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Original Research Article

Proportion of metabolic syndrome among overweight and obese children of age 6 to 16 years attending a tertiary care centre, Kerala

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ABSTRACT

Background: This study aimed to find out the proportion of overweight and obese children of age 6-16 years having metabolic syndrome and to find out the risk factors for the same.
Methods: This hospital based cross sectional study was conducted in obesity clinic of Department of Paediatric, Government T D Medical College, Alappuzha over a period of 18 months (from jan 2019 to june 2020). Sample size was calculated as 210 children including 20% expected dropout. Children of age 6-16 years with BMI > 85th centile attending the obesity clinics were enrolled for the study as per the inclusion and exclusion criteria. After getting consent/assent, relevant points from history, physical examination and investigations were recorded. The data obtained were entered in excel spread sheet and analyzed.
Results: In this study, 28.9% were overweight and 71.1% were obese. Proportion of metabolic syndrome [MetS] among subject with overweight and obese were 18% and 29.3% respectively. Metabolic syndrome were more in males, children receiving more calories, have passive smoking and were born as preterm or big baby. Abdominal obesity was present in all children with MetS. Significant associations were found between MetS and inflammatory markers like CRP. Among the metabolic parameters, elevated level of uric acid, SGOT, SGPT and abnormal lipid profile were found to have a positive correlation with MetS.
Conclusions: More than 25% of children with BMI > 85th centile is found to have MetS. Being overweight also is high risk for development of metabolic syndrome. High calorie intake, passive smoking, prematurity, birth weight more than 4 kg and abdominal obesity are significant risk factors identified.

Keywords: Abdominal circumference, Acanthosis nigricans, Metabolic syndrome, Obesity, Overweight

INTRODUCTION

Obesity in children and adolescents is in its rising trend. It is a global and severe problem of modern era, precipitating various health and psycho social consequences. To provide evidence for intervention and reduce the morbidity due to its consequences, it is critical to understand and document the linkage of childhood obesity to metabolic syndrome in different populations. We Indians, as an ethnic group, are particularly at high risk for insulin resistance and central obesity.[1] Both these factors are the forerunners of diabetes, Coronary Heart Disease and other lifestyle disorders.

Clinical definition of metabolic syndrome has been extremely variable in paediatric population. In this study, metabolic syndrome is defined according to the age modified standards of the ATP III MS criteria published previously. The examination of novel metabolic syndrome biomarkers which detect the metabolic abnormalities early with high specificity and sensitivity in paediatric population has been of great interest.

Understanding this complex cluster of risk factors in the paediatrics population is critical to ensure that their children are not going into cardiovascular complications in their near future. Each component of metabolic syndrome worsens with increasing obesity independent of age, sex and pubertal status. Limited studies have been published regarding the same in paediatric population from Kerala. It is important to detect metabolic syndrome early in childhood and adolescence to prevent further health hazards and minimize the socioeconomic burden. It is more relevant in paediatric age group as it is easy to control the disease and its complications. Therefore paediatricians have an undoubtedly important role in fighting against this epidemic.

In this study aimed to find out the proportion of metabolic syndrome among children attending the obesity clinic, Dept. of Paediatrics, Govt. TDMCH, Alappuzha who have obesity/overweight, and also to delineate the risk factors associated with the development of MetS.

METHODS

This is a hospital based cross sectional study was conducted in Obesity clinic of Department of Paediatrics, Govt. TDMCH, Alappuzha from January 2019 to June 2020.

Case definition

Metabolic Syndrome is nowhere unambiguously defined in pediatric population. Since IDF consensus definition of Metabolic syndrome in children does not include age group <10 years, in this study, National Cholesterol Education Program-Adult Treatment Panel III [NCEP-ATP III] is used as researches worldwide have preferred the same as it is relatively simple and much more clinically and practically applicable . The age modified standards of the ATP III MS Criteria used in this study allows for valid cross study comparisons.[2] Subjects with 3 or more of the following 5 features were categorized as having metabolic syndrome. 1. Abdominal obesity (waist circumference > the age and sex specific 90th percentile), 2. Elevated Blood Pressure (BP) (systolic and/or diastolic BP > the age, sex and height specific 90th percentile), 3. Low high density lipoprotein cholesterol (HDLC) level <40 mg/dl for all ages and sexes, 4. Elevated triglycerides (TG) - >110 mg/dl), 5. Elevated Fasting Plasma Glucose (> 110 mg/dl).

Inclusion criteria

All children of age group 6-16 yrs with BMI >85th centile on IAP growth chart and children should be accompanied by primary care taker were included.

Exclusion criteria

Children on oral hypoglycaemic agents, hypo-lipidemic drugs, steroids >2weeks, known case of familial hyperlipidaemias, type I diabetes mellitus, nephrotic syndrome, reno vascular hypertension and hypothyroidism were excluded.

Sample size

Sample size is calculated using the formula n= 4pq/d2. So we got sample size of 175 considering 20% drop outs, N=210.

Study tools

Proforma for collecting data from history and physical examination, mercury sphygmomanometer for measuring blood pressure, electronic digital weighing scale, stadiometer, non-stretchable measuring tape for anthropometric measurements, ERBA 5 part hematology analyser and Beckmann Biochemistry Autoanalyzer for blood investigations.

Study procedure

The study was initiated after getting approval from Institutional Research and Institutional Ethics Committee. The study participants were selected from the paediatric obesity clinic according to the inclusion and exclusion criteria. After receiving a written informed consent from the parent and assent from participant, history was taken according to the predesigned proforma. Physical examination including general examination, anthropometric measurements and head to foot and system examination was done and documented.

BP was measured in sitting position on the right upper limb with arm at the heart level after 10 minutes of rest with both palpation and auscultation methods using the standard mercury sphygmomanometer with cuff size suitable for the age and size of the child. Weight was measured using digital scales, without shoes in upright position, and recorded to nearest 0.1 kg. Height was measured without shoes using a stadiometer, while the child stands erect with his feet touching each other, the heel, calves, buttocks, upper back and occiput touching the wall, child looking straight ahead with eyes in the frankfurt plane and measurement taken to the nearest 0.5 cm. BMI is calculated as weight in kg divided by height in m2.

Waist circumference: The abdomen is visualized from the level of lower ribs to the level of pubic symphysis after providing adequate privacy for the child in presence of a nurse/ female bystander. The waist circumference was measured at the end of a normal expiration, using a non-elastic tape, at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest, to the nearest 0.1cm, while the subject stands with the arms by the sides and the feet positioned close together and weight evenly distributed across the feet. Hip circumference was measured as maximum circumference at the level of the greater trochanter and

then waist hip ratio is calculated. After a fat free diet for three consecutive days and overnight 12 hour fasting they were asked to review on morning at 8.00AM. On that day, blood samples were collected and sent to the Biochemistry lab and results were collected on the same day.

Statistical analysis

Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Independent t test was used as test of significance to identify the mean difference between two quantitative variables. p value (Probability that the result is true) of 0.05 was considered as statistically significant. MS Excel, SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used to analyse data.

Ethics committee approval was taken before starting the study. Written Informed assent/consent was taken from subjects/parents. Confidentiality of the information obtained was assured throughout the study.

RESULTS

Out of the 211 subjects 62.1% belongs to 6-10yrs. Male to female ratio was 0.95:1.71.1% were obese.

Table 1: Percentage distribution of sample according to age, gender and BMI.

		Number	Percentage
Age in years	6 - <10	131	62.1
	10-16	80	37.9
Sex	Male	103	48.8
	Female	108	51.2
BMI	85th- <95th centile	61	28.9
	>95th centile	150	71.1

There was no statistically significant difference for mean age, birth weight and waist-hip ratio between children with or without metabolic syndrome (Table 2).

Table 2: Profile of subjects with or without MS.

Parameters	Metabolic syndrome		P value
	Present	Absent	
	Mean (SD)	Mean (SD)	
Age (years)	9.78 (2.16)	9.32 (1.99)	0.147
Caloric excess	330.75 (134.36)	294.32 (173.51)	0.159
Screen time (hrs)/week	20.37 (8.48)	19.54 (8.30)	0.528
Birth weight	3.16 (0.66)	3.04 (0.56)	0.213
Weight (kg)	45.51 (10.83)	43.33 (11.29)	0.214
Height (cm)	138.14 (11.30)	136.81 (12.10)	0.477
BMI	23.58 (2.82)	22.74 (3.71)	0.103
Waist circumference (cm)	79.48 (9.40)	78.48 (9.26)	0.494
Waist: hip	0.95 (0.06)	0.94 (0.06)	0.261

Table 3: Prevalence of metabolic syndrome with respect to BMI.

BMI		85th to < 95th centile	95th centile or more	Total (%)
		Number (%)	Number (%)	
Metabolic syndrome	Present	11 (18)	44 (29.3)	55 (26.1)
	Absent	50 (82)	106 (70.7)	156 (73.9)
	Total	61 (100)	150 (100)	211 (100)

In the study prevalence of metabolic syndrome among subjects with overweight was 18% and among subjects who were obese was 29.3%. Even though the proportion of metabolic syndrome is high among obese children, it is not statistically significant (Table 3).

The prevalence of MetS with respect to sex distribution in this study showed statistical significance (Table 4).

There is a statistically significant association with skin tag and abdominal obesity for the development of metabolic syndrome (Table 6).

Among biochemical parameters LFT and lipid profile showed statistically significant association but FBS, PPBS and RFT not showed significant association (Table 7).

Table 4: Prevalence of MS with respect to age, gender and BMI.

Parameter		Metabolic syndrome			P value
		Present Number (%)	Absent Number (%)	Total Number (%)	
Age	6-< 10 yrs	30 (22.9)	101 (77.1)	131 (100)	0.180
	10- 16 yrs	25 (31.2)	55 (68.8)	80 (100)	
Sex	Male	34 (33)	69 (67)	103 (100)	0.025
	Female	21 (19.4)	87 (80.6)	108 (100)	
BMI (centile)	85th -<95th	11 (16)	50 (82)	61 (100)	0.090
	95th or more	44 (29.3)	106 (70.7)	150 (100)	

Table 5: Association between MS and parameters from history.

Parameter		Metabolic syndrome			P value
		Present Number (%)	Absent Number (%)	Total Number (%)	
Caloric intake	Normal	0 (0.0)	15 (100)	15 (100)	0.017
	Excess	55 (28.1)	141 (71.9)	196 (100)	
Type of diet	Non veg.	53 (25.4)	156 (74.6)	209 (100)	0.017
	Vegetarian	2 (100)	0 (0.0)	2 (100)	
Physical activity	Inadequate	19 (27.1)	51 (72.9)	70 (100)	0.802
	Adequate	36 (25.5)	105(74.5)	141(100)	
Screen time per week (hrs)	5-15	16 (22.2)	56 (77.8)	72 (100)	0.619
	15-25	25(29.1)	61 (70.9)	86 (100)	
	>25	14 (26.4)	39 (73.6)	53 (100)	
F/H of obesity	No	16 (41.0)	23 (59.0)	39 (100)	0.018
	Yes	39 (22.7)	133 (77.3)	172 (100)	
Passive smoking	No	24 (19.4)	100 (80.6)	124 (100)	0.008
	Yes	31 (35.6)	56 (64.4)	87 (100)	
Birth weight (kg)	< 2.5	4 (14.3)	24 (85.7)	28 (100)	0.003
	2.5-4.0	45 (25.7)	130 (74.3)	175 (100)	
	>4.0	6 (75.0)	2 (25.0)	8 (100)	
Gestational age (in weeks)	<28	2 (100)	0 (0.0)	2 (100)	0.009
	28-<32	2 (100)	0 (0.0)	2 (100)	
	32-<37	2 (28.6)	5 (71.4)	7 (100)	
	Term babies	49 (24.5)	151 (75.5)	200 (100)	

Table 6: Association between MS and parameters from physical examination.

Parameter		Metabolic syndrome			P value
		Present Number (%)	Absent Number (%)	Total Number (%)	
Abdominal obesity	No	0 (0.0)	14 (100.0)	14 (100.0)	0.021
	Yes	55 (27.9)	142 (72.1)	197 (100.0)	
Acanthosis nigricans (grade)	Nil	2 (50.0)	2 (50.0)	4 (100)	0.633
	1	0 (0.0)	3 (100.0)	3 (100.0)	
	2	10 (22.7)	34 (77.3)	44 (100.0)	
	3	21 (26.6)	58 (73.4)	79 (100.0)	
	4	22 (27.2)	59 (72.8)	81 (100.0)	
Skin tags	No	52 (25.0)	156 (75.0)	208 (100.0)	0.003
	Yes	3 (100.0)	0 (0.0)	3 (100.0)	
Hypertension	No	53 (25.5)	155 (74.5)	208 (100)	0.107
	Yes	2 (66.7)	1 (33.3)	3 (100)	

Table 7: Association between MS and parameters from investigation.

Parameters	Metabolic syndrome				P value
	Present		Absent		
	Mean	SD	Mean	SD	
Hb	12.6	1.0	12.4	0.7	0.094
PCV	36.6	2.6	35.9	2.7	0.082
ESR	11.2	4.0	11.7	6.8	0.619
RDW	13.5	1.2	13.0	1.0	0.005
Blood urea	22.9	6.4	21.7	5.8	0.191
S. creatinine	0.6	0.1	0.6	0.6	0.600
Uric acid	4.3	1.0	3.8	0.9	<0.001
SGPT	38.4	15.8	29.3	10.8	<0.001
SGOT	37.8	15.0	30.3	8.7	<0.001
CRP	3.8	2.0	2.8	1.8	0.001
T. cholesterol	176.4	37.1	162.1	27.2	0.003
TG	11.7	64.3	87.1	38.9	<0.001
HDL	37.1	2.8	46.4	6.8	<0.001
LDL	110.0	26.8	98.6	24.3	0.004
FBS	88.1	11.1	88.7	9.8	0.697
PPBS	105.5	11.1	108.5	11.7	0.091

DISCUSSION

The primary objective of the study was to find out what proportion of overweight and obese children is having metabolic syndrome in the age group of 6-16 years. In our study, 55 out of the 211 subjects had metabolic syndrome (26 %) with 18% among over weight and 29.3% among obese children. This difference of MetS among overweight and obese is not statistically significant (Table 3). The prevalence of MetS observed in obese group was similar to that cited by Al Hamad.[3] The prevalence of MetS with respect to gender distribution in this study showed statistical significance (Table 4). This was similar to the study done by Yu et al.[4] In adult population also few of the studies support the same regarding gender differences.[5] In majority of studies conducted so far, it has been found that excess calorie intake is a direct risk factor for obesity, thereby contributing to metabolic syndrome.[6] Excess caloric intake was found to be a risk factor for metabolic syndrome, with a p value of 0.017 (Table 5).This was similar to the study conducted by Hoyas and Leon Sanz.[7] Association of screen time with MetS was also analysed in our study and not found to have significant association. Tobacco exposure is another risk factor that is found to be associated with cardio-metabolic derangements as per numerous adult as well as paediatric studies. As far as children are considered, passive smoking is more inquirable even though in a proportion of adolescent age group, active smoking also co exists. In our study among children with no passive smoking history, 19.4% had MetS and among passive smokers, 35.6% had MetS (Table 5). This is a significant association and is similar to the result obtained by Kelishadi et al.[9] Regarding the birth history, the important factors to be taken into consideration include the gestational age at birth and the birth weight. In this study prematurity is found to have significant association with MS. All children who were less than 32 weeks have MetS. (100%) while 1.9% children have MS who were born after 32 weeks of GA with a p value of 0.0007 (Table 5). In our study, among preterm subjects, 54.5% had MetS while among term subjects it is 24.5%. There was significant association between MetS and Gestational age at delivery. Being preterm is a risk factor for MetS (Table 5). This is very much similar to other studies, one among them being the result observed by study of Markopoulou et al.[10]

In the case of birth weight, initial studies pointed out macrosomia/large for gestational age is a risk factor for obesity and MetS but recent studies bring out evidence that being low birth weight/small for gestational age is equally playing a significant role. In our study, among LBW subjects, 14.3% had MetS, among Normal Birth weight, 25.7% had MetS and among subjects with Macrosomia, 75% had MetS. Excess birth weight is therefore obtained as a significant risk factor for MetS.[11] When the dietary patterns were observed, in the study among Non-vegetarians, 25.4% had metabolic syndrome and among vegetarians, 100% had MetS. There was significant association between Diet and MetS. To the surprise Vegetarian had higher prevalence of MetS. This may be due to the fact that the sample size were too small and it included only two subjects who were following a vegetarian diet (only 0.9 % of the study population). But as per the world wide population studies, non-vegetarian diet is more strongly associated with obesity and metabolic syndrome and a vegetarian diet is protective as suggested by studies like Rizzo et al.[12]

Findings based on physical examination

Even though we use BMI to decide on obesity status, the complications of obesity including MS is more closely related to abdominal obesity. In our study, among subjects with abdominal obesity, 27.9% had metabolic syndrome, which was found to be significant with a p value of 0.021 (Table 6) and is similar to other studies.[13] Central obesity has got more significance, as a risk factor, for most of the metabolic complications associated with increased BMI. This is similar to what is suggested by Després Jean-Pierre et al.[14]

Obesity is associated with insulin resistance. Acanthosis nigricans is a marker of insulin resistance. So we included this parameter in this study and graded its severity.[15] Even though there were no case of MS in grade 1 Acanthosis and 27.2% had MS in grade 4 (Table 6) the difference was not statistically significant.

The study also shows significant association between skin tag and MS (Table 6). Presence of skin tag is another indicator if insulin resistance. The presence of multiple skin tags was strongly associated with insulin resistance irrespective of other risk factors in many studies.[16]

Comparison of laboratory parameters

Metabolic catastrophe is a major concern of increasing obesity. There are a number of blood parameters which are found to be abnormal in children and adults having overweight/obesity, the same leading to development of cardiovascular complications of metabolic syndrome and shortening the life span. Hb, RFT, LFT, ESR, CRP and Lipid profiles were compared between children with and without metabolic syndrome. RDW is the coefficient of variation of red cell size in blood which is used to evaluate the causes of anaemia. RDW may be an indicator of oxidative stress and is also an inflammatory marker used to predict the potential risk of cardiovascular events. In this study, mean RDW, when compared between the metabolic syndrome group and no metabolic syndrome group, were 13.5 and 13 respectively, which is found to be statistically significant. Studies have shown that increased levels of RDW (especially >14.5) is independently regarded as a risk factor for MetS, as cited by Laufer Perl et al.[17]

Considering the fact that obesity is a state of chronic low grade inflammation, another 2 inflammatory markers we looked were ESR and CRP. The mean CRP were significantly different between MetS +ve and MetS -ve groups. But for ESR we failed to observe such a deference. The importance is that, a variety of components of metabolic syndrome has been found to be positively correlated with the levels of these inflammatory markers.[18] Even though we got a significant association between MetS and S. uric acid level, the reliability is questionable as we have not assesses the SMR stages/sex hormone levels of these children, since sex hormones are known to control uricemia (Table 7).

The significant elevation of transaminases observed by us may be part of NAFLD associated with MetS.[19]

The additional point obtained was that, mean S. cholesterol, triglycerides and LDL which were found to be higher and mean HDL was low in the MetS group (Table 7). These findings emphasize on the need for regular screening for lipid profile in children with overweight/obesity attending our paediatric clinics in day to day practice, as suggested by Haney et al.[20]

Finally, when we observed the parameters that were positive to define the MetS, it was seen that, waist circumference was elevated in all cases (100%), HDL in 98.2%, TGL in 94.5%, HTN in 7.3% and FBS in 7.3%. From this we can infer that, increased waist circumference, low HDL and elevated TGL are more important in screening the children for metabolic syndrome. So our suggestion is to include the waist circumference and a fasting lipid profile for screening of MetS in children.

As this is a hospital based study the result may not be applicable to general population. This is limitation of this study.

CONCLUSION

The 25% of children of age 6-16yrs had Mets. Even though higher proportion of obese, in comparison to overweight children have Mets it is not statistically significant. Males are found to be more affected by mets than females. Excess calorie intake and passive smoking are other risk factors identified for development of mets. Birth weight more than 4 kg have a statistically significant association with mets. 100 percentage of babies born as preterm less than 32 weeks developed mets. Abdominal obesity was present in all cases of mets. Increased RDW alone is a significant risk factors for development of mets. The mean CRP in mets group was significantly higher than non mtes group. The lipid profile were significantly abnormal among mets group of children.

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