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Original Research Article

Prevalence of metabolic comorbidities in obese children

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ABSTRACT

Background: Obesity has been defined as an excess of body weight due to chronic caloric imbalance with more calories consumed than expended each day. Objective of present study was to determine the prevalence of metabolic co morbidities in obese children in our local population
Methods: Hospital based cross-sectional study conducted in the endocrinology clinic of a tertiary care hospital for a period of 1 year. Obese children attending the clinic during the study period were included. Their clinical and metabolic parameters including hypertension, lipid profile, diabetes and thyroid status were evaluated.
Results: A total of 65 children were included in the final analysis. Dyslipidemia was seen in 63% of the study subjects with high LDL cholesterol being the most frequent lipid abnormality.
Conclusions: The prevalence of dyslipidemia among obese children in our population was similar to that in other parts of the country, though we got a higher prevalence of LDL cholesterol.

Keywords: Dyslipidemia, LDL cholesterol, Metabolic co morbidities, Prevalence

INTRODUCTION

Obesity has been defined as an excess of body weight due to chronic caloric imbalance with more calories consumed than expended each day. Various factors like genetics, environment, metabolism, behavior, culture, and socioeconomic status have been linked to obesity.[1] Childhood obesity increases the risk of adulthood obesity and is the forerunner of various cardiovascular disease risk factors like dyslipidemias, hypertension and diabetes mellitus.[2] The prevalence of obesity is increasing in developing countries as well and has become a major public health concern. This can be attributed to multiple factors like rapid transition of nutrition, sedentary life style and rural to urban migration.[3]

Obesity during childhood and adolescence increases the risk of major cardiovascular events in adulthood irrespective of adult obesity status which has been demonstrated by land mark studies like Bogalusa, Muscatine and Cardiovascular risk in Young Finns study.[4-6] The consequences of childhood and adolescent obesity include not only health-related physical outcomes, such as high blood pressure, high cholesterol, metabolic syndrome, type 2 diabetes, orthopedic problems, sleep apnea, asthma, and fatty liver disease, but also psychological, social and behavioral consequences like problems related to body image, self-esteem, social isolation and discrimination, depression, and reduced quality of life. Worldwide prevalence of childhood obesity has increased remarkably over the past three decades.[7] Overweight or obese children are at a high risk for developing long-term chronic conditions, including high blood pressure (BP), elevated blood glucose, dyslipidemia, and metabolic syndrome (MetS) which are metabolic co-morbidities of obesity.[8]

The strong association between atherogenic dyslipidemia and childhood obesity has been demonstrated in a multicenter database study from Europe and also by Musso et al. from Argentina.[9,10] Metabolic syndrome is a constellation of traits including obesity, hypertension, dyslipidemias and insulin resistance.[11] Obesity leads to excess insulin production that in turn leads to increase in B.P and dyslipidemias.[12] Current evidence regarding worsening of cardiovascular health, both long and short term is convincing and its contribution to future cardiovascular morbidity and mortality is one of grave concern.[13] Literature shows that Indians (and other South Asians) are an ethnic group that are at high risk for insulin resistance.[14,15] This is further compounded by the presence of truncal obesity which is more in Indians compared to Caucasians.[16] Therefore an investigation for the presence of metabolic co morbidities in obese patients in the early stages of life is important to plan public health programmes for prevention and treatment.

Objective of present study was to determine the prevalence of metabolic co morbidities in obese children in our local population

METHODS

Study was conducted at pediatric endocrine clinic of a tertiary care hospital in Kerala. It is a hospital based cross- sectional clinical and metabolic study.

The study was conducted in the endocrinology clinic of a tertiary care hospital in north Kerala during a period of 1 year from January to December 2016. Children attending the clinic with complaints of obesity, during the study period who were willing to participate in the study, were included if they were found to be obese

Exclusion criteria

- All those patients with personal history of endocrine disease, malformation syndromes and iatrogenic obesity (drug treatments) were excluded.

Anthropometric measures

Standing height (in cm) was measured by a calibrated stadiometer and weight (in kg) was measured on a electronic digital weighing scale. Body mass index was calculated according to the formula BMI=weight in kg/squared height in m^2. Conventional definition of overweight and obesity include BMI $\geq 85^{th}$ percentile and BMI$\geq$ 95^{th} percentile, respectively.[17] We used the Indian Academy of Pediatrics (IAP) 2015 charts with cut-offs linked to adult cut–offs of 23 kg/m^2 and 27 kg /m^2 as "overweight" and obesity.[18] Only obese children were included in the study.

Waist circumference was measured at the midpoint between the sub costal bottom and the top of the iliac crest using a stretch resistant tape. It was interpreted as abnormal based on pan Indian waist circumference cut-offs (2014).[19] All measurements were taken by a single observer.

Blood pressure (BP)

Three BP determinations were obtained by standard methods on the right arm with the subject in a sitting position using a mercury sphygmomanometer. After rest while seated, BP was measured 3 times at 30 second intervals. The average of the second and third measurements was used in our analysis. Diagnosis of high normal B.P, hypertension and isolated systolic hypertension was made based on 2016 European society of hypertension guidelines.[20]

Laboratory tests

Blood samples were collected in the morning after fasting for at least 8 hours. Fasting blood glucose was analyzed using a reaction between glucose and ATP catalyzed by the enzyme hexokinase. Fasting blood glucose, Triglycerides, Total cholesterol, and HDL-Cholesterol levels were measured using an automated hematology analyzer (Beckman AU 680) in a central, certified laboratory. A fasting thyroid profile (free T4 and TSH) was obtained using the immune-chemiluminescence method.

Definition of metabolic co-morbidities

The definition of metabolic co-morbidities for our study was as follows:

1. High normal blood pressure, hypertension and isolated systolic hypertension

- Age group between 0-15 years: High-normal B.P is SBP and/or DBP $\geq$90th to <95th percentile, hypertension is systolic and/or diastolic BP$\geq$ 95^{th} percentile and isolated systolic hypertension is SBP $\geq$95th percentile and DBP <90th percentile for age, gender and height.
- Age group 16 years and above: High normal B.P is SBP and/or DBP values (mmHg) 130-139/85-89, hypertension is SBP and/or DBP values (mmHg) $\geq$140/90 and isolated systolic hypertension is SBP and/or DBP values (mmHg) $\geq$140/<90.

2. High glucose: fasting blood glucose $\geq$100 mg/dL (prediabetes), FBS $\geq$125 mg/dl and PPBS $\geq$200mg/dl (overt diabetes).[21]

3. Dyslipidemia: high triglycerides (TG), high total cholesterol (TC), high LDL-C, or low HDL-C. Categorized as borderline (>75^{th} percentile) and abnormal (90^{th} percentile) based on pediatric endocrine society 2008 clinical practice guidelines.[22]

- High TG: >110 mg/dl (75th percentile); ≥160 mg/dl (90th percentile).
- High TC: ≥180 mg/dl (75th percentile) and ≥200 mg/dl (90th percentile)
- LDL-cholesterol: ≥110 mg/dl (75th percentile) and ≥130 mg/dL (90th percentile).
- HDL-cholesterol: ≤40 mg/dl (25th percentile) and ≤35 mg/dL (10th percentile).

4. Metabolic syndrome: Having central obesity (waist circumference ≥90th percentile plus ≥2 of the following criteria based on pediatric endocrine society 2008 clinical practice guidelines for diabetes and dyslipidemia and European society of hypertension guidelines for blood pressure.[22]

- elevated BP: systolic BP ≥130 or diastolic BP ≥ 85 mm Hg, or treatment of previously diagnosed hypertension
- elevated fasting plasma glucose: ≥100 mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes
- elevated TG level: ≥150 mg/dL (1.7 mmol/L), or specific treatment for this lipid abnormality
- reduced HDL cholesterol: <40 mg/dL (1.03 mmol/L) in children aged 10-16 yrs and boys aged 16-19 yrs, and < 50 mg/dL (1.29 mmol/L) in girls aged 16-19 yrs, or specific treatment for this lipid abnormality.

5. Free T4 and TSH above the normal range for age were taken as abnormal. (SBP–systolic blood pressure, DBP–diastolic blood pressure, TG-triglycerides, TC–total cholesterol).

Statistical analysis

All data were entered in Microsoft excel 2010 and analyzed on computer using SPSS version 11.5 package (Chicago, IL, USA). Continuous variables are presented as mean ± standard deviation (SD).

RESULTS

A total of 65 children were included in the final analysis.30 (46.2%) were males and 35 (53.8%) were females. The youngest child was 5 years and the oldest was 18 years old.

The mean weight of the study subjects was 73.47 kg with a standard deviation of 19.75. The mean body mass index was 29.18 with a standard deviation of 4.82, the maximum being 48.6 kg/m^2 (Table 1).

Table 1: Mean and standard deviation of anthropometric parameters.

	N	Minimum	Maximum	Mean	Std. deviation
weight	65	31.6	147	73.47	19.75
height	64	113.5	180	157.16	13.85
BMI	65	20.7	48.6	29.18	4.82
WC	64	25.5	55	35.84	6.06

Table 2: Mean and standard deviation of metabolic parameters.

	N	Minimum	Maximum	Mean	Std. Deviation
FBS	65	0	1	0.08	0.27
PPBS	65	0	0	0.00	0.00
TC	65	125	243	178.88	23.85
LDL	65	51	186	113.52	25.70
HDL	65	19	105	48.62	14.00
TG	65	40	276	114.18	43.52
VLDL	65	10	62	27.27	9.84
SGPT	65	10	95	29.32	15.21
T4	65	4.4	15.2	8.62	1.87
TSH	65	1.09	25	3.67	3.34

Dyslipidemia was seen in 63% of the study subjects with high LDL cholesterol being the lipid abnormality that was most frequent (60%) (Table 2, 3). Hypertriglyceridemia was seen in 46.2%, high total cholesterol in 40% and low HDL cholesterol was seen in 40% of the study subjects. Prediabetes was seen in 5 of the study subjects (7.7%) and none of them had overt diabetes. Abnormal blood pressure was obtained in 6 children (9.2%) out of which 6.2% had high normal BP, overt hypertension in 1.5% and isolated systolic hypertension in 1.5% (Table 4).

Hypothyroidism was detected in 3 children (4.6%) and all of them had subclinical hypothyroidism (Table 4). The association of various metabolic co morbidities with gender was found to be statistically insignificant.

Table 3: Lipid profile of obese children.

	Normal %	Abnormal %		
TC	60	Abnormal	23.1	40
		High	16.9	
LDL	40	Abnormal	43.1	60
		High	16.9	
TG	53.8	Abnormal	32.3	46.2
		High	13.8	
HDL	69.2	Abnormal	15.4	30.8
		low	15.4	

Table 4: Metabolic comorbidities of obese children.

Metabolic comorbidities		
Hypertension	High normal BP	6.2%
	Isolated systolic hypertension	1.5%
	Hypertension	1.5%
Diabetes	Prediabetes	7.7%
	Overt diabetes	0
Hypothyroidism	Subclinical hypothyroidism	4.6%
	Hypothyroidism	0

The prevalence of central obesity was 55.4% and metabolic syndrome was 4.6%. Central obesity was higher among males (66.7%) but not significant. All children with metabolic syndrome were males but the association was not statistically significant.

Central obesity was found to be significantly related to low HDL and hypertriglyceridemia with P values of 0.03 and 0.01 respectively. There was no significant association between central obesity and other metabolic co morbidities though the prevalence of high LDL, hypercholesterolemia, high BP and high TSH was higher among children with central obesity.

DISCUSSION

The alarmingly increasing burden of obesity has led to an increase in the comorbidities related to it as well. Dyslipidemia is linked to CVD risk. There is enough evidence to suggest that dyslipidemias in childhood leads to atherosclerotic changes in later adulthood.[23] This coupled with the other comorbidities associated with obesity increases the overall risk of cardiovascular disease in later adulthood in obese children.

South Asians are at higher risk than Caucasians for the development of obesity related co morbidities like insulin resistance, the metabolic syndrome, type 2 diabetes mellitus (T2DM) and coronary artery disease.[8]

Fast transition in the nutritional status and life style has contributed to an increase in obesity related non-communicable diseases among South Asians. Body phenotype (high body fat, high truncal, subcutaneous and intra-abdominal fat and low muscle mass) is also a major determinant.

We studied the prevalence of various metabolic comorbidities among obese children in our local population. Dyslipidemia refers to increased total cholesterol, LDL cholesterol, triglycerides or reduced HDL either alone or in combination. The prevalence of dyslipidemias was high in our study population (63%). Various studies among obese children from different parts of the world reports different rates of dyslipidemias. Frequency of dyslipidemia was reported to be 69.9% among obese Iranian children, 42.9% among obese Turkish children and 45.8% among children in Germany.[24-26]

We have limited data from India regarding overall prevalence of dyslipidemias among obese children. A study from South India has reported a prevalence of 69%.[27] A recent study from South India among general population of adolescent school children reported a prevalence of dyslipidemia to be 62.27%.[28] Both these studies, one among obese children and the other among the general population of adolescents have reported low HDL as the most frequent of the dyslipidemias.

Among the various fractions of the lipid profile, high LDL cholesterol level (60%) was the most frequently observed dyslipidemia followed by hypertriglyceridemia (46.2%) and hypercholesterolemia (40%) in the present study. Studies have reported varying prevalence rates of various lipid fractions from different parts of the world. From a large database of American children, the most frequent dyslipidemia was hypertriglyceridemia.[29] Hypertriglyceridemia has been reported as the most frequently occurring dyslipidemia from different parts of the world Iran (49.9%), Turkey (21.7%) and Germany (33.9%).[24-26]

The study from Bangalore on 100 overweight and obese children above 6 years observed a triglyceride level >150 mg/dl in 15% and low HDL<40 mg/dl in 69% of them.[28] Low HDL levels was only 30.8% in present study. The variations in prevalence rates of dyslipidemias and lipid fractions may be due to the differences in ethnicity, dietary patterns, life style changes, inclusion criteria (overweight also may be included in some studies and definitions of dyslipidemias).

Deranged LDL and HDL showed a female predominance whereas deranged triglyceride levels were more prevalent in males and hypercholesterolemia showed an equal distribution among males and females. But this gender difference in the various lipid fractions was not found to be statistically significant similar to the study conducted in Turkey.

Obesity and associated insulin resistance causes chronic hyperinsulinemia that frequently leads to the development of type 2 diabetes mellitus which is also a

cardiovascular risk factor. A study in Europe among obese children reported a prevalence of glucose intolerance of 4.6% and in China a higher prevalence of 19.6% was observed.[30,31] The prevalence was 7.7% in our study population.

The prevalence of hypertension among overweight children was reported to be 35.4% in Western studies and 18.32% among obese children in an Indian study.[32,33] The prevalence in the present study was much lower (1.5%) may be because of the lower sample size we had analyzed.

Obesity and hypothyroidism are closely linked. Slight variations in thyroid hormones contribute to the tendency to weight gain. Hypothyroidism has been reported to be more prevalent among obese adolescents.[34] The prevalence of positive thyroid autoantibodies was also reported to be increased in the obese children with elevated TSH. It has also been shown that obese pediatric patients frequently have an ultrasound pattern of the thyroid which is highly suggestive of Hashimoto's thyroiditis.[35] Present study showed a prevalence of hypothyroidism to be 4.6%. We also tried to find out the association between hypothyroidism and hypertriglyceridemia. Out of 4 children 3 had hypertriglyceridemia [75%]. This supports the findings by other researchers who also have reported the association between hypertriglyceridemia and hypothyroidism.[36]

Present study showed a strong association between central obesity and cardiovascular risk factors like low HDL and hypertriglyceridemia in obese children. Though statistically not significant the prevalence of other cardiovascular risk factors was higher among the centrally obese children. Studies in South Asians have shown that central obesity is an independent risk factor for cardiovascular disorders.[37] The prevalence of central obesity was high in the study population. Considering the occurrence of high LDL cholesterol and hypertriglyceridemia the risk for cardiovascular disorders is considerably high in the population.

Limitations

The study population was small. We did not study the influence of dietary practices and life style on the lipid profile of children. We did not have a control group to assess the statistical significance of the association between weight and metabolic co morbidities.

CONCLUSION

The prevalence of dyslipidemia among obese children in our population was similar to that in other parts of the country; though we got a higher prevalence of LDL cholesterol. The prevalence of other metabolic co morbidities like abnormal BP, abnormal blood sugar and abnormal thyroid profile was low. This stress the importance of screening of all at risk children for dyslipidemia and accurate follow-up of these children to prevent future cardiovascular risk.

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