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Community Medicine

STUDY OF OBESITY AND DIABETES IN SCHOOL GOING CHILDREN OF MAYURBHANJ DISTRICT, ODISHA

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ABSTRACT A cross-sectional study was done among school children in both rural and urban area of Mayurbhanj district, Odisha. A total of 1096 children from 06-19 years age having equal percentage of male and female students are taken in my study.539(49.2%) children were having less than 18.5 (underweight) body mass index (BMI); 468(42.7%) goes to normal range of BMI (18.5-24.9); 39(7.1%) male and 28(5.1%) female are overweight and 10(1.8%) male and 12(2.2% female are obese. In both rural and urban area children are exposed to weight gain but in urban area it is more than rural children. In rural area male and female obesity percentage is 17(3.2%) and 15(2.8%) but in urban area 32(5.7%) and 25(4.5%) respectively. Both boys and girls are gaining weight generally after 10 years age. Mostly male children are gaining body weight than female children in both places. Children who used motorized vehicles for school going and parent earning is good having well family status are being overweight and obese compared to those who walked or cycling and having not so well family status. Children having more than one sibling and regularly doing physical activity at least 30 minutes per day were found to be protective against overweight and obesity. Rising of early onset obesity create problem from early life to later life. Morbidity and mortality rate increases in individual due to their early appearance and it increases the Non communicable Diseases in their future life. So, it is now necessary for periodic screening, awareness at school and parent counselling for changing their dietary habit and engage in any form of physical activity.

KEYWORDS : Obesity, Weight, Non communicable disease

INTRODUCTION

Overweight and obesity are two main terms used in obesity for calculating the category of excess weight in a body. In 21st century childhood obesity is a serious global health problem in whole world and it steeply rising from the last 2-3 decades. It not only problem of high-income countries but has been rapidly grasp among low and low-middle-income countries, under-nutrition is persistent, posing a threat of double burden of malnutrition (Popkin *et al*., 2020). India takes the third position after China and United States in the global burden of paediatric obesity. The prevalence of global childhood obesity has increased eightfold in the 5–19 years age group and doubled in the 2–4 years age group in the past four decades (Di Cesare *et al*., 2019). National family health survey-5 conducted during 2019-2021 state that, under-five overweight (Weight for age) rate increased from 2.1% in 2015-2016 to 3.4 % (urban- 4.2%, rural 3.2%) (NFHS-5, 2022).

The prevalence of obesity (BMI ≥30kg/m²) rises from 14% to 24% of the population over the same period, affecting nearly 2 billion adults, children and adolescents by 2035. The rising prevalence of obesity is expected to be steepest among children and adolescents, rising from 10% to 20% of the world's boys during the period 2020 to 2035, and rising from 8% to 18% of the world's girls (WOA, 2023). According to World Health Organisation (WHO) excessive fat accumulation increases the health risk in children under the age of 19 years of age. In children and adolescents overweight and obesity rates are increasing both in higher socio-economic groups and lower income groups where underweight still remains a major concern (Ranjani *et al*, 2016). Childhood obesity is also associated with a higher chance of obesity, cardiovascular diseases, hypertension, type 2 diabetes, high cholesterol levels, cancers, non-alcoholic fatty liver disease, obstructive sleep apnea, polycystic ovarian syndrome, asthma, orthopedic complications, psychiatric disease,premature death and disability in adulthood (Bhattacharjee *et al*., 2011).

According to Swati Bhardwaj and associates on Childhood obesity in Asian Indians showed have a higher magnitude of adiposity, abdominal obesity and a lower muscle mass than white Caucasians. Excess truncal subcutaneous fat has been proved to be a major determinant of insulin sensitivity and is associated with a high prevalence of insulin resistance in post-pubertal children (Bhardwaj *et al*, 2008). Body Mass Index (BMI) cannot distinguish fat and lean masses, and there is a two-fold range of variation in fatness for a given BMI. Waist-Hip Ratio (WHR) based on abdominal measurements, so it gives a better prediction of cardiovascular diseases and diabetes WHR, and the conicity index are used to correctly identify children with high trunk fat mass. waist circumference performs well as an index of central adiposity in children and adolescents of both sexes over a wide age range. WHR as a marker of fat distribution predicts several health disorders, such as cardiovascular diseases, adult-onset diabetes, elevated plasma lipids, hypertension, cancer (endometrial, ovarian and breast), gall bladder disease, depression, high stress level, and overall mortality (Powell-Wiley*et al*., 2021). Childhood health behaviour habits such as diet and physical activity are influenced by the school setting and often track into adulthood.

In clinical and research settings, obesity is determined mostly through BMI. BMI measures an individual's weight and height to classify them as normal, overweight, or obese. But its diagnostic accuracy is debatable as it often leads to an inaccurate assessment of adiposity (Romero-Corral, 2008). Therefore, waist circumference along with BMI was used for accurately assess the risk of obesity-related diseases. Abdominal or central obesity or Visceral obesity (body fat around abdominal organ) is defined as having a waist circumference of more than 80 cm in women and more than 94 cm in men. It is a strong predictor of cardiovascular diseases, type-2 diabetes, and other metabolic disorders (Powell-Wiley*et al.*, 2021). Asian Indians are more susceptible to abdominal obesity and accumulation of visceral fat, making them more vulnerable to associated health risks (Joshi, 2003). The focus of the present study was on identifying the prevalence of abdominal obesity in adolescent groups and study a comparison with BMI and WHR of rural and urban area children.

Although BMI is a reliable and easy-to-use tool at the population level over 5 years of age, it may not correspond to the same degree of fatness in different individuals. WHR, and the conicity index are used to correctly identify children with high trunk fat mass. waist circumference performs well as an index of central adiposity in children and adolescents of both sexes over a wide age range. As compared to BMI, WHR is a more sensitive parameter in picking up central obesity, which is known to be a potential risk factor for metabolic syndrome in adults (Vasavada *et al*., 2020).

Abdominal obesity could be developed in the absence of general overweight/obesity. Girls are more prone for complication of central obesity than boys. After 10 to 13 years age body fat distribution alters in female; that increase WHR also. Central obesity is predominantly higher among girls of both urban and rural schools as compared to boys. Total body fat % is a good indicator over all nutrition of children. Total body fat % increased with increase in WHR but the increment is not proportionate (Sunil *et al*., 2015).

METHOD

A cross-sectional study is carried out on school going children of rural, semi urban and urban area of Mayurbhanj district of Odisha in a large sample of both boys and girls ranging in ages from 6-19 years. Consent was taken from school principal prior to the gathering the data from

relevant children. Data were collected from school children at school in leisure period. Study period in school was from December 2022 to March 2023.

Inclusion Criteria

Students were selected at random in such a manner that an equal distribution of students from all age groups is attained. A nearly equal proportion of girls and boys are selected to eliminate sexual bias.

Exclusion Criteria

Children suffering from any major illness affecting nutrition and absent on the day of study were excluded from study.

Statistical Analysis

All the quantitative variables like age, height, weight, BMI and other anthropometric measurements are expressed in terms of mean and percentage. All qualitative variables like gender are expressed in terms of proportion and 95% confidence interval. Chi-squares test of statistical significance is used to test for difference in proportion of obesity between boys and girls.

Height was measured by using a non-flexible tape, without shoes, to the nearest 0.1cm, while child look straight and heels, buttocks, shoulder and occiput touching to the wall, stand in a relaxed manner with the arms hanging by the sides with the both feet and knees close together with head in the straight position facing to front and noted in metres.

Weight was measured according to UNICEFF recommendation by digital scale, with necessary clothing, without shoes, and recorded to the nearest 0.5 kg (Bhattacharyya, 2017). Body mass index is calculated using the following formula:

BMI=Weight (kg)/ Height (m^2)

(BMI below 18.5- Underweight, 18.5 - 24.9 Normal, 25.0- 29.9 Overweight, 30.0 and Above Obese)

Waist circumference was measured just above the umbilicus at the smallest circumference using a soft, non-elastic tape measure to the nearest 0.1cm. It is a highly sensitive and specific measure of central obesity. Cut off values for risk - 102 cm (males), 88 cm (females), and 71 cm (pre-pubertal children).

Hip circumference is measured at the widest point around the buttocks using the same tape measure to the nearest 0.1cm.

Waist-to-Hip ratio is calculated using the following formula:

WHR= Waist circumference (cm) /Hip circumference (cm)

In this study WHR was interpreted as follows: - WHR 0.80-0.84 were considered as over-weight, >0.85 were considered as obese, <0.79 were consider as normal (Kaur and Wala, 2007) and WHR > 0.9 were considered as central obesity (Bhave *et al.*, 2004).

Skin fold thickness is measured using a calliper which measures the thickness of a fold of skin along with its underlying fat. Measurements are taken at the triceps, biceps and waist. This is then used to calculate the total percentage of body fat on the body using fat percentage charts. Cut-off values for obesity - 30% body fat (girls) and 20- 25% body fat (boys).

Disadvantages– Significant inter and intra-observer variation, affected by gender and ethnicity, no Indian reference data, no significant advantage over BMI(Bhave *et al.*, 2004).

Body fat percentage is the percentage of fat your body contains; it will be calculated using the formula:

Child Body Fat % = (1.51 x BMI) - (0.70 x Age) - (3.6 x gender) + 1.4
(Male=1 & Female=0)

RESULT

A total of 1096 students age ranges from 06-19 years were studied. Out of these, 538(49%) belonged to rural area school and 558(51%) belonged to urban area school. Highest number of children were found in 11-15 years age group (260 in rural area and 266 in urban area school) in comparison to other two groups. Male and female number will be same in both rural and urban area school. But number of females slightly overcome the number of male children in most of the school. So, during comparison I cancel some female data. Rising of female number in educational institution reflects the increase of female literacy and outnumber of female candidate in govt. sector. The number of students per class in urban schools was more than rural schools. This may be because of lower population density and degree of absenteeism in rural schools, rather than a greater number of school enrolments per class in urban school (Table-1).

Table-1: Distribution Of Study Group According To Age And Sex. (N=1096)

Age groups	06-10 years		11-15 years		16-19 years		Total	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Male	62	69	130	133	77	77	269	279
Female	62	69	130	133	77	77	269	279
Total	124	138	260	266	154	154	538 (49%)	558 (51%)
Grand total	262(24%)		526(48%)		308(28%)		1096	

In case of height not any difference between rural and urban children I found. In every age group body fat percentage and other anthropometric measurements is more in urban area compared to rural area (Table-2).

Table-2: Mean And SD Of Weight, Height, BMI, WHR And Body Fat %.

Type of school	Age groups	Gender	Height in cm.	Weight in kg	BMI	Waist circumference (cm)	Hip circumference (cm)	WHR	Body fat %
Rural	6-10 years	Male	132 ±9	27 ±5	16±2	55±4	63±5	0.87±0.04	15±4
		Female	131 ±13	28 ±8	16.3 ±2	56 ±7	65 ±8	0.86±.05	18.4 ±3
	11-15 years	Male	152±10	43±12	18.1 ±4	64±9	75±9	0.85±0.04	16.3 ±6
		Female	146±7	41±10	19±4	63±8	77±8	0.81±0.05	21.3 ±6
	16-19 years	Male	163±6	56±12	21±3	73±10	86±9	0.84±0.05	17.6 ±5
		Female	151±5	46±9	20±3	63±10	81±8	0.77±.06	19±5
Urban	6-10 years	Male	129±8	30±7	17.7 ±3	56±4	63±5	0.9±.03	18.7 ±5
		Female	128±11	30±7	18.1 ±3	58±6	65±7	0.9±.03	22.9 ±4
	11-15 years	Male	151±10	44±11	19.1 ±4	65±9	76±9	0.85±.04	17.8 ±6
		Female	146±7	42±10	19.7 ±4	65±8	78±8	0.84±.05	22.7 ±5
	16-19 years	Male	163±5	59±12	22±4	73±10	88±8	0.83±.06	18.7 ±6
		Female	151±5	48.8±10	21.3 ±4	66±12	82±9	0.81±.06	21±6

Table-3: Gender Specific Co-relation Of BMI In Study Population

BMI	Age groups	Male		Female		Total
		Rural	Urban	Rural	22(2%)	
Underweight	6-10 years	57	47	48	22(2%)	193 (73.7%)
(BMI< 18.5)	11-15 years	82	69	61	22(2%)	261 (49.6%)
	16-19 years	20	13	30	22(2%)	85 (27.6%)
Total		288(52.6%)		251(45.8%)		539 (49.2%)
Normal	6-10 years	5	18	14	22(2%)	62 (23.7%)
(BMI=18.5-24.9)	11-15 years	38	49	61	22(2%)	222 (42.2%)
	16-19 years	50	51	40	22(2%)	184 (59.7%)
Total (Percentage)		211(38.5%)		251(45.8%)		468 (42.7%)

Overweigh t	6-10 years	0	4	0	22(2%)	7 (2.7%)
(BMI= 25-29.9)	11-15 years	9	14	6	22(2%)	37 (7%)
	16-19 years	4	8	5	22(2%)	23 (7.5%)
Total (Percentage)		39(7.1%)		28(5.1%)		67 (6.1%)
Obese	6-10 years	0	0	0	22(2%)	0
(BMI> 30)	11-15 years	1	1	2	2	6 (1.1%)
	16-19 years	3	5	2	6	16 (5.2%)
Total (Percentage)		10(1.8%)		12(2.2%)		22 (2%)

According to BMI 288(52.6%)male children were underweight, 211(38.5%)were normal, 39(7.1%)were overweight and 10(1.8%) were obese. In case of female children, 251(45.8%)were underweight, 251(45.8%)were normal, 28(5.1%)were overweight and 12(2.2%) were obese. In 6–10-year, age group overweight category was found i.e., 7(2.7%) but obese children were not found both in rural and urban area school.6(1.1%) and 16(5.2%)obese categories were found in 11-15 year and 16-19 years age group respectively. (Table 3).

Out of total 1096 adolescents in the study 539(49.2%) children were underweight according to BMI while 468(42.7%) had normal BMI and 67(6.1%) were overweight, among overweight 24(4.5%) were from rural school and 43(7.7%) from urban area. 22(2%) students fell in obesity category range based on BMI. From all total underweight category percentage is more in both area but, it is more in rural area than urban area. Overweight and obese percentage more in adolescent period i.e., >10 years age-group but underweight percentage more in 6-10 years age group. This suggests that undernutrition still remains the challenging form of malnutrition in both rural and urban Indian setup, addressed (Table 4).

Table-4: Age Specific Co-relation Of BMI In Study Population (N=1096)

Age	Underweight (BMI< 18.5)		Normal (BMI=18.5-24.9)		Overweight (BMI=25-29.9)		Obesity (BMI ≥ 30)	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
6-10 yrs.	105 (84.7 %)	88 (64%)	19 (17.6 %)	43 (31%)	0	7 (5%)	0	0
10-15 yrs.	143 (55%)	118 (44.4 %)	99(38 %)	123 (46.2 %)	15 (5.8%)	22 (8.3%)	3 (1.2%)	3 (1.1%)
16-19 yrs.	50 (32.5 %)	35 (22.7 %)	90(58. 4%)	94(61 %)	9(5.8 %)	14 (9%)	5 (3.25 %)	11 (7.1%)
Total	298 (55.4 %)	241 (43.2 %)	208(3 8.7%)	260(4 6.6%)	24(4.5 %)	43 (7.7%)	8 (1.5%)	14 (2.5%)
Grand total	539(49.2%)		468(42.7%)		67(6.1%)		22(2%)	

In rural area male having 17(3.2%) were goes to obesity category (i.e., both overweight and obese) and in female it was having 15(2.8%) but, in case of urban area 32(5.7%) and 25(4.5%) were found in male and female children respectively. In both male and female school children are being more risk in urban area in comparison to rural area (Table 5).

Table-5: Area specific BMI status in male and female children

BMI	Age groups	Rural		Urban	
		Male	Female	Male	Female
Overweight (BMI=25-29.9)	6-10 years	0	0	4	3
	11-15 years	9	6	14	8
	16-19 years	4	5	8	6
Obese (BMI> 30)	6-10 years	0	0	0	0
	11-15 years	1	2	1	2
	16-19 years	3	2	5	6
Total (Percentage)		17(3.2%)	15(2.8%)	32(5.7%)	25(4.5%)

Basing on WHR 234(21.4%) were having underweight children, 372(34%) were overweight and 490(44.7%)were obese category. Waist circumference and hip circumference difference gradually increases in case of female after age 11-12 due to hormonal difference but this difference also found in male in lower degree. In case of lower age group i.e., 6-10 waist circumference and hip circumference size is nearly close and they show more WHR in comparison to other two groups. These children are look very thin and have low BMI but generally WHR is high. In my study 192(73%) obese category found in 6-10 years age group and 227(43.2%) and 71(23%) found in11-15 and 16-19 age group respectively. But underweight category is lowest in 6-10 years age group i.e., 9(3.4%) and highest in 16-19 years age group i.e., 140(45%) (Table 6).

Table-6: Age And Gender Specific Comparison Of WHR Between Rural And Urban School.

Age group	Types of school	WHR					
		>0.85CM		0.80-0.84C		<0.79CM	
		Male	Female	Male	Female	Male	Female
6-10 yrs.	Rural	38	30	23	24	1	8
	Urban	63	61	6	8	0	0
Total		192(73%)		61(23.3%)		9(3.4%)	
11-15 yrs.	Rural	60	51	56	49	14	30
	Urban	65	51	58	51	10	31
Total		227(43.2%)		214(40.7%)		85(16.2%)	
16-19 yrs.	Rural	23	9	33	15	21	53
	Urban	23	16	25	24	29	37
Total		71(23%)		97(31.5%)		140(45%)	
Grand total		490(44.7%)		372(34%)		234(21.4%)	

Basing on WHR 234(21.4%) were having underweight children, 372(34%) were overweight and 490(44.7%)were obese category. Waist circumference and hip circumference difference gradually increases in case of female after age 11-12 due to hormonal difference but this difference also found in male in lower degree. In case of lower age group i.e., 6-10 waist circumference and hip circumference size is nearly close and they show more WHR in comparison to other two groups. These children are look very thin and have low BMI but generally WHR is high. In my study 192(73%) obese category found in 6-10 years age group and 227(43.2%) and 71(23%) found in11-15 and 16-19 age group respectively. But underweight category is lowest in 6-10 years age group i.e., 9(3.4%) and highest in 16-19 years age group i.e., 140(45%) (Table 6).

Table-7: Prevalence Of Obesity According To WHR And BMI		
Obesity status	**BMI**	**WHR**
Overweight	67(6.1%)	372(34%)
Obese	22(2%)	490(44.7%)

67(6.1%) adolescents had BMI ranges between 25-29.9 i.e., overweight and 22(2%) were obese because BMI is above 30. However overweight and obesity case based on WHR is 372(34%) and 490(44.7%) respectively. Increasing WHR indicates central obesity i.e., increase risk of metabolic syndrome. This variance between BMI and WHR may be attributed to the fact that in the present study, WHR either tends to overestimate overweight and obesity or it diagnoses overweight and obesity at the earlier stage (Vasavada *et al*., 2020) (Table 7).

DISCUSSION

The prevalence of obesity both in childhood and adult rising constantly reported from different study. The prevalence of obesity is higher among the urban populations, high socioeconomic states and also in South India followed by North India and lowest in West India. Urban areas obesity is higher than the national average throughout the study period and obesity prevalence was 1.54% but, urban areas the corresponding estimate was 2.51% (Ahirwarand Mondal, 2019; Sirisha,2022).

Incidence of overweight in male was 39(7.1%) and 28(5.1%) in female but rate of obese male children 10(1.8%) and female children was 12(2.2%). So, rate of overweight is more in case of male but obese rate is more in female children. Male children overweight based on BMI is more than female children of the same locality.This difference was not statistically significant, similar to the findings of other studies (Patnaik *et al*., 2011; Gautam and Jeong, 2019). Generally, lifestyle behaviour of an individual influence the development of obesity. Mosty due to inappropriate dietary habits and decreased physical activity.

67(6.1%) adolescents had BMI range of 25-29.9 which is considered to be overweight and 22(2%) had more than 30 BMI i.e., obese category.

However, the percentage of overweight and obese was raised at 372(34%) and 490(44.7%) respectively when classified as per WHR (Table 6).

WHR either tends to overestimate overweight and obesity or it diagnoses these in earlier stage. Increase WHR with normal BMI may indicates more of central fat distribution (central obesity) in Indian adolescents, which causes increase risk of metabolic syndromes. Only BMI not estimate properly the obesity category. So, a combination of both is required for proper estimation of obesity and the related health risk. If both BMI and WHR increases then health risk also increases. Serum lipid profile is a good indicator of obesity. So, with BMI and WHR serum lipid profile also correlate for best.

There were no significant influences of age on WHR reflected in the present study. This is in contrast to study conducted by Ridder et al., which concluded that with advancing age especially in the girls WHR decreases (De Ridder *et al*., 1992). South India study on childhood obesity reported that lack of physical activity was the most significant factor (Lazarus *et al*., 2016) but, North India study reported dietary factors, were the most significant factors contributing to childhood obesity (Sachdeva *et al*., 2018).Private school students are prone to high risk of being overweight/obese compared to students in government schools. There are equal chances in case of males and females regarding the burden of being overweight/obese (Gautam and Jeong, 2019).Delhi study reported that children who spending more than 2h per day watching television had higher chance of being obese (Gupta *et al.,* 2018).

CONCLUSION

Prevalence of obesity is comparatively more in male children than female one in adolescent stage in both rural and urban area. Increasing weight in early age decrease the life expectancy of adolescents than their parents, as adult obesity has its onset in childhood and their associated chronic diseases. Now, it is important to identify the obesity status among school going children to giving them a healthy future. Awareness may be created among the parents of school going children to reduce the risk.

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