

Prevalence of Overweight and Obesity Among School Children and Adolescents in Chennai

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Objectives: To determine the prevalence of overweight and obesity among children and adolescents in Chennai, India, using national and international age- and sex- specific body mass index (BMI) cut-off points.

Methods: The Obesity Reduction and Awareness and Screening of Non communicable diseases through Group Education in Children and Adolescents (ORANGE) project is a cross-sectional study carried out on 18,955 children (age 6-11 years) and adolescents (age 12-17 years) across 51 schools (31 private and 20 government) of Chennai. Overweight and obesity was classified by the International Obesity Task Force (IOTF 2000) and Khadilkar's criteria (2012), and Hypertension by the IDF criteria (in children ≥ 10 years and adolescents).

Results: The prevalence of overweight/obesity was significantly higher in private compared to government schools both by the

IOTF criteria [private schools: 21.4%, government schools: 3.6%, (OR: 7.4, 95% CI:6.3-8.6; $P < 0.001$) and by Khadilkar criteria (private school: 26.4%, government schools: 4.6% OR: 6.9, 95% CI:6.2-7.8; $P < 0.001$). Overweight/obesity was higher among girls (IOTF: 18%, Khadilkar: 21.3%) compared to boys (IOTF: 16.2%, Khadilkar: 20.7%) and higher among adolescents (IOTF: 18.1%, Khadilkar: 21.2%) compared to children (IOTF: 15.5%, Khadilkar: 20.7%). Prevalence of hypertension was 20.4% among obese/overweight and 5.2% among non-obese (OR 4.7, 95%CI: 4.2-5.3, $P < 0.001$).

Conclusion: The prevalence of overweight and obesity is high among private schools in Chennai, and hypertension is also common.

Keywords: Adolescents, Body mass index, Hypertension, Nutritional status.

Obesity has emerged as one of the global health problems with 200 million school-aged children world-wide categorized as being overweight/obese, of which 40-50 million are obese [1]. The factors attributing to increasing childhood obesity are increased intake of high-calorie foods that are low in vitamins, minerals and micronutrients coupled with decreased physical activity [2]. Various studies done in India from 2002-2012 indicate a rising trend in the prevalence of overweight and obesity in children and adolescents [3-11]. This may have major implications towards increasing prevalence of non-communicable disease (NCD) like diabetes, hypertension and cardiovascular disease in early adulthood [11,12].

Data from India related to obesity rates in children and adolescents comparing both national and international cut-offs are scarce. We present the age- and sex-specific prevalence of overweight and obesity among children and adolescents in Chennai using the International Obesity Task Force (IOTF) guidelines which corresponds to an adult-equivalent body mass index (BMI) of 25 kg/m² and 30 kg/m² [13], and

Khadilkar's Asian Indian guidelines for children and adolescents [14]; which corresponds to an adult-equivalent BMI of 23 kg/m² and 28 kg/m², respectively.

METHODS

The Obesity Reduction and Awareness of Non-communicable disease through Group Education (ORANGE) is a large three-year population-based cross-sectional study on children and adolescents (aged 6-17 y) of Chennai city, in Southern India. The study consists of two components (methodology published earlier) namely; the Colony (community) component and the School component [15]. This paper deals only with the school component.

Permission was obtained from the Chief Education Officer, Government of Tamil Nadu, school management of every school and the Institutional Ethics Committee of the Madras Diabetes Research Foundation to conduct the study. Informed written consent was obtained from one of the child's parents and in addition assent was obtained from the child before conducting the study.

Twenty thousand children and adolescents aged between 6-17 yrs were screened. The sample size was calculated based on an estimated prevalence of obesity of 10%, with 80% power, 95% confidence, and an estimated 3% margin of error to obtain an age- and gender-specific representative sample of children. Height was measured in centimeters (cm) using a stadiometer. Weight was measured in kilograms (Kg) using a standardized weighing machine. Body mass index (BMI) was calculated using the formula weight (Kg) divided by height in square meters (m²). Waist circumference was measured in centimeters using a non-stretchable fiber measuring tape. Blood pressure was measured in the left arm to the nearest 1 mmHg using an electronic machine (Omron Corporation Tokyo, Japan), with the participant seated in a relaxed position. The prevalence of overweight and obesity were determined based on the IOTF criteria [13] and the Khadilkar's criteria for children and adolescents [14].

Sampling method: Out of the 1384 government and private schools, listed under the Directorate of Education, Chennai, Tamil Nadu, 51 schools were selected by systematic sampling method with a random start. The ratio of government to private schools was maintained at 2:3 in keeping with the distribution of the schools in Chennai city. In each school, all students from two to four randomly selected standards (classes or grades) were screened till the sample size of 20,000 children and adolescents was reached.

The overall response rate was 95.3% ($n=19059$). The 941 non-responders included 641 individuals who did not submit the written consent form or those who did not give assent for the study, 200 absentees, and 100 participants excluded during data cleaning due to extraneous values. A further 104 were excluded as they did not meet the age criteria (<18 years); data of 18955 participants were included in the final analysis.

For the purpose of this study, participants aged 6-11 years were classified as children and those aged 12-17 years as adolescents. Participants from government schools were categorized as belonging to the lower socio-economic group, and those from private schools as higher socio-economic group.

Statistical analysis: Comparison of continuous variables was by One-way ANOVA and proportions by the Chi-squared test. Logistic regression analysis was carried out to examine the relationship between socio-economic status, gender and age with overweight/obesity. Analyses were done using Windows based SPSS Statistical Package (version 18.0; SPSS, Chicago, IL).

RESULTS

A total of 18955 children and adolescents (1799 children and 2904 adolescents from 20 government schools, and 6226 children and 8026 adolescents from 31 private schools) participated in the study. **Table I** gives the general characteristics of the participants. The school participants from private schools were significantly taller and had higher BMI, waist circumference and systolic and diastolic blood pressure compared to the government school participants.

Table II shows the prevalence of overweight and obesity in children and adolescents. **Web Table I** shows the age-wise prevalence (6-17 years) of overweight/obesity in children and adolescents in Chennai using both the criteria IOTF and Khadilkar's criteria. The prevalence of overweight/obesity was significantly higher in private schools compared to government schools at all age points, both among boys and girls.

Regression analysis showed that adolescents had 1.21 times greater odds of being overweight/obese by the IOTF criteria and 1.11 times by the Khadilkar's criteria than children. Private school participants had 7.4 times greater odds of being overweight/obese by the IOTF criteria and 6.94 times by the Khadilkar's criteria compared to government school participants. Girls had 1.13 times greater odds of being overweight/obese by the IOTF criteria and 1.36 times by the Khadilkar's criteria, compared to boys.

Table III presents the blood pressure profile of the study group shows a steady increase in both systolic and diastolic blood pressure with age. Hypertension diagnosed by IDF criteria [16], for children ≥ 10 years of age and adolescents was seen in 1185 (8%) participants. The prevalence of hypertension among overweight/obese children and adolescents was 20.4% compared to 5.2% among their non-obese counterparts (OR: 4.7, 95% CI: 4.2-5.3, $P < 0.001$).

DISCUSSION

This study showed that the overall prevalence of obesity is high in urban Chennai. This was predominantly dictated by the high prevalence of obesity in private schools as compared to government schools. The prevalence of obesity was higher in girls than boys, in adolescents than children, in private schools than government schools and higher on using the Khadilkar's criteria [14], compared to the IOTF criteria [13].

Most of the earlier studies done in children and adolescents in India have reported prevalence based on international cut-off points [3-11], with a meta-analysis

TABLE I GENERAL CHARACTERISTICS OF THE PARTICIPANTS

Variables	Children				Adolescents			
	Boys (n=4478)		Girls (n=3547)		Boys (n=6187)		Girls (n=4743)	
	Government schools (n = 976)	Private schools (n = 3502)	Government schools (n = 823)	Private schools (n = 2724)	Government schools (n = 2147)	Private schools (n = 4040)	Government schools (n = 757)	Private schools (n = 3986)
Age (y)	9.1 (1.8)	9.1 (1.6)	8.8 (1.7)	9.2 (1.7) [‡]	14.1 (1.6)	14.0 (1.5) [‡]	13.8 (1.6)	13.9 (1.5) [‡]
Height (cms)	125.7 (11.6)	133.7 (11.5) [‡]	123.6 (11.4)	133.9 (12.7) [‡]	152.1 (12)	160.9 (11.2) [‡]	147.2 (8)	155.4 (6.8) [‡]
Weight (kg)	23.2 (6.6)	30.9 (9.9) [‡]	22.4 (6.3)	30.9 (10.3) [‡]	39.1 (10.8)	51.6 (14.3) [‡]	38.6 (9)	49.8 (11.8) [‡]
BMI (kg/m ²)	14.4 (1.8)	16.9 (3.3) [‡]	14.4 (1.9)	16.8 (3.3) [‡]	16.6 (2.8)	19.7 (4) [‡]	17.6 (3.2)	20.5 (4.2) [‡]
WC (cms)	52.7 (6.1)	60.1 (9.9) [‡]	52.3 (5.9)	57.8 (8.5) [‡]	62.4 (8)	71.8 (11.8) [‡]	61.4 (7.6)	67.9 (9.3) [‡]
Systolic BP (mmHg)	100 (11)	105 (11) [‡]	99 (11)	104 (11)	108 (12)	116 (13) [‡]	107 (11)	112 (12) [‡]
Diastolic BP (mmHg)	62 (9)	63 (10) [‡]	62 (9)	63 (9) [*]	64 (9)	67 (9) [‡]	66 (8)	68 (9) [‡]
Z-score HFA	-0.48 (0.9)	0.16 (0.9)	-0.65 (0.9)	0.17 (1)	-0.40 (1.1)	0.43 (1)	-0.86 (0.8)	-0.09 (0.6)
Z-score WFA	-0.59 (0.7)	0.18 (0.9)	-0.67 (0.6)	0.18 (1)	-0.63 (0.8)	0.29 (1)	-0.67 (0.7)	0.16 (0.9)
Z-score BMI	-0.59 (0.6)	0.18 (1)	-0.59 (0.6)	0.16 (1)	-0.64 (0.7)	0.11 (0.9)	-0.40 (0.8)	0.31 (1)

Values are expressed in Mean (SD), [†]P<0.001, [‡]P<0.001; WC: Waist circumference; BP: Blood pressure; HFA: Height for age; WFA: Weight for age.

estimating the prevalence of overweight as 12.6% and obesity as 3.4% [17]. Another multicentric study reported an overall prevalence of overweight/obesity as 18.2% [10]. Our study adds to the literature by reporting on the prevalence estimates using both national and international cut points.

A strength of this study is that it is one of the largest studies done on overweight/obesity in a wide age group of school children (6-17 years) in a representative sample of Chennai, an urban area of Southern India. Two studies with comparable sample size were carried out in Delhi [7,8]. The findings of these studies and our study show a markedly higher prevalence of overweight/obesity among children attending private schools in comparison to those attending government schools. The combined influence of socioeconomic status, lifestyle and chronological age with a high prevalence of obesity among adolescents as seen in our study has also been reported earlier [4,18]. However, even among government schools, the prevalence of overweight/obesity is significant. This new trend can be attributed to increasing accessibility and affordability of both junk foods and modes of motorized transportation resulting in an increased consumption of energy-dense foods coupled with decreased physical activity in the lower income group [19].

Our study also shows a higher prevalence rates of overweight/obesity among girls, as did a previous study done in Chennai [20]. The influence of gender and adolescence on obesity can be attributed to hormonal changes at puberty and the development of secondary sexual characteristics resulting in fat accumulation and redistribution [21]. Moreover, we had shown earlier, that only 25% of the girls played outdoors for ≥1 hour/day compared to 43% of the boys [22]. Earlier studies showed that increase in adiposity lead to a higher risk of developing elevated systolic and diastolic blood pressures and hypertension in children and adolescents [11,23]. Our study also shows that overweight/obese children have a 5-fold higher risk of having hypertension than non-obese children.

The limitation of our study is that it is restricted to one large metropolitan city. The findings may not be representative of the whole country or even of the whole State of Tamil Nadu. Only a truly representative national study, involving both urban and rural populations, can provide the true picture on the nationwide prevalence of overweight/obesity.

The higher prevalence of obesity among children and adolescents attending private schools and among adolescents in general, suggests a need for targeted

TABLE II SCHOOL- AND GENDER-BASED PREVALENCE OF OVERWEIGHT AND OBESITY IN CHILDREN AND ADOLESCENTS

Criteria used	Children		Adolescents	
	Government schools	Private schools	Government schools	Private schools
IOTF [13] N (%)				
Boys (N)	976	3502	2147	4040
BMI ≥25-29.99	16 (1.6)	568 (16.2)	77 (3.6)	725 (17.9)
BMI ≥30	3 (0.3)	148 (4.2)	9 (0.4)	185 (4.6)
Overall	19 (1.9)	716 (20.4)	86 (4.0)	910 (22.5)
Girls (N)	823	2724	757	3986
BMI ≥25-29.99	21 (2.6)	374 (13.7)	31 (4.1)	765 (19.2)
BMI ≥30	3 (0.4)	107 (3.9)	8 (1.1)	182 (4.6)
Overall	24 (2.9)	481 (17.7)	39 (5.2)	947 (23.8)
Khadilkar [14] N (%)				
Boys (N)	976	3502	2147	4040
BMI ≥23-27.99	35 (3.6)	811 (23.2)	133 (6.2)	969 (24.0)
BMI ≥28	8 (0.8)	407 (11.6)	33 (1.5)	439 (10.9)
Overall	43 (4.4)	1218 (34.8)	166 (7.7)	1408 (34.9)
Girls (N)	823	2724	757	3986
BMI ≥23-27.99	47 (5.7)	631 (23.2)	74 (9.8)	1076 (27.0)
BMI ≥28	9 (1.1)	313 (11.5)	22 (2.9)	569 (14.3)
Overall	56 (6.8)	944 (34.7)	96 (12.7)	1645 (41.3)

Values are expressed in n (%); P<0.001 for all measures between government and private schools; IOTF: International Obesity Task Force Criteria [13].

TABLE III BLOOD PRESSURE PROFILE OF THE STUDY GROUPS

Age (y)	No.	Boys (N=10665)		No.	Girls (N=8290)	
		Systolic BP (mmHg)	Diastolic BP (mmHg)		Systolic BP (mmHg)	Diastolic BP (mmHg)
6	429	99 (10)	60 (11)	360	98 (12)	60 (10)
7	472	100 (11)	60 (10)	420	98 (11)	60 (11)
8	652	100 (11)	60 (9)	515	101 (11)	61 (9)
9	724	105 (11)	63 (9)	540	103 (11)	63 (9)
10	976	105 (10)	64 (9)	704	105 (11)	64 (8)
11	1225	107 (11)	64 (10)	1008	108 (11)	65 (9)
12	1354	108 (12)	65 (9)	1086	110 (12)	66 (9)
13	1334	110 (12)	65 (10)	1011	111 (11)	67 (9)
14	1141	113 (12)	65 (9)	917	112 (11)	67 (9)
15	1122	117 (14)	66 (9)	919	112 (12)	68 (9)
16	802	118 (14)	67 (10)	548	112 (11)	69 (9)
17	434	120 (12)	68 (9)	262	113 (12)	70 (9)

Values are expressed in Mean (SD).

intervention, as previously stressed [20]. Obese adolescents have a 70%-80% chance of developing adult obesity [24, 25]. Thus, inculcating and reinforcing both health eating habits and lifestyle needs to be the norm. The Government of India's National Program on

Prevention and Control of Diabetes, Cardiovascular Disease, and Stroke has a school component which needs to be strengthened. There is also an urgent need to increase awareness via education and motivation of all stakeholders. This will go a long way in preventing

WHAT IS ALREADY KNOWN?

- Most of the earlier studies done in India have given their overweight/obesity prevalence estimates for children and adolescents based on only international cut points.

WHAT THIS STUDY ADDS?

- The study reports on the prevalence of obesity using the IOTF (International) and Khadilkar's (National) cut-points, and also reports the prevalence of hypertension.

childhood obesity and thus ultimately stemming the rising tide of non-communicable diseases such as diabetes and cardio vascular disease in India.

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