ORIGINAL RESEARCH ARTICLE

DISCREPANCY BETWEEN SUBJECTIVE AND OBJECTIVE MEASURES OF OBESITY AMONGST THE UNDERGRADUATE MEDICAL AND DENTAL STUDENTS: AN INSTITUTION-BASED CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Obesity has been reported to be assessed both subjectively and objectively, with varying degrees of agreement. This study was conducted to assess the discrepancy between the subjective and objective measures of obesity amongst undergraduate medical and dental students.

Methods: A cross-sectional study was designed and conducted at College of Medical Sciences and Teaching Hospital, Nepal, from December 2019 to January 2020. First and second year undergraduate medical and dental students were first asked to report their height and weight, which were subsequently measured using standard stadiometer and weighing balance. Body mass index (BMI) was calculated from both subjective and objective height and weight, and was graded into different categories as underweight, normal, overweight and obese.

Results: Of the 181 participants, 51.4% were males. The prevalences of subjective and objective overweight/obesity were 24.8% and 25.4%, respectively, with the difference being −0.6% (95% CI: −9.5% to 8.4%; p>0.05). Likewise, the differences in prevalence rates were +4.3% (95% CI: −8.6% to 17.2%; p>0.05) in males and −5.7% (95% CI: −17.9% to 6.6%; p>0.05) in females. Further, the differences between the mean values of subjective and objective BMI were +0.4kg/m^2 (p=0.086, overall); +0.9kg/m^2 (p=0.002, males) and −0.3kg/m^2 (p=0.122, females).

Conclusions: In the face of varying degrees of discrepancy between subjective and objective measures of obesity in overall participants as well as in both gender groups, the findings suggest a reasonable degree of acceptability of the subjective assessment.

INTRODUCTION

The distressingly high prevalence of obesity has become one of the major public health concerns worldwide.[1] On top of different facets of obesity, one common issue is an assessment of obesity by using objective and subjective body mass index (BMI).[1]

In the face of inherent bias in using subjective measures of obesity, many studies have been conducted with results suggesting aberrations in subjectively measured obesity using body mass index (BMI).[2-4] Using BMI for the assessment of obesity is found to suffer from self-report biases in height and weight.[1, 5] Additionally, females have been particularly found to be susceptible to this bias, more profoundly so in the adolescents and early adult population.[6-8] A tendency to over-report the height and underreport the weight has been associated with the bias.[7] Emerging adults, 18 to 25 years old population in an important transitional period, face a strangely increasing burden of obesity.[9] Many individuals in this age-group are in their early university studies. For them, transition into college lifestyles is commonly accompanied with disordered eating in the face of insufficient physical activity, all contributing to weight gain and thus, obesity.[10] Medical and dental undergraduate students are no exception to this life-pattern and mindset.

Attributable to the context of very few, if any, studies carried out in such populations in Nepal, the aim of the study was to assess the discrepancy between subjective and objective measures of obesity in undergraduate medical and dental students and to compare these discrepancies gender wise.

METHODS

It was a cross-sectional study conducted at the Department of Physiology, College of Medical Science and Teaching Hospital (COMS-TH), Bharatpur, Chitwan, Nepal. After obtaining ethical clearance from the institutional review committee of COMS-TH (COMSTH-IRC) (Ref No: 2019-036), the study was conducted during December 2019 and January 2020.

The study population comprised of the medical and dental students who were in the first and second years at the time of the study. The total number of students considered under the sampling frame was 270. From this, the optimum sample size was calculated using the prevalence rate of obesity in the ado-

lescent population. In one study, Peltzer et al[11] prepared a collective report of the prevalence of overweight/obesity among university students of 22 countries. The overall prevalence of overweight/obesity as reported in their research was 22.0%. Using this prevalence rate, the optimum sample size was calculated to be 264 (Z=1.96, margin of error=0.05). Next, after correcting for the finite population of 270 students and adding 10% potential non-response rate, the optimum sample size was 148. However, by employing a lottery method of simple random sampling technique, a total of 181 students were selected from the study population, with an overshoot of 33 students over the optimum sample size.

After obtaining informed and written consents, participants were interviewed personally by the principal investigator. Criteria for excluding the students from the study were (a) any medical conditions that could significantly affect the weight and thus body mass index, creating an aberrant discrepancy between subjective and objective measurements, and (b) participants who have experienced very rapid increase of decrease in weight and thus BMI recently.

Next, data was collected from these participants in two sessions. During the first session, each participant was given a proforma and was asked to fill up the details including gender (male/female) and self-reported height (inches/cm) and weight (kg), as presumably recalled or decided by the participant to report (as per his/her perception). During the subsequent session, height (cm) and weight (kg) of each participant were measured in the laboratory. Height was measured using a standard stadiometer with the lowest decimal place of measurement being 0.5 cm. Similarly, weight was assessed using a standard weighing balance, with the lowest decimal place of measurement, 0.5 kg. Before assessments of weights, each participant was asked to remove his/her shoes/sandals and any extra items, including the heavy jackets/sweaters (excluding other clothing). To assess the overweight/obesity, both subjective and objective body mass index (BMI) were calculated from the self-reported and measured weight and height, respectively. The various cat-

egories of BMI were used to define the cutoff values for various types of body status, as (a) underweight (BMI<18 kg/m^2), (b) normal (18 kg/m$^2 \leq$BMI<25 kg/m^2), (c) Overweight (25 kg/m$^2 \leq$BMI<30 kg/m^2, and (d) Obese (BMI$\geq$30 kg/m^2).[12]

The collected data was initially entered in Microsoft Office Excel 2013. After preliminary data treatment (e.g. cleaning, coding), data was again entered into SPSS (Statistical Package for Social Sciences) version 16.0 for further management and final analysis. Categorical variables (gender, various categories of BMI) were depicted using frequency and percentage. After testing for the distribution of data in continuous variables (subjective and objective measures – weight, height and BMI) it was found that they did not differ significantly from the Gaussian distribution and were subsequently presented as mean with standard deviation (SD) apart from the mean-plots (with 95% confidence intervals or ±2SD). Mean values of subjective measures (weight, height and BMI) were compared with the objective measures using dependent t-test; prevalence rates of overweight/obesity and underweight status were compared using z-test for difference of proportions. Statistical significance was defined at the level of significance (p-value) less than 0.05.

RESULTS

Of the total 181 students randomly selected from the study population, the proportions of male and female students were 51.4% (n=93) and 48.6% (n=88), respectively.

Tables 1 and 2, and Figures 1–3 depict the mean values of subjective and objective body measures (weight, height and body mass index, BMI) and categories of BMI (underweight, normal, overweight and obese) in overall study participants and according to gender. As depicted in the Tables 1 and 2, 25.4% of the overall study participants were clinically measured overweight/obese (objective BMI), whereas 24.8% of them reported to being overweight/obese (subjective BMI). Similarly, the prevalence rates of underweight BMI were 9.4% (objective) and 7.2% (subjective).

Table 1: Mean values (standard deviation, SD) of subjective and objective body measures (weight, height and body mass index, BMI) and categories of BMI (underweight, normal, overweight and obese) in overall study participants and according to gender

|	Body Measures (Mean ± SD)			BMI Categories [Frequency (Percentage)]			
	Weight (kg)	Height (cm)	BMI (kg/m^2)	Underweight	Normal	Overweight	Obese
Total (n=181)							
Subjective	61.3±12.5	162.8±10.4	23.2±4.9	13 (7.2%)	123 (68.0%)	37 (20.4%)	8 (4.4%)
Objective	61.2±13.8	163.5±9.5	22.8±4.4	17 (9.4%)	118 (65.2%)	38 (21.0%)	8 (4.4%)
Gender							
Male (n=93)							
Subjective	67.9±11.9	168.8±8.3	24.0±5.7	5 (5.4%)	60 (64.5%)	23 (24.7%)	5 (5.4%)
Objective	66.9±13.7	170.2±6.3	23.1±4.5	8 (8.6%)	61 (65.6%)	20 (21.5%)	4 (4.3%)
Female (n=88)							
Subjective	54.3±8.9	156.4±8.3	22.3±3.6	8 (9.1%)	63 (71.6%)	14 (15.9%)	3 (3.4%)
Objective	55.2±11.3	156.3±6.5	22.6±4.4	9 (10.2%)	57 (64.8%)	18 (20.5%)	4 (4.5%)
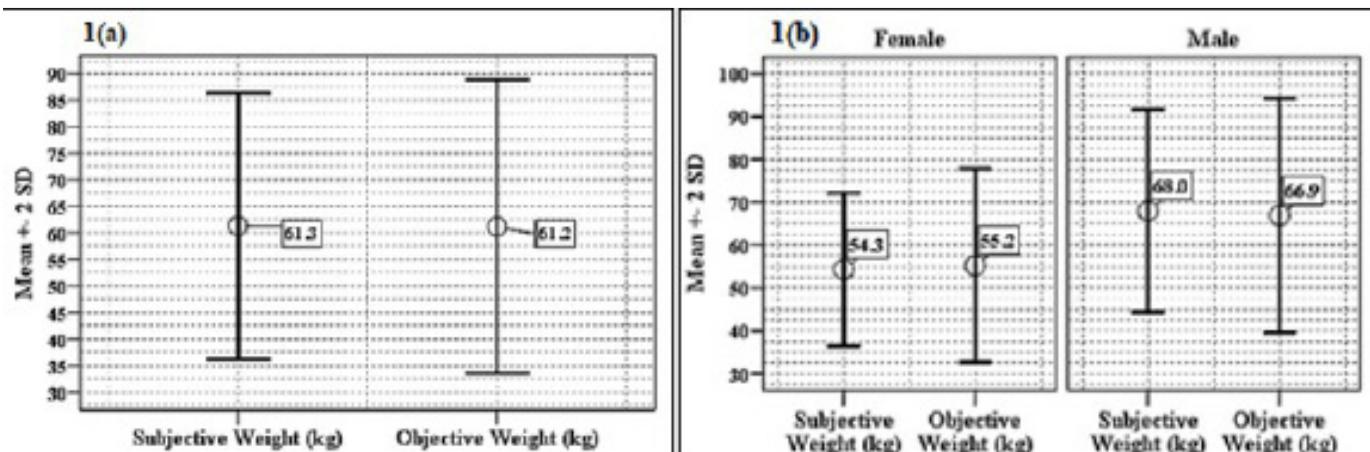
Figure 1: Mean values (±2SD) of subjective and objective weights (kg) in overall study participants (1a) and according to gender (1b)
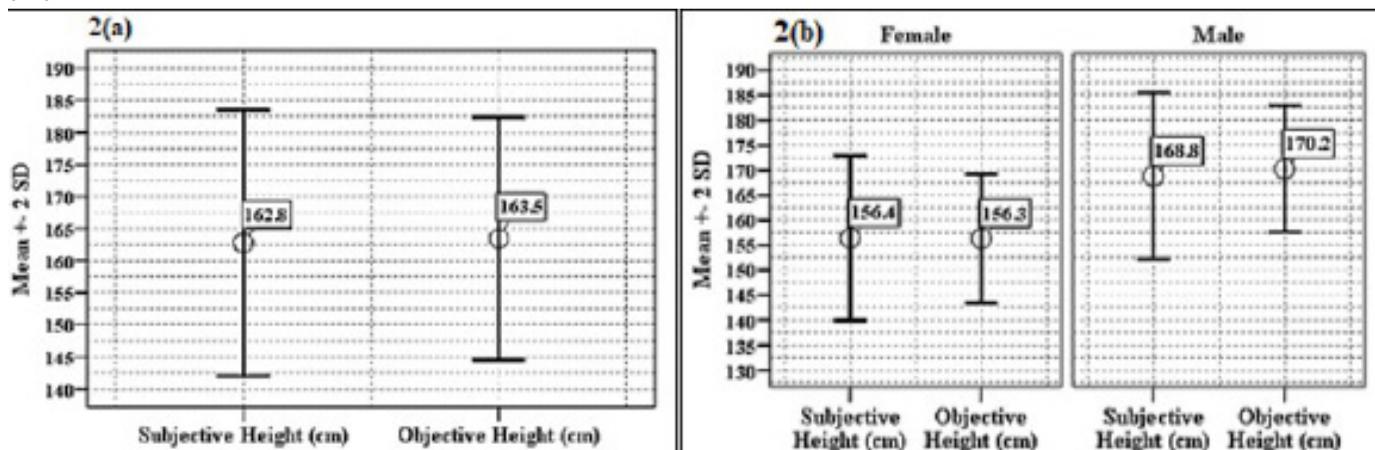

Figure 2: Mean values (±2SD) of subjective and objective body measures height (cm) in overall study participants (2a) and according to gender (2b)
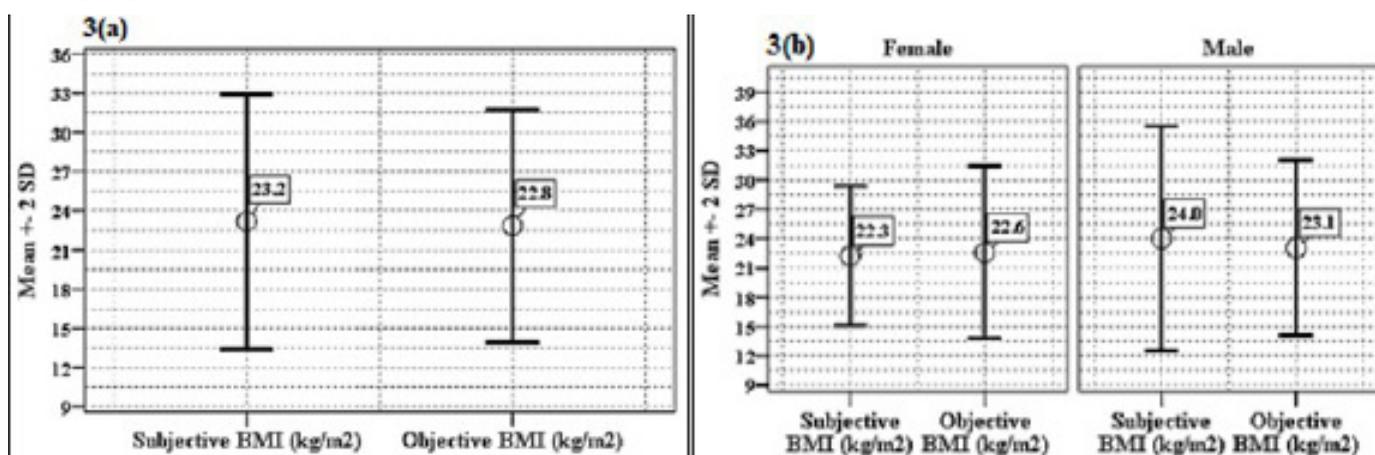

Figure 3: Mean values (±2SD) of subjective and objective body mass index (BMI) in overall study participants (3a) and according to gender (3b)

Across the gender, 25.8% (objective) and 30.1% (subjective) of the males were overweight/obese; the proportions of underweight males were 8.6% (objective) and 5.4% (subjective). Similarly, 25.0% (objective) and 19.3% (subjective) of the females were overweight/obese; the proportions of underweight females were 10.2% (objective) and 9.1% (subjective) (Tables 1 and 2).

In the overall participants, as compared to the subjective measures, the proportion of objective measures of overweight/obesity in the subjects was 0.6% more; that of underweight BMI was 2.2% more. The proportion of overweight/obese male subjects was 4.3% less, and that of underweight male subjects was 3.2% more according to the objective measure than the subjective. Similarly, the proportion of overweight/obese female subjects was 5.7% more, and that of underweight female subjects was 1.1% more in the objective measure than the subjective (Table 2).

Table 2: Comparison between proportions of subjective and objective BMI categories for overweight/obese and underweight subjects, in overall study participants and according to gender and year of study

| | Overweight/Obese | | | | | Underweight | | | | |
| | Subjective | | Objective | | Difference in Proportion (95% CI) | Subjective | | Objective | | Difference in Proportion (95% CI) |
	N	%	N	%		N	%	N	%	
Total	45	24.80%	46	25.40%	−0.6% (−9.5%; 8.4%)	13	7.20%	17	9.40%	−2.2% (−7.9%; 3.5%)
Gender										
Male	28	30.10%	24	25.80%	4.3% (−8.6%; 17.2%)	5	5.40%	8	8.60%	−3.2 (−10.5%; 4.1%)
Female	17	19.30%	22	25.00%	−5.7% (−17.9%; 6.6%)	8	9.10%	9	10.20%	−1.1% (−9.9%; 7.6%)

Table 3: Comparison between mean values of subjective and objective measures (weight, height and BMI) in overall study participants and according to gender

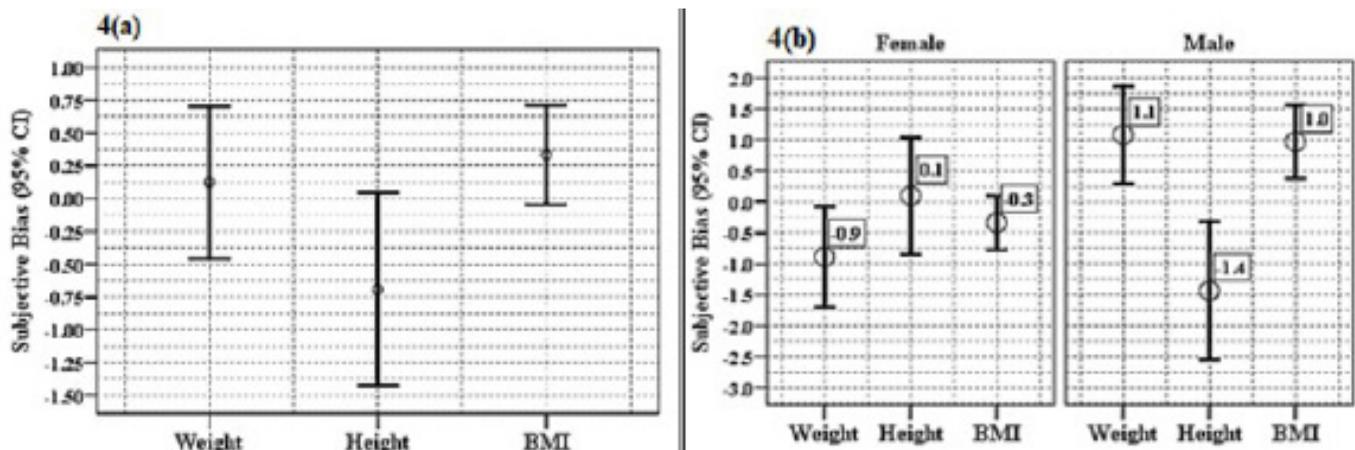| | Subjective Vs Objective | | | | | |
| | Weight (kg) | | Height (cm) | | BMI (kg/m^2) | |
	Mean Difference (95% CI)	't-value' [Significance (p-value)]	Mean Difference (95% CI)	't-value' [Significance (p-value)]	Mean Difference (95% CI)	't-value' [Significance (p-value)]
Total	0.1 (−0.5; 0.7)	't' = 0.423 (p = 0.673)	−0.7 (−1.4; 0.04)	't' = −1.858 (p = 0.065)	0.4 (−0.05; 0.7)	't' = 1.725 (p = 0.086)
Gender						
Male	1 (0.3; 1.9)	't' = 2.706 **(p = 0.008**)**	−1.4 (−2.6; −0.3)	't' = −2.555 **(p = 0.012**)**	0.9 (0.4; 1.6)	't' = 3.238 **(p = 0.002**)**
Female	−0.9 (−1.7; −0.1)	't' = −2.167 **(p = 0.033**)**	0.1 (−0.8; 1.0)	't' = 0.201 (p = 0.842)	−0.3 (−0.8; 0.1)	't' = 1.560 (p = 0.122)

Figure 4: Subjective bias (mean difference between subjective and objective measures) for body measures (weight, height and BMI) in overall study participants (4a) and according to gender (4b)

Table 3 and Figure 4 illustrate the comparisons between the mean values of subjective and objective body measures in overall study participants and according to gender. Overall, as compared to the measured weight and height, the participants reported a mean weight of 0.1 kg high and height of 0.7 cm less, respectively. Moreover, the mean subjective BMI was 0.4 kg/m^2 more than the objective BMI. The differences in mean values of weight, height and BMI between the subjective and objective measures were non-significant (p=0.673, 0.065 and 0.086, respectively).

The male subjects reported a mean weight of 1.0 kg more as compared to the measured weight; a mean height of 1.4 cm less as compared to the measured height. The mean subjective BMI in these subjects was 0.9 kg/m^2 more than the objective BMI. The differences in mean of these body measures (weight,

height and BMI) were all statistically significant (p=0.008, 0.012 and 0.002, respectively) (Table 3).

The female subjects reported a mean weight of 0.9 kg less as compared to the measured weight, with the difference being statistically significant (p=0.033). However, they reported a mean height of 0.1 cm more as compared to the measured height and the mean subjective BMI was 0.3 kg/m^2 less than the objective BMI. The differences in mean of these later two body measures (height and BMI) were statistically non-significant (p=0.842 and 0.122, respectively) (Table 3).

DISCUSSION

The subjective assessment of obesity is considered to be a practical and economical method and researchers have studied the reliability of subjective measures of obesity with an overall satisfactory outcome, i.e., significant correspondence with objective measures.[7] On the other hand, a number of factors associated with biases in subjective assessment have also been acknowledged. These include, most commonly, demographic factors and body composition factors.[13] The reported discrepancies in the prevalence rates of overweight/obesity and underweight in the population in various studies conducted far and wide prompted the design of the present study.

As documented in this study, the prevalence of objective overweight/obesity was in the overall study participants was 25.4%, i.e., 0.6% more than the prevalence of subjective overweight/obesity (24.8%). Similarly, the prevalence of objective underweight BMI was 9.4%, i.e., 2.2% more than the prevalence of subjective underweight BMI (7.2%). Moreover, in these participants, the subjective bias (difference between subjective and objective measures) in weight was 0.1 kg, height was -0.7 cm, and BMI was 0.4 kg/m^2. These differences were not statistically significant (p>0.05).

In a study conducted amongst German adolescents, Kurth et al[14] reported an underestimated prevalence rate of overweight/obesity when subjective body mass indices were compared with the measured values. However, in our study, although there was an underestimation in prevalence of subjective overweight/obesity, the subjective bias in BMI was positive, i.e., subjective BMI was more than the objective BMI. Brettschneider et al[3] assessed the soundness of subjective measures of obesity in 11-17 years old German adolescent subjects from the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) study. They found the overestimated height and underestimated weight, as a result of which subjective body mass index was underestimated. This evidently resulted in discrepancy in prevalences of subjective and objective overweight/obesity (15.1% vs 17.7%) and underweight BMI (9.7% vs 7.5%). Shiely et al[15] scrutinized the tendencies in discrepancies in objective and subjective BMI from three representative surveys conducted in Ireland during 1998, 2002 and 2007. They reported an underestimation of subjective BMI which was found to intensify through the three surveys.

In the present study, the prevalence of objective overweight/obesity in the males was 25.8%, 4.3% less than the prevalence of subjective overweight/obesity (30.1%). The prevalence of objective underweight-BMI was 8.6%, 3.2% more than the prevalence of subjective underweight BMI (5.4%). Further, in these subjects, the subjective bias in weight was 1.0 kg, height was -1.4 cm, BMI was 0.9 kg/m^2. The differences were statistically significant (p<0.05). In the females, the prevalence of objective overweight/obesity was 25.0%, 5.7% more than the prevalence of subjective overweight/obesity (19.3%). The prevalence of objective underweight BMI was 10.2%, 1.1% more than the prevalence of subjective underweight BMI (9.1%). In these students, the subjective bias in weight was -0.9 kg, height was 0.1 cm, and BMI was 0.3 kg/m^2. Only the difference in weight was statistically significant (p<0.05). The differences in height and BMI were not significant (p>0.05). The observed discrepancy in weight only (and not in height) could be attributed to the recent changes in the weight of the participants after they had them measured before reporting in the study.

Poston et al[13] assessed the legitimacy of subjective measures of obesity in male US firefighters, and found that subjective BMI led to overestimation of prevalence of obesity. In another study conducted amongst US college students, Wright et al[1] reported an underestimation of self-reported measure of obesity (BMI). Chang et al[16] analyzed the data from third National Health and Nutritional Examination Survey (NHANES) to assess the pertinence of subjective body weight. They found that 27.5% of female and 29.8% of male subjects reported discrepant subjective body weight. Peltzer et al[11] estimated the prevalence of overweight/obesity amongst university students from 22 countries and found that the rate was 24.7% in males 19.3% in females with the overall rate of 22.0%. Likewise, the prevalence of underweight was 10.8% in male and 17.6% in females. Maukonen et al,[17] in their literature review on researches conducted through 2006–2017 amongst grown-up people of both gender groups (males and females), found an overestimation of subjective height, an underestimation of subjective weight, with the resultant underestimation of subjective BMI. Similarly, Sherry at al[18] found that many studies reported an underestimated prevalence of subjective overweight with the bias being more in the females than in the males. In one study based on female South Korean university students, Jun et al[19] reported the prevalence rates of objective and subjective overweight/obesity to be 3.8% and 32.7%, respectively. These results were in sheer contrast to the findings of this study. Whereas in our study, less proportions of female students assumed that they were obese than they really were, the trend was just opposite amongst the South Korean female university students. Similarly, the rates of underweight BMI were 15.7% (objective) and 7.9% (subjective), similar to our findings.[19]

As presented in the present study and documented in many other similar studies, the use of body mass index (BMI) for the assessment of obesity is found to suffer from self-report bias, i.e., largely dependent on self-reported height and weight.[1, 5] There is a general tendency of many individuals to underestimate their weights and overestimate their height, with the resultant lower subjective BMI.[6, 7, 20] Women have been found

to report significantly lower weight and other body size descriptors than men. This can be ascribed to the prevailing media hype of ideal female body, lean and thin.[6-8] Men, on the other hand, have been found to overestimate their height and weight, under the conditioning of overhyped ideal male body, muscular and heavy.[21] To add, adolescents and early adult population of either of the gender groups have been found to be even more profoundly influenced and tend to report erroneously. Likewise, obese individuals are inclined to over-reporting their heights while under-reporting their weights, with the resultant erroneous body mass indices and thus errors in the reported prevalences of obesity.[7]

Some of the limitations of the study are basically related to the selection of participants and setting, amongst others. Undergraduate medical and dental do not truly represent the adolescent population, with the resultant lack of generalizability of the findings. Moreover, as the participants are likely to be aware of the importance of ideal body mass index, tendency to report the weight and height falsely (approximating more towards to the ideal) is high, affecting the results even more. Most importantly considering only the body mass index for the assessment of obesity is methodically inadequate and use of other measures such as waist circumference and weight and hip ratio could have given a clearer and accurate picture of obesity in the study participants.

Nonetheless, the study findings do endow with some future directions. The results can serve as valuable tools to plan any further research of the similar nature, within the institution, especially to assess the psychological make-up of the participants in whom the biases are substantial. Studies have reported association between body image/self-esteem and bias amongst ad-olescents, especially those in the groups of overweight/obese or underweight body mass indices.[10, 14, 19] Moreover, since the bias in overall participants was not statistically significant, subjective method can be relied upon for the assessment of BMI amongst the similar subjects.

CONCLUSION

In the overall participants, the prevalence of subjective obesity was less than the clinically measured one, although the difference was not statistically significant, so was the subjective bias in BMI. In the males, as compared to the rate of subjective obesity, clinical measured obesity was less, the difference being statistically non-significant. However, the subjective bias in BMI was statistically significant. In the females, the rate of subjective obesity was less (statistically non-significant) than the objective one, so was the subjective bias in BMI. These findings not only point towards some degree of acceptability of the subjective assessment of obesity, but also suggest the prospect of assessment of body image/self-esteem which becomes a paramount next step to plan for appropriate behavioral therapeutic approaches in subgroups of subjects with the greatest bias.

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