

Comparison of metabolic syndrome criteria in obese and overweight children

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Abstract

Background Metabolic syndrome (MS) is a group of disorders which occur in relation to increasing body weight. Only a few studies have reported the differences in the fulfillment of MS criteria between obese and overweight children, and none were from Indonesia.

Objective To determine the differences in metabolic syndrome disorders between obese and overweight children.

Methods A cross-sectional study was conducted in Manado from May to August 2010. The diagnosis of MS is established by fulfilling three of five criteria: waist circumference $\geq 90^{\text{th}}$ percentile, blood pressure $\geq 90^{\text{th}}$ percentile, fasting blood sugar (FBS) ≥ 100 mg/dl, triglycerides ≥ 110 mg/dl and high density lipoprotein (HDL) ≤ 40 mg/dl. Obesity was defined as body mass index (BMI) of > 3 SD and overweight as BMI of 2-3 SD. Results were analyzed by x^2 and t-test.

Results Thirty obese and 30 overweight children aged 10-14 years were examined for the disorders of MS. Twenty-three obese and 4 overweight children had waist circumferences $\geq 90^{\text{th}}$ percentile. Seventeen obese and 3 overweight children had blood pressure $\geq 90^{\text{th}}$ percentile. No significant differences in FBS, HDL, and triglycerides were observed between the two groups. Thirteen obese children met the MS inclusion criteria, while only 1 overweight child did so ($P < 0.001$).

Conclusions High blood pressure ($\geq 90^{\text{th}}$ percentile) and waist circumference ($\geq 90^{\text{th}}$ percentile) occurred were observed at higher frequency in obese children than in overweight children. The occurrence of MS in obese children was significantly higher than in overweight children. [Paediatr Indones. 2010;50:295-9].

Keywords: metabolic syndrome, obese, overweight

Metabolic syndrome (MS) is a group of lipid and non-lipid disorders, comprised of a cluster of risk factors for future cardiovascular disease and diabetes mellitus. The likelihood of MS increases with increased body weight.^{1,2} Many studies have shown that the mortality rate from metabolic syndrome correlates to obesity.³⁻⁶ Yoshinaga et al. compared obese and overweight children and found metabolic syndrome occurrence of 17.7% in obese children and 8.7% in overweight children.⁷ Few studies have reported the differences in fulfilled MS criteria between obese and overweight children, none of which were from Indonesia.

The aim of this study was to determine differences in metabolic syndrome criteria between obese and overweight children.

Methods

Study Design

A cross-sectional study was conducted in Tuminting District, Manado, from May to August 2010. After

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a preliminary study from five elementary and two junior high schools, samples of 30 obese children and 30 overweight children were collected consecutively. We included obese or overweight children aged 10-14 years. Children with diabetes, nephrotic syndrome, acute glomerulonephritis and subjects using corticosteroids more than seven days were excluded. Informed consent was obtained from all parents and assent was obtained from all children after the nature of the procedures was explained and before testing commenced. All subjects underwent physical examination and laboratory evaluation for MS.

Definitions

Metabolic syndrome, according to the modified National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III) consists 5 criteria: waist circumference $\geq 90^{\text{th}}$ percentile according to age and sex, blood pressure $\geq 90^{\text{th}}$ percentile according to age and sex, fasting blood sugar (FBS) ≥ 100 mg/dl, triglycerides (TG) ≥ 110 mg/dl and high density lipoprotein (HDL) ≤ 40 mg/dl. An MS diagnosis is established if three of five criteria are fulfilled.⁸ Obesity was defined as BMI > 3 SD and overweight as BMI 2-3 SD.

Sample Collection

A minimum sample size of 26 per group was calculated using the Kirk test for two group comparisons. The elementary and junior high schools chosen for sampling were determined based on a preliminary study to determine where sufficient samples of obese and overweight children were located. If the number of subjects collected reached 26-30 children in each group, then they were included in our study and we would discontinue sampling.

The height and weight of each child were measured and plotted according to the 2006 WHO Growth Reference Chart.⁸ We also measured blood pressure and waist circumference. Waist circumference was measured by measuring tape around the abdomen, passing through both the right and left middle points between the lower rib and upper iliac crest borders while subjects stood erect so that the distance between their feet was approximately 30 cm. Blood sampling was conducted after fasting for eight hours with as much as 5 cc blood taken from the

medial cubital vein. The fasting blood glucose, HDL, and triglycerides were then analyzed using a Hitachi 912 analyzer and Roche reagent. Midstream urine samples were analyzed microscopically and with the Mditron Junior 2 urine analyzer.

Statistical analysis

Measurements of waist circumference, blood pressure and the occurrence of metabolic syndrome were analyzed by χ^2 test. HDL, triglycerides and FBS were analyzed by t test. Statistical analysis was done using SPSS version 17.0. The value of $P < 0.05$ was considered significant in the statistical analysis.

Results

We included 30 obese and 30 overweight children in this study. Baseline characteristics are shown in **Table 1**. The mean age of obese subjects was 12.9 years, while the mean age of overweight subjects was 13.5 years. Number of boys and girls were similar between the two groups. Twenty-three children in the obese group had a waist circumference above the 90th percentile according to age and sex, while only 4 subjects in the overweight group did so. Seventeen children in the obese group had blood pressure above the 90th percentile according to age and sex, while only three did so in the overweight group. These differences were statistically significant as shown in **Table 2**. The means of FBS, HDL, and TG were not significantly different between the obese and the overweight groups as shown in **Table 3**. Of the 30 children in the obese group, 13 had MS, while only one child in the overweight group had MS, a significant difference (**Table 4**).

Table 1: Baseline characteristics

Characteristics	Obese	Overweight
Age, years		
10	3	0
11	5	3
12	5	4
13	12	13
14	5	10
Sex, n		
Male	14	13
Female	16	17

Table 2: Physical criteria of metabolic syndrome in obese and overweight groups

	Obese n=30	Overweight n=30	χ^2	P
Waist Circumference > 90 th , n	23	4	24.3	< 0.0001
Blood Pressure > 90 th , n	17	3	14.7	< 0.0001

Table 3. Laboratory criteria of metabolic syndrome in obese and overweight groups

	Obese n=30	95% CI	Overweight n=30	95% CI	P
FBS, mean(SD) mg/dl	86.5 (9.03)	83.13 to 89.87	83.5 (8.18)	80.41 to 86.52	0.89
HDL, mean (SD) mg/dl	42.3 (7.03)	39.71 to 44.96	44.5 (9.53)	40.94 to 48.06	0.16
TG, mean (SD) mg/dl	115.4 (67.34)	90.29 to 140.58	90.8 (65.93)	66.18 to 115.42	0.79

Table 4: Sum of MS criteria and occurrence of MS in obese and overweight groups

Criteria Of Metabolic Syndrome	Obese	Overweight
0	1	14
1	6	8
2	10	7
3	11	1
4	2	2
Metabolic Syndrome	13	1

Discussion

Past studies have reported a difference in fulfillment of the waist circumference criterion between obese and overweight children.^{7,9} Similarly, we also observed a significant difference in the fulfillment of this criteria for MS in the 2 groups. Increased waist circumference in children has been correlated to elevated blood pressure, total cholesterol, triglyceride, lipoprotein, and insulin levels, as well as decreased HDL levels. The correlation between cardiovascular risk and waist circumference is not only influenced by the degree of obesity, but also by distribution of fat tissue.¹⁰

We also found that the occurrence of high blood pressure fulfilling the metabolic syndrome's criteria between the obese and overweight groups differed significantly. A study in China found no significant difference in blood pressure between these two groups, but when compared with the children of normal weight, the difference was significant. Their study also showed that blood pressure is the most common MS criteria found in Chinese adolescents, a major difference from the adolescent population in America. They suggested that this finding may be

due to different genetics, feeding behavior, physical activity, or lifestyle. However, further study was thought to be needed.¹¹ The Bogalusa Heart Study found that pre-hypertensive children and adolescents had higher BMI than normotensive subjects.¹² Hypertension is an integral component of metabolic syndrome. The increasing sympathetic tone correlates with obesity and insulin resistance and seems to have a direct effect on sympathetic nervous system activity. Insulin stimulates sodium retention by the kidneys and stimulates growth of vascular muscle tissue.¹³

We found no significant difference in FBS between the obese and overweight groups. Other studies have reported similar results.^{11,14} Overweight or obesity is an important risk factor of type 2 diabetes in children and adolescents. At present it is believed that the prevalence of overweight has increased in a parallel fashion with cases of type 2 diabetes.²

HDL levels in the obese group were not significantly different from the overweight group in this study. Yoshinaga *et al.*⁷ had similar results, but a study by Steinberger *et al.* in obese and normal weight children found that HDL levels in the obese group were significantly lower than those of the normal group.¹³ 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.¹⁵ Triglyceride levels between the obese and overweight group were also not significantly different in our study. Other studies have been in agreement with our findings.^{7,11}

We found significant differences in MS occurrence between the two groups. Yoshinaga *et al.* found MS occurrence in obese children in Japan was significantly lower than in obese children in the US. However, in the overweight groups there was no significant difference between nationalities.⁷ Bustos *et al.* found the occurrence of MS in 37.5% of obese children and its prevalence was higher in females.¹⁴ Other studies found the prevalence of MS between obese and overweight children to differ significantly.^{10,11,16} Based on the sum of the criteria in each group, children who met 3 of 5 MS criteria were frequently found in the obese group. In contrast, the overweight group often met none of the MS criteria. A study by Cook *et al.* in overweight adolescents aged 12-19 years found that 41% had ≥ 1 risk factor, 14% ≥ 2 risk factors, but none fulfilled all 5 criteria of MS.⁵ Bustos *et al.* studied obese children aged 10-18 years and found only 4% not at risk of developing MS, with 95.5% fulfilling only 1 criterion, 72.9% fulfilling 2 criteria, 37.5% fulfilling 3 criteria, and 9.5% fulfilling 4 or more MS criteria.¹⁴

The most frequently fulfilled MS criteria in the obese group was waist circumference, but in the overweight group it was low HDL. Li *et al.* found the most frequently occurring MS criterion was low HDL (which group?). They also found that central obesity, FBS, and hypertension frequency increased along with increasing body weight.¹¹ Cook *et al.* found that high triglycerides and low HDL levels are more frequently found in white children and adolescents while children of Mexican descent tend to develop greater central obesity measured by waist circumference than other races. By contrast, children of African descent more often developed a rise in blood pressure than other races.¹⁰ De Ferananti *et al.* reported in the Third National Health and Nutrition Examination Survey in America that for 6 years the most frequently occurring criteria in children and adolescents aged 12-19 years were low HDL and abdominal obesity (waist circumference).¹⁶ Esmailzadeh *et al.* found that low HDL was most frequent while the most rare was FBS.¹⁸

The occurrence frequency of fulfilled metabolic syndrome criteria differed among studies. This was probably due to genetic factors, eating habits, food type, physical activity, and lifestyle.¹¹ Obesity has long been known to have a familial component, along with other factors such as excessive birth weight, and

maternal diabetes. Past studies on MS were usually cross-sectional and none have correlated MS or its criteria with lifestyle, eating patterns, or genetic factors.¹⁹ Further study on the relationship between MS and duration of obesity, eating patterns, lifestyle, and exercise should be conducted.

A limitation of our study is that we did not look into whether fulfillment of MS criteria was related to duration of obesity, eating patterns, lifestyle, or exercise. Secondly, the nature of our cross-sectional study did not allow for determining explain the length of time between onset of the obesity and MS occurrence.

In conclusion, high blood pressure and waist circumference occurred more commonly in obese than in overweight children. The occurrence of MS in obese children was significantly higher than in overweight children. We suggest that knowledge of tendencies for fulfillment of MS criteria in obese and overweight children may be useful for diagnosing MS and providing earlier treatment.

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