STUDY OF OBESITY IN THE 11-16 YEARS AGE GROUP OF SCHOOL CHILDRENS- A CROSS SECTIONAL STUDY

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Abstract

Background: Obesity is evolving as a major nutritional problem in developing countries affecting a substantial number of adults and resulting in an increased burden of chronic disease.

Objectives: To study the prevalence of obesity and to establish the correlation between BMI and Neck Circumference in childrens of Rural & Urban Raipur.

Methods: Height measured using a stadiometer. Weight recorded to the nearest 0.1 kg using a weighing scale. BMI measured from the available WHO growth charts for children. Waist and neck circumference measured using a standard measuring tape to the nearest 0.1cm.

Results: The overall prevalence of overweight and obesity was found to be 9.8% and 7.8% respectively in our study. The prevalence of overweight was found to be 9.5% and 10.2% in males and females, respectively while obesity was more common in males (8.8%) compared to females (6.6%). Also there was direct correlation of prevalence of obesity with the choice of diet. 64.4% obese or overweight children belonged to the non vegetarian diet group as opposed to 35.6% in vegetarian group.

Conclusion: There was positive correlation between the socio-economic status and prevalence of obesity, also with the choice of diet. Children studying in Private schools had a higher prevalence of obesity when compared to Government schools.

Keywords: Height, Neck Circumference, Obesity, Overweight, Vegetarian Diet, Waist.

Introduction

Childhood obesity is a global phenomenon affecting all socio-economic groups, irrespective of age, sex or ethnicity. Etiopathogenesis of childhood obesity is multi-factorial and includes genetic, neuro-endocrine, metabolic, psychological, environmental and socio-cultural factors.¹ The National Health and Nutrition Examination Survey, 2009-10 found 32% children 2-19 yrs old to be overweight or obese in US. 17% of these were in obese range.² A Global School based survey in 2007 (largest study conducted in adolescent age group in India) reported prevalence of overweight between 3%-24.7% and obese 1.5%-14%. The least prevalence of obesity was reported from Nagaland (2.3%) and the maximum from New Delhi (29%).³ Obesity is a state of excess adipose tissue mass in the human body. It

results from an imbalance of calorie intake and energy expenditure.^{1,4}

Under healthy conditions, most triglyceride is stored in adipocytes; the amount of triglyceride stored in non-adipocyte tissues (such as the pancreas, liver, and myocardium) is minimal and very tightly regulated. Various genetic rodent models of obesity have shown that cytosolic triglyceride accumulates excessively in these organs (termed steatosis) when this regulation is disrupted. This accumulation has been implicated in activating adverse signaling cascades that culminate in irreversible cell death (termed lipotoxicity) and lead to several well-recognized clinical syndromes.⁴ These include nonalcoholic hepatic steatosis; pancreatic-cell failure in type 2 diabetes; and most recently, dilated cardiomyopathy.^{4,5}

Obesity is evolving as a major nutritional problem in

developing countries affecting a substantial number of adults and resulting in an increased burden of chronic disease. In national surveys conducted in USA from 1960 to 1990's, the prevalence of overweight in children increased from 5% to 11%. Studies on urban Indian school children from selected regions report a high prevalence of obese and overweight children. In addition, studies on Indian school children have also demonstrated that the prevalence of hypertension in overweight children is significantly higher than that among normal children.⁶

This was an observational study conducted to study the prevalence of obesity in school going children. It will also establish the correlation between BMI and Neck Circumference in those Rural & Urban Raipur children.

METHODS

This was a cross sectional study conducted on 11-16 year old school children in rural and urban Raipur population. Total 1100 school children were observed in the period of January 2017 to August 2018.

Adolescent children having dysmorphic features, Genetic aberrations, endocrinal problems and children under steroid therapy were excluded from the study. Parents of children not willing to give consent for their child to participate in the study also excluded.

The following parameters were noted under Anthropometry-

- Height measured using a stadiometer.
- Weight recorded to the nearest 0.1 kg using a weighing scale (Salter, Kent, England).
- BMI measured from the available WHO growth charts for children.
- Waist and neck circumference measured using a standard measuring tape to the nearest 0.1cm.
- Neck circumference was measured between the mid-cervical spine and mid-anterior neck just below the laryngeal prominence with the head in the Frankfurt plane.
- Waist Circumference was measured at the mid-point, half-way between the right iliac crest and the lower costal region.
- Sample size was calculated using the formula, $n = \frac{z\alpha^2pqD}{L^2}$

CATEGORY	BMI RANGE (Kg/m ²)	HEALTH RISK
Underweight	<18.5	Malnutrition
Normal	18.5-23	Normal
Overweight	23-27.5	Low risk of CHD & type 2 DM
Obese	>27.5	High risk of CHD & type 2 DM

Adults whose BMI is between 18.5 and 23, have a low risk of developing heart disease and other health problems such as diabetes. Those with a BMI between 23 and 27.5 are at moderate risk while those with a BMI of 27.5 and above are at high risk of heart disease and other health problems. Statistical analysis was performed by using MS Excel-2010 and SPSS software trial version 21.0. Mean and standard deviation was calculated.

RESULTS

This study was conducted on 1100 school children age range between 11-16 years. All the parameters were calculated and statistical analysis was performed to get a definite conclusion.

The overall prevalence of overweight and obesity was found to be 9.8% and 7.8% respectively in our study. The prevalence of overweight was found to be 9.5% and 10.2% in males and females, respectively while obesity was more common in males (8.8%) compared to females (6.6%). Also there was direct correlation of prevalence of obesity with the choice of diet. 64.4% obese or overweight children belonged to the non vegetarian diet group as opposed to 35.6% in vegetarian group.

Our study also found that 62.1% Children who were obese/ overweight were living in the urban areas of Raipur when compared with rural areas 37.9%. Children studying in Private schools had a higher prevalence of obesity i.e. 89% when compared to Government schools. Prevalence of obesity was taken to be 8.4%.

The number of hours of sleep was not found to be correlational with presence of obesity. 76.7% obese children slept for <8 hrs a day compared to 23.3% sleeping for >8hrs.

The metabolic syndrome (central obesity, hypertension, glucose intolerance, and hyperlipidemia) increases risk for cardiovascular morbidity and mortality. Nonalcoholic fatty liver

disease (NAFLD) occurs in 10-25% of obese adolescents.¹²

Out of the children 219 children found to be obese/overweight 66% had a normal liver on Abdominal Ultrasound, 6% had Grade I NAFLD, 27% had Grade II NAFLD, and only 1% had Grade III NAFLD.

BMI values for adults are age and sex independent. However, in children BMI changes physiologically

with age and sex. At birth the median BMI is as low as 13 KG/m², increasing to 17 Kg/m² at age 1, decreasing to 15.5 Kg/m² at age 6 and then increasing to 21 Kg/m² at age 20. The American Obesity Association used 85th percentile of BMI for the age and sex as a reference point for overweight and the 95th percentile for obesity in children.

Table 1: Prevalence of overweight and obesity in affluent and non affluent children.

Age(years)	Affluent children			Non affluent children		
	No.	Overweight	Obese	No.	Overweight	Obese
12	12	-	-	31	-	-
13	57	2	1	32	1	-
14	67	5	1	55	-	-
15	27	1	-	52	1	-
16	56	3	3	54	1	-
17	49	2	5	26	1	-
Total	268	13(4.85%)	10(3.73%)	250	4(1.6)	0(0%)

Table 2: BMI percentiles for Indian boys.

Age (y)	3	10	25	50	75	85	95
5	12.4	13.0	13.7	14.6	15.8	16.6	18.3
5.5	12.4	13.1	13.8	14.8	16.1	17.0	18.8
6	12.5	13.1	13.9	15.0	16.4	17.3	19.4
6.5	12.5	13.2	14.0	15.2	16.7	17.7	20.0
7	12.5	13.2	14.1	15.4	17.0	18.1	20.6
7.5	12.5	13.3	14.3	15.6	17.4	18.5	21.2
8	12.5	13.4	14.4	15.8	17.7	19.0	21.8
8.5	12.6	13.5	14.6	16.1	18.1	19.4	22.4
9	12.6	13.6	14.7	16.3	18.4	19.9	23.0
9.5	12.7	13.7	14.9	16.6	18.8	20.3	23.6

10	12.7	13.8	15.1	16.9	19.2	20.8	24.1
10.5	12.8	14.0	15.3	17.2	19.6	21.2	24.7
11	13.0	14.1	15.6	17.5	20.0	21.7	25.3
11.5	13.1	14.3	15.8	17.8	20.4	22.2	25.8
12	13.3	14.6	16.1	18.2	20.8	22.6	26.3
12.5	13.5	14.8	16.3	18.5	21.2	23.0	26.8
13	13.7	15.0	16.6	18.8	21.6	23.4	27.2
13.5	13.8	15.2	16.8	19.1	21.9	23.8	27.6
14	14.0	15.4	17.1	19.3	22.2	24.1	28.0
14.5	14.2	15.6	17.3	19.6	22.5	24.4	28.3
15	14.4	15.8	17.5	19.8	22.7	24.7	28.6
15.5	14.6	16.0	17.7	20.1	23.0	24.9	28.9
16	14.8	16.2	18.0	20.3	23.3	25.2	29.2
16.5	15.0	16.4	18.2	20.5	23.5	25.4	29.5
17	15.2	16.6	18.4	20.7	23.7	25.7	29.8
17.5	15.4	16.8	18.6	20.9	23.9	25.9	30.0
18	15.5	17.0	18.7	21.1	24.2	26.2	30.3

Table 3: BMI percentiles for Indian girls.

Age (y)	3	10	25	50	75	85	95
5	11.9	12.5	13.2	14.2	15.4	16.1	17.8
5.5	12.0	12.6	13.4	14.4	15.7	16.5	18.3
6	12.0	12.7	13.5	14.6	16.0	16.9	18.8
6.5	12.1	12.8	13.7	14.8	16.3	17.3	19.4
7	12.1	12.9	13.8	15.1	16.7	17.8	20.0
7.5	12.2	13.0	14.0	15.3	17.1	18.2	20.6
8	12.2	13.1	14.2	15.6	17.5	18.7	21.2

8.5	12.3	13.2	14.4	15.9	17.9	19.1	21.8
9	12.3	13.3	14.6	16.2	18.3	19.6	22.4
9.5	12.4	13.5	14.8	16.5	18.7	20.1	23.0
10	12.5	13.7	15.0	16.9	19.1	20.6	23.5
10.5	12.7	13.9	15.3	17.2	19.6	21.1	24.1
11	12.9	14.1	15.6	17.6	20.1	21.6	24.7
11.5	13.1	14.4	15.9	18.0	20.5	22.1	25.3
12	13.4	14.7	16.3	18.4	21.0	22.6	25.9
12.5	13.6	15.0	16.6	18.8	21.1	23.1	26.5
13	13.9	15.3	16.9	19.1	21.8	23.6	27.0
13.5	14.2	15.6	17.2	19.5	22.2	24.0	27.5
14	14.4	15.8	17.5	19.7	22.5	24.3	27.9
14.5	14.7	16.1	17.7	20.0	22.8	24.6	28.3
15	14.9	16.3	17.9	20.2	23.0	24.8	28.5
15.5	15.1	16.4	18.1	20.3	23.2	25.0	28.8
16	15.2	16.6	18.2	20.5	23.3	25.2	29.0
16.5	15.4	16.8	18.4	20.6	23.5	25.3	29.2
17	15.6	16.9	18.6	20.8	23.7	25.5	29.5
17.5	15.7	17.1	18.7	21.0	23.8	25.7	29.7
18	15.9	17.2	18.9	21.1	24.0	25.9	29.9

DISCUSSION

Obesity is one of the most prevalent nutritional problems of children and adolescent in many developed and developing countries. Overweight and obesity in adolescent are associated with hypertension, dyslipidemia and reduce glucose metabolism that has an impact on the physical health and can lead to an increase in the risk of early illness and death in later life.

The present cross-sectional study was done in the rural and urban schools of Raipur, among the school going children of the age group of 11-16 years.

The overall prevalence of overweight and obesity was found to be 9.8% and 7.8% respectively in our study. The prevalence of overweight was found to be 9.5% and 10.2% in males and females, respectively while obesity was more common in males (8.8%) compared to females (6.6%). Similar study was done by (1) Chhatwal et al in Punjab in 2004 among children of 9-15 yrs age reported overweight to be 14.2% and obesity 11.1%. (2) Gupta et al performed a study in 2013 in Bankura on 452 adolescents (10-18yrs) found 7.7% to be overweight and 4% obese. Amongst them 8.9%

boys and 6.3% girls were overweight and 4% of boys, 3.9% girls were obese. **(3)** Bharat et al conducted a cross-sectional school based study on 1000 children in Udaipur, which found prevalence of overweight as 8.2% and obesity to be 2.6%. **(4)** Anjali et al found in their study overweight children were 12.5% and obese were 5.6%.

A study conducted by Hatipoglu et al concluded that a significant correlation was found between Neck circumference and BMI and waist circumference ($p < 0.001$) and that measuring Neck circumference was a reliable and easy tool in overweight and obese children.⁽⁷⁾

Xiaofan Guo et al found that Compared to waist circumference, neck circumference has its advantages. It showed very good inter- and intra-rater reliability, which did not require multiple measurements for precision and reliability and Unlike WC, it would not be influenced by the timing of measurement (e.g. pre-prandial and postprandial period) and it is more practical especially in winter and at busy healthcare sites. Therefore, Neck Circumference is a better predictor in normal weight children and adolescents for elevated blood pressure.⁽⁸⁾

In 2012 A cross sectional population based study was conducted among Han Chinese children by Dong-Hui Lu et al to determine the usefulness of Neck circumference in determining obesity. It was found to be sensitive in 75.5-86.7% in boys and 80.0-92.5% in girls. The specificities were 73.9-91.7% in boys and 74.7-93.3% in girls.⁹

A Cross-sectional study conducted using the data from a Brazilian multicentric project called Study of Cardiovascular Risks in Adolescents - ERICA, included adolescents with age between 12-17 years' residents in two cities in Brazil. It evaluated the use of neck circumference as a screening measure for predicting overweight and obesity in adolescent age group. The group of 12 to 14 years old presented a positive correlation between NC and WC ($r = 0.692$; $p < 0.001$); NC and BMI ($r = 0.658$; $p < 0.001$) and NC and Systolic Arterial Pressure ($r = 0.514$; $p < 0.001$); and in the age group between 15 and 17 years old the NC and WC ($r = 0.619$; $p < 0.001$); NC and BMI ($r = 0.494$; $p < 0.001$) and NC and Systolic Arterial Pressure ($r = 0.530$; $p < 0.001$).¹⁰

A study was conducted by Youngwan Kim et al in US children to see the classification accuracy of Neck Circumference in predicting obesity in comparison to BMI. It was found that for boys, Cohen's κ (0.25), sensitivity (38.1%), and specificity (85.0%) of NC were smaller in comparison with Cohen's κ (0.57), sensitivity (57.1%), and specificity (95.0%) of BMI in relation to Body Fat % categorization. For girls, Cohen's κ (0.45), sensitivity (50.0%), and specificity (91.3%) of NC were smaller in comparison with Cohen's κ (0.52), sensitivity (50.0%), and specificity (95.7%) of BMI. The study was of the view that NC measurement was not better than BMI in classifying childhood overweight/obesity.¹¹

The metabolic syndrome (central obesity, hypertension, glucose intolerance, and hyperlipidemia) increases risk for cardiovascular morbidity and mortality. Nonalcoholic fatty liver disease (NAFLD) occurs in 10-25% of obese adolescents.¹²

A more rapid increase in weight-for-length during the first six months of life has been shown to be significantly associated with an increased risk of obesity at three years of age.¹³ In addition to low cost, simplicity, and availability, this method could be a screening tool to predict respiratory complications during surgery and abnormal metabolic status.¹⁴

In one study the cut off values for neck circumference and waist circumference were established. It was found that the cut-off value of neck circumference for screening adolescent obesity in boys and girls were 30.75 cm and 29.75 cm respectively, while cut-off values for waist circumference were 70.75 cm for boys and 69.25 cm for girls.¹⁵

A cross-sectional study conducted in KIMS, Bangalore in October 2016 on students aged 13-17 years age group. In this study the neck circumference cut off was 29-32.5 cm for pre and postpubertal boys, while it was 28-31cm for pre and post- pubertal girls. Optimal cut NC cutoff values indicative of high BMI in boys was found to be 28.5-39 cm, while it was 27-34.6 cm in girls.

In our study 3.9% of subjects were undernourished. 4 % males and 3.2% females. Goyal et al found in their study the prevalence of

underweight children to be 11.1% in boys and 8.6% in girls.⁵

In our study mean value of Weight was 43.59 kg among Males and 41.59 kg among Females. The least weight recorded was 22 kg and the maximum weight recorded was 85 kg. The Mean Height among males is 153.85 cm and Females 149.4 cm (Minimum 102 cm, Maximum 181 cm). Mean Waist Circumference of boys is more i.e. 70.3 cm compared to girls 67.99 cm. Mean value of Neck circumference measured amongst the boys was 30.11 cm and girls was 29.04 cm. All the parameters studied are found to be more in boys. This could be attributed to the fact that the number of boys in our study was more (684) compared to girls (557).

The cut off values of Neck circumference for males were 29.5 cm and 28.7 cm for females for obesity. It was found that Neck circumference had 84% sensitivity in screening obese individuals. In a cross sectional prospective observational study conducted in KIMS Bangalore in age group 13-17 years the mean neck circumference was 33.43 ± 2.3 cm and 31.50 ± 1.4 in overweight/obese boys and girl respectively.⁶

In another school based cross sectional study in Bhubaneswar, Odessa it was found that the cut-off value of neck circumference for screening adolescent obesity in boys and girls were 30.75 cm and 29.75 cm respectively. The sensitivity in predicting obesity was 79.2% in boys and 72.5% in girls, respectively.⁷

In our study the Mean value of Waist circumference in the Overweight/Obese category was 79.72 cm and it was found to be statistically significant. The Mean value of Neck Circumference was 31.62 cm\ which was statistically significant. BMI was found to have positive correlation with Neck Circumference which was statistically significant. (P value <0.001) in both males and females

BMI values for adults are age and sex independent. However, in children BMI changes physiologically with age and sex. At birth the median BMI is as low as 13 KG/m², increasing to 17 Kg/m² at age 1, decreasing to 15.5 Kg/m² at age 6 and then increasing to 21 Kg/m² at age 20. The American Obesity Association used the 85th percentile of BMI for the age and sex as a reference point for overweight and the 95th percentile for obesity in

children. (Table 4)

VV Khandikar, AV Khadilkar, TJ Cole and MG Sayyad produced contemporary growth curves for Indian children from 5-18 years for height, weight and BMI for Affluent Indian Children in 2007.

There was positive correlation between the socio-economic status and prevalence of obesity. There were 34.2% children in the highest socioeconomic category i.e Upper Middle class in our study group. Marwaha *et al.*⁸ classified children as normal, overweight and obese as per the IOTF guidelines and showed that among the upper socio-economic status (USES) children, prevalence of overweight and obesity was 17% and 5.6% in boys and 19% and 5.7% in girls, respectively, whereas in the lower socio-economic status (LSES) it was 2.7% and 0.4% in boys and 2.1% and 0.5% in girls, respectively.

Also there was direct correlation of prevalence of obesity with the choice of diet. 64.4% obese or overweight children belonged to the non vegetarian diet group as opposed to 35.6% in vegetarian group.

Our study also found that 62.1% Children who were obese/ overweight were living in the urban areas of Raipur when compared with rural areas 37.9%. Children studying in Private schools had a higher prevalence of obesity i.e 89% when compared to Government schools.

The number of hours of sleep was not found to be correlational with presence of obesity. 76.7% obese children slept for <8 hrs a day compared to 23.3% sleeping for >8hrs. Out of the children 219 children found to be obese/overweight 66% had a normal liver on Abdominal Ultrasound, 6% had Grade I NAFLD, 27% had Grade II NAFLD, and only 1% had Grade III NAFLD. The children with Fatty liver only 5.3 % had abnormal AST and 24.3% had abnormal ALT.

In our study group 35 % male obese children were aged 12 years and 34% of female obese children in 12 years. Out of the children who were overweight 10.7% had abnormal LDL value. 24.7% obese children had abnormal LDL values.

A study performed by Ferretti, Roberta de Lucena et al suggested that Upper body subcutaneous fat, estimated by neck circumference (NC), has presented greater metabolic risk than visceral fat.⁶

Table 4: Obesity in children in other cities of India.

Reigion, N [Year of data collection]	Age in years	Overweight			Obesity		
		Total	Boys	Girls	Total	Boys	Girls
Chennai, N= 4700 [July – Nov 2000]	13-18	-	17.8	15.8	-	3.6	2.9
Delhi, N=5000* [2000]	4-18	29.0	-	-	6.0	-	-
Chennai, [1981, N=707]	10-15	9.62	-	-	5.94	-	-
[1998, N=610]		9.67	-	-	6.23	-	-
Punjab, N=2008 [1999]	9-15	14.2	15.7	12.9	-	-	-
Pune, N=1228 [2003]	10-15	19.9	19.9	-	5.7	5.7	-
Panjab, N=640 [2000-2001]	10-15	10.9	9.9	12.0	5.6	5.0	6.3
Baroda, N=5329 [2001-2004]	12-18	8.5	8.0	9.0	1.5	1.4	1.7

CONCLUSION

This was an observational study conducted in private as well as government highschool. The children taken to be granted for the study were in the age group of 11-16 years old. There was positive correlation between the socio-economic status and prevalence of obesity, also with the choice of diet. Children studying in private schools had a higher prevalence of obesity when compared to Government schools. Biological factors such as family history of obesity, overweight at birth and presence of fat polymorphism were associated with the obesity in children and adolescents.

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