JAFES Journal of the ASEAN Federation of Endocrine Societies

ORIGINAL ARTICLE

Metabolic Syndrome in Obese and Normal Weight Myanmar Children

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Abstract

Objectives. To estimate the frequency of Metabolic Syndrome (MS in Myanmar obese children and to determine the risk factors associated with MS in obese children comparing with normal weight children.

Methodology. A cross-sectional study was conducted to compare the risk factors for metabolic syndrome between normal and obese children by using the pediatric definition for metabolic syndrome [International Diabetes Federation (IDF), 2007]. Twenty-three obese children (BMI, ≥ 97th percentile) and 23 normal weight children (BMI, < 85th percentile) aged 5-12 years were included in the study. Blood pressure, body weight, height, waist circumference (WC), fasting triglycerides, HDL-cholesterol, total cholesterol and glucose concentrations were determined.

Results. Based on the IDF pediatric criteria, 9 obese children (39.1%) had metabolic syndrome while no normal weight child had metabolic syndrome. Ten (43.5%) normal weight children and 3 (13.0%) obese children had at least one risk factor for the metabolic syndrome. Central obesity (WC ≥ 90th percentile for age and sex), the most common risk factor, was observed in 25 children (54.4% of the total population).

Conclusion. This study highlights the need for early recognition of risk factors for metabolic syndrome in all children to halt the progression of type 2 diabetes and cardiovascular diseases (CVD) in later life.

Keywords: metabolic syndrome, risk factors, obese children

INTRODUCTION

The prevalence of obesity in children and adults has increased over several decades in many countries due to changes in lifestyle and nutritional behaviors. In Myanmar, according to the national survey in 2009, the prevalence of overweight and obesity were 25.38% and 6.8% in adults. Among children and adolescents aged 10-19 years in Yangon, the prevalence of obesity was 7.6%.[1] It is known that one-third of obese children and 80% of obese adolescents remain obese when they reach adulthood.[2]

Metabolic syndrome (MS) is recognized as the clustering of risk factors of obesity, insulin resistance, dyslipidemia and hypertension with the subsequent development of CVD and type 2 diabetes.[3] Reaven described Syndrome X as the combination of hyperglycemia, hypertension and hyperuricemia and noted the relationship between systemic insulin resistance and the metabolic syndrome in 1988.[4] The World Health Organization (WHO) in 1988, the National Cholesterol Education Program (NCEP) in 2001 and the International Diabetes Federation (IDF) in 2005 have further defined the criteria for the syndrome.[5-7] The most commonly applied criteria recommended for children in comparative studies are the modified WHO, NCEP using childhood cut-off values, Cook and the IDF consensus criteria. The IDF (2007) recently proposed a definition of MS used for children and adolescents.[8] It has been divided according to the age groups: 6 to <10, 10 to <16 and ≥16 years. In all three groups, abdominal obesity is the essential condition for diagnosis of the MS. It suggests that below 10 years old, MS should not be diagnosed but further measurements should be made if there is a family history of the syndrome, type 2 diabetes, dyslipidemia, CVD, hypertension, and/or obesity. A strong message for weight reduction should be delivered for those with abdominal obesity. For children aged 10 to <16 years, a diagnosis of MS can be made with abdominal obesity and the presence of two or more of the other components (elevated triglyceride, low HDL-cholesterol, high blood pressure and elevated plasma glucose). For

ISSN 0857-1074
Printed in the Philippines

Received February 19, 2013. Accepted April 23, 2013.

The paper has been presented in the Myanmar Health Research Congress (2012) on 8th January, 2013 in Department of Medical Research (Lower Myanmar), Yangon, Myanmar.

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adolescents aged ≥16 years, the IDF adult criteria can be used including 90th percentile cut-off for WC and <40 mg/dl of HDL for both sexes.

Children with the cluster of factors defined as pediatric metabolic syndrome were significantly more likely to have CVD 25 years later as adults, compared with their peers.[9]The aims of the study were to estimate the frequency of MS in Myanmar obese children and to determine the risk factors associated with MS in obese children comparing with normal weight children.

METHODOLOGY

Study population

The study population included a total of 46 children aged 5-12 years (25 boys and 21 girls). Twenty three obese children (BMI, ≥ 97th percentile) from the Obesity Clinic, Yangon Child Hospital and 23 age-and gender-matched controls (BMI, between 15th to 85th percentile) were recruited as comparison groups using the WHO (2007) growth reference for children 5-19 years of age. Informed consent was obtained from the guardian of each child and the study was reviewed and approved by the Ethical Committee of Department of Medical Research.

General examination and anthropometry

Body weight and height were measured to the nearest 0.1 kg and 0.1 cm respectively, using standardized equipment and procedures.[10] Body mass index (BMI) was calculated from the formula: weight (kg) divided by height (m) to the power of two (weight/height^2). The waist circumference (WC) measurement was measured to the nearest 0.1 cm, at a level parallel to the floor, midpoint between the top of the iliac crest and the lower margin of the last palpable rib in the mid-axillary line.[11] The WC percentiles were determined based upon from the age- and gender-specific WC percentiles chart of Hong Kong Chinese children.[12] The children with WC ≥90th percentile for age and sex were recorded as having central obesity. Systolic and diastolic blood pressures were measured using a standardized sphygmomanometer in lying position. Hypertension was defined as systolic or diastolic blood pressure ≥ 130 or ≥ 85 mmHg, respectively.

Laboratory procedures

Blood samples were obtained after a 10- to 12-hour fast for determination of plasma glucose, cholesterol, triglyceride, and lipoprotein fraction concentrations. Plasma glucose was obtained by the glucose oxidase technique and serum lipids were measured by enzymatic colorimetric methods.

Definition of the Metabolic Syndrome

All participants were defined as having MS based on the pediatric definition of IDF (2007). An individual has MS if WC was ≥ 90th percentile and at least two of the following components were above or under a single cut-off point: triglyceride ≥ 150 mg/dl, HDL-cholesterol< 40 mg/dl, fasting plasma glucose ≥ 100 mg/dl, systolic or diastolic blood pressure (BP) ≥ 130 or ≥ 85 mmHg, respectively.

Statistical analyses

Statistical analysis was performed using Stata Version 11. Means and standard deviation were used to summarize variables. Between the two groups, differences in general characteristics, metabolic profiles and risk of MS were tested using Student-t test and Fisher's exact test. Bivariate correlation analysis was performed using the Spearman correlation. The level of significant was set at $p<0.05$.

RESULTS

Table 1 shows the physical and clinical characteristics of the participants in both groups. The mean age of obese children was 8.9 ± 1.98 years and the mean age of the control group was 9.99 ± 2.02 years. Despite the higher mean height of the obese children (134.08 ± 11.71 cm), they were not significantly taller than the normal weight children who had a mean height of 132.13 ± 12.83 cm. However, the obese group had significantly higher values for weight, BMI and WC compared to the normal weight group ($p<0.05$).

Table 1. Characteristics of children according to weight category (mean ± SD)

Variables	Obese (n=23)	Normal (n=23)	p value
Physical characteristics			
Age (years)	8.9 ± 1.98	9.99 ± 2.02	0.0721
Weight (kg)	49.95 ± 14.23*	27.96 ± 6.70	0.0000
Height (cm)	134.08 ± 11.71	132.13 ± 12.83	0.5918
BMI (kg/m^2)	27.35 ± 5.18*	15.87 ± 1.37	0.0000
Waist circumference (cm)	85.39 ± 12.63*	58.62 ± 5.09	0.0000
Systolic BP (mm Hg)	107.23 ± 17.53*	91.52 ± 9.59	0.0005
Diastolic BP (mm Hg)	67.05 ± 16.45*	54.35 ± 9.08	0.0024
Biochemical parameters			
Fasting plasma glucose(mg/dl)	78.35 ± 15.38	82.98 ± 9.79	0.2301
Total cholesterol (mg/dl)	154.89 ± 48.25*	127.97 ± 29.52	0.0274
LDL-cholesterol (mg/dl)	94.64 ± 46.88*	69.08 ± 30.36	0.0335
HDL-cholesterol (mg/dl)	36.97 ± 14.97	44.02 ± 8.89	0.0587
Triglycerides (mg/dl)	107.00 ± 47.93*	68.81 ± 27.62	0.0019

*. * p<0.05*

Based on clinical profiles, the obese group had significantly higher systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol, LDL-cholesterol and triglyceride levels compared to the normal weight group ($p<0.05$). Although the mean HDL-cholesterol and fasting glucose levels were lower in the obese group, there was no statistically significant difference between the two groups.

The prevalence of MS

According to the IDF pediatric definition, the overall prevalence of MS in the study population was 19.6 %. According to weight category, the prevalence of MS was

39.1 % in obese children compared to 0% in normal weight children (Table 2).

Table 2. Prevalence and clustering of metabolic syndrome components according to the IDF pediatric definition [expressed as number (%)]

Components	Obese (n = 23)	Normal (n = 23)	Overall (n = 46)
Individual components of metabolic syndrome			
Large WC (≥90th percentile)	23 (100.0)	2 (8.7)	25 (54.4)
High blood pressure (SBP≥130/ DBP≥85 mm Hg)	4 (17.4)	0	4 (8.7)
High fasting blood sugar (≥100 mg/dl)	1 (4.3)	1 (4.3)	2 (4.3)
High triglyceride level (≥150 mg/dl)	6 (26.1)	0	6 (13.0)
Low HDL-cholesterol level (<40 mg/dl)	19 (82.6)	9 (39.1)	28 (60.9)
Metabolic syndrome	9 (39.1)	0	9 (19.6)
Pattern of risk factor clustering			
None	0	12 (52.2)	12 (26.1)
One risk factor only	3 (13.0)	10 (43.5)	13 (28.3)
Two risk factors	11 (47.8)	1 (4.3)	12 (26.1)
Three risk factors	8 (34.8)	0	8 (17.4)
Four risk factors	1 (4.3)	0	1 (2.2)
Five risk factors	0	0	0

The prevalence of individual metabolic abnormalities

Among the individual components of MS, large WC was the most common risk factor in the present study population. All obese children had central obesity, whereas 2 normal weight girls were centrally obese. This was followed by low HDL-cholesterol (82.6%), high triglyceride level (26.1%), high blood pressure (17.4%) and high fasting blood sugar (4.3%) in obese children. Unexpectedly, risk factors like low HDL-cholesterol (39.1%) and high fasting blood sugar (4.3%) were found in normal weight children (Table 2).

More than half of the normal weight children (52.2%) did not have any risk factor of MS. However, all the obese children have at least one factor of MS but none of the children had all five components of MS (Table 2).

DISCUSSION

The overall prevalence of MS in the present clinic-based study population was 19.6% based on the IDF pediatric definition (2007). It is similar to that reported in children aged 6-11 years in Japan (14.5%) and 7-17 year-old children in a French study (15.9%).[13-14] The overall prevalence of MS is diverse in different countries because of the different criteria used. The prevalence is low in 8-10 year-old Malaysian children (1.3%), and is around 5-5.6% in 6-11 year-old US children.[15-17] Although variability existed between studies, the strikingly higher prevalence of MS among obese children and adolescents was found in many studies (30-38.8%) similar to the present study (39.1%).[18-22]

Among obese children, abdominal obesity (increased WC) was the most prevalent component (100%), followed by low HDL-cholesterol (82.6%), high triglyceride (26.1%), elevated blood pressure (17.4%) and impaired fasting plasma glucose (4.3%). The distribution of risk factors seen in our study was consistent with those in Malaysian obese children: highest WC (84.1%) followed by low HDL-cholesterol (19.7%), increased triglyceride level (12.5%), abnormal blood pressure (6.3%), and high fasting glucose level (5.8%).[23] Esmailzadeh et al., reported that low HDL-cholesterol was the most frequent while the least frequent was impaired fasting blood glucose.[24] Decrease in HDL-cholesterol level in obese children may be due to the rapid clearance from the circulation. Weight gain, especially if visceral fat increases, can in turn increase triglyceride lipolysis that will elevate free fatty acid levels. In the circulation, the triglyceride-rich VLDL will exchange triglycerides with cholesterol esters in HDL, resulting in triglyceride-rich and low cholesterol ester HDL plasma. This type of HDL is more easily catabolized by the kidney resulting in decreased HDL levels.[25]

The abnormal glucose homeostasis has a wide range and can progress from insulin resistance to diabetes.[26] A longer duration of obesity may be required for the development of impaired glucose tolerance and type 2 diabetes. [21]

The BMI showed a significant positive relationship with WC (r=0.677, p<0.001) and SBP (r=0.469, p<0.05) in normal weight children and also with WC (r=0.594, p<0.01), SBP (r=0.640, p<0.01) and DBP (r=0.600, p<0.01) in obese children. However, the WC showed a significant relationship with SBP (r=0.553, p<0.01) and DBP (r=0.548, p<0.01) in obese children (Figure 1). Maffeis et al., proved that waist circumference showed a better correlation with SBP and DBP (r=0.45 and 0.39, respectively; p< 0.01)in obese prepubertal children than the total sample population.[27] Moreover, Lee et al., supported that WC should be included in the evaluation of childhood obesity along with BMI percentile to identify those at increased health risks due to excess abdominal fat.[28] Therefore, WC is a sensitive marker of cardiovascular risk in identifying obese children at higher metabolic risk.

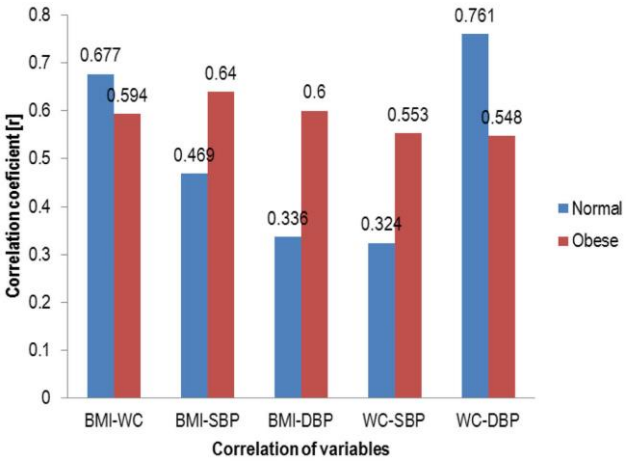

Figure 1. Correlation coefficient between variables, body mass index (BMI), waist circumference (WC), systolic blood pressure (SBP) and diastolic blood pressure (DBP) by weight category.

However, there are no age-, gender- and ethnic-specific WC standards for Asian children, with the exception of the values based on a database of Hong Kong children and one from Malaysia.[12,29,30] Accordingly, it would be extremely useful to develop a WC cut-off point for each country so that meaningful comparisons could be made.

This study is not without its limitations. We did not include the family history of the children as well as their physical activity and dietary pattern. There is a positive relationship between the different components of MS with obesity, family history of hypertension, diabetes mellitus and CVD.[31-32] Moreover, the risk of MS was 2.4 times higher in children with a family history of diabetes, hypercholesterolemia, high blood pressure or cardiovascular disease.[15] Another limitation is the small sample size of the present study. A large sample size including non-urban samples is recommended in future studies to get a more representative study population.

CONCLUSION

The present study reveals that 39.1% of obese children in Myanmar have metabolic syndrome. None of them are free from the MS risks. This is in sharp contrast to 52.2% of the normal weight children who were free from all risk factors. However, the existence of one or more components of the metabolic syndrome risks in the normal weight children needs closer attention. There is evidence that clustered risk factors track strongly from childhood to young adulthood. Therefore, it is important to identify those children at greater risk for obesity-related ill health at an early stage to increase awareness and to have the opportunity to promote healthy lifestyle in children. This will reduce the death and disability in adulthood and help minimize the global burden of CVD and type 2 diabetes.

Acknowledgements
We thank all the team members, all participants and their parents. Special thanks to Dr. Kyaw Oo and Dr. Moh Moh Hlaing for their suggestions and contribution to this paper.

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