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Prevalence of Childhood Obesity among School Children of Dehradun city, Uttarakhand

Ekta Belwal*, K. Uma Devi and Aparna Kuna

Department of Foods and Nutrition, Post Graduate and Research Centre, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Telangana, India

**Corresponding author*

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A B S T R A C T

Childhood obesity is one of the most serious problems of 21st century as it has a significant impact on both physical and psychological health of children. The objective of the study was to estimate the prevalence of overweight and obesity among school-going children of Dehradun using WHO standards. Based on the monthly fee structure, schools were classified into 3 groups representing different socio-economic classes i.e., high (HSE), middle (MSE) and low (LSE). Two schools were selected from each group. Altogether 6 schools were selected and a total of 1823 school children (6-15 years) were screened for obesity using standard anthropometric measurements of height and weight. Weight-for-age, height-for-age and BMI-for-age percentiles were calculated using WHO AnthroPlus Software. The overall prevalence of obesity and overweight was 7.6 and 3.3% respectively. The Weight-for-age, height-for-age and BMI-for-age percentiles increased with the increasing socio-economic status. Obesity has become an extra burden with the already prevailing problem of under-nutrition in school going children. School, parents and government should work as a team and take timely action to prevent the emerging problem.

Introduction

Childhood obesity is predictive of adult obesity and is one of the most serious public health challenges of the 21st century. Worldwide, the prevalence of combined overweight and obesity rose by 27.5% for adults and 47.1% for children between 1980 and 2013. Once considered a high-income country problem, overweight and obesity are now on the rise in low- and middle-income countries, particularly in urban settings. In developing countries with emerging economies (classified by the World Bank as lower- and middle-income countries) the rate of increase of childhood overweight and obesity has been more than 30% higher than that of developed countries (WHO, 2015). Food habits, nutritional status and lifestyle in childhood are the major contributors that determine the health of an adult. Unhealthy diet and lack of physical activity during

childhood are the leading risk factors accounting for the burden of non-communicable diseases in adulthood (Bharati *et al.*, 2008).

Obesity epidemic consists of four overlapping phases. Phase 1 began in the early 1970s and is ongoing: average weight is progressively increasing among children. Phase 2, we are now entering, is characterized by the emergence of serious weight-related problems. The incidence of type 2 diabetes among adolescents, though still not high, has increased by a factor of more than 10 in the past two decades. Fatty liver associated with excessive weight, unrecognized in the pediatric literature before 1980, today occurs in about one in three obese children.

Other obesity-related complications affecting virtually every organ ranging from crippling orthopedic problems to sleep apnea are being diagnosed with increasing frequency in children. Obese children tend to be socially isolated and have high rates of disordered eating, anxiety, and depression. It may take many years to reach phase 3 of the epidemic, in which the medical complications of obesity lead to life-threatening disease. Phase 4 of the epidemic will entail an acceleration of the obesity rate through trans-generational mechanisms (Ludwig, 2007).

In developing countries like India where over nutrition coexists with under nutrition create a double burden in addition to the remaining, unconquered infectious diseases that have always afflicted the country. Most of the attempts were made in past to study the problem of under nutrition only, in Uttarakhand. Therefore it was necessary to find out the prevalence of overweight and obesity among children and to assess the contributing factors to address the rising problem of childhood obesity.

Materials and Methods

This was an observational cross-sectional study conducted during the year 2015 in the Dehradun city of Uttarakhand and 6 schools representing the three socio-economic class i.e. low socioeconomic class (LSE), middle socioeconomic class (MSE) and high socioeconomic class (HSE) were selected. Two schools representing each of the socio-economic class. The schools were grouped into low, middle and high socio-economic groups based on the monthly school fee taken from the children. Those schools which charged monthly school fee below ₹ 100 were LSE, those with school fee ₹ 100-600 per month as MSE and those with monthly school fee above ₹ 600 as high HSE class respectively.

Sampling method

All the children present at the day of investigation, of all the selected schools, studying in class I to IX (6-15 years of age) were screened for their BMI to classify them as obese and non-obese (N=1823). A body mass index (BMI) ≥85th percentile and a BMI ≥97th percentile are used as the cut-off for overweight for obesity respectively, as per the WHO 2007 classification (de Onis *et al.*, 2007).

Anthropometry

Height was measured using a portable stadiometre looking erect and straight on a leveled surface, without shoes with heels together and toes apart. The reading was taken to the nearest 0.1 cm. Body weight was measured (to the nearest 0.5 kg) with the subject standing erect and motionless on the bathroom weighing scale. Weighing scale was standardised regularly with a weight of 10 kg. The percentiles of BMI were calculated subsequently using WHO Anthro Plus

software to assess the prevalence of overweight and obesity.

Statistical analysis was performed using Microsoft Office Excel 2010. Differences between categorical variables were tested using Chi-square test and one way ANOVA and the value of $p < 0.05$ considered statistically significant. Odds ratio (OR) and CI calculator was used to calculate OR and 95% CI (https://select-statistics.co.uk/).

A written consent was taken from the school authority and the parents to measure the height and weight of the children.

Results and Discussion

Demographic Profile of the School Children

Children from six schools were classified based on age, gender and socioeconomic group of the school (Table 1). All the schools were located in rural or semi-urban areas of Dehradun city. A total of 1823 school children (57.4% boys and 42.6% girls) of age 6-15 years were screened for obesity. Only those students who were absent (7.7%) or < 6 yrs or >15yrs of age (2.5%) were excluded from the study.

Schools serving the children of middle socio-economic group (MSE) were private and government in nature whereas both the schools related to low socio-economic (LSE) group were run by government. Nearly half of the children belonged to MSE group (48%) followed by HSE (33%) and only 19% was from LSE group.

Anthropometric Assessment of School Children

Two anthropometric measurements, height and weight were taken for all the students from classes I-IX (6-15yrs) of the selected 6 schools and were screened for childhood obesity based on their age specific BMI.

Height: Height was recorded for each child and the mean values for height in each age group for both boys and girls are tabulated in table 2. Mean height of the HSE school girls in all the age groups (except 6-7 and 14-15 years) were greater than the heights of girls of MSE group and the heights of LSE girls were lower than HSE and MSE groups.

The mean height of boys of 6-7yrs of LSE group was 122.4±6.8cm and it was the highest followed by MSE (121.8±6.0cm) and lowest for HSE class boys (121.7±6.6cm) of the same age, where as in 8-9 years group MSE boys had highest mean height (132.5±6.4) followed by HSE boys (131.6±6.7cm) and lowest among LSE boys (131.0±10.9cm). Mean heights of boys was highest in HSE followed by MSE and lowest in LSE boys in rest of the age groups i.e., 10-11 years, 12-13 years and 14-15 years.

While significant difference was observed in the mean height of girls in HSE, MSE and LSE ($p<0.05$) in all age groups (except 10-11 years), no significant difference was observed in the mean heights of boys of any age group in different socioeconomic groups, indicating that during the school age and adolescence the food intake of LSE girls was relatively lower than MSE and HSE and highest for HSE girls.

Weight: Weight was recorded for each individual child and the mean values for weight across various age groups are given in table 3. Mean weights of girls of in all age groups (except 14-15 years where MSE girls had highest mean weight) were greater than the weights of girls of MSE group, and the weights of LSE girls were lowest of all. Significant difference was observed in the mean weight of girls in HSE, MSE and LSE

($p<0.05$) in all age groups except 10-11 and 14-15 years, where no significant difference was observed. Decreasing trend in the body weight of girls in the order of HSE, MSE followed by LSE could be directly related to food intake patterns of the different socioeconomic classes.

Similarly mean weight of boys is highest for HSE group followed by MSE group and lowest for LSE group in all the age groups. As the age was increasing a gradual gain in weight was observed in all the age groups among all three socioeconomic classes HSE, MSE and LSE. But there was a marked and significant difference ($p<0.05$) in the weights of boys in the three socioeconomic groups in any age group and the difference was in the decreasing order of weight from HSE to MSE to LSE.

Body Mass Index: The mean BMI of the boys and girls as calculated are given in table 4. Mean BMI was highest for the HSE group (both boys and girls) followed by MSE group and was found to be lowest for LSE group across all age groups. Significant difference was observed in the mean BMI of girls in HSE, MSE and LSE ($p<0.05$) in all age groups except 10-11 and 14-15 years, where no significant difference was observed. Significant difference was observed in the mean BMI of boys in HSE, MSE and LSE ($p<0.05$) in all age groups except 6-7 and 14-15 years, where no significant difference was observed.

Weight for Age and the prevalence of undernourishment

The percentile division of weight/age cut-offs of WHO (2007) namely <3rd, ≥3rd to <15th, ≥15th to <85th, ≥85th to <97th and ≥97th percentile were discussed as severely under-nourished, undernourished, normal, slightly over-nourished and over-nourished respectively for children up to 10 years of age only.

It was observed that among 782 children (boys and girls of 6-10 years age) 7% (24 girls and 28 boys) were severely undernourished, 14% (59 girls and 54 boys) were undernourished, 68% (210girls and 320 boys) were normal, 6% (20girls and 30 boys) were slightly over-nourished and 5% (14 girls and 23 boys) were over-nourished.

The incidence of severely undernourished (19% for LSE and 9% for both HSE and MSE) and undernourished children (29% for LSE, 16% for MSE and 8% HSE) decreased with the increasing income status. Contrary to that there was a proportionate increase in the incidence of slightly over-nourished (2% for LSE, 5% for MSE and 9% HSE) and over-nourished (0% for LSE, 4% for MSE and 8% HSE) children with the increasing income status.

Among girls (n=327) of age 6-10yrs, 64% were found to have normal weight/age (≥15th to <85th), 6% were in 85th-97th percentile and 4% above 97th percentile, while 26% girls were found to be below 15th percentile indicating that 1/4th of girls had low weight and 1/10th had more weight for their age. The incidence of severe under-nutrition in girls was almost similar in both HSE and MSE (6% and 5% respectively) compared to LSE, where it was four times higher (23%). The incidence of undernourished girls decreased almost three times (8%) in the HSE group compared to MSE and LSE group (23% for each). Proportionately there was a decrease in the percentage of girls under slightly over-nourished (8% HSE, 5% MSE and 3% for LSE) and over-nourished (6% HSE and 4% MSE) as the income decreased.

Among boys (n= 455) of age 6-10yrs, 70% were found to have normal weight/age (≥15th

to <85th), 7% were in 85th-97th percentile and 5% above 97th percentile, while 18% boys were found to be below 15th percentile indicating that 1/10th of boys had low weight and 1/5th had more weight for their age. The incidence of severe under-nutrition in boys was similar (5%) in both HSE and MSE compared to LSE, where it was three times higher (16%).

The incidence of undernourished boys decreased with the increasing income status, from 29% in LSE to 12% in MSE and 8% in HSE. Proportionately there was a decrease in the percentage of boys under slightly over-nourished (10% HSE, 5% MSE and 2% for LSE) and over-nourished (9% HSE and 3% MSE) as the income decreased.

Compared to girls boys were found to be more underweight in both HSE and MSE group (3% each), while in LSE group percentage of underweight girls (10%) was higher compared to boys (9%). Percentage of slightly undernourished boys were higher in both HSE (5%) and LSE (16%) compared to 3 and 13% girls in the respective groups, while percentage of slightly undernourished boys (6%) is lower than girls (10%) in MSE group. Slightly over-nourished and over-nourished children were of the same percentage among boys and girls of all three socio-economic groups except that over-nourished boys were more in HSE group compared to girls.

Higher percentage of boys was found to be under normal weight category compared to girls in all three socioeconomic groups. Gupta *et al.*, (2011) in a school based study of Varanasi found 5.8% children as wasted (weight for age <2 SD) according to their age (6.7% boys and 3.7% girls). There was no significant difference in wasting between both sexes.

Height for Age and the prevalence of stunting

The height for age of children is used as an indicator for the prevalence of under nutrition, i.e., 'stunting' according to Borooah (2005). Stunting is a cumulative indicator of nutritional deprivation from birth (or rather, conception) onwards. It is relatively independent of immediate circumstances, since height does not change much in the short term (Deaton and Dreeze, 2009). The percentile division of Height/age cut-offs of WHO (2007) namely <3rd, ≥3rd to <15th, ≥15th to <85th, ≥85th to <97th and ≥97th percentile were discussed as stunted, below normal, normal, above normal and taller respectively.

Overall 7% children (59 girls and 66 boys) were stunted, 17% (145 girls and 162 boys) had below normal height for their age. Gupta *et al.*, (2011) found 5.5% children to be stunted (height for age < 2 SD) according to their age (5.7% boys and 5.1% girls) in a school based study of Varanasi. There was no significant difference in stunting between both the sexes.

Among girls (n=776) 18% had below normal height for age and 8% were stunted. The incidence of stunted girls decreased with the increasing income status, from 16% in LSE to 6% in MSE and 4% in HSE. The incidence of below normal height was almost similar in both HSE (15%) and MSE (16%) compared to LSE, where it is two times higher (30%).

Among boys (n=1047) 16% were found to had below normal height for their age and 6% stunted. The incidence of stunted and below normal boys decreased with the increasing income status, from 10 and 20% in LSE to 5 and 15% in MSE and 6 and 13% in HSE, respectively.

While in HSE group % of stunting is higher for boys (4%) compared to girls (1%), contrary to that percentage of girls who were stunted (7%) or had below normal height (14%) is higher compared to boys (10% & 20% respectively) in LSE group (Figure 1). Though equal percentage (3%) of boys and girls were stunted in MSE group, higher percentage of boys (9%) compared to girls (7%) were found to be below normal.

BMI for Age and Prevalence of Obesity

The percentile division of BMI/age cut-offs of WHO (2007) namely <5th, ≥5th to ≤85th, >85th to ≤97th and ≥97th percentile were discussed as underweight, normal, overweight and obese, respectively. Distribution of school children based on their BMI for age percentiles in different age groups is given in Table 6.

Results showed that out of 1823 children (boys and girls) of age 6-15 years, 11.9% children (73 girls and 143 boys) were underweight, 77.2% (614 girls and 794 boys) were normal, 7.6% (62 girls and 77 boys) were overweight and 3.3% (27 girls and 33 boys) were obese. Significant ($p<0.05$) gender differences were observed only in the prevalence of underweight among children. Gender differences were statistically non-significant for the prevalence of obesity and being overweight among children.

Among girls (n=776) 79.1% had normal BMI/age, 8% were overweight and 3.5% obese, while 9.4% girls were found to be underweight, indicating that 1/10th of girls had low BMI and 1/11th had a high BMI for their age. The incidence of underweight girls decreased significantly ($p<0.05$) with the increasing income status, from 16.0% in LSE to 9.1% in MSE and 5.4% in HSE (Table 5). The incidence of overweight ($p<0.05$) and obesity (not significant) increased with the increasing socioeconomic conditions from 4.3 and 1.8% in LSE to 5.9 and 3.2% in MSE and to 13.8 and 5.0% in HSE groups.

Among boys (n=1047) 75.7% had normal BMI/age, 7.4% were overweight and 3.2% obese, while 13.7% boys were found to be underweight, indicating that approx. 1/14th of boys had low BMI and 1/10th had more BMI for their age. The incidence of underweight boys decreased significantly ($p<0.05$) with the increasing income status, from 29.9% in LSE to 12.1% in MSE and 7.6% in HSE (Table 5). The incidence of overweight ($p<0.05$) and obesity (not significant) increased with the increasing socioeconomic conditions from 1.1% each in LSE to 6.2 and 3.0% in MSE and to 12.5 and 4.5% in HSE groups.

Table 1 Distribution of children according to age and gender in groups of socio-economic class of school

Age (in year)	HSE (n=593)		MSE (n=881)		LSE (n=349)		Pooled		
	Boys	Girls	Boys	Girls	Boys	Girls	**Boys**	**Girls**	**Total**
6-7	76	57	101	84	16	10	193	151	**344 (18.9)**
8-9	89	55	132	90	26	25	247	170	**417 (22.9)**
10-11	80	46	115	90	45	36	240	172	**412 (22.6)**
12-13	73	57	119	85	70	57	262	199	**461(25.2)**
14-15	35	25	41	25	29	35	105	84	**189 (10.4)**
Total	**353** (59.5)	**240** (40.5)	**508** (57.6)	**373** (42.4)	**186** (53.3)	**163** (46.7)	**1047** (57.4)	**776** (42.6)	**1823(100)**

Figures in parenthesis indicate percentage

Table 2 Mean height (cm) of children by age-sex group in three types of schools

Age (years)	HSE	MSE	LSE	ANOVA		
				F	P	Fc
	Girls (n=777)					
6-7 (n=151)	121.1±6.4	121.7±6.1	117.1±5.6	10.92*	0.00	3.06
8-9 (n=170)	132.1±7.3	130.8±6.9	126.4±6.9	5.65*	0.00	3.05
10-11(n=172)	143.8±8.9	143.1±8.4	142.4±6.8	0.29 ^{NS}	0.75	3.05
12-13(n=199)	153.8±5.6	150.9±7.3	147.8±14.6	6.42*	0.00	3.04
14-15 (n=84)	154.2±5.2	156.02±5.9	151.8±5.5	4.32*	0.02	3.11
	Boys (n=1047)					
6-7 (n=193)	121.7±6.6	121.8±6.0	122.4±6.8	0.65 ^{NS}	0.52	3.04
8-9 (n=247)	131.6±6.7	132.5±6.4	131.0±10.9	1.44 ^{NS}	0.24	3.03
10-11 (n=240)	142.5±7.6	141.7±8.1	141.3±9.7	0.37 ^{NS}	0.69	3.03
12-13 (n=262)	155.5±9.5	155.3±9.4	153.7±8.4	0.90 ^{NS}	0.41	3.03
14-15 (n=105)	164.8±6.8	163.5±9.2	160.1±8.3	2.72 ^{NS}	0.07	3.09

Note: F- F calculated value Fc- F critical value P- probability value
* Significant at 5% level (p≤0.05) NS- Not significant

Table 3 Mean weight (kg) of children by age-sex group in three types of schools

Age (years)	HSE	MSE	LSE	ANOVA		
				F	P	Fc
Girls (n=777)						
6-7 (n=151)	23.9±4.3	22.1±4.2	19.7±2.5	3.37*	0.04	3.06
8-9 (n=170)	30.0±7.2	27.8±6.3	24.0±4.0	8.25*	0.00	3.05
10-11(n=172)	36.9±8.5	35.0±7.1	33.8±6.5	2.00^{NS}	0.14	3.05
12-13(n=199)	46.6±8.8	41.2±9.0	40.2±7.1	9.86*	0.00	3.04
14-15 (n=84)	45.8±6.6	47.3±9.9	43.4±7.6	1.78^{NS}	0.18	3.11
Boys (n=1047)						
6-7 (n=193)	24.4±4.7	22.6±3.7	21.4±3.2	5.72*	0.00	3.04
8-9 (n=247)	29.7±6.3	28.1±5.5	25.8±5.0	3.62*	0.03	3.03
10-11 (n=240)	34.5±5.7	34.0±8.0	30.8±6.2	4.26*	0.02	3.03
12-13 (n=262)	45.6±11.0	42.5±8.4	40.0±8.0	6.77*	0.00	3.03
14-15 (n=105)	52.2±11.5	48.3±11	45.2±7.8	3.79*	0.03	3.09

Note: F- F calculated value Fc- F critical value P- probability value
* Significant at 5% level (p≤0.05) NS- Not significant

Table 4 Mean body mass index of children by age-sex group in three types of schools

Age (years)	HSE	MSE	LSE	ANOVA		
				F	P	Fc
Girls (n=777)						
6-7 (n=151)	16.2±1.8	14.8±1.6	14.3±0.8	14.41*	0.00	3.06
8-9 (n=170)	17.0±2.5	16.1±2.5	14.8±1.4	7.66*	0.00	3.05
10-11(n=172)	17.7±2.7	16.9±2.2	16.6±2.4	2.42 NS	0.09	3.05
12-13(n=199)	19.6±3.3	18.1±3.6	17.9±2.6	5.22*	0.01	3.04
14-15 (n=84)	19.3±2.9	19.4±3.8	18.8±3.1	0.30 NS	0.74	3.11
Boys (n=1047)						
6-7 (n=193)	16.4±2.2	15.2±1.6	14.2±0.8	1.14 NS	0.32	3.04
8-9 (n=247)	17.0±2	15.9±2.1	14.9±1.0	4.08*	0.02	3.03
10-11 (n=240)	16.9±1.6	16.8±2.6	15.3±1.8	8.80*	0.00	3.03
12-13 (n=262)	18.7±3.2	17.5±2.1	16.8±2.2	10.65*	0.00	3.03
14-15 (n=105)	19.1±3.2	17.9±2.8	17.6±2.2	2.66 NS	0.07	3.09

Note: F- F calculated value Fc- F critical value P- probability value
* Significant at 5% level (p≤0.05) NS- Not significant

Table 5 Difference in Prevalence of Under-Weight, Overweight and Obesity among School Children Based on Different Socio-Economic Class #

BMI %	Under-weight ≤5th	Normal >5th to ≤85th	Overweight >85th to ≤97th	Obese ≥97th
Overall Prevalence				
HSE(n1=593)	**40** (6.7)	**448** (75.5)	**77** (13)	**28** (4.7)
MSE (n2=881)	**95** (10.8)	**706** (80)	**53** (6)	**27** (3.1)
LSE(n3=349)	**81** (23.3)	**254** (72.6)	**9** (2.6)	**5** (1.4)
X^2 (p-value)	58.8684* (<0.0001)	9.1179* (0.0105)	40.0425 * (< 0.0001)	7.7421* (0.0208)
Girls				
HSE(n1=240)	**13** (5.4)	**182** (75.8)	**33** (13.8)	**12** (5)
MSE (n2=373)	**34** (9.1)	**305** (81.8)	**22** (5.9)	**12** (3.2)
LSE(n3=163)	**26** (16)	**127** (77.9)	**7** (4.3)	**3** (1.8)
X^2 (p-value)	12.7118* (0.0017)	3.2981^{NS} (0.1922)	16.08 * (0.0003)	3.0325 ^{NS} (0. 2195)
Boys				
HSE(n1=353)	**27** (7.6) 326	**266** (75.4) 87	**44** (12.5) 309	**16** (4.5) 337
MSE (n2=508)	**61** (12.1) 447	**401** (78.7) 107	**31** (6.2) 477	**15** (3.0) 493
LSE(n3=186)	**55** (29.9) 131	**127** (67.9) 59	**2** (1.1) 184	**2** (1.1) 184
X^2 (p-value)	51.9168* (< 0.0001)	8.5061* (0.0142)	25.4614* (< 0.0001)	4.8981 ^{NS} (0.0864)

HSE: High Socio-economic class **MSE:** Middle Socio-economic class **LSE:** Low Socio-economic class
Figures in parenthesis are percentage values
***** Significant at 5% level (p≤0.05) **NS**- Not significant

Table 6 Distribution of school children based on BMI for age percentiles as per WHO (2007)

BMI %	Under-weight ≤5th		Normal >5th to ≤85th		Overweight >85th to ≤97th		Obese ≥97th	
Overall Prevalence (N=1823) Girls (n1=776) Boys (n2=1047)	**216** (11.9)		**1408** (77.2)		**139** (7.6)		**60** (3.3)	
Age	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**
6-7 years	14 (1.8)	18 (1.7)	115 (14.8)	147 (14.0)	17 (2.2)	19 (1.8)	5 (0.6)	9 (0.9)
8-9 years	15 (1.9)	19 (1.8)	130 (16.8)	196 (18.7)	18 (2.3)	23 (2.2)	7 (0.9)	9 (0.9)
10-11 years	12 (1.5)	37 (3.5)	142 (18.3)	185 (17.7)	12 (1.5)	12 (1.1)	6 (0.8)	6 (0.6)
12-13 years	18 (2.3)	44 (4.2)	164 (21.1)	195 (18.6)	9 (1.2)	16 (1.5)	8 (1.0)	7 (0.7)
14-15 years	14 (1.8)	25 (2.4)	63 (8.1)	71 (6.8)	6 (0.8)	7 (0.7)	1 (0.1)	2 (0.2)
Total	**73 (9.4)**	**143 (13.7)**	**614 (79.1)**	**794 (75.7)**	**62 (8.0)**	**77 (7.4)**	**27 (3.5)**	**33 (3.2)**
X^2 Value (p-value)	7.7104 * (0.0055)		2.7403 ^{NS} (0.0978)		0.2554 ^{NS} (0.6133)		0.1502 ^{NS} (0.6983)	

Figures in parenthesis are percentage values
* Significant at 5% level (p≤0.05) NS- Not significant

Fig.1

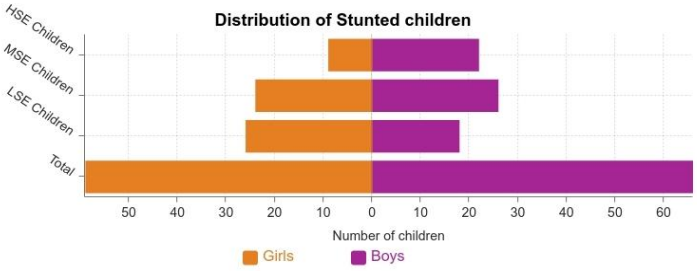
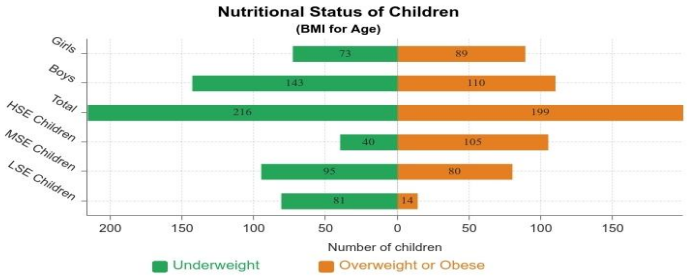


Fig.2



While overweight, obese and normal girls percentage was higher compared to boys in all the socio-economic groups, higher percentage of boys (7.6% HSE, 12.1% MSE and 29.9% LSE) compared to girls (5.4% HSE, 9.1% MSE and 16% LSE) were found to be underweight. It was evident from the table 5 that the incidence of underweight children decreased significantly ($p<0.05$) with increasing socio-economic status from 23.3% in LSE to 10.8% MSE and 6.7% in HSE. Contrary to that incidence of overweight and obesity increased significantly ($p<0.05$) with the increasing socio-economic status from 2.6 and 1.4% in LSE, to 6 and 3.1% in MSE and to 13 and 4.7% in HSE group (Figure 2).

Results showed nearly half of the children who were part of the study belonged to MSE group (48%) followed by HSE (33%) and only 19% was from LSE group. Dearth of modern amenities and perception of parents that more tuition fee means better education were the reasons for reduction in the enrolment of children in government schools in comparison with the private schools located in area. While overall prevalence for obesity was 3.3% (3.5% girls and 13.2% boys) and overweight prevalence was 7.6% (8% girls and 7.4% boys), the underweight prevalence was found 11.9%. While girls were found to be more overweight and obese compared to boys, the prevalence of underweight was higher among boys (13.7%) compared to girls (9.4%). This could be attributed to the tendency of girls to gain weight during age of puberty.

The results of the present study were in line with the findings of study conducted by Cherian *et al.,* (2012) who found prevalence of obesity as 3% for boys and 5.3% for girls in urban school children of 6-15 years (n=1634) of Kochi, Kerala, South India. Goyal *et al.,* (2010) also reported prevalence of obesity in Ahmedabad as 2.9% in boys and 1.5% in girls. Gupta *et al.,* (2011) also reported 12% prevalence of underweight (12.4% boys and 11.1% girls) and 5.4% for overweight and obesity (5.71% boys and 4.63% girls) among 4-16 years age school children of Varanasi.

In the same environment, the impact of socio-economic status was evident from these results. The reasons for better mean height and weight among HSE class children could be attributed to better quantity and quality of foods that were provided during the growth spurt due to better socio-economic conditions of these families. Availability of conducive environmental conditions, small family size, better nutritional value of diet (particularly protein and calcium), housing, personal hygiene, health habits and medical care facility were the factors observed. These results confirmed the findings of Freedman *et al.,* (2001) in their Bogalusa Heart study conducted among U.S. children and of Zhao *et al.,* (2010) among European American children.

The study strengthens the evidences for the prevailing problem of double burden of malnutrition in the country. It shows that overweight and obesity rates in children and adolescents are increasing in all the sections of the society, and is ready to set foot even in the Himalayan states. Now is the time that the school and the parents along with the government engage collaboratively to tackle this emerging health problem of the children.

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