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ASSOCIATION OF METABOLIC SYNDROME WITH CHILDHOOD OBESITY

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ABSTRACT

Introduction: Childhood obesity has become an epidemic worldwide. The adverse consequence of childhood obesity includes hypertension, impaired glucose tolerance and dyslipidemia which are the components of metabolic syndrome. It is well recognized that metabolic syndrome is strongly associated with chronic non-communicable diseases like coronary artery disease and cerebro-vascular disease. **Objective:** To assess the association of obesity with metabolic syndrome in Bangladeshi obese children and adolescents. **Methods:** It was a cross sectional study done in children, aged 10 to 16 years, attending Department of paediatrics, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. Fifty obese children as case and 50 normal weight children as control were enrolled in the study. Medical history, physical examination including blood pressure measurement and anthropometric measurements including waist circumference were recorded. Investigations were done including fasting lipid profile and fasting plasma glucose. **Results:** The prevalence of dyslipidemia was 86% and metabolic syndrome was 34% in obese children. Low HDL (72%) was the most common lipid abnormality followed by high TG (48%) among obese children. **Conclusion: A** strong association was found between childhood obesity and metabolic syndrome in this study.

KEYWORDS: Metabolic syndrome, obesity, dyslipidemia.

INTRODUCTION

Worldwide the prevalence of obesity in children and adolescent has increased in the past three decades.[1] The rising prevalence of childhood obesity is creating a major public health challenge both in developing and developed countries by increasing the burden of chronic non-communicable diseases.[2] According to World Health Organization, non-communicable diseases would account for nearly three quarters of all deaths in the developing countries by the year 2020.[3] Obesity is a major risk factor for chronic non-communicable diseases and plays a significant role in metabolic syndrome, which includes hypertension, hyperlipidemia, hyperinsulinemia and type 2 diabetes mellitus. Dyslipidemia pattern associated with childhood obesity consists of a combination of elevated total cholesterol, triglycerides (TG), low density lipoprotein cholesterol (LDL-C) and decreased high density lipoprotein cholesterol (HDL-C).[4] Very limited data is available in our country regarding the association of childhood obesity with metabolic syndrome.[5] Aim of this study was to find out the association between childhood obesity with metabolic syndrome in a tertiary care hospital setting.

MATERIALS AND METHODOLOGY

It was a cross sectional study conducted in Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh from February 2016 to July 2018. Children aged 10 to 16 years attending the Department of Paediatrics (both inpatient and outpatient), BSMMU for obesity were included in the study. A total number of 50 children were included in the study as case considering inclusion criteria. Children who were taking systemic steroids or any other drugs (e.g. estrogen, progesterone, diuretics, anticonvulsant, antipsychotic etc.) which can alter lipid profile were not included in the study. Children suffering from genetic, endocrine, neurological or any other chronic illness that might cause obesity and hyperlipidemia were also excluded from the study.

In order to minimize the effect of confounding variables, age and sex matched normal weight children in a ratio of 1:1 were included in the study as control. They came with acute illness like viral fever, common cold or growing pain etc. in paediatric outpatient department.

Ethical clearance was taken from Institutional Review Board, BSMMU. Informed written consent was obtained from children or their guardians after explaining to them the objectives as well as the method of the study.

A structured questionnaire was used to collect data. Weight was measured by using an electronic weighing machine to a nearest 100gm and height was recorded using a locally made height board where two horizontal flat wooden boards, one for head-end and another for foot-end, was attached with a long vertical scale. After measuring height and weight, BMI was calculated and categorized as normal weight and obese according to Centers for disease control and prevention criteria.[6] Children having BMI for age and sex in between 5th to <85th percentile of reference population were classified as normal weight and children having.

BMI for age and sex ≥ 95th percentile of reference population were classified as obese. Waist circumference was measured using a non-stretchable measuring tape. It was measured at the midpoint of lower border of 12th rib and upper border of highest point of iliac crest.

Abdominal obesity was assessed by plotting the waist circumference in the CDC growth chart.[6] Blood pressure was measured using a mercury sphygmomanometer by standard methods on the right arm with the subject in a sitting position. BP was measured 3 times at 30 second intervals. The average of the second and third measurements was used in our analysis. Diagnosis of hypertension was made on the basis of national high blood pressure education program (NHBPEP) guidelines.[7] After clinical evaluation, obese children were advised investigations including fasting lipid profile and fasting blood sugar. National heart lung and blood institute (NHLBI) panel definition of dyslipidemia in 2011 was used in our study.[8] Accordingly, in this study dyslipidemia was defined as Total Cholesterol (TC) level 200mg/dl or more, Low density Lipoprotien level (LDL) 130 mg/dl or more, High density Lipoprotein level (HDL) less than 40 mg/dl and Triglyceride level (TG) 130 mg/dl or more. Metabolic syndrome (MS) was defined using the International Diabetic Federation (IDF) guideline which required abdominal obesity plus the presence of two or more of other components (elevated triglycerides, low high-density lipoprotein cholesterol, high blood pressure and elevated plasma glucose).[9] Accordingly elevated fasting plasma glucose level was considered as 100 mg/dl or more.

Statistical analysis in this study was done using SPSS. Qualitative data was analyzed by Chi square test, Fisher exact test, quantitative data by Student's t test and descriptive data was analyzed by proportion test or frequency distribution. A p value ≤0.05 with 95% confidence interval was considered as the level of statistical significance.

RESULTS

The study included a total number of 100 children, among them 50 were in obese children (case) and another 50 were normal weight children (control). Sixty two percent were male and 38% were female in both the groups. Borderline high (30% vs. 18%) and high total cholesterol level (16% vs. 6%) were more among cases, whereas, acceptable level of TC (76%) was more in control group. HDL level was much lower among cases (72% vs. 52%). Fifty six percent of obese children and 78.0% of control group had acceptable levels of LDL. But borderline LDL (22%) and high LDL (22%) were almost double among cases. Most of the children in control group had acceptable levels of TG (56% vs. 22%), but borderline high (30%) and high TG level (48%) were more among cases. The differences of LDL among the groups were significant (Table I). Regarding mean lipid levels of the study children, it was observed that mean total cholesterol levels (169.20 ±37.29), LDL (105.62 ±33.77) and TG levels (140.08 ±59.05) were significantly higher among cases (p<0.05) but mean HDL levels were low in both the groups (37.40 ±7.81 and 39.54±10.5) and was not significantly different (Table II).

It was evident that dyslipidemia was present in 86.0% of cases and 64.0% of controls (Table III and the difference was highly significant (p=0.011)

Eighty percent of obese children had abdominal obesity which was evident by waist circumference >90th percentile for the age and sex. High TG and low HDL levels among obese children were found in 48% and 72% respectively. Impaired fasting glycemia (IFG) and hypertension was present in 14% and 18% of obese children respectively. Among normal weight children (controls), no one had abdominal obesity, hypertension or high fasting blood glucose but 26% had high TG and 52% had low HDL (Table IV). Metabolic syndrome was present in 34% of children among cases. No children in control group had MS (Table V).

Table I: Lipid Profile of Cases and Controls (n=50+50).

Fasting lipid profile	Cases (n=50)		Controls (n=50)		*p value
	n	%	n	%	
Total cholesterol					
Acceptable	27	54.0	38	76.0	0.059
Borderline	15	30.0	09	18.0	
High	08	16.0	03	6.0	
HDL					
Acceptable	06	12.0	12	24.0	0.110
Borderline	08	16.0	12	24.0	

Low	36	72.0	26	52.0	
LDL					
Acceptable	28	56.0	39	78.0	0.063
Borderline	11	22.0	06	12.0	
High	11	22.0	05	10.0	
TG					
Acceptable	11	22.0	28	56.0	**0.002**
Borderline	15	30.0	09	18.0	
High	24	48.0	13	26.0	

*p value reached from Chi square test, McNemar test, Fisher's Exact test

Table II: Comparison of fasting lipid profile levels between cases and controls (n=50+50).

Fasting lipid profile	Case (n=50)		Control (n=50)		* p value
	Mean	±SD	Mean	±SD	
Total Cholesterol (mg/dl)	169.20	±37.29	150.02	±28.89	0.005
HDL (mg/dl)	37.40	±7.81	39.54	±10.51	0.251
LDL (mg/dl)	105.62	±33.77	92.22	±24.79	0.026
TG (mg/dl)	140.08	±59.05	96.04	±6.89	0.001

*p value reached from unpaired t-test

Table III: Distribution of Cases and Controls by Dyslipidemia (n=50+50).

Dyslipidemia	Cases (n=50)		Controls (n=50)		*p value
	n	%	n	%	
Present	43	86.0	32	64.0	0.011
Absent	07	14.0	18	36.0	

* p value reached from Chi square test

Table IV: Components of Metabolic Syndrome among cases and controls (n=50+50).

Findings	Case (n=50)		Control (n=50)	
	n	%	n	%
Abdominal Obesity	40	80.0	00	00.0
High TG	24	48.0	13	26.0
Low HDL	36	72.0	26	52.0
Impaired fasting glycemia	07	14.0	00	00.0
Hypertensive	09	18.0	00	00.0

Table V: Distribution of cases and controls by Metabolic syndrome (n=50+50).

Metabolic syndrome	Case(n=50)		Control(n=50)		*p value
	n	%	n	%	
Present	17	34.0	00	0.0	0.001
Absent	33	66.0	50	100.0	

* p value reached from Chi square test

DISCUSSION

Paediatric obesity is associated with abnormal lipids and secondary combined dyslipidemia in a large group of children.[10] Elmaoğulları et al in their study showed that 42.9% met the dyslipidemia criteria. Among them 18.6% had hypercholesterolemia, 19.7% had low levels of HDL-C, 21.7% had hypertriglyceridemia and 13.7% had high levels of LDL-C.[11] A Canadian study also observed that dyslipidemia was a common finding in obese children and adolescent with 10% having elevated TC, 21% low HDL and 11% having elevated TG.[12] A study done in Argentina showed that the prevalence of dyslipidemia was 50.4% among obese children and high TG (31.7%) was the most important lipid abnormality.[13] Minakshi and Chithambaram in their study found that 15% of obese children in India had high TG and 69% had low HDL-C.[14] Another Indian study by Jacob and Reetha showed that dyslipidemia was present in 63% of obese children with high LDL cholesterol as the most frequent (60%) abnormality.[15] They also found high total cholesterol in 40%, hypertriglyceridemia in 46.2%, and low HDL cholesterol in 40% of obese children.[15] In our study most common type of dyslipidemia was low HDL (72%) followed by significantly high TG (48%), though HDL level was not significantly different between the cases and controls. The present study also found borderline high cholesterol (30%), LDL (22%) and TG (30%) and borderline low HDL among 16% of cases (Table I).

Dyslipidemia refers to increased total cholesterol, LDL cholesterol, triglycerides or reduced HDL either alone or

in combination. Frequency of dyslipidemia was reported to be 69.9% among obese Iranian children[11], 63% among obese Indian children[15] and 45.8% among obese German children.[16] In this present study it was observed that 86% of cases and 60% of controls had dyslipidemia and the frequency of dyslipidemia was significantly higher (p=0.011) among cases. Our study findings found higher prevalence of dyslipidemia than above mentioned studies (Table III).

Combined dyslipidemia (CD) is the most frequent lipid abnormality in childhood obesity.CD is virtually always related with obesity and found in more than 40% of obese adolescents. CD was found as the principal dyslipidemia pattern in childhood obesity in the study conducted by Kavey RE.[4] Our study is also consistent with above study as more than 50% of our cases had CD and additionally, significantly higher mean cholesterol, mean LDL and mean TG levels were also present. However though low HDL levels were present in both the groups it was not significantly different (Table II).

Childhood obesity has a great impact on risk factors for Cardiovascular diseases and development of atherosclerosis.[17] The metabolic syndrome (MS) is the most serious complication of obesity. Abdominal obesity is strongly associated with atherogenic risk as it increases the cardio-metabolic risk factors like raised lipid profile, systolic hypertension, and abnormal fasting blood glucose in children.[18-20] As such, waist circumference has been accepted as the best indirect clinical index of visceral fat accumulation.[21] The prevalence of abdominal obesity in children and adolescents varies from 8.7 to 33.2 % in developed countries.[22] In the present study, 80% of obese children had abdominal obesity.

Glycemic inconsistency causes oxidative stress and possibly contributes to the development of both micro vascular and macro vascular complications.[23] Impaired glucose tolerance (IGT) is reported in 10–27% of obese children and adolescents.[24] A population based study done among 3088 Italian obese children and adolescent found that the prevalence of impaired fasting glucose was 3.2% and 3.3% and IGT was 4.6% and 5.0% among obese children and adolescents. Children with isolated IGT had a 2 to11 fold increased risk of high LDL-C, HDL-C and TG/HDL-C ratio when compared with normal glucose tolerance (NGT).[25] In the present study impaired fasting glycemia was observed in 14% of cases which is alarmingly higher than other studies (Table IV).

Obesity is recognized as a predictor of hypertension.[26] It is well known that hypertension is one of the key risk factors for coronary artery and cerebro-vascular disease.[27] Chinese overweight and obese children had 2.9 and 6 times higher risk for developing hypertension respectively than the normal-weight children, and the prevalence of hypertension was much higher among children having abdominal obesity than their counterparts.[28] Present study found that 18% of obese children had hypertension and 32% of them were pre-hypertensive (Table IV).

Pediatric metabolic syndrome has different definitions. In our study, metabolic syndrome was defined by using the International Diabetes Federation (IDF) criteria.[9] Use of this definition was possible as this study included obese children aged 10 to 16 years. The IDF definition for children from 10 to 16 years included the presence of central obesity plus two of the other four factors: a) central obesity (WC ≥90th percentile) b) TG ≥ 150 mg/dl c) HDL-C < 40mg/dl) Hypertension with systolic blood pressure≥130 and/or diastolic blood pressure ≥85 mm Hg e)Fasting glucose ≥100 mg/dl.

Liu et al in their study found that among 1844 children aged 7-14 years, the prevalence of MS was 33.1% in obese and 2.3% in normal weight children.[29] The prevalence of MS may vary considerably by children's weight status. Another Chinese study showed that MS was associated in 27.6% of obese children and 0.2% in normal weight childrenp.[30] A Bangladeshi study showed that the prevalence of metabolic syndrome in obese children and adolescence was 36.6%.[5] Our study is consistent with these studies, as 34% of our obese children had associated metabolic syndrome. None of our control group children had mctabolic syndrome.

CONCLUSION

Obese children and adolescents were more susceptible to have dyslipidemia and metabolic syndrome. It was observed that 86% obese children had dyslipidemia and 34% had metabolic syndrome. However, further studies including large sample size in the community is necessary to confirm these findings.

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