Research Article

Comparison of body mass index in the evaluation of overall obesity in Finnish and Bangladeshi undergraduate students aged 18–35 years: a pilot study

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Abstract

Background: The incidence of overall obesity has increased dramatically, not only in high-income countries but also in low- and middle-income countries. Body mass index (BMI) is widely used as a measure of overweight and obesity.

Objective: To assess the prevalence of overall obesity in Finnish and Bangladeshi undergraduate students aged 18–35 years.

Materials and Methods: A population-based cross-sectional pilot study of undergraduate students in Finland and Bangladesh. BMI was calculated as the weight in kilograms divided by the square of the height in meters. Based on cut-points recommended by the World Health Organization, BMI (kg/m^2) for normal weight is 18.5–24.9 kg/m^2 and that for pre-obesity and obesity is 25.0–29.9 and 30.0–34.9 kg/m^2, respectively, in Finnish; obesity of Asians was found as 25–29.9 kg/m^2 for moderate category (obese I) and more than 30 kg/m^2 for severe category (obese II), while for pre-obese and for normal weight the BMI was 23–24.9 and 18.5–22.9 kg/m^2, respectively.

Result: The mean age was 24.70 ± 4.31 years for Finnish and Bangladeshi students, whereas mean BMI of Bangladeshi and Finnish students were 23.64 ± 4.55 and 24.48 ± 3.35 kg/m^2, respectively. The relationship between body height (167.80 ± 8.93 cm vs 159.65 ± 7.37 cm) and body weight (68.60 ± 8.08 kg vs 60.49 ± 13.40 kg) of Finnish and Bangladeshi participants were very significant ($P < 0.001$) while BMI distribution was found to be nonsignificant (24.48 ± 3.35 vs 23.64 ± 4.55 kg/m^2, $P = 0.4411$). Very significant connotations were documented amidst four groups of BMI categorized Finnish ($P < 0.0001$) and Bangladeshi ($P < 0.0001$) students. Adjusted R^2 of percentiles itemized for body height, body weight, and BMI were significant among Finnish and Bangladeshi participants.

Conclusion: Obesity, 36.7% (20% for pre-obesity), is predominant in Bangladeshi adults, whereas pre-obesity, 30% (10% for obesity), is higher in Finnish. An understanding of the reasons behind the high predominance of pre-obesity is essential for its prevention as well as for the prevention of the morbidities to which it may lead.

KEY WORDS: Prevalence, pre-obesity, body mass index (BMI), undergraduate

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Introduction

The anthropometric valuation of nutritional status in juveniles is a multifaceted tactic because of the great inconsistency of growth patterns and body size in this age group. This inconsistency depends on the individual's nutritional status as well as on growth performance during childhood and hormonal factors related to the process of sexual maturation.[1–4]

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In 1995, the World Health Organization (WHO) recommended that the body mass index (BMI) be used in the screening of overweight and obese adolescents because this index is well correlated with body fat, easy to perform, and has reference values that permit a comparison between different populations and the use of this principle for assessments in adulthood.[5] Typically, in adult males, the desirable body fat content is about 15%–20%, and in females it is higher at about 25%–30%.[6] Women have more fat than men for a given BMI. An analogous situation is seen for Asians compared to whites and blacks. Asian populations have 3%–5% higher body fat than others at an identical BMI.[7] Similarly, for a given amount of body fat, the BMI is 2–3 units lower in Asians than in whites. This observable fact is ascribed to the smaller body frame of Asians. Hence, the usual cut-points of obesity may not be suitable for Asians in general, and South Asians in particular.[8] A BMI more than 25 is considered obese for Asians in variation to 30 for other populations.[8] Furthermore, blacks have lower body fat and different metabolic abnormalities for a given BMI. The optimum BMI appears to be below 23 for Asians, 23–25 for whites, and 23–30 for blacks.[8] Obesity increases the risk of cardiovascular diseases and type 2 diabetes[9,10] at the same time imposing functional limitations in a number of subjects, which translate into a reduced quality of life as well as life expectancy.[11,12]

In this study, the BMI was used to assess overall obesity comparing body weight and body height in two groups of population samples, one group (n = 30) from Finland and the other from (n = 30) Bangladesh. The working hypothesis is that there are noticed associations among body height, body weight, and BMI of participants. In Bangladesh, the context of obesity and overweight has been under explored, more so among younger age groups. The existing position and inclinations will provide useful understandings into its risk factors and will back health professionals and policy-makers in decision-making and developing future research outline. This work explored the availability of literature on adult obesity/overweight and offers a much broader perspective in the respective field, which makes it a more appropriate method to assess the situation of obesity in Bangladesh.

Materials and Methods

The data (from healthy undergraduate students) were collected from Primeasia University (n = 30, male 15 and female 15) in Bangladesh and University of Oulu (n = 30, male 15 and female 15) in Finland in 2014. Height (measured to the nearest 0.1 cm) and weight (measured to the nearest 0.1 kg) were measured by trained staff during one visit. BMI was calculated by dividing weight in kilograms by height in meters squared. Data were collected by interview in individual's university. To ensure that the samples from each participating country were as nationally-representative as possible, responses were prejudiced by demographic factors for each sampling point based on the official statistics.

Based on cut-points recommended by the WHO, the 30 respondents included in this study were divided into three health risk categories based on BMI (kg/m^2)—normal weight, 18.5–24.9 kg/m^2; pre-obesity, 25.0–29.9 kg/m^2; and obesity, 30.0–34.9 kg/m^2—in Finnish.[13] WHO recommends different cut-off points for obesity in Asians. Obesity of Asians was acknowledged as 25–29.9 kg/m^2 in moderate category (obese I) and more than 30 kg/m^2 in severe category (obese II) while 23–24.9 kg/m^2 for pre-obese and 18.5–22.9 kg/m^2 for normal weight.[14] This study pertains to respondents aged 18–35 years, and pregnant women and respondents aged below 18 years as well as above 35 years were excluded.

The Questionnaire

Assessment of the literature learned the selection of questionnaire items and scales. Results from authenticated scales were used under license or with the permission of the authors. To calculate BMI, responders' body weight and body height were measured with their written consent. Age (years) and sexes (male and female) of respondents were also included in the questionnaire to describe the study sample. Questions evaluating obesity of respondents were associated with the categorical and numerical responses.

Data Analysis

Data were analyzed using the Statistical Package for Social Science version 21 (SPSS, Chicago, IL) software. Continuous variables were tested for normality using histogram and Kolmogorov test. Continuous variables were expressed as mean with standard deviation, and categorical variables were expressed as frequency with percentage. Comparison of anthropometric variables between Finnish and Bangladeshi undergraduate students with age and sex stratified was made using Pearson's chi squared test for categorical variables and independent samples and Student's t-test for continuous scale variables. More than two variables were evaluated statistically by using one-way ANOVA while compared between two variables with Student's t-test. $P < 0.05$ was considered significant level of statistically assessed variables. Error bars were generated with 95% confidence interval (CI). The Finnish and Bangladeshi samples were investigated separately to establish which independent variables were the best predictors of BMI (kg/m^2) within each country. Continuous measures (age) were adjusted to assess if there were any potential interactions with sex.

Results

The general characteristics of Finnish and Bangladeshi undergraduate students with sex adjusted are presented in Table 1. The mean age of Finnish and Bangladeshi participants was 24.7 years (SD 4.31).

In Finnish students, mean body height and weight were 167.8 cm (male 168.46 cm and female 167.13 cm) and 68.60 kg

(male 70.53 kg and 66.67 kg), respectively, whereas in Bangladeshi students, body height was 159.65 cm (male 162.24 cm and female 157.06 cm) and body weight was 60.49 kg (male 69.83 kg and female 51.15 kg). It was found that the mean BMI was 23.64 ± 4.55 (male 26.57 ± 3.48 and female 20.71 ± 3.52) in Bangladeshi students, whereas 24.48 ± 3.35 (male 23.63 ± 3.07 and female 25.33 ± 3.50) in Finnish students.

Statistically significant differences were found between male and female Bangladeshi undergraduate students regarding their body weight ($P < 0.05$), body height ($P = 0.05$), and BMI (<0.05). Overall statistically nonsignificant relationship in body weight, height, and BMI among Finnish undergraduate students was found. The age- and sex-dependent variables are distributed symmetrically in this pilot study, as shown in Figure 1.

The crude relationship of body weight, height, and BMI between Bangladeshi and Finnish undergraduate students is presented graphically in Figure 2. To underline the role of lifestyle in undergraduate Bangladeshi and Finnish students, we calculated the BMI; results are shown in Tables 1–3. The crude relationship among variables of body weight, height, and BMI in both Bangladeshi and Finnish students were evaluated using student's *t*-test (paired *t*-test), and very significant relationship (***$P < 0.01$) was found between the two variables (body height and body weight). A nonsignificant ($P > 0.05$) crude relationship was found with BMI of participants.

Tables 2 and 3 show the crude prevalence of pre-obesity and obesity in Finnish and Bangladeshi students. The crude prevalence of pre-obesity and obesity for both sexes was 30% and 10%, respectively, in Finnish students [Table 2].

Finnish female students presented higher prevalence of pre-obesity (20%) and obesity (3.33%) than male (10% in pre-obesity and 6.66% in obesity). Randomly selected Finnish undergraduate students were not in underweight BMI (<18.5 kg/m^2).

In Bangladeshi students [Table 3], 20% and 36.7% overall prevalence of pre-obesity and obesity were found, respectively. Sex-adjusted point prevalence of pre-obesity was 13.33% in male and 6.67% in female while 30% obesity was documented in male but 6.67% in female students.

Here, it is clear that the male Bangladeshi participants are more disposed to pre-obesity and obesity. BMI stratified participants in this study was scrutinized statistically, as shown in Figure 3A and B.

In Figure 4A and B, body height, weight, and BMI of Finnish participants were figured out with sex specifications. Here boxplots were generated with 95% CI.

The ethnic specified body height, body weight, and BMI were evaluated statistically, as shown in Figure 5.

The percentiles (5th, 10th, 15th, 20th, 25th, 30th, 35th, 40th, 45th, 50th, 75th, 85th, and 95th) of body height, weight, and BMI were also statistically explored. The height of Finnish and Bangladeshi undergraduate students were linearly correlated (y = 2.3643x + 148.8; R^2 = 0.9593 for Finnish students and y = 2.132x + 146.12; R^2 = 0.9665 for Bangladeshi students). The 95th percentile of body height of Finnish was 181.35 cm, whereas it was 177.15 cm in Bangladeshi students, as shown in Figure 6.

A coefficient of determination (adjusted R^2) equal to 0.96 in Finnish and 0.97 in Bangladeshi undergraduate student's body height percentiles indicated that for about 96% and 97% of the variation in statistics grades, the dependent variable (body height) could be explained by the relationship to percentiles (the independent variable).

Some overlapping body weight percentiles were calculated in Finnish and Bangladeshi undergraduate students. The 25th and 85th percentiles of body weight of Finnish and Bangladeshi students overlapped. The 95th percentile of Bangladeshi student's body weight percentile was higher than that of Finnish students. Remaining percentile values of body weight in Bangladeshi students were lower than that in Finnish students.

Percentiles are the most commonly used indicator to assess the size and growth patterns of individuals. In Figure 7, pre-obese category of percentiles (5th to less than 85th) among Finnish and Bangladeshi participants overlapped. At 95th percentile or above, Bangladeshi participants were ahead the Finnish participants.

Discussion

In this pilot study, it is unusual in that it has considered two culturally diverse demonstrative samples of adult aged Finnish and Bangladeshi students. To allow for the possibility of cultural differences in how demographic factors, lifestyle, and psychological well-being interact with obesity. We found that the overall obesity (reflected by higher BMI) of Finnish and Bangladeshi undergraduate students. Overweight and obesity can be defined to inform health status from a population perspective and from an individual perspective. While the purpose of this study is to guide treating physicians, our focus is on the individual, and it is still informative to discuss overweight and obesity definitions from a population level. The current pre-obesity and obesity are defined on BMI of 25.0–29.9 and 30.0–34.9 kg/m^2, respectively, in Finnish students.[13] Obesity of Asians was acknowledged as 25–29.9 kg/m^2 in moderate category (obese I) and more than 30 kg/m^2 in severe category (obese II) while 23–24.9 kg/m^2 for pre-obese in Bangladeshi individuals.[14]

Because BMI tracks well with total body fat on a population level,[15] such a definition is acceptable from an epidemiologic standpoint. On an individual basis, these definitions do not always serve to identify those at health risk because of excess body fat. For those with increased muscle mass, such as body builders, BMI overestimates health risks because the total body fat may not be increased, and for the elderly, with a reduced lean mass, the BMI underestimates the health risk of fatness. Thus, because of the implications for health risks and increased demands on the health-care system for advice

Table 1: Characteristics of study population

Features	Bangladesh*			Finnish		
	Male	Female	Total	Male	Female	Total
N	15	15	30	15	15	30
Age (y) (mean ± SD)[a]	25.40 ± 3.58	24.00 ± 4.97	24.70 ± 4.31	24.80 ± 3.68	24.60 ± 4.99	24.70 ± 4.31
Body weight (kg) (mean ± SD)[b]	69.83 ± 9.88	51.15 ± 9.33	60.49 ± 13.40	70.53 ± 7.18	66.67 ± 8.70	68.60 ± 8.08
Body height (cm) (mean ± SD)[c]	162.24 ± 7.76	157.06 ± 6.15	159.65 ± 7.37	168.46 ± 7.26	167.13 ± 10.56	167.80 ± 8.93
Body mass index (mean ± SD)[d]	26.57 ± 3.48	20.71 ± 3.52	23.64 ± 4.55	23.63 ± 3.07	25.33 ± 3.50	24.48 ± 3.35

SD, Standard deviation; y, years.
[a]P (independent sample t-test) = 0.90; 0.38*
[b]P (independent sample t-test) = 0.19; <0.01*
[c]P (independent sample t-test) = 0.69; 0.05*
[d]P (independent sample t-test) = 0.169; <0.01*
*Level of statistical significance ($P \leq 0.05$).

Table 2: Mean BMI and the prevalence of pre-obesity (BMI 25–29.9 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) by sex and BMI specified in Finnish students

Age groups (y)	Finnish students				
	n	BMI (mean ± SD)	Normal BMI 18.5–24.9 (% *n*)	Pre-obese BMI 25–29.9 (% *n*)	Obese BMI ≥ 30 (% *n*)
Male					
18–35	15	23.63 ± 3.07	22.18 (36.66)	26.44 (10)	31.14 (3.33)
Female					
18–35	15	25.33 ± 3.50	22.27 (23.33)	27.01 (20)	31.02 (6.66)
Total					
18–35	30	24.48 ± 3.35	22.22 (60)	26.82 (30)	31.06 (10)

BMI, Body mass index; SD, standard deviation; % n, frequency with percentage; y, years in age.

Table 3: Mean BMI and the prevalence of pre-obesity (BMI 23–24.9 kg/m^2) and obesity (BMI ≥ 25 kg/m^2) by sex and age specified Bangladeshi students

Age groups (y)	Bangladeshi students[a]					
	N	BMI (mean ± SD)	Underweight BMI <18.5 (% *n*)	Normal BMI 18.5-22.9 (% *n*)	Pre-obese BMI 23–24.9 (% *n*)	Obese BMI ≥ 25 (% *n*)
Male						
18–35	15	26.57 ± 3.48	00.00 (0)	22.58 (6.66)	24.4 (13.33)	28.43 (30)
Female						
18–35	15	20.71 ± 3.52	16.91 (16.7)	20.90 (20)	23.79 (6.67)	26.58 (6.67)
Total						
18–35	30	23.64 ± 4.55	16.91 (16.7)	21.32 (26.7)	24.19 (20.0)	28.09 (36.7)

BMI, Body mass index; SD, standard deviation; % *n*, frequency with percentage; y, years in age.
[a]Correlation is significant between stratified BMI and gender at the $P < 0.01$ level (2-tailed); Pearson's chi-square (df), P, 12.121[b] (3), 0.007.
[b]Six cells (75.0%) have expected count less than 5. The minimum expected count is 2.50.

and treatment, we need a set of ground rules that define overweight and obesity in terms of health risk to the individual and to guide a risk–benefit approach to selecting treatments. Health risks drive treatment options.

According to the results of this study, BMI assessment showed 30% of Finnish participants were pre-obese (20% female and 10% male) and 10% were obese (3.33% male and 6.67% female). On the other hand, 20% of Bangladeshi participants were in pre-obese category (13.33% male and 6.67% female) and 36.7% participants in obese (30% male and 6.67% female) category.

The results indicated differences in which factors best clarified obesity within the two countries. BMI among the Bangladeshi students was explained by having spent less time in education, having reported illness-related events, and lack of physical activity. The predominance of obesity is very high in high-income countries and many of them have acknowledged obesity an epidemic.[16,17]

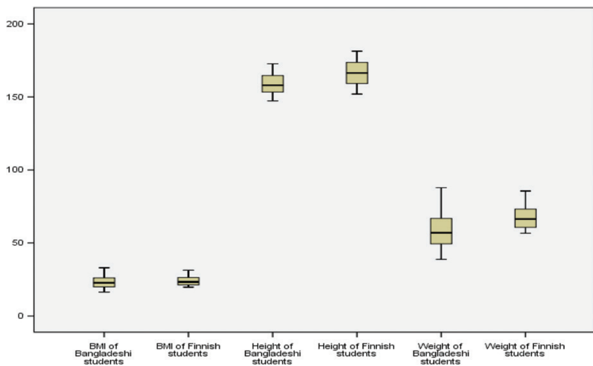

Figure 1: Distribution of dependent variables in this pilot study. Boxplots are generated (nonparametric parameter) for the distributional characteristics of participants as well as the level of the scores. A boxplot splits the data set into quartiles. The body of the boxplot consists of a "box" (hence, the name), which goes from the first quartile (Q1) to the third quartile (Q3). There are no outliers among dependent variables. Q1, Q2, and Q3 of body height are 160, 168, and 177.25 cm for Finnish students, whereas 153.75, 158.35, and 165.32 cm for Bangladeshi participants. Q1, Q2, and Q3 have body weights 61.5, 68, and 75.25 kg, respectively, for Finnish participants while Bangladeshi participants have bodyweights 49.77, 63.55, and 67.92 kg, respectively, for Q1, Q2, and Q3. Outliers were not found in case of body mass index evaluations. So subsequent parametric statistical analysis was done for obesity assessment in participants with their relevant variables stratified.

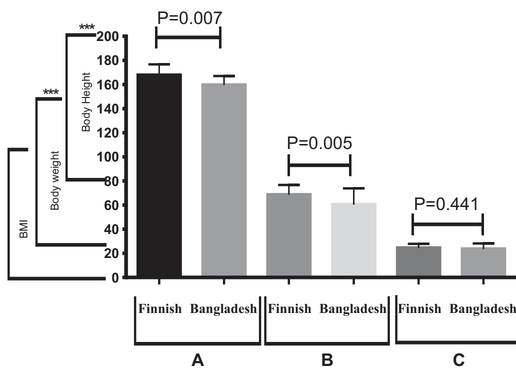

Figure 2: Relationship of body weight, height, and body mass index (BMI) between Bangladeshi and Finnish undergraduate students. Error bars were generated with 95% confidence interval (CI) with age categorized in relation to mean of body weight, height, and BMI. ***$P < 0.01$ (Bangladeshi and Finnish undergraduate students). (A) Explore the correlation of participant's body height ($P < 0.01$) and 95% CI of mean differences of height is 3.748–12.55, (B) statistical evaluation of participants' body weight ($P < 0.01$) and 95% CI of mean differences of weight is –13.57 to -2.648, (C) participants BMI was statistically non-significant and 95% CI of mean differences of BMI is –3.038 to 1.360.

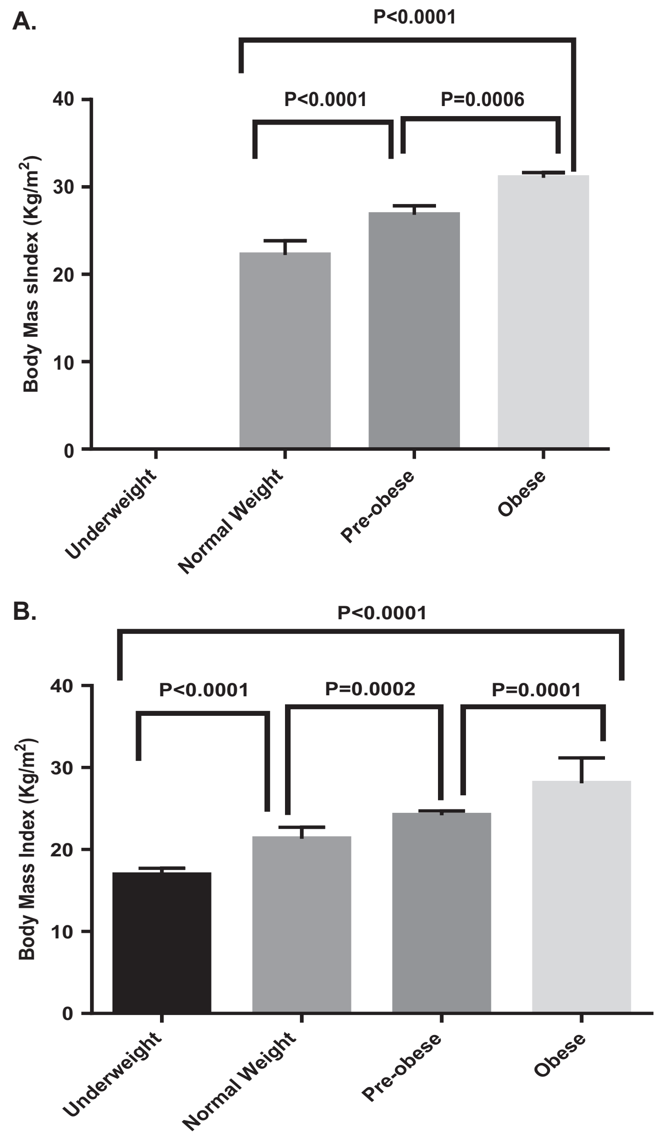

Figure 3: Characterizations of participants with body mass index stratifications. (A) One-way ANOVA of variables (normal weight, pre-obese, and obese) in Finnish participants shows the strong correlation ($P < 0.001$), and paired *t*-test of normal weight vs pre-obese and obese vs pre-obese shows the significant relationships, $P < 0.0001$ and $P < 0.001$, respectively. (B) In Bangladeshi participants, four variables (underweight, normal weight, pre-obese, and obese) were judged statistically utilizing one-way ANOVA, which shows strong relationship ($P < 0.0001$). Paired *t*-test in case of normal weight vs underweight ($P < 0.0001$), normal weight vs pre-obese (P value 0.0002), and obese vs pre-obese (P value 0.0001) shows the statistically significant relationship.

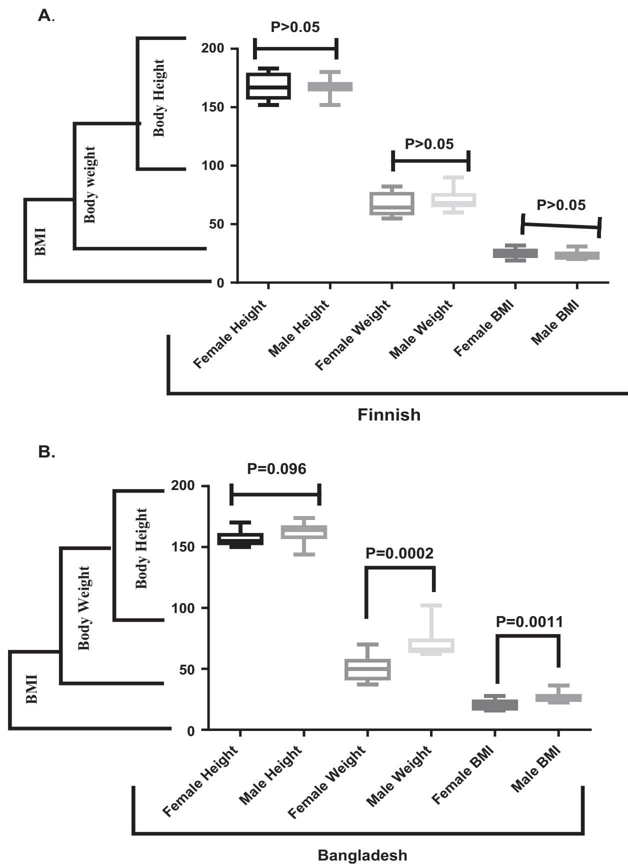

Figure 4: The distribution of body height, body weight, and body mass index (BMI) of participants are statistically evaluated. The evaluations were done with participants' sex stratifications. (A) Nonsignificant ($P > 0.05$) mean differences of Finnish male and female participants were found. (B) Statistically very strong association ($P < 0.001$) was found in Bangladeshi male and female body weight and BMI while nonsignificant association between male and female body height ($P > 0.05$).

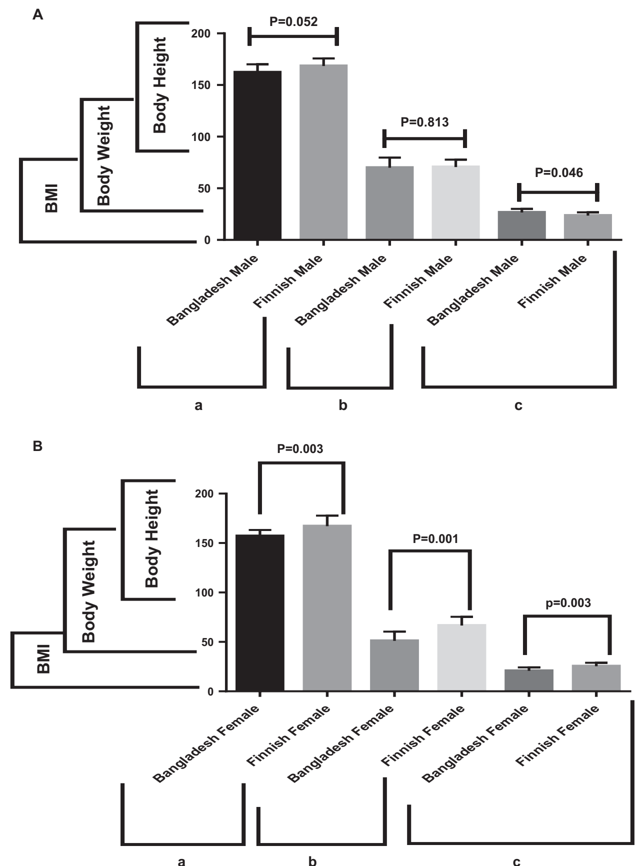

Figure 5: Ethnic stratified male and female body height, body weight, and body mass index (BMI). (A) Discovered the mean differences of male stratified Bangladeshi and Finnish participants and significant inference was in BMI (c; $P < 0.05$), whereas the rest of the variables (a and b) showed nonsignificant ($P > 0.05$) connotation. (B) In female stratified, the mean differences of body height (a), body weight (b) and BMI (c) among Bangladeshi female participants were estimated and statistically very significant relationship was found: "a ($P = 0.003$)", "b ($P = 0.001$)," and "c ($P = 0.003$)".

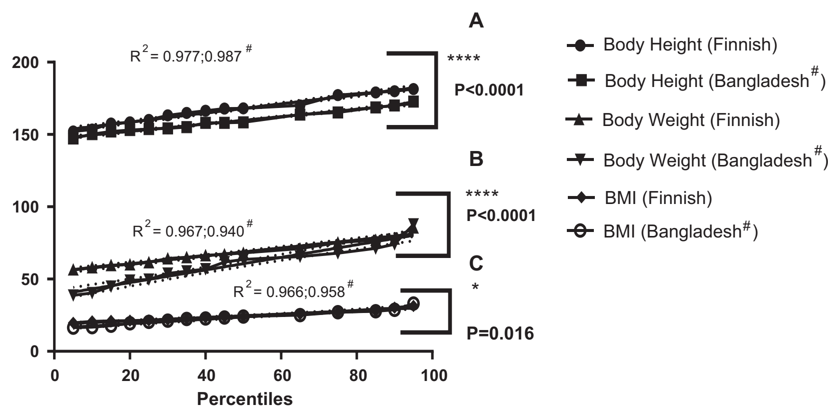

Figure 6: Linear regression analysis of percentiles stratified body height, body weight, and body mass index (BMI). (A) Linear regression analysis of body height percentiles of Finnish and Bangladeshi participants were statistically very strong ($P < 0.0001$), and adjusted R^2 of Finnish participants was 0.97 and 0.98 in Bangladeshi participants. (B) Statistically very strong significance was also found ($P < 0.0001$) in body weight percentiles among Finnish and Bangladeshi participants and adjusted R^2 of Finnish participants was 0.96 and Bangladeshi participants was 0.94. (C) Statistically significant link was found ($P < 0.01$) in BMI percentiles of participants and adjusted R^2 of Finnish participants was 0.96 and Bangladeshi participants was 0.95.

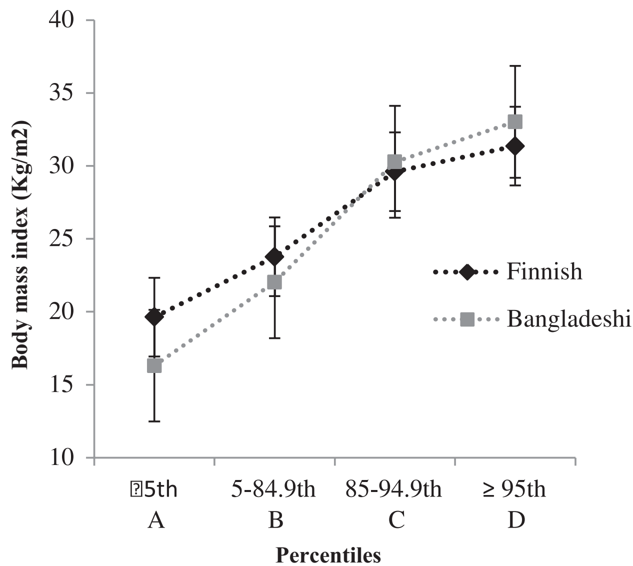

Figure 7: Percentiles range of body mass index evaluating weight status category. (A) Less than 5th percentiles reflect on the underweight weight status, (B) 5th percentile to less than the 85th percentile is considered healthy weight category, (C) 85th to less than 95th percentile is mirror of pre-obese, and (D) equal to or greater than the 95th percentile is considered obese.

The low-income countries are showing the same trend as the high-income countries. And the dual burden households are very common where underweight and overweight coexist among the children.[18] Rapid urbanization and industrialization are changing the food habits resulting in socioeconomic, demographic, and cultural changes leading to nutritional transition in low-income countries.[19,20] The proportions of obesity among women in Bangladesh, and the related health and social problems have already been addressed in several studies.[21,22] However, there is a lack of national data for overall body weight status of school-aged children. The finding that BMI in Bangladeshi students was predicted by sedentary behavior is in observance with acknowledged science signifying that obesity is allied with lifestyle.[23,24]

In this study, the percentiles (5th–99th) of body height, weight, and BMI were calculated and compared to both of Finnish and Bangladeshi participants. Statistical analysis of crude data and percentile stratified data were evaluated significantly ($P < 0.001$). In Finnish participants, maximum females (26.67%) were obese while 43.33% (highest) males in Bangladesh was obese. Furthermore, it was found that the difference in body height and body weight between Finnish and Bangladeshi participants were statistically significant (***$P < 0.001$, **$P < 0.01$, and *$P \leq 0.05$). On the other hand, mean differences of BMI between two groups were not significant ($P > 0.05$).

The prevalence of obesity and overweight is alarming among the undergraduate students in Bangladesh. Underweight is still predominant among the Bangladeshi female students (BMI: 16.91), obesity and overweight prevailing among the male students. BMI of <18.5 kg/m^2 was found among Finnish randomly selected student in this pilot study. Overweight and obesity are still predominant in female Finnish students.

To fight the forthcoming twin weight of infectious diseases and the noncommunicable diseases as a value of underweight and overweight, we want to comprehend the social viewpoint of overweight and obesity in the low-income countries in order to take suitable measure by the government and other patrons.

Strengths and Limitations

Participant observation was a quantitative method to help researchers study the standpoints held by study populations. We postulate that there will be multiple viewpoints within any given community. We are fascinated in knowing what those diverse perceptions are and in understanding the relationship among them. However, in these community settings, researchers make cautious, objective minutes about what they perceive, footage all accounts and observations as field transcripts in a field notepad. Casual discussion and communication with members of the study people are also important components of the method and should be noted in the field minutes, in as much detail as possible. An important strength of this study was the uniform documentation to measure BMI with a standardized approach. This study was conducted on pilot basis, as this was a feasible way to recruit large number of individuals in each country; the response rate was 98%, even though students were not waged. More expensive to conduct than questionnaires and tests data analysis sometimes time-consuming. It was not possible to determine whether the relationship between obesity of Finnish and Bangladeshi respondent(s) fluctuated across ethnic groups within geographic regions, because race was not documented in this study as a result of legal constraints in some countries.

Conclusion

BMI was associated with high risk for many diseases and health conditions including type 2 diabetes, coronary heart disease, gallbladder disease, and so on. However, few studies have compared the predictive power of overall obesity. This study provides evidence of overall obesity assessed by BMI in Bangladeshi and Finnish students. The regional frequencies of overweight/pre-obese were dissimilar. The upswing in obesity universal is possible to pay to major rises in morbidity and mortality from diabetes mellitus and cardiovascular disease without it can be sufficiently lectured by public health sequencers.

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