Original Article: 
Overweight, Obesity and Thinness Prevalence with Different Growth Standards Among School Children and Adolescents in Saurashtra Region, India.

Authors
Rajesh K Chudasama Associate Professor, Department of Community Medicine, P D U Government Medical College, Rajkot, Gujarat, India
T K M Eshwar, Medical Director, Milestone Hospital, Rajkot, Gujarat, India,
Subhasini T Eshwar, Diabetic Educator, Milestone Hospital, Rajkot, Gujarat, India,
Dhara Thakrar, Resident, Department of Community Medicine, P D U Government Medical College, Rajkot, Gujarat, India.

Address for Correspondence
Dr. Rajesh K Chudasama, Vandana Embroidery, Mato Shree Complex,
Sardar Nagar Main Road,
Rajkot – 360 001,
Gujarat, India.
E-mail: dranakonda@yahoo.com

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Abstract: Background: Overweight/obesity and thinness emerged as an important public health problem in India. The present study was conducted to estimate the prevalence and compare any difference in estimating prevalence of these conditions by using different standards among school children and adolescents. Methods: Anthropometric measurements of all students of four schools from 3rd to 12th standards were taken. Prevalence of overweight, obesity and thinness were assessed using two standards – Agarwal 2001 standards and revised IAP 2015 standards. Results: A total of 1496 children including 79.1% boys and 20.9% girls participated. Boys grow taller than girls from 12 years age and also gains more weight than girls from 11 years. The mean BMI of boys remain more than girls for all the years except age 16. Significant difference was observed (independent t test) for difference age years when height, weight and BMI of boys were compared with girls. Revised IAP 2015 standards reported high prevalence of overweight (19.1%) and obesity (14.0%) than Agarwal standards (17.0% & 9.1% respectively). Prevalence of thinness was reported more by Agarwal standards (59%) than IAP standards (3.4%). A good level of agreement (?=0.773) found between two standards considering four categories. The agreement was improved further up to 0.90 when compared for two combined categories overweight/obese vs. normal weight/thinness. Conclusion: High prevalence of obesity and overweight was reported with IAP 2015 standards and Agarwal standards. Good agreement was found for both standards indicate Agarwal standards can still be used in current scenario like revised IAP 2015 standards.

Key Words: Prevalence, Obesity, Overweight, Thinness, School children, Rajkot.

Introduction: Globally, the prevalence of overweight and obesity is growing and becoming an important public health problem; reporting in both developed and developing countries.(1-3) Obesity has increased from 4.2% in 1990 to 6.7% in 2010 worldwide and is expected to reach 9.1% in 2020. Worldwide 43 million children were estimated in year 2010 including 35 million (81.4%) from developing countries.(4) Overweight and obesity emerged as an important public health problem in India also.(5-7) Childhood obesity increases morbidities and also the risk of obesity in adulthood.(8, 9) Obesity may have implications towards increasing prevalence of diabetes mellitus, hypertension, coronary artery disease, orthopaedic problems, mental disorders and impaired quality of life.(10, 11) The prevention of child obesity has been recognized as a public health priority considering the difficulty in curing obesity and overweight in adults and many long term adverse effects of childhood obesity.(12) Thinness/under-nutrition increases the risk of morbidity, affects development and reduces work productivity in later life.(13) Many countries in South East Asia region including India is going through an economic and nutrition transition which leads to threat of under and over nutrition.(6,14,15) The prevalence of overweight ranged from 9 to 27.5% , obesity ranged from 1 to 12.9% and of thinness/underweight in range of 12.2 to 37.5% among Indian children.(4-7,13,16,17) These studies conducted at different times in India by using different standards with different cut-off points to assess the
prevalence of obesity, overweight and thinness. The different standards used in these studies included WHO 2007 references (18), Centre for Disease Control (CDC) growth charts (19), International Obesity Task Force references (20, 21), and Indian Association of Paediatrics (IAP) 2007 reference (22). Insufficient data is available related to prevalence of obesity and overweight among school children and adolescents in Saurashtra region in context of different growth standards available. Considering this, present study was conducted to estimate the prevalence and compare any difference in estimating prevalence of obesity, overweight and thinness by using the earlier 2001 IAP data from Agarwal KN et al standards (23) and latest revised IAP 2015 standards (24), among school children and adolescents aged 8-18 years from Rajkot city, Saurashtra region, India.

Materials and Methods:
Rajkot city is the central part of Saurashtra region of Gujarat state, India. The study included schools with coeducation for boys and girls having primary, secondary and higher secondary education system. The schools were listed with their annual fees structure and top five selected schools with highest annual fees were selected for the study. The children studying in these schools are coming from affluent families. The authorities of selected five schools were informed about the study objective and asked for the permission to conduct study but four schools agreed to participate in the study. All the four schools have given permission to collect information from 3rd standard to 12th standard children aged 8-18 years. So, data was collected from 1496 children and adolescents including 1183 boys and 313 girls studying in these standards. Ethical clearance was taken from the institutional ethical committee to conduct the study. The study was conducted from January 2015 to April 2015. A team of three members was formed to collect the data and prior training was given to record anthropometric data. The team members remained same throughout the study period. The school authorities were informed prior for the visit of study team with date schedules for different standards. The message was given by school authorities to children to remain present on the day of study team visit. Those children remained present on days of visit of schools and given informed consent to participate were included in the study. The anthropometric data like height and weight measurements were made and recorded following the standard techniques. (25) The students removed their shoes and any other heavy items before measurement. Weight was measured by using a digital scale and the scale was calibrated daily against standard weight. Height was measured using a standardized stadiometer. The weight was recorded to the nearest 0.1 kg and height to the nearest 0.1 cm.

Body Mass Index (BMI) was used to classify the study participants into obesity, overweight and thinness category. The BMI was calculated by using standard formula of weight in kg/height in squared meter. The participants were classified by using age and gender specific cut-off points. Two different standards were used to classify them (1) the earlier 2001 data published by Agarwal KN et al standards (23) for overweight, obesity and thinness among 5-18 years old children and (2) Indian Association of Paediatrics (IAP) – revised 2015 growth charts for height, weight and BMI for 5-18 years old Indian children. (24) The data of school children in Agarwal study was collected in the years 1988-1991, more than two decades before. The children were grouped in to different age groups like 8-9 (childhood), 10-12 (early adolescence), 13-15 (mid adolescence) and 16-18 (late adolescence). (6) The data was entered and analyzed by using the statistical software Epi Info (Version 3.5.1) from Centre for Disease control and prevention, Atlanta, USA. (26) The descriptive statistics of mean, standard deviation (SD) and percentiles were calculated for height, weight and BMI of students of all ages and both sexes. Independent t test was used to test difference between the boys and girls for mean height, weight, BMI and chi square test used to test difference in proportion of obesity, overweight and thinness.

Results
Present study included 1496 school children and adolescents aged 8-18 years including 1183 (79.1%) boys and 313 (20.9%) girls. As the age increases, height of boys also increases up to 16 years (Table 1). The BMI of girls increases with age from 8 years up to 16 years. Boys grow taller than girls from 12 years age (p<0.05) and also gains more weight than girls from 11 years (p<0.05) (Table 1). The mean BMI of boys remain more than girls for all the years except age 16. Significant difference was observed (independent t test) for difference age years when height, weight and BMI of boys were compared with girls.

The weight of boys also increases with their age up to 17 years. The BMI varies at the different age years among boys. The height and weight of girls’ increases with age from 8 years to 14 years (Table 2).

Prevalence of overweight, obesity, normal weight and thinness/underweight was calculated by using Agarwal standards and revised IAP 2015 growth standards (table 3). Overweight prevalence was reported 17%, followed by obesity prevalence of 9.1%, thinness prevalence of 5.9% with 65.3% children falling in normal weight by Agarwal KN et al standards. Revised IAP 2015 standards reported overweight prevalence of 19.1% followed by obesity prevalence of 14%, thinness prevalence of 3.4% with 63.5% children falling in normal weight.
Based on the BMI criteria, the children were grouped into different age groups to calculate the prevalence of overweight, obesity and thinness (table 4). For both the standards, prevalence of obesity was more among boys than girls. High obesity prevalence was reported among boys with IAP standards for all age groups compare to Agarwal standards. Prevalence of overweight and obesity increases with age up to mid adolescence but then decreases in late adolescence group for Agarwal standards.

#### Table 4: Age group wise prevalence of obesity, overweight and thinness as per different standards

<table>
<thead>
<tr>
<th>Age group</th>
<th>Sex</th>
<th>N</th>
<th>Obesity (%: No. (%)</th>
<th>Overweight (%: No. (%)</th>
<th>Thinness (%: No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-9</td>
<td>M</td>
<td>146</td>
<td>16 (12.9)</td>
<td>21 (15.1)</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>54</td>
<td>2 (3.7)</td>
<td>5 (9.3)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>10-12</td>
<td>M</td>
<td>250</td>
<td>26 (10.4)#</td>
<td>52 (20.8)#</td>
<td>12 (4.8)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>107</td>
<td>2 (1.9)</td>
<td>5 (4.7)</td>
<td>3 (2.8)</td>
</tr>
<tr>
<td>13-15</td>
<td>M</td>
<td>539</td>
<td>64 (11.9)#</td>
<td>122 (22.6)</td>
<td>10 (1.9)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>60</td>
<td>2 (3.3)</td>
<td>3 (5.0)</td>
<td>3 (5.0)</td>
</tr>
<tr>
<td>16-18</td>
<td>M</td>
<td>248</td>
<td>18 (7.3)</td>
<td>52 (21.0)</td>
<td>12 (4.9)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>92</td>
<td>6 (6.5)</td>
<td>8 (8.7)</td>
<td>8 (8.7)</td>
</tr>
<tr>
<td>Total</td>
<td>M</td>
<td>1183</td>
<td>124 (10.5)#</td>
<td>257 (21.7)</td>
<td>40 (3.4)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>313</td>
<td>12 (3.8)</td>
<td>18 (5.8)</td>
<td>10 (3.2)</td>
</tr>
</tbody>
</table>

(Chi-square test, *p*<0.05, **p**<0.01)

The Kappa agreement between Agarwal and IAP 2015 standards found 0.773 indicating a good level of agreement between the two standards (table 5). The agreement was improved further up to 0.90 when compared for two combined categories – overweight/obese vs. normal/weight/thinness.

#### Table 5: Distribution of participants by weight status and growth standard (n=1496)

<table>
<thead>
<tr>
<th>Agarwal 2001 standard</th>
<th>Revised IAP 2015 standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obese</td>
<td>Overweight</td>
</tr>
<tr>
<td>Obese</td>
<td>136 (100%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>74 (25.1%)</td>
</tr>
<tr>
<td>Normal weight</td>
<td>0 (6.6%)</td>
</tr>
<tr>
<td>Underweight</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>210</td>
</tr>
</tbody>
</table>

Kappa – 0.773, 95% CI: 0.73 - 0.80; considering above four categories

Kappa – 0.90, 95% CI: 0.84 – 0.95; considering two groups overweight/obesity vs. Normal/thinness

**Discussion**

Obesity as a chronic disease, prevalent in both developed and developing countries, and affecting children as well as adults, it is now so common that it is replacing the more traditional public health concerns including undernutrition.(20) Overweight and obesity are the fifth leading risk of global deaths.(27) Various studies from India reported increase in prevalence of obesity and overweight.(15-8,10,13,16,17) Present study describes height, weight and BMI values of 1496 school children and adolescents aged 8-18 years from Rajkot city, Saurashtra region. Different growth standards were recommended by IAP to be used for obesity and overweight measurement in last two decades.(22,23,28) Recently IAP has suggested revised growth charts for height, weight and BMI for 5-18 years of Indian children.(24) Present study compares the standards suggested by Agarwal et al in 2001 and recent 2015 standards suggested by IAP to estimate prevalence of overweight, obesity and thinness among school children.

Prevalence of obesity was reported 14%, of overweight 19.1% and of thinness 3.4% as per recent Indian IAP 2015 standards.(24) The prevalence rates of obesity as per revised IAP 2015 standards were higher than Agarwal standards. It indicates that revised IAP 2015 standards detect more obesity cases among children than Agarwal standards. The prevalence of obesity was reported high among boys and girls both with revised IAP standards than Agarwal standards.

With revised IAP 2015 standards, the prevalence of overweight reported in present study was 19.1%, higher than 17% with Agarwal standard indicating again that revised IAP 2015 standards detect more overweight children than Agarwal standards. The prevalence of overweight with Agarwal standards among boys was reported high (21.7%) than IAP standards (19.6%) and among girls low (12.1%) than IAP standards (16.9%). These variations in measuring overweight status among children may be due to that Agarwal standards measures overweight between 85th and 95th percentile for boys and girls, while revised IAP 2015 measures between 71th to 90th percentile for boys adult equivalent and 75th to 95th percentile for girls adult equivalent.(24)

Overweight and obesity prevalence reported among present study as per revised IAP 2015 standards (24) and also with Agarwal standards (23) was higher than reported by different studies carried out in different states of India.(3,5-8,9,29-31) The high prevalence of overweight and obesity in present study probably due to the affluent families background of the study participants. The life style and dietary habits of these affluent children probably affects their nutritional status and makes them overweight and obese. Further study with history of dietary habits of these children will help us to support these findings.

Prevalence of overweight and obesity among boys found higher than girls in present study with both the standards. There are proportionately more obese girls than boys in both developed and developing countries.(29) Various studies reported obesity as per IOTF standards more among girls than boys.(5,6) In contrast, present study reported more obese boys compare to girls like previous studies.(22,23) Similarly, high prevalence of overweight boys was reported than girls in present study, while others reported high prevalence among girls.(16,34,35)

Thinness prevalence was reported high 9.5% with Agarwal standards (23) than 3.3% with revised IAP 2015 standards.(24) The prevalence of thinness among girls (7.7%) and boys (5.4%) was high with Agarwal standards.(23) The Agarwal standards (23) used the 3rd percentile to classify thinness. The revised IAP 2015 standards (24) used the 3rd percentile to classify thinness.
considering the BMI of children and that may be the reason Agarwal standards reported high prevalence of thinness than revised IAP 2015 standards. The prevalence of thinness among both sexes as per both standards found much lower than previous studies from India.(6,13) Present study reported little high prevalence of thinness among girls than boys. In contrast to these findings, various studies have reported that thinness was more common in boys than girls in India.(6,13,36,37)

A good agreement (K = 0.773) (38) was observed among Agarwal standards and revised IAP 2015 standards when compared for obesity, overweight, normal weight and thinness among school children and adolescents. The agreement was even more (K = 0.90) when parameters were combined in two group i.e. obesity/overweight vs. normal weight/thinness. The agreement suggests that though the Agarwal standards can be used like the latest revised IAP 2015 standards to estimate the prevalence of obesity, overweight, normal weight and thinness among school children and adolescents in India. Limitations of present study includes, selection of urban schools only; selection of four schools; government schools were not selected; instead of 5-18 years, age group of 8-18 years was covered; and enrolment of girl participants was less than boys. Further studies involving proportionate sample size, government schools, urban and rural schools, enquiring about eating habits and diet pattern, involving all socio-economic class children, age group of 5-18 years will help to detect and compare more accurate prevalence of overweight, obesity and thinness among the school children and adolescents with different cut-off points and different growth standards.

**Conclusion**

High prevalence of obesity and overweight was reported with IAP 2015 standards and Agarwal standards in the age group of 8-18 years in Rajkot considering the BMI values of school children and adolescents. Good agreement was found for both standards indicate Agarwal standards can still be used in current scenario like revised IAP 2015 standards.

**References**