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Original Article

Relationship between the degree of obesity and oral glucose tolerance in primary obese adolescents

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ABSTRACT

Background Obesity has long been recognized as a risk factor for a variety of adverse health consequences. Obese adolescents tend to have a decrease in sensitivity to insulin resulted in elevated plasma glucose level. The oral glucose tolerance test has often been used to evaluate this insulin resistance. The aim of this study was to find out the relationship between the degree of obesity (according various classification) and the ability to tolerate oral glucose load in adolescents with primary obesity.

Methods Subjects of this cross-sectional study consisted of 75 adolescents aged between 12 and 15 years. Obesity status was determined according to the weight for height (W-H), body mass index (BMI), triceps skin folds thickness (TST) and sub scapular skin folds thickness (SST) classifications. All subjects underwent oral glucose tolerance test. The plasma glucose level was measured while fasting and two hours after taking 1.75 gram glucose per kilogram of body weight (maximum 75 gram). Impaired glucose tolerance was defined as a fasting glucose level ≤126 mg/dL and two-hour plasma glucose ³ 140 mg/dL but < 200 mg/dL.

Results There was a significant difference in two-hour plasma glucose level between the mild and moderate obese group based on W-H classification (p = 0.02), also between the non obese and the obese group based on BMI classification (p = 0.02). The Pearson's correlation of two-hour plasma glucose level with W-H and BMI parameters showed a significant correlation (r = 0.316; p = 0.005 and r = 0.268; p = 0.018). There were two adolescent girls who showed impaired glucose tolerance.

Conclusion Although impaired glucose tolerance found only in a few obese adolescents, decreased ability to tolerate oral glucose load was found in subjects studied and correlated well with the degree of obesity **[Paediatr Indones 2002;42:249-253].**

Keywords: *obesity, glucose tolerance, insulin resistance, adolescents*

At present, nutrition problems in Indonesian children have two different issues. In spite of the increasing malnutrition problems, several population groups have obesity problems. Most obesity problems in children are influenced by the environmental factors such as lifestyle, calorie intake, and genetic factor (primary obesity). The increasing prevalence of obesity nowadays shows us the necessity to control external factors.[1] Obesity has long been recognized as a risk factor for a variety of adverse health consequences. Obesity is associated with insulin resistance with or without type 2 diabetes mellitus (DM), hypertension, dyslipidemia, and cardiovascular disease.[2] Insulin resistance is one of the early signs of progressing type 2 DM. During puberty, there is an increase of tissue resistance towards insulin action that results in a hyperinsulinemic state.[3,4] Impaired glucose tolerance (IGT) is a sign of type 2 DM and it is related with the increase of body weight and insulin resistance state of the peripheral tissue.[5]

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This cross sectional study was conducted to find out the relationship between the degree of obesity (according to various classifications) and the ability of oral glucose tolerance in adolescents with primary obesity.

Methods

Subjects

Subjects were recruited in step random orders from obese adolescents with age ranged between 12-15 years according to the weight for height classification. Obesity state was reevaluated based on the body mass index (BMI), triceps skin-fold thickness, and sub scapular skin-fold thickness classification. Measurements of the body composition were done by specially trained personnel. Body height was measured using a microtoire and body weight using a platform beam balance scale standard. BMI was calculated as body weight in kilogram divided by the square of the height in meter. The triceps and subscapular skin-fold thickness were measured using the Harpenden Skin Fold Caliper. This study was performed in ten junior high schools in Bandung between February–April 2002.

All subjects fulfilled the body weight criteria of more than 120% body weight compared to body height, based on the WHO/NCHS 1977 standard. Physical examination showed no congenital malformation or signs of secondary obesity. All parents knew their children's exact birthday. All parents agreed to include their children in this study–-after a brief explanation with informed consent–until the end. All children were not taking any corticosteroid, thiazide diuretic, or salicylic acid drugs.

Oral glucose tolerance test

After fasting for 10 hours, venous blood sample was taken from each subject to measure their fasting glucose level. Then every subject was given a glucose drink containing 1.75 gram/kg body weight or maximum of 75 gram to be finished in a short time. Two hours later blood samples were retaken for measuring the plasma glucose level. All blood samples were mixed with NaF and delivered to the laboratory.

Glucose levels were measured from NaF serum using hexokinase method with glucose analysis equipment from Hitachi 911. Impaired Glucose Tolerance (IGT) was described as a normal fasting glucose level (less than 126 mg/dL) and two-hour glucose level–after an intake of 75 gram glucose–greater than or equal to 140 mg/dL but less than 200 mg/dl.[6]

Data analysis

Several statistic tests were used to analyze data, such as the t-test to compare the means of fasting glucose level and the 2 hours post loading glucose level of two groups and ANOVA test to compare means of more than two groups. Pearson correlation test was used to evaluate the relationship between glucose level and body weight- body height and BMI.

Results

There were 75 subjects who fulfilled the inclusion criteria. Forty-one were males (55%) and 34 were females (45%). Based on the weight for height classification, there were 53 mild obese (71%) and 22 moderate obese adolescents (29%). Based on the BMI classification, there were 21 non-obese (28%) and 54 obese adolescents (72%). Based on the triceps skin- fold thickness classification, there were 13 non-obese (17%), 39 mild obese (52%), and 23 severe obese adolescents (31%). Based on the subscapular skin fold thickness classification, there were 2 non-obese (3%), 15 mild obese (20%) and 58 severe obese adolescents (77%).

The family characteristic of the subjects showed 72 non-obese (96%) and 3 obese fathers (4%), while 63 mothers were non-obese (84%) and 12 mothers were obese (16%). Family history of having type 2 DM disease was found in 8 fathers (11%), 6 mothers (8%), 12 grandfathers (16%), and 17 grandmothers (23%).

The state of plasma glucose level

The mean of plasma glucose levels in mg/dL (SD) based on several obesity classifications and its degree is shown in **Table 1.**

There was a significant difference in two-hour post loading plasma glucose level between the non

TABLE 1. PLASMA GLUCOSE LEVELS BASED ON SEVERAL OBESITY CLASSIFICATIONS

Classification	**Degree of Obesity**			
Weight for Height	**Non obese**	**Mild Obese** (n = 53)	**Moderate Obese** (n = 22)	
Fasting glucose level(SD)	-	84.3(8.8)	85.9(9.2)	t = 0.72 p = 0.471
Two-hours PP glucose level(SD)	—	101.1(16.5)	110.4(14.2)	t = 2.30p = 0.024
BMI	Non obese **(n=21)**	Obese**(n=54)**		
Fasting glucose level(SD)	84.8(8.0)	84.8(9.3)	—	t = 0.03p = 0.973
Two-hour PP glucose level(SD)	96.8(15.2)	105.5(16.0)	—	t = 2.38p = 0.02
Triceps skin fold	Non Obese **(n=13)**	Mild Obese**(n=39)**	Severe Obese**(n=23)**	
Fasting glucose level(SD)	88.2(9.4)	83.7 (6.6)	84.7(11.5)	F = 1.23p = 0.299
Two-hour PP glucose level(SD)	98.8(18.8)	102.9 (16.1)	108.1(14.7)	F = 1.48p = 0.234
Subscapular skin fold	Non Obese **(n=2)**	Mild Obese**(n=15)**	Severe Obese**(n=58)**	
Fasting glucose level(SD)	99.5(20.5)	82.9 (8.6)	84.8(8.2)	F = 3.29 p = 0.043
Two-hour PP glucose level(SD)	110.5(17.3)	99.5 (12.6)	104.7(15.6)	F = 0.77 p = 0.469

obese group and the obese group based on BMI classification, also between the mild obese and moderate obese group based on the weight for height classification. But there was no significant difference based on the triceps and sub scapular skin fold classification.

There was a significant relationship between two-hour plasma glucose level based on body weight-body height and BMI variable using the Pearson correlation test ($r = 0.32$; $p = 0.005$ and $r = 0.27$; $p = 0.018$).

Impaired glucose tolerance

Using the ADA Expert Committee 1997 criteria of impaired glucose tolerance, results are shown in the following **Table 2.**

Two subjects (3%) fulfilled the ADA Expert Committee 1997 criteria, while most of the subjects (73 subjects) were in normal baseline. All subjects with impaired glucose tolerance were females.

Discussion

The study showed a significant difference in the two-hour post loading plasma glucose level between the mild obese and the moderate obese group based on the weight for height classification ($t=2.30$; $p=0.024$) also between the non obese and the obese group based on the BMI classification ($t=2.38$; $p=0.02$). These results showed that increased glucose intolerance equals with increased obesity degree. Pearson's correlation test showed a significant relationship between two-hour post loading plasma glucose level using the weight for height ($r= 0.32$; $p= 0.005$) and BMI classification ($r=0.27$; $p= 0.018$). This relationship proved that the weight for height and BMI classification were reliable to predict an increase of glucose intolerance.

Previous study also showed that the greater the obesity degree, the higher insulin resistance

TABLE 2. ORAL GLUCOSE TOLERANCE TEST BASED ON SEVERAL OBESITY CLASSIFICATIONS

Classification	**Degree of Obesity**		
BB-TB	Non obese	Mild Obese	Moderate Obese
Normal	—	52	21
Abnormal	—	1	1
BMI	Non obese	Obese	
Normal	21	52	
Abnormal	0	2	
Triceps skin fold	Non obese	Mild Obese	Severe Obese
Normal	12	38	23
Abnormal	1	1	0
Subscapular skin fold	Mild Obese	Severe Obese	
NormalAbnormal	15	57	
Non obese11	0	1	

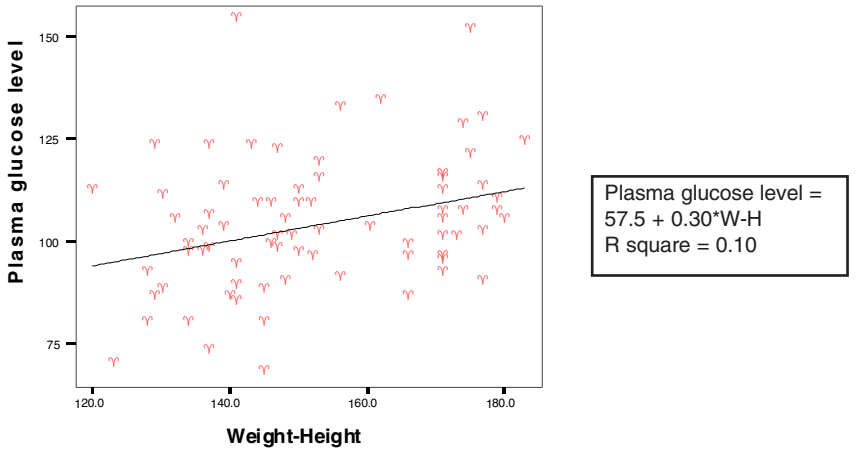

Figure 1. Relationship between two-hour plasma glucose levels and weight for height in 52

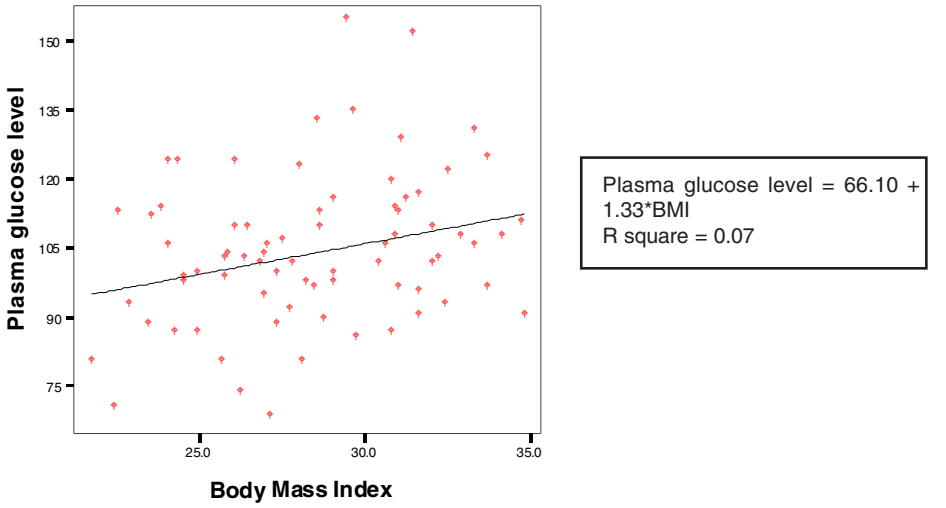

Figure 2. Relationship between two-hour plasma glucose levels and BMI in 52 obese adolescents. r = 0.27; p = 0.018

and increased plasma glucose level after an oral glucose intake.[7]

Based on the triceps and subscapular skin fold classification, there was no significant difference found on the measurement of the two-hour post loading plasma glucose level. This result was similar to the statement that insulin resistance was related to central obesity.[8]

Sinha *et al* conclude that the impaired glucose tolerance group showed a higher level of plasma glucose level after two-hour post loading compared to the normal group. This state was related to an increase of insulin resistance.[9] Insulin resistance reflects defective insulin action predominantly in skeletal muscle and liver.[10] Despite the presence of diminished insulin action, glucose homeostasis remains relatively normal for a long period of time. At first, the pancreatic beta-cell is able to compensate by increasing insulin level leading to hyperinsulinemia.[3]

Previous studies found that the prevalence of impaired glucose tolerance in adolescents was 8-21%.[9,11] Based on the impaired glucose tolerance criteria according to ADA Expert Committee 1997,

this study only found 2 subjects with impaired glucose tolerance. This difference might be caused by different genetic factors of the subjects. A study by Arslanian & Suprasongsin concluded that each different race had a different insulin secretion and sensitivity.[12]

A mild postprandial hyperglycemia is an important sign of risk for getting type 2 DM. Patient with impaired glucose tolerance may benefit from timely patients education and perhaps even more aggressive forms of intervention such as diet, exercise, or medications.[8] Both subjects with impaired glucose tolerance were females. This result was similar to the previous study that concluded female children had more insulin resistance compared to male children.[7]

In conclusion, although impaired glucose tolerance was only found in a few obese adolescents, decreased ability to tolerate oral glucose load was found in subjects studied and correlated well with the degree of obesity.

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