# Original Articles

## Overweight and obesity among schoolchildren in Manipur, India

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### ABSTRACT

***Background.*** The prevalence of overweight and obesity and their associated factors among schoolchildren in Manipur has not been studied.

***Methods.*** We did a cross-sectional study among 3356 schoolchildren of classes VIII to XII in Imphal West district, Manipur between September 2005 and August 2006. The characteristics of the respondents and related variables such as parental build, watching television, eating habits, playing of video/computer games and outdoor games, dietary pattern and knowledge of obesity were assessed using a questionnaire. Height, weight, waist circumference, hip circumference, fat percentage, fat mass and fat-free mass were measured. Body mass index (BMI) and waist–hip ratio for each student were calculated.

***Results.*** The BMI of the sampled students was lower than the corresponding WHO and International Obesity Task Force standards. Using the WHO standard, the prevalence of overweight was 4.2% and of obesity 0.8%. Using multivariate logistic regression, mother being reported to be obese (OR 1.9, 95% CI 1.4–2.6), watching television for > 2 hours a day (OR 2.052, 95% CI 1.191–3.536), higher family income (OR 5.844, 95% CI 2.135–15.99), not eating other type of vegetables in the past 1 week (OR 2.338, 95% CI 1.04–5.24) and waist–hip ratio (OR 7.737, 95% CI 4.429–13.51) were found to be independent predictors of a higher BMI. Mother's literacy below class X (OR 0.6, 95% CI 0.378–0.997) and eating between major meals (OR 0.447, 95% CI 0.293–0.681) were significant predictors of a lower BMI.

***Conclusion.*** The prevalence of overweight and obesity among schoolchildren in the Imphal West district of Manipur is low. The possible reasons for this include a more traditional low-fat diet, less exposure to sedentary past-times and a greater time spent playing outdoors.


Natl Med J India 2010;23:263–6

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### INTRODUCTION

Obesity is a condition of abnormal or excessive fat accumulation to the extent that health may be impaired.[1] Weight gain and obesity pose a growing threat to health all over the world.[2] The health consequences of obesity range from an increased risk of premature death to several non-fatal but debilitating diseases that have an adverse effect on life.[2]

Adolescence is characterized by rapid physical and sexual growth and changes in body fat. Obesity during childhood and adolescence is a risk factor for obesity in adulthood and is related to an increased morbidity and mortality in adulthood.[3] The prevalence and health consequences of overweight and obesity need to be evaluated especially among adolescents in whom preventive and corrective measures can be instituted early. The International Obesity Task Force (IOTF) estimates that 1.1 billion adults are overweight and of these 312 million are obese. With the new Asian body mass index (BMI) criteria of overweight at a lower cut-off of >23.0 kg/m$^2$, the figure is even higher (1.7 billion).[4] Although the highest rates of childhood obesity have been observed in developed countries, its prevalence is increasing in developing countries.

Few studies have assessed the prevalence and lifestyle/food habits associated with obesity in India particularly in the northeastern region. We did a study to determine the prevalence of overweight and obesity and their associated factors in adolescents in Manipur.

### METHODS

The study was done among adolescents (classes VIII to XII) studying in high schools and higher secondary schools located in the Imphal West district from September 2005 to August 2006. Children who were absent on the day of our visit, those with bony deformities that would hinder anthropometric measurements, those with chronic diseases or acute diarrhoeal diseases, and children on long term medication were excluded.

The sample size was calculated using an obesity prevalence of

11% (based on the findings of a previous Indian study[5]) with a precision of 10% at 5% significance level using the formula for single proportion ($n$=4pq/d$^2$). A sample size of 3236 was calculated that was rounded off to 3300. We purposively selected all the 3 girls-only schools and the 2 boys-only schools. This was done in the hope of recruiting a similar number of boys and girls. From the remaining 28 co-educational schools in the district, 7 were selected by a lottery method. Based on the information on the number of students in each school, the sample size was expected to be met when these 12 schools—5 government, 7 private—were covered.

The variables studied included height, weight, BMI, body composition such as fat percentage, fat mass, fat-free mass, waist–hip ratio (WHR) and variables related to overweight.

A pre-designed and pre-tested questionnaire which included the characteristics of respondents and variables such as parental build, watching television, eating habits, playing video/computer games, outdoor games, dietary pattern and knowledge of obesity was distributed among the students, which they completed on their own. Once the students had filled in the questionnaire, they were called to a separate room to take their anthropometric measurements.

A beam balance (CMS Equipments, London) was used for measuring weight, with the students standing barefoot and minimum clothes, up to the nearest 10 g. A correction factor was applied taking the average weight of the uniforms for each sex to the measurements of the students who wished to wear uniforms while being weighed.

A calibrated vertical bar with horizontal headboard (Anthropometer) was used to measure the height. Each student was made to stand still, upright and with bare feet. For waist measurement the students were made to stand comfortably with both feet apart (25–30 cm). Measurements were taken with a non-stretchable tape at the end of normal expiration to the nearest 0.1 cm midway between the subcostal margin and the upper margin of the iliac crest, in a horizontal plane.[6] With minimum clothing the students were made to stand erect with arms at the side and feet together for hip measurement which were also obtained using a non-stretchable measuring tape up to the nearest 0.1 cm at the level of the maximum protuberance of the buttock in a horizontal plane.

We used the TANITA body composition analyser (TBF-300, Japan) for measuring body composition. This analyser uses bioelectrical impedance and is a relatively simple, quick and non-invasive procedure, which gives reliable and reproducible measurements of body composition with minimal intra- and inter-observer variation.[7,8] The percentage body fat measured by this method has been found to correlate significantly with body fat determined by DEXA (r=0.89, p=0.0001).[9] As per the manufacturer, the TANITA Body Fat Monitor Series is accurate within 5% of DEXA in determining body composition and is repeatable within 1% variation when used under consistent conditions.[10] The BMI, fat mass, fat-free mass and fat percentages were recorded. A minimum of 2 measurements were taken for each student and the average calculated.

The WHO classification of overweight and obesity in children based on the BMI for age (between 85th and 95th percentile as overweight and above 95th percentile as obese) was followed.[6] The prevalence of overweight and obesity in the sampled students according to the WHO criteria was compared with the IOTF criteria.[11] The BMI distribution at the 85th and 95th percentiles of the sampled students was compared with the WHO and IOTF criteria.

Data were analysed using SPSS version 11.5. Multivariate logistic regression analysis was used to assess the predictors of BMI. A value of p<0.05 was considered statistically significant.

The study protocol was approved by the Committee for Research and Advanced Studies of Medical Sciences, Regional Institute of Medical Sciences, Imphal, Manipur. Permission of the school authorities was obtained. Verbal consent was taken from the students. Individual data with identifiers were kept confidential.

## RESULTS

There were 3789 students in the 12 schools covered. Of these, 3356 were studied. The remaining students either did not fulfil the inclusion criteria or refused to participate. The age of the students ranged from 12 to 19 years. There were 1469 boys (44%) and 1887 girls. The maximum number of students ($n$=852) were 14 years of age, followed by 724 who were 15 years of age.

The BMI of the students were lower than the corresponding percentiles of the WHO and IOTF standards. IOTF data were comparable with the WHO standard. The prevalence of obesity according to the WHO standard was 0.8% (27 of 3356) and that of overweight was 4.2% (141 of 3356). Using the IOTF standard, the corresponding values were 0.7% for obesity and 4.4% for overweight. Obesity was found to be more prevalent among boys whereas overweight was more prevalent among girls. By the WHO standard, the highest prevalence of overweight (6.3%) was in 16-year-old boys and of obesity (2.4%) in 13-year-olds. As per the IOTF criteria, the highest prevalence of overweight (6.3%) was in 16-year-olds and obesity was commonest (2.2%) among 12-year-old boys. By the WHO standard, the highest prevalence of overweight (6.1%) was in 19-year-old girls but by the IOTF criteria, it was seen in 16-year-olds (7.2%; Table I).

TABLE I. Prevalence of overweight and obesity using the WHO and International Obesity Task Force (IOTF) criteria

| Age (years) | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *n* | Overweight | | Obesity | | *n* | Overweight | | Obesity | |
| | | WHO | IOTF | WHO | IOTF | | WHO | IOTF | WHO | IOTF |
| 12 | 45 | 1 (2.2) | 1 (2.2) | 1 (2.2) | 1 (2.2) | 42 | 1 (2.4) | 3 (1.7) | 2 (4.8) | 0 (0) |
| 13 | 211 | 5 (2.4) | 7 (3.3) | 5 (2.4) | 3 (1.4) | 246 | 12 (4.9) | 15 (6.1) | 4 (1.6) | 4 (1.6) |
| 14 | 319 | 17 (5.3) | 18 (5.6) | 5 (1.6) | 5 (1.6) | 533 | 23 (4.3) | 29 (5.4) | 2 (0.4) | 2 (0.4) |
| 15 | 368 | 10 (2.7) | 13 (3.5) | 5 (1.4) | 5 (1.4) | 366 | 19 (5.2) | 21 (5.7) | 1 (0.3) | 1 (0.3) |
| 16 | 174 | 11 (6.3) | 11 (6.3) | 1 (0.6) | 1 (0.6) | 290 | 17 (5.9) | 21 (7.2) | 0 (0) | 0 (0) |
| 17 | 137 | 3 (2.2) | 4 (2.9) | 0 (0) | 0 (0) | 188 | 8 (4.3) | 8 (4.3) | 1 (0.5) | 1 (0.5) |
| 18 | 150 | 0 (0) | 3 (2.0) | 0 (0) | 0 (0) | 189 | 8 (4.2) | 10 (5.3) | 0 (0) | 0 (0) |
| 19 | 65 | 4 (6.2) | 4 (6.2) | 0 (0) | 0 (0) | 33 | 2 (6.1) | 2 (6.1) | 0 (0) | 0 (0) |
| Total | 1469 | 51 (3.5) | 61 (4.1) | 17 (1.2) | 15 (1) | 1887 | 90 (4.8) | 88 (4.7) | 10 (0.5) | 8 (0.4) |

Values in parentheses are percentages

The BMI was found to be positively correlated with waist circumference, hip circumference, WHR, fat percentage and fat mass.

There was no significant difference in the results when the analysis was done by excluding or including low BMI (≤5th percentile). Hence, we excluded students with a low BMI (*n*=399) from further analysis.

In the univariate analysis, a high BMI was significantly associated with an obese father (OR 1.861, 95% CI 1.318–2.628, p<0.001) and with not eating green leafy vegetables during the past 1 week (OR 2.581, 95% CI 1.207–5.521, p<0.015) but after adjustment these associations were no longer seen.

Also, in the multivariate regression analysis a significant association was found between having a high BMI and reporting mothers to be fat (OR 1.896, 95% CI 1.373–2.619, p<0.001), watching television for >2 hours (OR 2.052, 95% CI 1.191–3.536, p<0.01), higher family income (OR 5.844, 95% CI 2.135–15.99, p<0.001) (though for the highest quintile there was no significant association), not eating other type of vegetables during the past 1 week (OR 5.844, 95% CI 2.135–15.99, p<0.001) and a higher WHR (OR 7.737, 95% CI 4.429–13.51, p<0.0001). The odds of having a high BMI were significantly lower among those whose mothers were educated to less than class X (OR 0.614, 95% CI 0.378–0.997, p=0.049) and for children who reported eating between meals (OR 0.447, 95% CI 0.293–0.681, p<0.0001; Table II).

TABLE II. Regression analysis with high BMI as dependent variable with other selected independent variables

| Variable | Adjusted odds ratio (95% CI) | p value |
|---|---|---|
| Male sex | 1.063 (0.654–1.728) | 0.805 |
| Mother reported obese | 2.095 (1.393–3.153) | 0.000 |
| Father reported obese | 1.089 (0.668–1.776) | 0.731 |
| Mother educated to ≤Class X | 0.614 (0.378–0.997) | 0.049 |
| Father educated to ≤Class X | 1.099 (0.622–1.943) | 0.745 |
| Watching television for ≥ hours/day | 2.052 (1.191–3.536) | 0.010 |
| Eating snacks while watching television | 0.798 (0.484–1.317) | 0.377 |
| Taking cold drinks while watching television | 1.073 (0.665–1.730) | 0.773 |
| Eating between meals | 0.447 (0.293–0.681) | 0.000 |
| Playing computer/video games | 0.959 (0.599–1.536) | 0.863 |
| Not playing outdoor games | 1.502 (0.937–2.408) | 0.091 |
| Reading for ≤2 hours/day | 1.118 (0.741–1.687) | 0.596 |
| Sleeping for ≥6 hours/day | 0.972 (0.622–1.520) | 0.901 |
| *Family income (Rs/month)* | | |
| 0–3199 | Reference | |
| 3200–5999 | 5.844 (2.135–15.99) | 0.001 |
| 6000–9999 | 6.147 (2.018–18.72) | 0.001 |
| ≥10 000 | 2.345 (0.714–7.698) | 0.160 |
| Not eating green leafy vegetables | 1.332 (0.438–4.051) | 0.614 |
| Not eating any vegetables | 2.415 (1.274–4.578) | 0.007 |
| Waist–hip ratio >0.90 | 7.737 (4.429–13.51) | 0.000 |

## DISCUSSION

Ours is the first large study to determine the prevalence of overweight and obesity among adolescent schoolchildren in Manipur. The BMI for age percentile distribution of the sampled students were lower than the corresponding percentile of the WHO as well as the IOTF criteria by 1 to 5 points. This could be because of genetic differences as well as differences in local and environmental factors between our sampled population and the reference population. In a study among Whites and Asians, Wang *et al*. showed that the BMI of Asians was 2–3 kg/m$^2$ lower than that of white adults with the same body fat composition.[12]

The prevalence of obesity among schoolchildren in Imphal West district was found to be low. The overall prevalence of obesity and overweight in the sampled students according to WHO criteria (0.8% and 4.2%, respectively) was comparable with the prevalence with the IOTF criteria (0.7% and 4.4%, respectively). Other Indian studies among schoolchildren showed a wide variation in the prevalence of overweight and obesity (Table III).[5,13–21] This could be due to differences in age groups included in these studies, different criteria being used to define overweight and obesity or different socioeconomic and lifestyle factors.

Lissau *et al*.[22] reported a prevalence of overweight and obesity in 15-year-old boys in Lithuania to be 5.2% and 0.8%, respectively, which is similar to our results using the WHO and IOTF criteria. However, other studies recorded a higher prevalence of overweight. In a study among Spanish adolescents, the prevalence was 25.6% and 19.1% in boys and girls, respectively.[23] In the USA, among children 6–19 years of age, 31% were at risk of overweight and 16% were overweight.[24] Zephier *et al*. reported a prevalence of overweight and obesity as high as 49.1% and 29.8%, respectively, in boys and 46.3% and 26.1%, respectively, in girls among American Indian children.[25]

The higher prevalence of obesity in more affluent societies could reflect differences in dietary as well as physical activity patterns. Vegetables constitute a major portion of the Manipuri diet and fast food outlets are yet to invade this part of India. Most children still do not have access to computer/video games and outdoor games constitute the predominant leisure-time activity.

TABLE III. Studies on overweight/obesity among Indian children

| Author, place | Age group (years) | *n* | Prevalence (%) | |
|---|---|---|---|---|
| | | | Overweight | Obesity |
| Chhatwal *et al*.,[5] Punjab | 9–15 | 2008 | 14.2 | 11.1 |
| Gupta *et al*.,[13] Delhi | 5–15 | 3861 | – | 7.5 |
| Kapil *et al*.,[14] Delhi | 10–16 | 870 | – | 7.4 |
| Augustine *et al*.,[15] Ernakulam | 17–18* | 200 | 14.0 | 10.5 |
| Mohan *et al*.,[16] Ludhiana | 11–17 | 2467 | 11.6 | 2.5 |
| Rao *et al*.,[17] Pune | 9–16 | 2223 | 27.5* | – |
| | | | 20.9# | |
| Sharma *et al*.,[18] Delhi | 4–17 | 4399 | 22.0 | 6.0 |
| Bharati *et al*.,[19] Wardha | 10–17 | 2555 | 3.1 | 1.2 |
| Aggarwal *et al*.,[20] Ludhiana | – | 1000 | 12.7 | 3.4 |
| Ramachandran *et al*.,[21] Chennai | 13–18 | 4700 | 17.8* | 3.6* |
| | | | 15.8# | 2.7# |

The higher prevalence of overweight among girls could be due to differences in physical activity or body fat composition. The average body fat is 15%–18% in men and 22%–25% in women.[26]

The BMI was found to correlate significantly with the measured body parameters. Other studies have also shown a significant correlation between BMI and body composition.[27] The BMI was significantly higher among the high-income group but not at the highest quintile. Sichieri *et al*. in two Brazilian surveys reported a positive association between obesity and income.[28] In their study, parental physique had an association with high BMI. Similar findings were reported in a study from Sao Paulo, Brazil.[29] Parental obesity may increase the risk of obesity through genetic mechanisms or by shared familial characteristics such as food preferences.[30]

The BMI was significantly higher in children whose mothers were educated beyond class X. This could be because with higher education the mothers were more likely to get jobs making them economically better off and leading to changes in lifestyle. Ekelund *et al*. reported a significant association between maternal education and high BMI among girls.[31]

Watching television for >2 hours a day was significantly associated with a high BMI. This could be because of the lack of physical activity in this group. A positive association with hours of TV watching and prevalence of overweight and obesity have been reported among children by others.[32–34] Eating between meals was found to be associated with a lower BMI. This could be because those who did not eat between meals were more likely to eat large amounts at meal times leading to greater fat deposition than taking smaller frequent meals. Moreover, other factors such as physical inactivity might have influenced this association.

Children who usually did not consume green leafy vegetables or any other vegetables had a higher BMI. This could be explained by the high caloric content of the diet of those who did not consume vegetables. Howarth *et al*. in their multiethnic study in Hawaii reported a significantly increased risk of being overweight with an increase in the energy density of food consumed.[35]

We believe that the weight measurements were accurate as these were taken with minimal clothing and correction factors were applied. The body composition of the students was assessed with the TANITA Body Composition Analyzer, which is a validated instrument for body composition measurements.[36] Our findings could be generalized to the adolescent population of Imphal as the sample size was adequate and school enrollment in this population is above 90%.

Though the findings of the study showed a lower prevalence of obesity, this cannot be ignored. As the state is witnessing a gradual change in lifestyle, including diet, physical activity and environment, the prevalence of obesity is expected to increase. There is a need to create awareness among adolescents regarding a healthy lifestyle and overweight and its consequences.

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