

## Original Article

# Obesity among pre-adolescent and adolescents of a developing country (India)

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There are very few reports from the developing world on the prevalence of obesity among children even though in developed countries it has reached epidemic proportions. The objective of this study was to determine the prevalence of obesity in pre-adolescent and adolescent children in a developing country (India) using WHO guidelines for defining obesity and overweight. This cross-sectional study was carried out on 2008 school-children aged 9-15 years. Approximately half the subjects belonged to a school attended by children of well to do families while the rest belonged to two schools from middle and lower socio-economic background. Weight and height were taken for all children and the body mass index (BMI) calculated. Children whose BMI was  $>85^{\text{th}}$  percentile for age and sex were defined as overweight. Triceps skin fold thickness (TSFT) was measured for all overweight children and those with TSFT  $>90^{\text{th}}$  percentile for age and sex were defined as obese. The overall prevalence of obesity and overweight was 11.1% and 14.2% respectively. The prevalence of obesity as well as overweight was higher in boys as compared to girls (12.4% vs 9.9%, 15.7% vs 12.9%). Prevalence of obesity decreased significantly with age, from 18.5% at 9 years to 7.6% at 14 years, rising at 15 years to 12.1%. Significantly more children from higher socio-economic status were obese and overweight than those from lower socio-economic status groups. No significant gender difference for obesity prevalence was seen among children from a less privileged background, however, amongst children from affluent families, significantly more boys were obese as compared to girls. Pediatric obesity is an emerging problem in developing countries, especially among higher socio-economic status groups. Significant gender disparity is seen, with boys of affluent background having a higher prevalence.

**Key Words:** Body mass index, triceps skin fold thickness, obesity, developing country, adolescents, pre-adolescents, WHO guidelines, socio-economic status, India.

## Introduction

The last quarter of the twentieth century has seen childhood obesity emerging as an epidemic in developed countries and a cause of concern worldwide as it is being reported in significant numbers from nations previously considered poor or developing. It is no longer a problem of the affluent countries only.<sup>1</sup> In Nigeria 18% of children aged 5-15 years from a relatively privileged section of a community, were found to be obese.<sup>2</sup> Even in a famine stricken country like Ethiopia<sup>3</sup>, 25% of adolescents were found to be obese. In India, little attention has been paid to childhood obesity until recently. The few studies<sup>4-7</sup> done have looked at obesity as a part of cardiovascular factors viz hypertension. As yet, there are no nationally representative studies available. In 1985-86, a report from northern India found a prevalence of 7.5% for obesity among schoolchildren.<sup>4</sup>

An important factor that prevents meaningful interpretation or comparison of data from different parts of the world is the wide variation in the definition of pediatric obesity. In 1995, WHO gave guidelines to define overweight and obesity in adolescents.<sup>8</sup> The present study was conducted as per the WHO guidelines and is probably the only one reporting obesity prevalence in this region using these guidelines.

## Subjects and methods

### Subjects

A cross-sectional study was carried out on 2008 schoolchildren of both sexes, aged 9-15 years, from the city of Ludhiana. The sample size was calculated from the formula  $n = 4pq/L^2$  where 'p' is the positive character, 'q' = 1 - p and L is the allowable error ie 20% of 'p'. With 'n' number of subjects, the risk that the true estimate would not exceed allowable error by 20% of 'p' was 5%.<sup>9</sup> The value of 'p' was taken from a previous study from this institution which found 5.12% schoolchildren obese.<sup>7</sup> The schools were selected in a random manner. Approximately half the children were from a school catering to mostly affluent families, while the rest belonged to two schools with middle and lower socio-economic background. Age was taken from the date of birth as recorded in the school register or self-reported

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by older children. If the child's next birthday was within six months from the date of examination, his/her age was taken according to the next birthday. If on the other hand, it was exactly or more than six months away, the age was taken as on the last birthday.

### Measurements

After removing heavy warm clothing, belts and shoes all children were weighed using a standardized spring balance scale (Salter Electronic, model 831 2879, Kent, England) with an error of  $\pm 100$  gms and a maximum capacity of 137 kg. The machine was regularly checked using test weights. Each child was made to stand still and upright with weight evenly distributed between two feet. A calibrated vertical bar with a horizontal head-board was used for measuring the height which was recorded to the nearest 0.5 cm.<sup>10</sup>

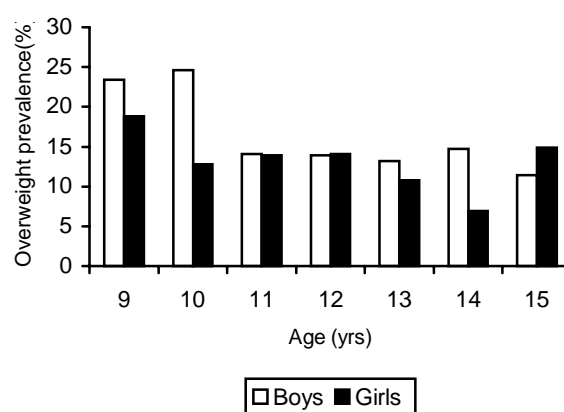
Based on the weight and height, the Body Mass Index (BMI) was calculated as per the formula  $BMI = Wt (kg) / Ht (m)^2$ . The BMI percentile charts of WHO based on the first National Health and Nutrition Examination Survey (NHANES I) were used to define overweight.<sup>11</sup> All subjects who had a BMI  $\geq 85^{\text{th}}$  percentile for sex and age were defined as overweight.<sup>8</sup> All overweight children were further screened by measuring triceps skin fold thickness (TSFT) with Harpenden's calipers. TSFT over the left arm was measured and the mean of three readings was taken. Children whose mean TSFT was  $\geq 90^{\text{th}}$  percentile for sex and age were considered obese. The percentile charts of TSFT by WHO based on the Health Examination Survey and the first National Health and Nutrition Examination Survey (NHANES I, 1991) in the United States of America were used.<sup>11</sup> All measurements were made by the same person (SKR). Prasad's updated social classification, which takes the consumer price index into consideration, was used to define five socio-economic classes.<sup>12</sup> On the basis of per capita income the following classification was performed: class I -  $\geq$  Rs 1650, class II - Rs 820 to 1649, class III - Rs 500 to 819, class IV - Rs 250 to 499 and class V -  $<$  Rs 250.

### Statistical analysis

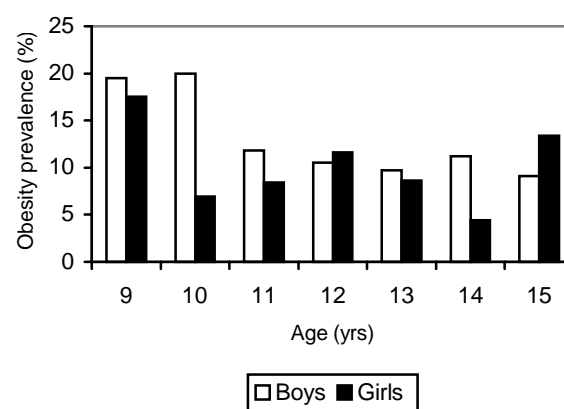
The data was analyzed using Chi-square and ANOVA statistical methods. For all statistical tests a *P* value of less than 0.05 was taken as significant. The computer program used was 'Epi Info 6, version 6.04d- January 2001'.

### Results

Of the total 2008 children, the largest group (21.2%) comprised of 12 year olds and the smallest (7.8%) of 9 year olds. There were more girls than boys (52.1 vs 47.9%, *P* value = 0.00) in the total sample. Half of the children (50.3%) were from families of socio-economic status I ie. higher status followed by middle-income groups (43.2%). Only 6.4% belonged to the lower socio-economic status (classes IV & V). As described earlier, taking  $\geq 85^{\text{th}}$  percentile of BMI for age and sex, 14.2% of the children were overweight. The prevalence of obesity was 11.1%. More boys were overweight (15.7% vs. 12.9%) as well as obese (12.4% vs. 9.9%) as compared to girls.



**Figure 1.** Overweight prevalence by age and gender x-axis = Age (years); y-axis = Prevalence of overweight (%)



**Figure 2.** Obesity Prevalence. x-axis = Age (years); y-axis = Prevalence of obesity (%)

This pattern was seen in all age groups with the exception of 12 and 15 years of age where a higher number of girls were obese although statistically not significant (Fig. 1, 2). The prevalence of both overweight and obesity decreased significantly with increasing age till 14 years (from 21.0 to 10.6% for overweight and 18.5 to 7.6% for obesity; *P* value  $< 0.05$ ) but tended to rise at 15 years (Table 1).

In the school catering to affluent families, the prevalence of obesity was 15.9% as compared to 6.4% in the other two schools (*P* value = 0.000). On comparing the prevalence of obesity among boys and girls of the two school groups it was seen that in the affluent school significantly more boys were overweight (25% vs 16.6%, *P* value = 0.001) and obese (19.9% vs 13.1%, *P* value = 0.003). In the other group of schools, the prevalence of overweight and obesity was almost similar in both sexes. Taking different socioeconomic classes, prevalence of obesity was found to be directly proportional to the socio-economic status, being highest among socio-economic class I and decreasing progressively to 0% in lowest class (V). This held true for the whole group as well as boys and girls taken separately (Table 2).

**Table 1.** Prevalence of overweight and obesity, by age

Age (in yrs)	Total	Overweight (%)*	Obesity (%)**
9	157	33 (21.0)	29 (18.5)
10	212	40 (18.9)	29 (13.7)
11	336	47 (13.9)	34 (10.1)
12	428	60 (14.0)	47 (10.9)
13	283	34 (12.0)	26 (9.2)
14	303	32 (10.6)	23 (7.6)
15	289	40 (13.8)	35 (12.1)
Total	2008	286 (14.2)	223 (11.1)

\*Chi-square = 14.36; df = 6; *P* value = 0.02; \*\* Chi-square = 15.63; df = 6; *P* value = 0.015

**Table 2.** Prevalence of obesity, by socio-economic classes

Socio-economic class	Total		Boys		Girls	
	Total	Obese (%)*	Total	Obese (%)	Total	Obese (%)
I	1011	157 (15.5)	444	82 (18.5)†	567	75 (13.2)†
II	521	48 (9.2)	250	28 (11.2)	271	20 (7.4)
III	347	15 (4.3)	182	8 (4.4)	165	7 (4.2)
IV	112	3 (2.7)	76	1 (1.3)	36	2 (5.6)
V	17	0 (0)	9	0 (0)	8	0 (0)
Total	2008	223 (11.1)	961	119 (12.4)	1047	104 (9.9)

\* Chi-square = 48.28; df = 4; *P* value = 0.000; † Chi-square = 5.21; df = 1; *P* value = 0.022

## Discussion

The present study was performed on 9-15 year old children from randomly selected schools. The prevalence of obesity was 11.1% while 14.2% of the children were overweight. This is the highest prevalence reported so far from the few studies in the Indian subcontinent. Agarwal *et al* in 1982, using 120% of Harvard's 50<sup>th</sup> percentile as the cut-off noted 1.1% of 2694 schoolchildren from western India as obese.<sup>5</sup> The Davenport Index [Wt (g)/Ht (cm)<sup>2</sup>] was popular among researchers in the early nineties and two studies using this criterion found a similar prevalence of obesity in schoolchildren – 7.5% and 6.8% by Gupta & Ahmad (1990) and Anand & Tandon (1996) respectively.<sup>4,6</sup> Also in an earlier study (1994) from this institution, the prevalence of obesity using Davenport Index was 5.12%, which is half the prevalence rate of the present study.<sup>7</sup> On applying the Davenport Index to the present data 10.5% of the children were found to be obese, which indicates a definite increase in obesity among schoolchildren.

Except for Sundaram *et al*, the other Indian studies on childhood obesity have not differentiated between the prevalence of overweight and obese children.<sup>13</sup> They took the Harvard 50<sup>th</sup> percentile as the standard and defined overweight by two different criteria; taking 110% relative weight, the prevalence was 8.5% but taking Wt/Ht<sup>2</sup> exceeding mean + 1 standard deviation (SD), the prevalence rate was 10.9%, both figures are lower than the

present study. For obesity the prevalence rates of 4.2% (weight > 120% of Harvard standard) and 4.3% (Wt/ Ht<sup>2</sup> more than mean + 2 SD) reported by them were also much lower. On comparing the present study with prevalence rates of developed countries, 10.1% of 17-year-old adolescents from Israel<sup>14</sup> were obese, a rate similar to the present report. Lower prevalence rates ranging from 0.9 to 3.1% using relative weight index more than 130% of normal were noted from Britain in the mid-eighties in 6–14 year olds.<sup>15</sup> A report from Northern Ireland in 1993 showed a higher prevalence ranging from 25.5 to 26.9%.<sup>16</sup> Surprisingly a high prevalence of obesity has been reported from the African continent. In a study on adolescents from Ethiopia (1993), 25% were obese, while 18% of 904 Nigerian children aged 5 – 15 years were obese.<sup>3,2</sup> The fact that obesity is acquiring epidemic proportions in the developed world is well accepted but the rising prevalence in developing countries warrants greater concern. In the last decade or so rising affluence, urbanization, satellite television invasion have changed lifestyles drastically. Paradoxically, as is happening elsewhere in the developing world, people are using their growing incomes to replace their traditional diets rich in fibre and grain with diets that include a greater proportion of fats and caloric sweeteners.<sup>17</sup> Burgeoning city populations and increasing school education burden leave children hardly any space and time for physical activity.

This adds to the widespread preoccupation with television. All these are probably responsible for the increasing prevalence of obesity. Troiano *et al.*, (1995) used the 85<sup>th</sup> percentile of BMI to define overweight in 3000 to 14000 youths aged 6 through 17 years examined in each of the five separate national surveys in the United States.<sup>18</sup> Prevalence of children with BMI  $\geq 85^{\text{th}}$  percentile increased from 15.2% in boys and girls aged 6 to 11 years in 1963-65 to 22.3% in boys and girls of the same age by 1988-91. Among children aged 12 to 17 years the percentage increased from 15.1% and 15.2% to 21.7% and 21.2% in boys and girls respectively. In adjoining Canada, Johnson-Down *et al.*, (1997) found a strikingly high prevalence rate of 33.4% in a low-income, multi-ethnic population sample.<sup>19</sup>

In our study a significant age related decrease in prevalence of obesity from 18.5% at 9 yrs to 7.6% at 14 yrs was seen and thereafter a rise at 15 yrs to 12.1%. In NHANES III, another large cross-sectional study amongst 6 to 17 year old children, the prevalence of overweight was lowest between 9-11 yrs and showed an increase subsequently.<sup>18</sup> The longitudinal study by Whitaker *et al.*, (1997) in 854 children showed obesity prevalence to be 13% at 9 yrs, which decreased by 14 yrs to 9% followed by an increase subsequently, a finding similar to that in our study.<sup>20</sup> In Britain, Braddon *et al.*, (1986) studying the same birth cohort over a period ranging from 6 to 36 years found that the prevalence of obesity in boys and girls reached a peak at the age of 11 years before falling at the age of 20 years and showing a subsequent rise.<sup>15</sup> Peckham *et al.*, (1983) studying a later British cohort from 7 to 16 years found the lowest prevalence at 7 years, peak at 11 years and a slight decrease subsequently.<sup>21</sup>

The higher prevalence of obesity among boys in our study is consistent with the gender difference in two other Indian studies.<sup>4,13</sup> The study from Nigeria also had more obese boys than girl.<sup>2</sup> Boreham *et al.*, (1993) and Troiano *et al.*, (1995) also had similar findings.<sup>16,18</sup> The higher prevalence of obesity among male children in the present study may be attributable to the cultural advantage boys enjoy in our country. They get larger helpings of food, more freedom to go out of the house and thus snack and also do not contribute much to the household chores. Other studies from developed countries do not show this pattern. Seidman *et al.*, (1991) from Israel found a similar prevalence among boys and girls.<sup>14</sup> Stark *et al.*, (1981) found a higher prevalence of obesity among British girls.<sup>22</sup> In the present study, only at age 15 years were more girls obese compared to boys which may be related to the growth spurt and the effects of hormonal surge which occurs earlier in girls. The Ten State Nutrition Survey showed that while for females adolescence is a period of increasing outer fatness, the male undergoes a transient reduction in outer fatness in early adolescence.<sup>23</sup>

The direct relationship between affluence and obesity seen in our study is in marked contrast to the findings of most studies from developed countries, where obesity is more prevalent in the lower socio-economic strata.<sup>19,24,25</sup> Another Indian study had findings similar to the present report as also the study from Ethiopia.<sup>13,3</sup> Interestingly, an early study from USA, (Garn and Clark, 1975) a review

of the Ten State Nutrition Survey had conclusions quite like ours in that they found that children from higher socio-economic status are systematically fatter than those from low-income status.<sup>23</sup> However in later adolescence and adulthood, obesity in women showed a remarkable income related reversal of fatness. While a 'less-prudent' fat rich diet accounts for a high prevalence of obesity among lower socio-economic status children in developed countries, the less privileged in the developing countries still suffer from a relative lack of calories and hence less obesity. In addition their lifestyles involve more physical work as compared to those more affluent.

### Conclusion

The present study revealed that more than one tenth of the school children in the age group of 9 to 15 yrs were obese, a figure only slightly lower than that reported from most western countries. More disturbing is the fact that compared with earlier studies, there is an increasing trend for obesity among adolescents.

As there are strong indications that childhood obesity tends to track into adulthood the increasing prevalence of childhood obesity is going to translate into higher adult obesity. India being a country of diverse population, it has regions still struggling with the burden of malnutrition but at the same time there are rapidly emerging population sub-groups which are falling into the trap of affluence related problems. Hence there is a need to assess obesity prevalence by conducting wider, nationally representative studies and also create awareness regarding the emerging trend.

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