

Original Article

Leptin, blood pressure, and left ventricular mass in obese adolescents

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Abstract

Background Obesity is characterized by an excessive accumulation of body fat and has become a major health problem in industrialized societies especially with regards to heart disease. Adipose tissue derived hormone (leptin) can cause obesity. Leptin acts to reduce food consumption and enhance energy expenditure.

Objective To assess for a relationship between leptin, blood pressure, and left ventricular mass in obese adolescents.

Methods This was a cross-sectional study conducted from November 2011 to April 2012 in Prof. Dr. RD. Kandou Hospital. This study included obese and healthy adolescents aged 13-18 years who attended school in Tuminting District of Manado. Each subject underwent measurements of body mass index (BMI), blood pressure, and plasma leptin level. Correlation regression test was used for data analysis. Results were considered to be statistically significant if P values <0.05.

Results There was a significant relationship between leptin and left ventricular mass ($r=-0.467$; $P=0.006$), as well as leptin and systolic blood pressure ($r=-0.366$; $P=0.028$), but not between leptin and diastolic blood pressure ($r=-0.261$; $P=0.09$). We also found significant relationships between systolic blood pressure and left ventricular mass ($r=0.724$; $P<0.001$), and between diastolic blood pressure and left ventricular mass ($r=0.615$; $P<0.001$) in obese adolescents.

Conclusion Higher leptin levels are associated with lower left ventricular mass and lower systolic blood pressure, but are not associated with diastolic blood pressure.

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Keywords: Leptin, blood pressure, left ventricular mass, obesity

Obesity is a major nutritional problem worldwide. In the USA, obesity rates have more than tripled among adolescents (from 10.8-14%).¹ In Indonesia, obesity rates are 15-30% among primary school students.² Nutritional and lifestyle changes, as well as economic conditions, are likely to be primarily responsible for increased obesity in children around the world.³⁻⁴ Adipose tissue-derived hormone (leptin) can also cause obesity. Leptin is a nonglycosylated, 167 kD polypeptide hormone synthesized mainly by adipocytes. It acts to reduce food consumption and enhance energy expenditure. Serum leptin levels have been reported to increase with the degree of obesity.⁵ Serum leptin has been positively correlated with blood pressure, heart rate, and body mass index.⁶ Obesity is an independent risk factor for cardiovascular disease (CVD). Obesity is associated with an increased risk of morbidity and mortality, as well as reduced life expectancy. Furthermore, obese subjects have a high prevalence of left ventricular hypertrophy.^{7,8} The aim of this study was to assess for associations between leptin, blood pressure, and left ventricular mass in obese adolescents.

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Methods

This cross-sectional study was approved by the Sam Ratulangi University Medical School Review Board. The inclusion criteria were adolescents aged 13-18 years who were obese and healthy. We excluded teens with endogenous obesity and heart diseases. All subjects provided informed consent. Obesity was defined as BMI > 25 kg/m². Subjects underwent cardiovascular examinations including blood tests, blood pressure measurements, and echocardiography). BMI was calculated by the formula: weight (kg)/height (m)².

Leptin was measured using the Human Leptin Immunoassay kit (*Quantikine*®, R&D Systems Inc., 614 McKinley Place, N.E. Minneapolis, MN 55413 USA). Serum leptin was measured in the morning after an overnight fast. Hypertension was defined as a resting blood pressure greater than the 95th percentile for age and sex.⁹ Blood pressures were measured twice with a GEA sphygmomanometer in a sitting position after resting for at least 3 minutes. Two-dimensional and M-mode echocardiographic images were obtained from standard imaging by *E Saote Mylab 4.0* cardiovascular echocardiography, performed by a pediatric cardiologist. Left ventricular mass (LVM) was calculated by the formula described by Devereux and Reichek.¹⁰ Left ventricular hypertrophy was defined as a LVM index over the 95th percentile for healthy children and adolescents (38.6 g/m²).¹¹

This study was conducted from November 2011 until April 2012 on obese adolescents who attended school in the Tuminting District of Manado. Subjects underwent measurements for body weight, height, and waist circumference. Subjects consisted of 19 boys and 9 girls who met the obesity criteria. Data was analyzed by Pearson's correlation, linear regression and descriptive analyses using *Statistical Product and Services Solutions* (SPSS) 20.

Results

From 28 obese adolescents, we found the following baseline characteristics: mean weight 88.73 (SD 10.6) kg, mean BMI 33.39 (SD 2.9) kg/m², mean waist hip ratio (WHR) 0.91 (SD 0.05), mean systolic blood pressure 132.26 (SD 7.2) mmHg, mean diastolic blood

pressure 87.37 (SD 7.9) mmHg, mean leptin level 44,402.33 (SD 24,568.8) pg/mL, mean LVM 277.14 (SD 82.8) grams.

Pearson's correlation analysis revealed a significant relationship between higher leptin level and lower LVM ($r = -0.467$; $P = 0.006$) (**Figure 1**). In addition, higher leptin level was significantly associated with lower systolic blood pressure ($r = -0.366$; $P = 0.028$), but was not associated with diastolic blood pressure ($r = -0.261$; $P = 0.090$). Furthermore, Pearson's correlation analysis revealed that both higher systolic and higher diastolic blood pressures were significantly associated with higher LVM ($r = 0.724$; $P < 0.001$ and $r = 0.615$; $P < 0.001$, respectively).

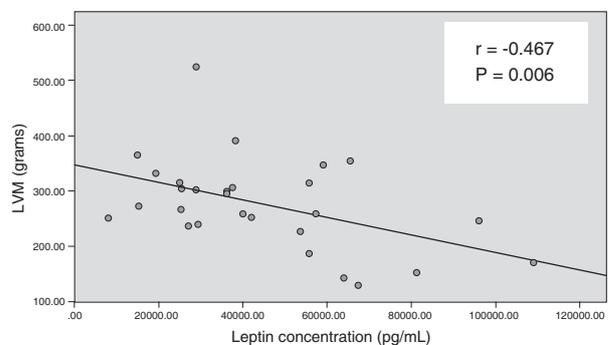


Figure 1. The relationship between leptin level and left ventricular mass

Discussion

Increased LVM and relative thickening of the ventricular wall are important risk factors in cardiovascular morbidity and mortality. In obese children, the ventricular wall is thicker and ventricular size is larger than those of normal weight children.¹² Echocardiography can be used to detect an increased LVM in children. In recent studies, increased LVM was observed after exposure to leptin.¹²⁻¹⁶ However, we found that leptin had a significantly inverse association with LVM, similar to the other findings.^{17,18}

Previous studies reported that the LVM depends on the improvement of the body, genotype, male and increased hemodynamic factors.¹⁹ The balance is disturbed, the cause of leptin resistance and hyperinsulinemia (insulin resistance). Hemodynamic factors such as blood pressure, are determined by

the balance between leptin, endothelin-1 (ET-1), Angiotensin II (Ang II), nitric oxide (NO), endothelium-derived hyperpolarizing factor (EDHF) and natriuresis that occurs in obese people.²⁰ Leptin also has an effect on natriuresis. Leptin has been associated with increased blood pressure.^{21,22} A study found no meaningful relationship between leptin and systolic and diastolic blood pressures ($P > 0.05$).¹⁷ Leptin induces vasoconstriction through ET-1 and angiotensin II but leptin can also induce vasodilatation via EDHF.²³⁻²⁵

Limitations of our study were the small sample size and the cross-sectional design, as we did not obtain data on the onset of obesity. Also, we did not examine nitric oxide, EDGF, total cholesterol, high-density lipoprotein (HDL), triglyceride, or homeostatic model assessment insulin resistance HOMA-IR.

Based on this study, obese adolescents should undergo echocardiography to assess their LVM. Further research is needed to evaluate the effects of leptin on nitric oxide, EDHF and HOMA-IR in order to study cardiovascular events in obese children.

In conclusion, higher leptin levels are associated with lower LVM and lower systolic blood pressure, but not associated with diastolic blood pressure. In addition, higher systolic and diastolic blood pressure is associated with higher LVM.

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