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Original Article

Metabolic Syndrome and its determinants in a sample of young Iranian children with obesity

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ABSTRACT

Objective: Childhood obesity increases the risk of metabolic syndrome (MetS) both in childhood and adulthood. The present study aimed to determine the prevalence of MetS and its potential determinants in a sample of Iranian obese children.

Methodology: This cross-sectional study was conducted in 2011 among 150 obese children (body mass index ≥ 95^{th} percentile) with seven years of age. They were randomly selected from 9 health centers in three districts of the north Tehran. Trained nutritionists completed a socio-demographic questionnaire by interviewing parents, and conducted the physical examination. MetS was defined based on modified Adult treatment panel III criteria.

Results: The mean (SD) of weight, height, and BMI was 37.5 (6.3) kg, 127.2 (4.7) cm and 23.08 (2.9) kg/m^2, respectively. The prevalence of MetS was 13.4%, without significant difference in terms of gender. The most common component of MetS was abdominal obesity (79%). While 21.3% of children did not have any component of MetS, 42% of them had at least one component. Most children with MetS had a history of breastfeeding for less than six months. Waist circumference, systolic and diastolic blood pressure, fasting blood glucose, and triglyceride levels were higher in MetS compared to controls ($p < 0.05$). Logistic regression model revealed that children with birth weight of ≤ 2500 gr. were at higher risk of MetS than children with a higher birth weight (OR=4.3; 95%CI: 1.1-9.7).

Conclusion: Primordial prevention of childhood obesity, and screening the components of MetS among obese children, should be considered as a health priority at individual and public levels. Prevention of low birth weight can have long-term impact on prevention of childhood obesity.

KEY WORDS: Metabolic Syndrome, Children, Obesity, Prevention.

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INTRODUCTION

Metabolic Syndrome (MetS) is a collection of co-existence of disorders as hyperglycemia, dyslipidemia and hypertension.[1,2] This syndrome increases the risk of chronic non-communicable diseases (CNCDs),[3] which are a global emerging public health issues.[4] The main cause of MetS remains to be determined but it is believed that this syndrome can be caused by a complex interaction between genetic, metabolic and environmental factors[5-7] Childhood obesity is one of the most important public health problem in developing and developed countries.[8] Obesity in children will also increase the risk of metabolic syndrome in adulthood.[9] More than 50% of obese children become obese adults with MetS in the future.[10]

There are various definitions for MetS.[7,11,12] MetS is a considerable health problem in pediatric age group, notably among those with excess weight, though its reported prevalence varies in several studies due to lack of uniform criteria.[13] The highest prevalence of MetS among over weight and obese children and adolescents were reported in Turkey (41.8%)[14] and the United State (39%).[15] The first nationwide studies in Middle-eastern adults16 and children and adolescents revealed considerably high prevalence of MetS. Considering that "School-age" is the most appropriate time for acquiring knowledge and habits, and given the impact of preventable factors on obesity and MetS,[17-18] The present study was conducted to evaluate metabolic syndrome and its determinants in a sample of young Iranian children with obesity.

METHODOLOGY

This cross sectional study was conducted in 2011 within the framework of the "Assessing the effect of lifestyle modification intervention in school-age obese Children"[19] on one hundred fifty, children with body mass index (BMI) ≥95th percentile[20] who were selected randomly from three districts of health center in Tehran, Iran. Parents completed a socio-demographic questionnaire including age, birth order, birth weight & height, history of breastfeeding and duration, mothers' age, marital status, parents' occupation and education level, number of household members, through interviewing by trained nutritionists.

The Ethics Committee of the National Nutrition and Food Technology Research Institute approved the study. At the initial screening visit, oral consent was obtained from children and written consent from parents. Those children with genetic syndromes, any chronic diseases or disability as well as those with history of chronic medication use or those on special diet were not included.

Anthropometric Measurements: A team of trained health professionals measured anthropometric indexes including weight, height, and waist circumference (WC). Weight was measured to the nearest 0.1 kg using a calibrated and certified portable digital scale (Beurer, Germany) with lightly dressed, barefoot, and empty pockets. Height was measured in a standing position, barefoot and using a portable height gauge (Seca, Germany) with accuracy of 0.1 cm. Then BMI was calculated as weight (kg) divided by height squared (m^2). WC was measured with an accuracy of 0.1 cm at the smallest area between the edge of the lower chest and the iliac crest bone.[21] Before the examination, the scale was calibrated and the mean of two measurements was recorded.

Blood Pressure[22]: BP was measured using a manual standard mercury sphygmomanometer from the right arm, after 5-10 minutes rest in sitting position by a qualified nurse. After that, the average of two measurements was recorded at the observer's eye level.[23]

Biochemical Analysis: For Blood sampling, children were asked to fast overnight for 12 hours on the day of analysis and were invited to attend in accompaniment of one of their parents to a health center near the fieldwork at National Nutrition and Food Technology Research Institute. For measuring serum glucose and lipid concentrations, 5 ml blood was taken from the cubital vein. The fasting blood glucose (FBG), triglycerides (TG) and high-density lipoprotein-cholesterol (HDL-C) concentration were analyzed on fresh blood, using a commercial kit based on the enzymatic methods (Pars Azmoon, Iran) with auto-analyzer (Selectra E, Vita lab, Netherlands). Validity and reliability of measurement instruments in each of the cases were evaluated. After collecting blood samples, the children were served healthy breakfast and a gift.

Definition of MetS: We defined MetS based on ATP III modified for the pediatric age group[24] i.e. having three or more of the followings: FBG ≥ 100 mg/dl;[25] Fasting TG≥ 110 mg/dl; HDL-C <40 mg/dl; WC ≥90th percentile for age and sex, according to national references curve;[26] systolic BP (SBP) or diastolic BP (DBP) ≥90th percentile for age and sex and height, from national reference cut-off points.[27]

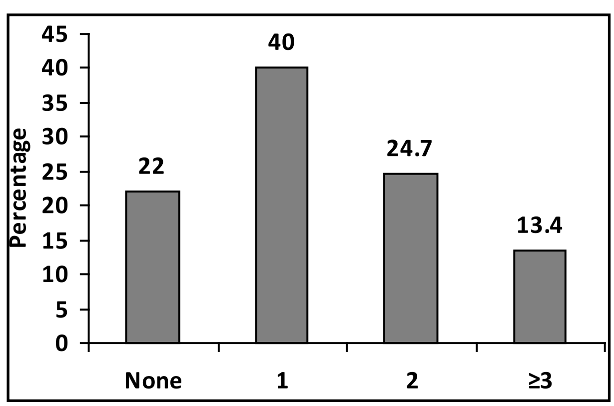

Fig.1: Frequency of obese children according to the number of metabolic syndrome components.

Statistical Analysis: After recheck and editing the data, all statistical analyses were performed using SPSS software package (version 16; SPSS Inc., Chicago, IL, USA). Chi-square and the Student t tests were used to compare the ratios and the means of the groups. Pearson correlation coefficients were used to assess relationship between independent variable. Multivariate logistic regression analysis was used to determine the potential determinants of the MetS. Statistical significance was established at p-value <0.05.

RESULTS

This study comprised of 150 obese children (52% girls) with a mean (SD) age of 6.65±0.83. The mean (SD) of weight, height and BMI were 37.5 (6.3) kg, 127/2 (4.7) cm, and 23.1 (2/9) kg/m², respectively. The prevalence of MetS was 13.4%, without significant difference between girls and boys (10.3% vs. 16.7%, respectively>0.05). As depicted in Fig.1, 21.3% of children did not have any MetS components, 42% had at least one component, and 13.4% fulfilled the criteria of MetS and there were no children who had all of components.

As presented in Table-I, the majority of children with MetS had a birth weight of lower than 2500(gr) and were breastfed for less than 6 months. Other characteristics such as parents occupation and education, as well as family history of obesity were not significantly different among these children (data not shown). When the variables were simultaneously assessed into the logistic regression models, the risk of MetS was higher in those children with lower birth weight (≤2500gr) than in those with higher birth weight (OR=4.3; 95%CI: 1.1-9.7). The corresponding figure was not significant for other variables.

Table-I: Characteristics of obese children with or without metabolic syndrome.

Index	*Overall (n=150)*	*Non-MetS (n=130)*	*MetS (n=20)*	*P value*
Sex				
Girl	78 (100)	70 (89.7)	8 (10.3)	NS
Boy	72 (100)	60 (83.3)	12 (16.7)	
Birth order				
1	85 (100)	73 (85.9)	12 (14.1)	NS
≥2	65 (100)	57 (87.7)	8 (12.3)	
Birth weight(g)				
≤ 2500	15 (100)	10 (66.7)	5 (33.3)	0.035*
> 4000	131 (100)	116 (88.5)	15 (11.5)	
History of breastfeeding				
Yes	138 (100)	120 (87)	18 (13)	NS
No	12 (100)	10 (83.3)	2 (16.7)	
Duration of breastfeeding (mo)				
>6	75 (100)	61 (81.3)	14 (18.7)	0.045*
≥ 6	75 (100)	69 (92)	6 (8)	
Number of household members				
>3	55 (100)	49 (89.1)	6 (10.9)	NS
≤4	95 (100)	81 (85.3)	14 (14.7)	
Mothers' age (year)				
≥32	41 (100)	34 (82.9)	7 (17.1)	NS
<32	108 (100)	95 (88)	13 (12)	
Gestational Diabetes				
Yes	8 (100)	7 (87.5)	1 (12.5)	NS
No	142 (100)	123 (86.6)	19 (13.4)	

Data are presented as number (percent) or mean (SD)
*p < 0.05 (significantly different between two groups); NS: non-significant MetS: metabolic syndrome

The mean (SD) of metabolic risk factors in obese children with and without MetS is presented in Table-II. Waist circumference, systolic and diastolic blood pressure, fasting blood glucose, and triglyceride levels were higher in MetS compared

Table-II: Comparison of metabolic risk factors in obese children with and without metabolic syndrome.

Index	*Overall (n=150)*	*Non-MetS (n=130)*	*MetS (n = 20)*	*P value*
BMI (kg/m2)	23.07 (2.90)	22.99 (2.99)	23.59 (2.24)	NS
WC (cm)	74.02 (6.55)	73.84 (6.68)	75.20 (5.66)	* 0.047
SBP (mmHg)	99.61 (11.16)	97.16 (8.93)	115.50 (11.39)	* 0.000
DBP (mmHg)	62.59 (8.54)	60.67 (6.58)	75.05 (9.42)	* 0.000
FBG (mg/dl)	85.65 (8.31)	84.91 (7.72)	90.05 (10.61)	* 0.010
TG (mg/dl)	103.53 (46.27)	99.58 (45.63)	129.15 (43.03)	* 0.007
HDL-C (mg/dl)	51.07 (9.42)	51.33 (8.92)	49.30 (12.30)	NS

Data are presented as mean (±SD)
*p < 0.05 (significantly different between two groups); NS: non-significant
MetS: metabolic syndrome; BMI: body mass index; WC: waist circumferences; SBP: systolic blood pressure;
DBP: diastolic blood pressure; FBG: fasting blood glucose; TG: triglyceride;
HDL-C: high-density lipoprotein-cholesterol.

to controls ($p<0.05$). Significant relationship was documented for WC and BMI ($r=0.85$, $p<0.001$), SBP ($r=0.25$, $p<0.01$), and DBP ($r=0.22$, $p<0.01$). The most common components of MetS were abdominal obesity (79%) followed by high serum TG (74%) and high DBP (74%). High FBG has the lowest percentage in those components (21%). The prevalence of MetS components was not significantly different in terms of gender.

DISCUSSION

The rapid rising prevalence of childhood obesity is related to increased risk of metabolic syndrome. In our study, the prevalence of metabolic syndrome in obese children according to ATPШ criteria was similar to Brazil (13.4% vs. 13/2%)[28] and other reports[29-35] from 10% to 20%. Tailor discussed in her review that the prevalence of MetS among children and adolescents around the world is on average about 10%, ranging from near 2% among normal weight children and adolescents to about 32% among the obese.[36] The range of discrepancies in the prevalence of MetS were considerable in various studies, and can be attributed to ununified definition of this syndrome, different cut-off values, population size, age and degree of obesity in children.

The role of breastfeeding in prevention of obesity and MetS was shown in previous studies.[27,37-38] It has been reported that the prevalence of obesity were twice in children who were not breastfed as compared to breastfed children, with a concurrent increase in MetS prevalence.[39] There was no relationship between breastfeeding and metabolic syndrome in a study by Kelishadi et al,[40] although the duration of breastfeeding has protective effect against MetS. Birth weight reflects the pattern of intrauterine growth and might have long-term impacts on chronic disease in adulthood.[41] Our results showed the significant correlation between MetS and birth weight and supported the reports in studies that demonstrate the effect of low birth weight on the development of MetS in adulthood.[42-43] We also measured waist circumferences, as a good predictor of cardio vascular disease (CVD) risk factors and MetS in children and adolescents.[44-45]

Increased waist circumference indicates abdominal obesity that was considered an important factor for the other components of MetS.[46] The high prevalence of hypertriglyceridemia may be explained by role of dietary habits, for instance diets high in Trans fatty acid. This was not evaluated in our survey. The children's high blood pressure in this study was in keeping with the existing knowledge that abdominal obesity is clearly linked to hypertension.[47,48] In this study the prevalence of hyperglycemia was lowest among the components of metabolic syndrome ,which is consistent with some previous studies.[24,49] It is believed that hyperglycemia probably is increased later than the other components of metabolic syndrome and may be associated with the duration of obesity.

Considering the global problem of childhood obesity,[50] Detecting MetS at an early stage and improving it by life style changes should be considered as an important goal in childhood. Early primary prevention to reduce weight, increase physical activities and train the parents of obese children are necessary.It is recommended that lifestyle modifications and plans for weight loss should be at the core of treating and preventing MetS and its components.

CONCLUSION

Although the prevalence of MetS depends on the definition used and population studied, it has been clearly increasing globally in parallel with childhood obesity and it can be a warning for the policy priorities in health strategic plans. Need to be alerted regarding the existence of the metabolic syndrome in obese children can reduce the health care costs. The health politics, potential screening and mass intervention programs at early age groups are crucial. Establishment of a uniform and universally accepted set of criteria for defining overweight, obesity and the metabolic syndrome in children would be a foundation for addressing this emerging public health concern. Further national prospective studies with long-term follow up in children with different ages are needed.

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