Arabia,
r - pearson's correlation coefficient

Table 4 - Comparison between measured and self reported weight and height among school students in Jeddah, KSA.

Students characteristics	Weight (kg)				Height (cm)			
	Measured Mean	(SD)	Reported Mean	(SD)	Measured Mean	(SD)	Reported Mean	(SD)
Students (N=1167)	53.4	(18.1)	50.7*	(17.7)	158.5	(14.9)	162.5†	(11.3)
Age (years)								
9-≤12 (N=70)	36.9	(13.0)	36.5	(13.9)	146.1	(9.9)	145	(14.59)
13-≤15 (N=320)	50.5	(16.0)	48.2	(14.6)	158	(9.7)	154.5†	(11.6)
16-21 (N=777)	61.7	(17.6)	59.2*	(16.7)	161.7	(10.5)	169.7†	(15.1)
Sex								
Boys (N=594)	57	(19.6)	57.1	(18.4)	166.1	(10.7)	161.6†	(14.3)
Girls (N=573)	48.9	(14.2)	46†	(14.1)	155.4	(8.8)	159†	(14.6)
BMI percentile								
Underweight (N=298)	35	(9.6)	38†	(11.6)	149.7	(14.8)	149.4	(15.9)
Normal (N=569)	46.9	(11.5)	47.7	(12.8)	152	(13)	152.9	(15.4)
Overweight (N=152)	60	(14.7)	60.9	(15.9)	153.8	(13.3)	164.5‡	(12.2)
Obese (N=148)	73.3	(20.8)	70.7†	(20.6)	149.2	(19.9)	159.6‡	(13.5)
Socio-economic status								
Low (N=980)	49.6	(17.1)	49.2	(15.2)	150.1	(13.7)	156.3‡	(13.7)
High (N=189)	51.9	(18.1)	48.1‡	(18)	150.9	(14.8)	158.5‡	(15.2)
Mothers' education								
Low (N=490)	48.1	(17.7)	59.6	(17.9)	151.5	(14.5)	157.8‡	(15.6)
Middle (N=421)	50.1	(18.7)	51.1†	(17.8)	151.3	(14.9)	159.5‡	(15.3)
High (N=256)	52.1	(17.8)	48.1‡	(17.2)	149.3	(14.5)	159‡	(10.7)

* p<0.05, † - p<0.01, ‡ - p<0.001, N - number, BMI - body mass index, SD - standard deviation, KSA - Kingdom of Saudi Arabia

Table 6 - Sensitivity and specificity for determining clinical obesity (BMI≥95th percentile) using self-reported measurement among school students in Jeddah, KSA.

Students characteristics	Sensitivity %	Specificity %
Age (years)		
9-≤12 (N=70)	84	91.2
13-≤15 (N=320)	82.4	93.5
16-21 (N=777)	78.1	94.3
Sex		
Boys (N=594)	80.1	93.2
Girls (N=573)	77	91.3

N - number, BMI - body mass index, KSA - Kingdom of Saudi Arabia

girls, overweight and obese students, those of at least 16 years of age in all socio-economic classes and maternal educational level. As shown in **Table 5,** correlation between self-reported weight and actual weight ranged between 0.82 to 0.92 depending on gender or age. Lower correlations for self-reported weight were noted in females compared to males and for the 16-21 year old students as compared to the younger age groups ($p<0.01$). Correlation between self-reported height and actual height ranged between 0.62-0.82. Low correlations for self-reported height were reported by both sexes but still the 16-21 year old students showed lower correlation than the younger age groups ($p<0.01$). Sensitivity (**Table 6**) of determining clinical obesity (BMI ≥95th percentile) by using self-reported weight and height was low especially among girls and those of at least 16-years of age. Specificity was more among boys than girls and improved by increase in age.

Discussion. The results of this study have shown the inefficiency of self-reported weight and height to identify obese subjects and inaccuracies varied with age, sex and nutritional status. Slightly over half of the subjects were not aware of their weight and height giving an unknown BMI of around 60%. Unknown data did not differ by sex and BMI percentiles. Among the remaining 40% who reported their weight and height, underestimation of weight was reported and differed with age, sex, nutritional status, socio-economic status and maternal educational level. Obese girls and those at the age of 16 years or above underestimated their weight. Females were likely to under-report their weight to a greater extent than males. Similar results have been previously described in both children and adults. Dwyer et al showed that teenage boys reported their weight more accurately than teenage girls.[23,24] Discrepancies in self-reported height and actual height were highest in heavy children,[24,25] similar to what was observed in the current study. Gender differences in self-reported weight and weight status may indicate a general desire to lesser weight.[26] Maloney et al[26] and Gustafson-Larson et al[27] reported that pre-teen and adolescent girls were almost twice as likely as similar aged boys to report a desire to be thinner. Height was underestimated by boys and overestimated by girls. It was also overestimated in students of at least 13 years of age and with BMI ≥ 85th percentile, which resulted in a larger misclassification of self-reported height compared to self-reported weight (70% correct classification for within 8 cm from actual height compared to 77% correct classification of self-reported weight within 5 kg of actual weight). Also, self-reported height data was more unknown to students compared to self-reported weight (57% versus 48%). This high misclassification of height compared to weight needed to be studied more in depth in this age group. A reasonable explanation, could be the difficulty of taking the height measure compared to weight, namely height is not easily self-measured compared to weight (it need someone else to take the height measure than the person himself). Another explanation is the easy availability of weight scale compared to the height board. Lastly, it could be due to the relative perception of the importance of knowing current weight compared to knowing current height especially in adolescents. Our results have shown the high prevalence of overweight and obesity among the high socio-economic class. This observation is not new in KSA. In a National Epidemiological Household Survey for Overweight and Obesity conducted among Saudi subjects of at least 20 years of age between 1990-1993, obesity was found to be significantly increased with high income showing a trend starting from childhood to adolescence to adult life and to older ages.[28] The resulting lifestyles from high income can predispose to obesity, since the majority of these families own more than 2 cars and perhaps also engage in little or no physical exercises, their children watch television, use computers and play electronic games for hours. These findings, by using mothers education and type of school attended as proxy measures for social class, appeared contrary to the study carried out in New York State, USA, where children 6-12 years old of low socio-economic class reported child fatness.[29] In another study in England and Scotland in 5-11 years old primary school children, the percentage of overweight was higher in children born to mothers of university educational level than in primary education level.[30] This study has also shown that

socio-economic factors (mother education and type of school attended) were associated with bias in reporting weight and height. This bias was in the form of underestimation of weight and overestimation of height in high socio-economic status group compared to low socio-economic one, although this high socio-economic group showed higher reporting of weight and height. The underestimation of weight in a high socio-economic status reflect the desirable body image socially, namely the higher the social class, the greater the social pressure and social desirability. Relatively few studies have dealt with the effects of socio-economic factors on reporting weight and height. Their results are discordant, perhaps due to the heterogeneity of the factors studied (education, occupation, income, and so forth) or of cultural differences between countries. Some authors found a bias that increased with higher education for weight[17,31,32] or height.[33] Inverse associations were also observed thus a higher educational level reduced the difference between measured and self-reported values for height[17,31] and weight.[17] Jalkanen et al[32] also showed that the lower the annual family income the more likely men and women were to report their weight incorrectly. Thus, despite the fact that self reported weight and height are easily obtained and time saving, they were found from our results to be liable to inaccuracies that were influenced by age, gender and actual nutritional status. These results coincide with previous studies 14-16 that reported inaccuracies of self-reported measurements and discouraged their use among youth. In the present study, self-reported weight and height resulted in a relatively low classification of obesity (≥95th percentile) status in females (sensitivity 77% and specificity 91%). In the Scottish adult population, the sensitivity and specificity for determining clinical obesity were 83% and 96% for men and 89% and 97% for women.[12] The relatively high validity of obesity classification in young students (9-12 years) and high correlation between actual weight versus reported weight and actual height versus reported height may have resulted to a large extent due to the large percent of unknown (93.3%) data for both self-reported weight and height in this age group.

In conclusion, our results confirmed the prevalence of overweight and obesity among school children and displayed the inaccuracy of self-reported weight and height, if we take into account the large percentage of unknown data regarding self-reported weight and height, in tracking overweight and obesity in our youth population. The study results have also pointed to the low classification (large misclassification) of self-reported height compared to self-reported weight and biases in reporting weight and height in obese individuals than non-obese individuals. Also, the tendency of girls to underestimate their weight, which may be related to, a general desire to be thinner. These results also emphasize the need of community based programs for preventing and reducing obesity. The focus of these efforts should be directed to the youth as well as their parents. Since general education is important to parents and their siblings, but will not improve nutritional knowledge. Nutrition health education on other hand is important as well and should go hand to hand with general education to improve nutritional knowledge. The core of any nutritional programs should concentrate on nutritional status awareness, appropriate diet habits and life style, in order to ensure proper development, health and longevity. Children and adolescents accurate knowledge regarding their weight and height as well as presence or absence of clinical obesity through periodic self-measurement of weight and height needs to be improved before self-reporting can be used as a reliable instrument in obesity screening. Needless to say school health records should show periodic screening for obesity in students which help to improve awareness. Future studies on validity of self-reported weight and height are needed to indicate the extent to which the validity of self-reporting is changing in pre-teen and adolescents.

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