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Original Research Article

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

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ABSTRACT

Background: Metabolic syndrome is a complex disorder and an emerging clinical challenge all over the world. It is considered a multiplex cardiovascular risk factor, in that each component of the cluster of abnormalities is a risk factor in its own right. The objective of the study was to identify the risk factors and diagnose metabolic syndrome early in overweight and obese children.
Methods: The observational study was conducted at the Vydehi Institute of Medical Sciences and Research Centre, Bangalore. Total 100 children who were overweight and obese were participated. The outcome measure of the study was considered as metabolic syndrome. In patients above 6 years who are overweight and obese, a detailed history including antenatal history, birth weight, diet history, personal history was taken. In these patient's demographic details, anthropometric measurements weight, height, BMI, waist circumference, waist hip ratio and blood pressure were recorded. FBS, triglyceride and HDL were also done.
Results: Out of 100 children studied, 61% were overweight and 39% were obese. Males were 52% and females were 48%. 92 were AGA, 6 were SGA and 2 were LGA .92% had normal FBS and 8% had high levels of FBS .85% had normal TGL and 15% more than 150mg/dl. 69% had HDL-C less than 40 mg/dl and 31% had HDL-C more than or equal to 40mg/dl. Out of 8 cases of MS, 3 had abnormal FBS and HDL-C, 2 cases had abnormal TGL and HDL-C, and 3 cases abnormal FBS, TGL and HDL-C. In the remaining 92 cases, only one metabolic abnormality was noticed in 73 cases (abnormal FBS- 2, abnormal TGL-10 and abnormal HDL-C in 61) and in remaining 19 cases none of the risk factors for MS were detected.
Conclusions: 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, Obesity, Overweight

INTRODUCTION

Metabolic syndrome is a complex disorder and an emerging clinical challenge all over the world. It is considered a multiplex cardiovascular risk factor, in that each component of the cluster of abnormalities is a risk factor in its own right. The metabolic syndrome has its origins in 1923 when Kylin described a syndrome involving hypertension, hyperglycaemia and hyperuricaemia.[1] In the 1940s Vague wrote about abdominal obesity and fat distribution and its relation to diabetes and other disorders.[2] Following this, in 1965 an abstract was presented at the European Association for the Study of Diabetes annual meeting by Avogaro and Crepaldi which again described a syndrome which comprised hypertension, hyperglycaemia, and obesity.[3] The field moved forward significantly following the 1988 Banting Lecture given by Gerry Reaven.[4] He described a

cluster of risk factors for diabetes and cardiovascular disease and named it Syndrome X. His main contribution was the introduction of the concept of insulin resistance. Metabolic syndrome is recognized clinically by the findings of abdominal obesity, elevated triglycerides, atherogenic dyslipidemia- i.e., low levels of high-density lipoprotein cholesterol (HDL-C), elevated blood pressure, high blood glucose and/or insulin resistance. In 1989, Kaplan renamed the syndrome The Deadly Quartet and in 1992 it was again renamed The Insulin Resistance Syndrome.[5] It is now agreed that the well-established term metabolic syndrome remains the most usual description of this cluster of metabolic abnormalities.

The definition of MS is divided according to age-groups: age 6 to 10, 10 to 16 and 16 or older. IDF suggests that the metabolic syndrome should not be diagnosed in children younger than 10, but that a strong message for weight reduction should be delivered for those with abdominal obesity. For children age 10 to 16 years, metabolic syndrome can be diagnosed with abdominal obesity (using waist circumference percentiles) and the presence of two or more other features (elevated triglycerides, low HDL-cholesterol, high blood pressure, increased plasma glucose).[6]

Metabolic syndrome (MS) is a rising disease entity characterized by a clustering of metabolic conditions. Although prevalence of obesity as defined by the World Health Organization (WHO) is relatively low in Asia compared to western countries, metabolic syndrome is growing into a significant public health problem. Comparative studies indicate that metabolic responses to obesity may be greater in South and East Asians than their western counterparts at given Body Mass Indexes (BMIs).[7] Higher percentage body fat in Asians at given BMIs and over-responsiveness to obesity may in part explain the phenomenon for which the underlying causes are not clear. Prospective data show that the metabolic syndrome not only increases the risk of coronary artery disease but also cerebrovascular disease in Asians.[7]

India leads the world with largest number of diabetic subjects earning the dubious distinction of being termed the diabetes capital of the world. According to the Diabetes Atlas 2006 published by the International Diabetes Federation, the number of people with diabetes in India currently around 40.9 million is expected to rise to 69.9 million by 2025 unless urgent preventive steps are taken.[8] The so called Asian Indian Phenotype refers to certain unique clinical and biochemical abnormalities in Indians which include increased insulin resistance, greater abdominal adiposity i.e., higher waist circumference despite lower body mass index, lower adiponectin and higher highly sensitive C-reactive protein levels. This phenotype makes Asian Indians more prone to diabetes and premature coronary artery disease. At least a part of this is due to genetic factors. However, the primary driver of the epidemic of diabetes is the rapid epidemiological transition associated with changes in dietary patterns and decreased physical activity as evident from the higher prevalence of diabetes in the urban population.[8]

Even though the prevalence of microvascular complications of diabetes like retinopathy and nephropathy are comparatively lower in Indians, the prevalence of premature coronary artery disease is much higher in Indians compared to other ethnic groups. The most disturbing trend is the shift in age of onset of diabetes to a younger age in the recent years. This could have long lasting adverse effects on nation's health and economy. Early identification of at-risk individuals using simple screening tools like the Indian Diabetes Risk Score (IDRS) and appropriate lifestyle intervention would greatly help in preventing or postponing the onset of diabetes and thus reducing the burden on the community and the nation as a whole.[9]

Obesity plays a central role in the insulin resistance syndrome, which includes hyperinsulinemia, hypertension, hyperlipidemia, type 2 diabetes mellitus, and an increased risk of atherosclerotic cardiovascular disease.[10] The incidence of type 2 diabetes reported in children has increased alarmingly. Over the last 5 years, reports from several developing countries indicate prevalence rates of obesity (inclusive of overweight) >15% in children and adolescents aged 5-19 years and in India it is 22.0%. Childhood obesity tracks into adulthood, thus increasing the risk for conditions like the metabolic syndrome, type 2 diabetes mellitus (T2DM), polycystic ovarian syndrome, hypertension, dyslipidemia and coronary artery disease later in life.[11]

The objective of the study was to identify the risk factors for metabolic syndrome and to diagnose metabolic syndrome early in overweight and obese children above 6 years of age.

METHODS

This study was conducted at Vydehi Institute of Medical Sciences and Research Centre, Bangalore between December 2013 to January 2015. It was an observational study, where 100 patients who were overweight and obese were included in the study. Study design: All children above 6 years with overweight and obese who report to the Department of Pediatrics were enrolled in the study. Children with known diabetes, on long term medications, syndromic conditions with obesity and with endocrine disorders which causes obesity were excluded from the study. A detailed history including antenatal history for gestational diabetes mellitus, birth weight for IUGR, diet history, personal history was taken. In these subjects, demographic measures like age, sex, anthropometric measurements like weight, height, BMI, waist circumference, waist hip ratio and blood pressure were recorded. In these subject's blood investigations like fasting blood glucose, triglyceride and HDL was done.

Body weight was measured to the nearest 0.1 kg with a balance scale (Baurer, PS 07), and height was measured to the nearest 0.1 cm with stadiometer (Hyssna Limfog, AB) with subjects lightly dressed and without shoes. Body mass index (BMI) was calculated as weight (kg) divided by height square (m^2). The degree of obesity was quantified using international cut off points for body mass index for overweight and obesity by sex between 2 and 18 years, according to Cole's reference data. Waist circumference (WC) was measured midway between the lateral lower rib margin and the uppermost lateral border of iliac crest, and hip circumference was measured at the widest point over the great trochanters. Both circumferences were measured in the standing position and at the end of gentle expiration.[12] The waist-to-hip ratio (WHR) was calculated. All measurements were taken 3 times at each site, and the mean of 3 values was used. Blood glucose, HDL-C and TG were determined from blood samples taken after an overnight fast. Glucose, and TG measurements were performed using enzymatic assays (Instrumentation Lab, MA, USA). HDL-C was measured by a direct enzymatic assay without precipitation (Instrumentation Lab, MA, USA). Serum TG, and HDL-C were considered high or low when they fell above or below the recommended values. Statistical analysis: Data were analyzed using STATA for Windows version 10.1 (Stata Corp, College Station, TX, USA).

RESULTS

As given in table 1, out of 100 children studied, 61% (61cases) were overweight and 39% (39 cases) were obese. Males were 52% (52 cases) and females were 48% (48 cases). 92 cases had normal birth weight, 6 cases were SGA and 2 cases were LGA babies. Consumption of junk food, one of the risk factors for the weight gain was noted in 95 % of the cases studied in the present study. All the cases undertaken had 4-6 hours of screen time which includes television, video games, higher gadgets and mobile phones. Lack of physical activity was noted in all the cases.

Table 1: Demographic data.

Total	100
Overweight	61 (61%)
Obesity	31 (31%)
Sex	
Males	52 (52%)
Females	48 (48%)
Birthweight	
SGA	6 (6%)
AGA	92 (92%)
LGA	2 (2%)
Others	
Consumption of Junk food	95 (95%)
Screen time > 4-6 hours/day	100 (100%)
Lack of physical activity	100 (100%)

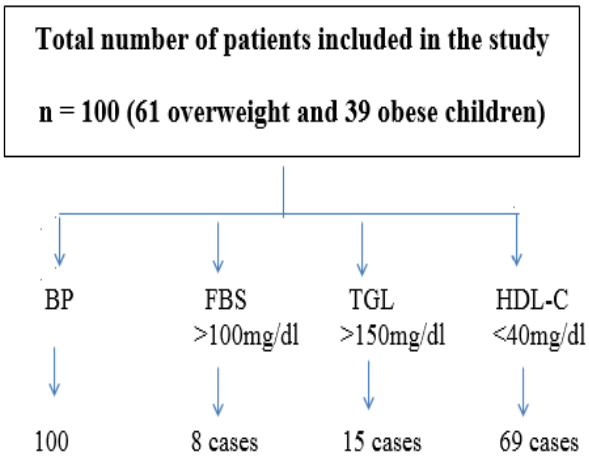

Figure 1: Details of various parameters in study subjects.

Systolic BP and Diastolic BP were found to be normal in all the children taken for the study.

92% of the cases had normal FBS and 8 % had high levels of FBS >100mg/dl. 85% had TGL levels less than 150 mg/dl and 15% had TGL levels high or equal to 150mg/dl. 69% of the cases had HDL-C less than 40mg/dl and 31 % of the cases had HDL-C more than or equal to 40mg/dl.

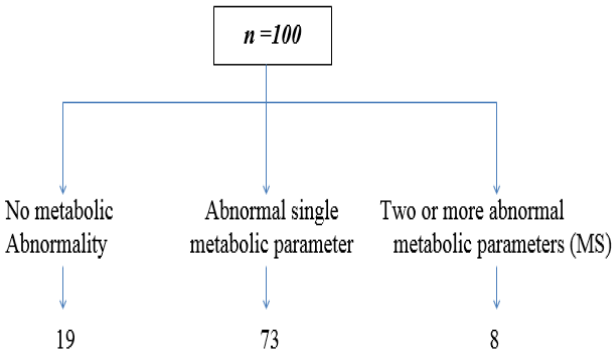

Figure 2: Abnormal metabolic parameters in study subjects for diagnosing metabolic syndrome.

The present study done in 100 cases, abnormality of a single metabolic parameter was found in 73 cases (FBS - 2, TGL - 10, HDL-C in 61). Two or more abnormal metabolic parameters (which qualify for MS) were found in 8 cases and no metabolic abnormality was detected in 19 subjects.

Out of 8 cases of MS, 3 cases had abnormal FBS and HDL-C, 2 cases had abnormal TGL and HDL-C, and 3 cases abnormal FBS, TGL and HDL-C. In the remaining 92 cases, only one metabolic abnormality was noticed in 73 cases (abnormal FBS in 2 cases, only abnormal TGL in 10 cases and only abnormal HDL-C in 61 cases) and in remaining 19 cases none of the risk factors for MS were

detected. Out of total of 8 cases of Metabolic Syndrome, the prevalence was more common in the age group of 10-16 years in present study.

Table 2 showing age range range of overweight and obese children. Table 3 showing waist and hip circumference data.

Table 2: Age range of overweight and obese children.

			OO		Total
			weight	Obese	
Age (range)	<10 years	Count	17	31	48
		% within OO	43.6%	50.8%	48.0%
	10-16 years	Count Over	22	30	52
		% within OO	56.4%	49.2%	52.0%
Total		Count	39	61	100
		% within OO	100.0%	100.0%	100.0%

Table 3: Waist and hip circumference data

OO		N	Mean	Std. deviation	Std. Error mean
Waist Circumference	Over weight	39	94.18	10.086	1.615
	Obese	61	86.15	6.562	0.840
Hip Circumference	Over weight	39	98.08	11.2118	1.7953
	Obese	61	91.04	8.6218	1.1039

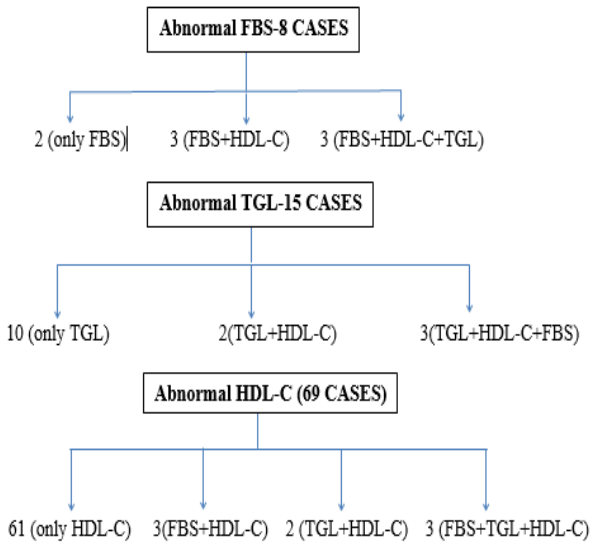

Figure 2: Association of abnormal FBS, TGL, HDL-C in study subjects.

The mean waist circumference of the children was 94.18 cms in overweight children whereas in obese children the mean observed was 86.15cms which is significant. The mean hip circumference of the children was 98.08cms in overweight children whereas in obese children it was 91.04 cms, which is also significant

DISCUSSION

In this study of 100 overweight and obese children totally 8 cases of metabolic syndrome were detected. The incidence of risk for metabolic syndrome was found to be more common in males than in females in our study which is similar to studies done on pediatric population.[12] A study done by Singh N et al, found that the metabolic syndrome was more common in obese children.[13] But in present study, majority of cases (61%) are overweight children than obese. This finding correlate with the study done by Rodri LG et al where overweight seems to be the determinant condition, highlighting the importance of early diagnosis and monitoring aiming to reduce cardiovascular diseases in early adult life.[14]

The present study which included 100 cases showed that majority of the cases (92%) had normal birth weight and 2% of the cases were LGA babies and 6% were SGA babies. The incidence of metabolic syndrome is higher in SGA babies in their future life as postulated in Barker's hypothesis.[15] Boney CM et al showed that LGA offspring of diabetic mothers were at significant risk of developing MS in childhood.[16] Consumption of junk food, one of the risk factors for the development of metabolic syndrome has been noted in 95 % of the cases studied.[17]

All the children in our study had 4-6 hours of screen time which includes television, video games, higher gadgets and mobile phones which is more than the recommendations of American academy of pediatrics and

pediatric child health 2003 which recommends maximum 2 hours of screen time per day, as far as MS is concerned.[17] The likelihood of having MS was only increased by 21% in the 2 hours/day screen time group, an amount that was far from reaching statistical relevance. However, once a screen time level of 3 hours/day was achieved, the likelihood of the MS was increased by about twofold, and was clinically meaningful and of borderline significance (P=0.06).

All children in present study showed lack of physical activity which might have caused weight gain. However, decreased physical activity is likely to be an important etiological factor, as shown in a study done by Guinhouya BC where the author examined.[18] The relationship between MS and objectively measured physical activity and whether fitness modified this relationship and concluded that physical activity helps in reducing the after effects of MS. Regarding age of detection of risk factors, the present study showed MS is more prevalent in the age group of 10-16 years which correlates with another study done by Wang X et al, where the authors compared the prevalence of MS and insulin release in Chinese obese children born LGA with those born AGA and also explained that MS was more prevalent in obese pediatric populations born LGA and noted to start manifesting by 3 years of age.[19]

IDF criteria for BP varies with the different age groups. There are various studies on MS in children which showed that SBP should be more than or equal to 130mm Hg and DBP more than or equal to 85 mm Hg as per European Society of Hypertension, European Society of Cardiology and Am J Hypertens guidelines for the management of arterial hypertension. But in present study, in all the cases more than 10 years, the blood pressure both systolic and diastolic were within normal range which correlates with a study done in Srinagar, India by Andrabi SMS et al.[20] Hence even in children aged more than 10 years with MS, BP can be normal. As per the IDF criteria for Fasting Blood Sugar (FBS), any value above 100 mg/dl is a risk factor for metabolic syndrome. But in our study, FBS was less than 100mg/dl in 92 cases (92%) and above 100 mg/dl in 8 cases (8%) of the cases. A fasting blood sugar level of 100 mg/dL or higher (or being on medicine to treat high blood sugar) is a metabolic risk factor as quoted per the National Heart Lung Blood Institute, Reaven, Zimmet et al, which quotes raised FPG: ≥100 mg/dl or previously diagnosed type 2 DM.[4-6]

In present study, Triglyceride levels were less than 150mg/dl in 85 cases (85%) and15 cases (15%) had more than or equal to 150mg/dl. In the studies done by Peter W, Scott M, Zimmet et al describes the combination of raised triglycerides (TG) and low concentrations of HDL-c together with elevated apolipoprotein B (ApoB), small dense LDL and small HDL particles, all of which are independently atherogenic and which is commonly observed in people with both type 2 diabetes and the metabolic syndrome. On the contrary, this study showed triglyceride levels less than 150mg/dl in 85% of the cases. Hence even though the triglyceride levels are less than 150 mg/dl, metabolic syndrome cannot be ruled out as per IDF criteria.[22,23]

As per the IDF criteria HDL-C level less than 40 mg/dl is one of the criteria for metabolic syndrome. Present study showed that HDL-C levels were less than 40mg/dl in 69 cases (69%) and 31 cases (31%) showed HDL-C level equal to or more than 40mg/dl which is similiar to other indian study by Bhalavi V et al.[24] Studies done by Banting, Liu X, IDF criteria, NCEP et al shows high prevalence of MS among cases having less HDL-C levels.[4,24,25]

Limitations

The present study is that the study was conducted in a tertiary care teaching hospital and the children taken for the study does not reflect the true prevalence of Metabolic Syndrome in the community. HS CRP is off late included as one of the most sensitive risk factor for diagnosing metabolic syndrome because recent studies show obesity is also one of the chronic inflammatory conditions where HS CRP levels are elevated and is described in the study done by Ridker PM.[26,27] However we could not estimate HS CRP in present study in view of financial constraints. Physical activity in all subjects in our study was not quantified which would have given some clue regarding weight gain in study subjects.

CONCLUSION

This study was done to identify the risk factors and to diagnose metabolic syndrome early in life in overweight and obese children in a tertiary care centre in South India. Out of the total number of 100 children taken up for the study, 95% children had evidence of consuming junk food, 100% had more than 4-6 hours of screen time and all of them had lack of physical activity. With regards to diagnosis of children with MS, we had detected 8 children with MS. All the children taken up for the study had normal Blood Pressure,8% had FBS >100mg/dl, 15% had increased TGL >150mg/dl and 69% had HDL-C less than 40 mg/dl. Out of all these patients with metabolic abnormalities, 8 children had minimum 2 out of 4 criteria's fulfilled for diagnosing MS in the age group of 6-16 years. However, in the remaining 92 cases, only one abnormal criteria for MS was noticed in 73 cases and in the remaining 19 cases none of the risk factors for metabolic syndrome were detected.

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.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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