

Original Research Article

Pattern and prevalence of metabolic syndrome in obese adolescents aged 10-18 years: a community based study

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ABSTRACT

Background: The prevalence and magnitude of childhood obesity is increasing in pediatric age group. Incidence of metabolic syndrome is high among obese children and adolescents leading to increased risk of cardiovascular morbidity in long term. For this reason, recognition of metabolic syndrome in obese children is of great importance.

Methods: This study was a cross-sectional study carried out among children aged 10-18 years from both urban and rural schools in Coimbatore. Children were screened, sample for metabolic studies collected after consent and analyzed.

Results: Total 1582 children in the age group of 10-18 years were screened. 300 children were recruited. Among the studied group, 19.3% were overweight, 30.7% were obese. Metabolic syndrome was present in 55.1% of obese and overweight children. Hyperinsulinemia was present in 30% of obese children.

Conclusions: This study done in adolescent school children showed a strong association between obesity and early onset of metabolic syndrome. Early intervention with lifestyle modifications is strongly recommended to prevent long term cardiovascular morbidity.

Keywords: Adolescent children, Metabolic syndrome, Obesity

INTRODUCTION

The prevalence and magnitude of childhood obesity is alarmingly increasing in pediatric population. Incidence of metabolic syndrome is high among obese children and adolescents, and it proportionately increases with worsening obesity. There is significantly increased risk of coronary morbidity and mortality in early adulthood among obese adolescents.¹ For this reason, the recognition of the metabolic syndrome in obese children is of great importance from a clinical and public health perspective. There are only few studies regarding the prevalence of the metabolic syndrome in children and adolescents in India.²⁻⁴ This cross-sectional study was done to evaluate the pattern and prevalence of metabolic syndrome among adolescents aged between 10-18 years

in Coimbatore, India. Metabolic syndrome was defined by using WHO and modified National Cholesterol Education Program Adult Treatment Panel III [NCEP ATP III] criteria.

In 1988, Reaven and colleagues coined the term Metabolic Syndrome (MetS) that refers to a combination of hypertension, abdominal obesity, insulin resistance, and hyperlipidemia and it was closely associated with obesity and increased risk for atherosclerotic cardiovascular disease.^{5,6} What was first considered as adult condition has now been recognized in children.⁷ With increasing prevalence of childhood obesity, it is very likely that pediatric metabolic syndrome will also be more prevalent recently, with implications for future increase in cardiovascular morbidity and mortality.

The International Association for the Study of Obesity (IASO) and International Obesity Task Force (IOTF) estimate that 200 million school children are either overweight or obese.⁸

A recent study among 38,296 children aged 8-18 y from five cities of India reported the prevalence of overweight and obesity (based on IOTF reference) as 14.4% and 2.8% respectively.⁹ This may have major implications towards increasing prevalence of non-communicable diseases like diabetes, hypertension and cardiovascular disease in early adulthood.¹⁰ Worldwide estimates of the prevalence of MetS range from 1.2% to 22.6% for youth and 9.0% to 35.0% for adults, depending on the definition of MetS used, the region, the study design, the years of the study, and the age group and study population.¹¹⁻¹⁵ Only very few data are available in India in this context.

METHODS

This study was a cross-sectional study and was carried out among children aged 10-18 years from schools in Coimbatore, including urban and rural areas. Children were screened for overweight and obesity based on BMI and waist circumference.

Weight was measured while the subjects were minimally clothed without shoes in upright position using digital scales and recorded to the nearest 0.1 kg. Height was measured in a standing position, without shoes, using a stadiometer and inch tape to the nearest 0.1 cm. BMI was calculated as weight in kilograms divided by height in meters squared. Waist circumference was measured in centimeters to the nearest 0.1 cm using a non-stretchable measuring tape, without any pressure to body surface at the narrowest level between the lower border of ribcage and iliac crest. Those adolescents classified under overweight and obesity are further evaluated for the presence of metabolic syndrome. Age and sex matched normal children were taken as control. They were selected by simple random sampling.

Informed consent was obtained from parent/guardians and assent from the children. A qualified physician measured blood pressure two times with the subject in a seated position during physical examinations after one initial measurement for determining peak inflation level using a standard mercury sphygmomanometer. The mean of two measurements was considered to be the participant's blood pressure. The systolic blood pressure was defined as the appearance of the first sound (Korotkoff phase 1) and diastolic blood pressure was defined as the disappearance of the sound (Korotkoff phase 5) during deflation of the cuff at a 2 - 3 mm/s decrement rate of the mercury column.

Fasting blood samples for the serum glucose and lipid profile was drawn after the subjects had fasted overnight. Samples were collected for rural children from rural health centre and urban children at PSG Hospital

respectively. Fasting plasma glucose was measured on the day of blood collection by the glucose oxidase peroxide method, and lipid profile was measured by enzymatic assay on a Hitachi 704 system auto-analyzer. Lipid profiles [(triglyceride (TG), total cholesterol (C), high-density lipoprotein-cholesterol (HDL-C), low-density lipoprotein-cholesterol (LDL-C), and very-low-density lipoprotein-cholesterol (VLDL-C)] were determined in the fasting blood samples.

Fasting insulin was measured. Pubertal stage was determined in each patient using Tanner's criteria and hyperinsulinism (H1) was defined according to the norms for fasting insulin according to pubertal stage: prepubertal ≥ 15 mIU/L, mid-puberty (breast, genital stages 2-4) ≥ 30 mIU/L post-pubertal ≥ 20 mIU/L. Insulin resistance (IR) was analyzed using the homeostasis model assessment of insulin resistance (HOMA-IR). HOMA-IR was calculated by the following formula: fasting insulin* fasting glucose/22.5. An HOMA-IR value greater than 3.16 was used to determine IR in pubertal students.

Definition of metabolic syndrome

For the diagnosis of MetS, the presence of at least three of the following criteria (in accordance with the WHO and National Cholesterol Education Program Adult Treatment Panel III [NCEP ATP III] recommendations) was considered. These criteria included:

- Obesity: BMI ≥ 95 th percentile for age and gender (6-18 years, WHO growth charts)
- Abnormal glucose homeostasis: the presence of one of the following:
 - Hyperinsulinemia and insulin resistance (using fasting blood insulin appropriate for pubertal stage or sum of insulin levels in the first 120 min of oral glucose tolerance test)
 - Elevated fasting glucose (EPG): FG ≥ 110 mg/dL
 - Impaired glucose tolerance (IGT), glucose at 120 min: 140-200 mg/dL
- Hypertension: systolic/diastolic blood pressure ≥ 95 th percentile for age and sex.
- Dyslipidemia: presence of one of the following: (AAP Clinical Report on Lipid Screening in children).
 - High TG (≥ 95 th percentile for age and sex)
 - Low HDL-C levels (< 5 th percentile for age and sex).
 - High total or LDL-C (≥ 95 th percentile for age and sex).

Inclusion criteria

Children and adolescents aged between 10-18 years of age studying in urban and rural schools in Coimbatore, India. Study was done over a period of one year.

Sample size

Previous studies have estimated the prevalence of metabolic syndrome to be 4%. With this prevalence, the power of 80% and excluding the underweight children (prevalence of 30%), the screening sample size calculated as 1582. Considering the prevalence of 8% for overweight and obese children, sample size for second stage was calculated to be 150 with equal number of normal children. The samples were distributed evenly through urban and rural areas.

The data were entered in individual proforma. The collected data were then converted to excel format.

Data analysis

All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL) version 19. Data expressed as percentage. Chi square test was used to find out association between categorical variables.

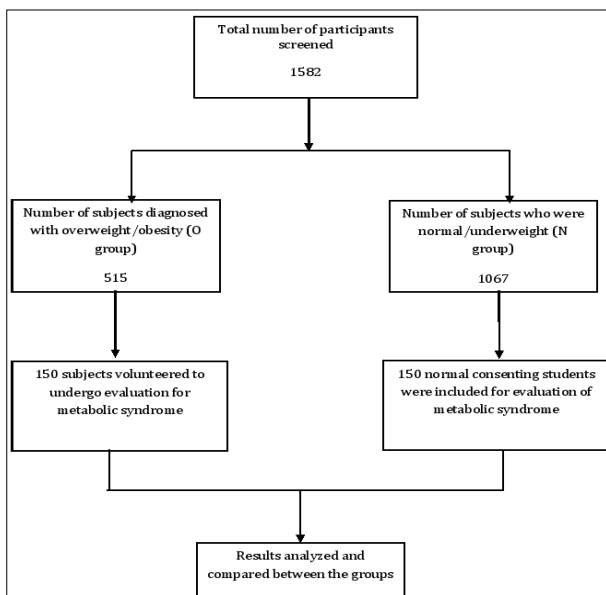


Figure 1: Flow diagram of subject recruitment.

RESULTS

Total number of school children recruited for this study in the age group of 10-18 years were 300, among whom 149 (49.7%) were boys and 151 (50.3%) were girls; in our study, there was almost equal distribution of boys and girls. Among the studied group 58 (19.3%), 92 (30.7%), 124 (41.3%), 26 (8.7%) children were overweight, obese and normal weight and underweight children respectively. Abnormal FBS (>110mg/dL) was seen in 5% of obese children and 2.1% in normal weight group, which was statistically significant. Abnormal total cholesterol level was found in 6% of obese and overweight group and 3.3% in normal group. (p value = 0.27) Triglyceride level was abnormal in 40.6% of O group children and 12.6% in N group children which was statistically significant (p=0.0001%). HDL was abnormal in 24.6% of O group children and 9.3% in N group children also had statistically significant difference (p=0.0001%). Hyperinsulinemia was present in 30% of O group children and 9.3% of N group children. HOMA - IR elevated in 60.6% of O group children and 22% in N group children. Both are statistically significant. Elevated BP was observed in 4.6% of N group children and 7.3% of O group children. Stage 1 hypertension seen in 3.3% of N group children and 14% of O group children which was statistically significant (p=0.002%). Among studied group MS was present in 55.1% in obese, overweight children. MS was more evidenced in the age group of 10-12 years (38.3%) as compared to the other age groups.

Table 1: Baseline characteristics of the study population.

Parameters	Number	Percentage	
Age in years	10-12	122	40.7
	13-15	121	40.3
	16-17	57	19
Sex	Males	149	49.7
	Females	151	50.3
Overweight	58	19.3	
Obese	92	30.7	
Normal	124	41.3	
Underweight	26	8.7	

Table 2: Lipid profile, HOMA-IR, insulin levels, blood pressure between normal and overweight/obese children.

Variables	Overweight and obese(%)	Normal and underweight(%)	Chi square and p-value
TC	6	3.3	1.19,0.27
TGL	40.6	12.6	30.06,0.0001*
HDL	24.6	9.3	12.49,0.0001*
LDL	11.3	8.6	0.793,0.441
HOMA-IR	60.6	22	46,2,0.0001*
Insulin	30	9.3	20.27,0.0001*
BP	Normal	78.6	12.29, p- 0.002
	Elevated	7.3	
	Stage1	14	

Table 1 indicating baseline characteristics of the study population including 1. Age group, majority of the children studied were between 10-15 years of age (81%). 2. Equally distributed between both sexes. 3. 30.7% children were obese and 19.3% were overweight.

Table 2 depicting the variables of lipid profile, insulin levels and blood pressure between normal and overweight, obese group.

Table 3 depicts that 50% of children with obesity in the study population had criteria to fulfill metabolic syndrome. 5.1% of children in the overweight group and 3.3% in the normal weight group had metabolic syndrome.

Table 3: Metabolic syndrome in the study population.

Category	Number	Percentage
Normal and under weight	5	3.3
Overweight	3	5.1
Obese	46	50

Table 4 shows the distribution of metabolic syndrome, age wise amongst overweight and obese children. 38.3% between 10-12 years, 28.5% between 13-15 years and 21.4 percent 16 and 17 years fulfilled criteria for metabolic syndrome. This indicates that screening and interventions should be planned early.

Table 4: Distribution of metabolic syndrome age-wise among overweight and obese children.

Age	Number	Percentage
10-12	28	38.3
13-15	18	28.5
16-17	3	21.4

DISCUSSION

Metabolic syndrome is a group of risk factors which has been increasingly prevalent concurrent with obesity.¹⁶ Consistently high prevalence of MS has been recorded in obese and overweight adolescents across the globe varying from 24% to 38.8% of obese children (Turkey). These figures have varied in accordance with the criteria used. Using a combination of WHO and ATP-III criteria in the present study, we found that 50% of obese and 5.1% of overweight adolescent had MS respectively. Such figures in children is a potential harbinger of adult onset cardiovascular morbidity and mortality thereon. In this study, we found that there was equal preponderance of male and female adolescents for MS.

The children between 10-12 years had higher percentage of MS as compared to older adolescents.¹⁷ This fact highlights early screening and dietary and lifestyle modifications for younger adolescents.

Authors observed that there was no statistically significant difference in total cholesterol and LDL levels between the 2 groups. However, the circulatory triglyceride levels were statistically more in the overweight and obese children with MS. High TG has been reported in studies.^{2,17,18} The significance of hypertriglyceridemia in adolescents as a harbinger of adult onset of cardiovascular disease is gradually being appreciated. (Another factor noted in this study was that a small subset of normal weight adolescents had triglyceride values above the age specific cutoff with other parameters remaining normal.) Levels of HDL were statistically significantly lower in the overweight and obese groups as quoted by other studies.^{17,19,2} Hyperinsulinemia was present in 30% of obese and overweight adolescents qualifying for MS as observed by Mehmet Atabek.²⁰ Acanthosis nigricans as an external marker for hyperinsulinemia was seen in 3% of obese adolescents. High FBS (>110mg/dL) was found in 5% of obese and overweight children in the study. HOMA - IR was found to be elevated in 60.6% of the overweight and obese group which was statistically significant (p value 0.0001).¹¹ adolescents (7.3%) in the overweight and obese group had elevated BP and 14% of children in the group and high BP qualifying for stage I hypertension.

Limitation of the study was that detailed dietary assessment could not be done as it was a school based study. Exact duration of physical activity was not included in the proforma.

CONCLUSION

This study done in children between 10-18 years has shown a strong association between obesity and incidence of metabolic syndrome. Early intervention with lifestyle modifications is strongly recommended to prevent long-term cardiovascular morbidity.

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