ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 7, Issue – 5, September – 2022 , Page No. : 176 – 183

Early diagnosis of metabolic syndrome and identification of risk factors in overweight and obese children between 6-13 years of age

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Citation this Article: Dr Sake Manjuvani, Dr Shalaka P. Patil, Dr Swati Mihir Bapat, "Horseshoe Kidney and Its Various Clinical Presentations – Our Institutional Experience", IJMSIR- September - 2022, Vol – 7, Issue - 5, P. No. 176 – 183.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Metabolic syndrome (MS) has a high prevalence in children, and its presence increases in those with high BMI. It is defined as a group of cardio metabolic disorders that increase the risk of suffering from cardiovascular diseases and type-2 diabetes, pathologies that are among the leading causes of death worldwide. The present study was undertaken to identify the risk factors and diagnose MS among overweight and obese children between 6-13years of age.

Method: This prospective observational study was conducted in 50 children of age 6–13 years, who satisfy and fulfil the criteria for overweight and obese using BMI, presenting to the Department of Paediatrics of a Tertiary Care Hospital in Mumbai during a period from 2019 to October 2020.

Results: Most of the children (60%) were in the age group of 6-10 years followed by 11-13 years (40%) with mean age of 9.131±1.98 years. Females (54%) were higher than males (46%). The subjects were classified according to BMI where 38 subjects were overweight, and 12 were obese. Also, subjects were divided based on WHR where 30% subjects were at higher risk, 2% were at moderate risk and 68% were at low risk. Significance was observed between WHR, HOMA, Triglycerides, high density lipids and systolic blood pressure when compared with BMI, ($p<0.05$). Also, association was seen between BMI and physical activity and junk food consumption, ($p<0.05$).

Conclusion: By identifying these risk factors early in overweight and obese children, we can identify metabolic syndrome early and initiate necessary treatment and prevent the complications of MS.

Keywords: Metabolic syndrome; Risk factor**s;** Overweight, Obese; BMI; Triglycerides

Introduction

Childhood overweight and obesity have become major public health concerns as incidences have increased substantially in India and worldwide during the past two decades. Obesity is often associated with other metabolic abnormalities which includes hypertension, dyslipidemia, insulin resistance, and impaired glucose tolerance. The

nest of these abnormalities is defined as metabolic syndrome (MS) [1], associated with increased new cases of several non-communicable diseases like cardiovascular disease and type 2 diabetes and are leading causes of mortality during adulthood [2, 3].

Several different definitions of MS in children have been proposed by various research groups [4, 5] and expert general agreement [6]. All of the definitions share common features: All definitions include an obesity element (BMI), dyslipidemia (elevated triglycerides and low HDL), elevated blood pressure, and a component of glucose metabolism (impaired fasting glucose). The cause of metabolic syndrome is not understood completely. Insulin resistance, overweight, obesity, aging, hormonal factors, sedentary lifestyle, increased sugar intake and genetics have been indicated in the pathogenesis of MS [7, 8].

Increasing BMI during childhood represents a continuous risk factor for the development of coronary heart disease in adulthood even within the normal BMI range [9], severely obese children may have a significantly worse metabolic phenotype compared with moderately obese children [10] and upper normal fasting glucose in the context of obesity may signify future risk [11]. Particular combination/s included in the definitions of the metabolic syndrome confers higher risks and questions arise regarding the equal value given in the overall score to each of the components.

As the proportion of population with obesity continues to rise, the prevalence of metabolic syndrome is increasing in both children and adolescents [12]. Children with metabolic syndrome have an increased risk of metabolic syndrome as adults, and possibly an increased risk of type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD) [13]. Thus, it has become crucial to gain a better understanding of its pathophysiology, risk factors and to identify strategies for management of metabolic syndrome in childhood [14]. Despite above findings, the etiology and pathophysiology of metabolic syndrome remains uncertain. Metabolic syndrome though highly prevalent and associated with other complications but not much has been studied. So present study was undertaken with the aim of early identification of risk factors and diagnosing metabolic syndrome among overweight and obese children.

Materials and Methods

This prospective observational study was conducted in 50 children (in and outpatient) of age 6–13 years, who satisfy and fulfil the criteria for overweight and obese using BMI, presenting to the Department of Paediatrics of a tertiary care Hospital in Mumbai during a period from 2019 to October 2020. Institutional ethical committee approval was obtained prior to the initiation of the study. Children with type 1 or type 2 DM, using drugs that alters blood pressure, glucose and lipid metabolism, syndromic obesity, endocrinological disorders (like hypothyroidism, cushing syndrome Addisons disease etc..) and subjects not willing to participate in the study were excluded from the study.

After obtaining written informed consent from all the subjects or their parents, a detail history was taken. Demographic information was noted, and a complete clinical examination was done. After the completion of the questionnaire, anthropometric measurements (height, weight, and Waist circumference) were taken. Criteria used to diagnose overweight, and obesity were BMI -> 95^{th} percentile for obesity and > 85^{th} percentile for overweight according to the growth charts designed by WHO. Based on this criterion subjects were classified as obese, overweight, normal, and underweight. However, for assessing the significance of differences with respect to various parameters, underweight and normal were

taken as one category and overweight and obese as another category.

Blood and urine samples were collected from all patients and sent for routine blood investigations as to rule out anaemia, leukaemia and other disorders. Fasting (<126mg/dl) and post (<200mg/dl) prandial blood glucose, triglycerides and HDL, LDL, VLDL, S. Insulin were done, and findings noted. Triglycerides and high-density lipids were noted the cut of being <75mg/dl and >45mg/dl respectively. Routine urine analysis was done to monitor ketone bodies. Study variables were anthropometric measurements (Height, Weight, and BMI measurement); dietary pattern (frequency of eating, consumption of junk foods and carbonated drinks); and physical activity (exercise, outdoor activity, watching TV, video games).

Data analysis

The data was collected, coded, entered into Microsoft excel work sheet and exported to SPSS. Data was analyzed using SPSS version 21. Data was presented as percentage in categories and then presented as tables and diagrams. Independent T test and Chi-square test was used for test of significance. P value <0.05 was considered statistically significant.

Observations and Results

Out of the 50 subjects, 30 (60%) subjects were between 6-10 years and the remaining 20 (40%) were between 11-13 years. The mean age was 9.131±1.98 years. Females (54%) were higher than males (46%) with sex ratio was 0.85:1 [M: F]. The anthropometric measurements were done for all the subjects and the mean values are shown in table 1.

Table 1: Means distribution of subjects according to anthropometry (n=50)

Anthropometry	Mean ± SD
Weight (kgs)	47.1±9.03
Height (cm)	133.9±12.01
BMI (kg/m^2)	26.11±1.989
Waist circumference (cm)	88.12±10.85
Hip circumference (cm)	93.91±9.04
Waist hip ratio (WHR) (cm)	0.898±0.102

The international BMI classification was used, 38 subjects were overweight, and 12 subjects were obese as seen in table 2. The prevalence of overweight among males was 38% and among females also it was 38%. The prevalence of obesity among males was 8% and among females it was 16%. The subjects were also divided based on WHR where 30% subjects were at a higher risk, 2% were at a moderate risk and 68% were at a low risk (Table 2).

Table 2: Distribution of subjects according to BMI and WHR classification (n=50)

Classifications		Males	Females	Number
BMI classification	Overweight (25.0-29.9)	19 (38%)	19 (38%)	38 (76%)
	Obese (>30)	04 (8%)	08 (16%)	12 (24%)
WHR classification	Low	18 (365)	16 (32%)	34 (68%)
	Moderate	00 (0.0%)	01 (2.0%)	01 (2.0%)
	High	05(10%)	10 (20%)	15(30%)

The complete blood count (CBC) was noted among all the subjects are seen in table 3. The fasting blood glucose

(FBG) was recorded for all the subjects and all the subjects had their levels within 126mg/dl. Post prandial blood sugars (PPBS) was done for all and 12% of the subjects had PPBS level >200 mg/dl. Just above half of the total subjects (27;54%) had high HOMA (>3.80), 20% had borderline high HOMA (2.60-3.80) and 26% had normal range HOMA value (<2.60). among the subjects were 44 subjects had elevated levels above 75 mg/dl and only 6 subjects had normal levels that are below 75 mg/dl. 31 (62%) subjects had abnormal HDL level (<45 mg/dl), (Table 3).

Table 3: Laboratory blood investigations

Laboratory parameters		**Mean**
CBC	Hb%	13.87±0.955
	WBC	7694±1901.7
	Platelet count (L)	2.72±73.43
Fasting blood sugar	Fasting (<126 mg/dl)	86.49 ± 9.03
	Post prandial (>126 mg/dl)	143.63±20.91
Lipid profile	Triglyceride level	109.2 ±29.96
	HDL levels	39.52 ±29.59
	LDL	100.56±11.79
	VLDL	20.14±8.231
HOMA-IR value		3.826±0.392
Serum uric acid		5.19±0.380
Serum insulin		16.24±2.177

Figure 1 shows the blood pressure means.

Figure 1: Distribution of subjects according to mean blood pressure

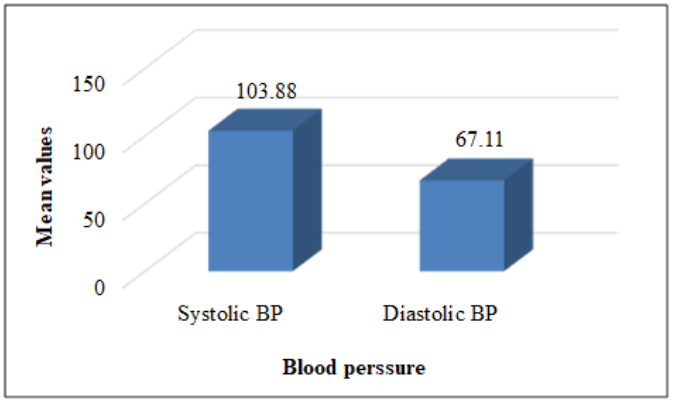

Table 4 summarizes the metabolic factors for early identification among overweight and obese children. Significance was observed between WHR, HOMA, Triglycerides, high density lipids and systolic blood pressure when compared with body mass index. There was no association seen between fasting blood glucose, post prandial blood glucose and diastolic blood pressure with body mass index. Association was also seen between BMI and physical activity and also junk food consumption. There was no association between BMI and diet and screen time.

Table 4: Summary of metabolic syndrome characteristics

Variables		Mean	95% CI		p-value
			Lower	Upper	
BMI*WHR	BMI	26.11	0.1354	0.0201	0.04*
	WHR	0.898	0.184	0.0167	
BMI*FBS	BMI	26.11	1.850	7.453	0.16
	FBS	86.49	1.011	6.944	
BMI*PPBS	BMI	26.11	10.201	15.464	0.56
	PPBS	143.63	11.154	14.657	
BMI*HOMA	BMI	26.11	25.401	26.11	0.001*
	HOMA	3.826	2.981	3.857	
BMI*TG	BMI	26.11	3.492	39.360	0.01*
	TG	109.2	9.423	33.653	

BMI*LIPID PROFILE	BMI	26.11	33.749	5.698	0.001*
	HDL	39.52	57.303	17.641	
	LDL	100.56	109.21	117.39	
	VLDL	20.14	25.67	30.94	
BMI*SBP	BMI	26.11	5.907	0.970	0.02*
	SBP	103.88	8.159	1.753	
BMI*DBP	BMI	26.11	3.142	5.461	0.79
	DBP	67.11	2.661	4.339	

Parameters		Total	BMI		P value
			Overweight	Obese	
Physical activity	Yes	23 (46%)	20	03	0.02*
	No	27 (54%)	18	09	
Screen time	Yes	36 (72%)	30	06	0.56
	No	14 (28%)	08	06	
Diet	Vegetarian	08 (16%)	06	02	0.61
	Non-vegetarian	42 (84%)	32	10	
Consumption of ready-made food	Yes	43 (86%)	33	10	0.03*
	No	07 (14%)	05	02	

Significance value ≤ 0.05

Discussion

In the present study, the majority (62.8%) of subjects were between 6 to 10 years with female preponderance which is similar to the study done by Sánchez-Rodríguez MA et al [15]. The mean weight among the subjects was 47.1±9.03 kilograms. The mean height was 133.9±12.01 centimeters. The mean BMI was 26.11±1.989 suggesting majority of the subjects were overweight. The mean waist circumference was 88.12±10.85 centimeters and the mean hip circumference was 93.91±9.04 centimeters. The mean waist hip ratio (WHR) was 0.898±0.102 centimeters suggesting the subjects are a risk of being overweight/obese using the WHR classification. The international BMI classification showed 83% subjects were overweight and 15.7% subjects were obese. These findings are similar to the study done by Gebrie A et al [16], Dobashi K et al [17] and Karki A et al [18].

The fasting blood glucose was recorded, and all the subjects had their levels <126mg/dl. The mean fasting blood glucose among the subjects was 88.24±9.59 mg/dl. The assessment of post prandial blood glucose distribution showed 97.1% subjects with blood sugar below 200 mg/dl and only 3.9% subjects had levels above 200 mg/dl. The mean post prandial blood sugars were 146.28±22.89 mg/dl. The mean SBP was 106.40±7.858 mm Hg and mean DBP was 69.91±6.763 mm Hg. Almost 91.4% of study subjects had raised triglyceride level i.e., >75 mg/dl and only 5.6% subjects had normal levels i.e., <75 mg/dl. The mean triglyceride level was 111.2±32.98 mg/dl. The HDL levels were found to be low in almost 75.7% of study subjects i.e., below 45 mg/dl and only 24.3% subjects had levels above 45 mg/dl. The mean HDL level was 42.18±32.98mg/dl. These findings are comparable with the study conducted by David J Hill et al [19].

There was significant association was observed between WHR, Triglycerides, high density lipids and systolic blood pressure when compared with body mass index. There was no statistical association between fasting blood glucose, post prandial blood glucose and diastolic blood pressure with body mass index. These results are consistent with the study done by Khoury M et al [20] and Maffeis C et al [21]. Association was also seen

between BMI and physical activity and junk food consumption. Singh SK et al in their study observed that about two fifths (18.3% boys and 22.2% girls) responded as not being physically active for 1 hour per day at least three days in a week. Also 54.4% of boys and 69.3% of girls replied as not being engaged in sports at school [22]. Laxmiah et al reported that the prevalence of overweight among adolescents who were sedentary, watching television 3 hours a day, was significantly higher (10.4%) compared with those who watched 0 or less than 3 hours a day (5.9% to 6.3%). They concluded that an increase in dietary energy intake combined with decreased energy expenditure contributes to weight gain [23]. However, the observations made by Janssen I et al showed that consumption of foods away from home increased considerably in children. The proportion of foods that children consumed from restaurants and fast-food outlets increased by nearly 300%. Fast food consumption was reported by 42% children, although investigators noted that there is no uniform definition of fast food and definitions varied among studies [24].

Conclusion

In children with only one abnormal criteria for MS, if we do not initiate appropriate therapy, they will progress to get other metabolic abnormalities over a period of time and finally to MS and hence it becomes important to identify these risk factors for early in life in overweight and obese children, we can identify MS early and initiate necessary treatment and prevent the complications of MS.

Limitations

This study had small sample size. It needs to be done on a larger population. There might be an element of bias as study is done in a tertiary care centre.

Recommendations

- Every child needs to be screened and evaluated for metabolic disease beyond 6 years of age.
- Rural areas need to be screened for metabolic disease in children.
- A detailed clinical assessment before the child is discharged from hospital.
- To foresee complications in children with metabolic disease.
- Urban areas need to be strengthened with regard to screening and treatment of obesity.
- Parent education & educating children about Metabolic syndrome needs to be done.

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