RESEARCH ARTICLE

Correlation of Body Mass Index and Bioelectrical Impedance Analysis of Total Body Fat with Serum Lipid Profile

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Abstract

Since dyslipidemia is a known primary factor that can cause cardiovascular disease, it is important to evaluate the parameters of serum lipid profile. Determination of body mass index (BMI) and total body fat using the impedance method can be applied as an indirect strategy to predict body fat. Both these methods are easy to perform and can be used by the community. The aim of this study was to determine the relationship of BMI and total body fat measured using the impedance method with serum lipid profile. Using a cross-sectional study design, 128 subjects were recruited in this investigation and their lipid profiles were evaluated at the Clinical Pathology Laboratory, Cipto Mangunkusumo National Hospital, Jakarta. Body weight, height, and total body fat using the impedance method were measured. Lipid profile data, i.e., the levels of triglycerides, total cholesterol, HDL cholesterol, and LDL cholesterol, were obtained from the Clinical Pathology Laboratory information system in April–Juni 2016. Data were analyzed by the Pearson test to determine the relationship of BMI and total body fat measured using the impedance method with serum lipid profile. The results showed no significant correlation between BMI and serum lipid profile (P > 0.5), no significant correlation was found between total body fat and serum lipid profile (P > 0.5) and no correlation was found in each group of subjects with normal and high total body fat. In conclusion there is no association of BMI and total body fat with the lipid profile parameters, including the levels of triglycerides, total cholesterol, HDL cholesterol, and LDL cholesterol (p>0.05).
Keywords: *body mass index, impedance method, serum lipid profile, total body fat.*

Hubungan Indeks Massa Tubuh dan Lemak Total Menggunakan Metode Bioelectric Impedansi dengan Profile Lipid Serum

Abstrak

Dislipidemia merupakan faktor primer yang dapat menyebabkan penyakit kardiovaskular, sehingga evaluasi parameter profil lipid serum perlu dilakukan. Indeks massa tubuh (IMT) dan total lemak tubuh metode impedansi merupakan cara untuk memprediksi lemak tubuh secara tidak langsung. Kedua cara ini merupakan metode yang mudah dan dapat digunakan masyarakat. Penelitian bertujuan mencari hubungan IMT dan total lemak tubuh metode impedansi dengan profil lipid serum. Penelitian menggunakan desain penelitian potong lintang pada 128 subyek yang memeriksakan profil lipidnya ke Laboratorium Patologi Klinik, RSUPN dr. Cipto Mangunkusumo (RSUPNCM). Subyek diukur berat badan, tinggi badan, total lemak tubuh dengan metode impedansi. Data profil lipid, yaitu trigliserida, kolesterol total, kolesterol-HDL, dan kolesterol-LDL, diperoleh dari sistem informasi Laboratorium Patologi Klinik RSUPNCM pada bulan April– Juni 2016. Data diolah dengan uji Pearson untuk mengetahui hubungan IMT dan total lemak tubuh metode impedansi dengan profil lipid serum. Hasil tidak terdapat hubungan yang bermakna antara IMT dan profil lipid serum (P > 0,5), tidak ditemukan adanya hubungan yang bermakna antara total lemak tubuh dengan profil lipid serum (P > 0,5) dan tidak didapatkan juga hubungan pada setiap kelompok subyek dengan total lemak tubuh normal dan tinggi. Disimpulkan tidak terdapat hubungan IMT dan total lemak tubuh metode impedansi dengan parameter profil lipid, meliputi trigliserida, kolesterol total, kolesterol-HDL, dan kolesterol-LDL (p>0,05).
Kata Kunci: *Indeks massa tubuh, metode impedansi, profil lipid serum, total lemak tubuh.*

Introduction

Dyslipidemia or an abnormality in the blood lipid profile is the primary risk factor for coronary heart disease, ischemic stroke, and peripheral artery disease caused by atherosclerosis.[1] The World Health Organization (WHO) states these three cardiovascular diseases are the first major causes of death in the world.[2] Management of dyslipidemia is one of the strategies to reduce the risk of death from coronary heart disease.[1,3]

According to the 2013 Dyslipidemia Management Manual of the Indonesian Cardiovascular Specialist Association,[3] it is necessary to conduct laboratory evaluations of the parameters of lipid and lipoprotein profile, especially in people with risk factors for metabolic syndrome (DM, obesity) or cardiovascular-related diseases (such as hypertension), those with a smoking history, all men aged >40 years, and female aged >50 years or in the postmenopausal stage. The recommended parameters for routine assessment include total cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides. This assessment is intended to determine the risk factors and forms a basis for choosing the management and targeted therapy.[3]

The measurement of body mass index (BMI) and total body fat using the impedance method is another strategy to determine the proportion of body fat in an indirect manner.[1,3] BMI is calculated by dividing the body weight in kilograms by body height in square meters (m^2).[4] The impedance method can be used to measure the total body fat in the form of body fat percentage. The working principle of this tool involves distinguishing the components of the body's compartments, especially total body fluids and total body fat, by determining their electrical impedance.[5,6] As these two methods comprise an indirect technique, they have the limitation of not being able to indicate the distribution of body fat and thus cannot predict the total body fat in all populations. However, both BMI and total body fat can be measured in an easy, convenient manner and can be accepted by a wider community.

Studies investigating the relationship of BMI and total body fat measured using the impedance method with serum lipid profile are lacking in Indonesia, therefore this study was conducted to determine the correlation of BMI and total body fat measured by the impedance method with serum lipid profile.

Methods

In this research, a cross-sectional study design was used to determine the relationship of BMI and total body fat measured using the impedance method with serum lipid profile. The study subjects comprised 128 adult patients whose serum lipid profiles were evaluated at the Clinical Pathology Laboratory, Cipto Mangunkusumo National Hospital, Jakarta, on April–June 2016. The minimum sample were 125 subject, that calculated by correlative analysis formula. Patients' body weight and total body fat were measured by the personal scales with ISA body analysis function ISA (Medisana), and their height was measured using a microtoise staturemeter. Serum lipid profile data were obtained from the Laboratory Information System (LIS) of the Clinical Pathology Laboratory of RSCM. Data were processed using a statistical processing program (SPSS vs 20). Data were analyzed descriptively, tested for normality by the Kolmogorov–Smirnov test, and analyzed by the Pearson correlation test in case of normal data distribution.

Table 1. Subjects' Characteristics and Research Variables

Variables	Mean (SD)/ Median (Min-Max)
Sex*	
Male	57 (44.5%)
Female	71 (55.4%)
Age**	55.24 (12.68)
BMI**	24.90 (3.81%)
Total body fat**	23.72 (9.42)
Triglycerides***	107.5 (40-792)
Low-Normal BMI***	96.50 (40-432)
High BMI***	113.50 (49-792)
Normal Total Body Fat***	104 (40-792)
High Total Body Fat***	116.50 (45-407)
Total Cholesterol**	183.36 (42.38)
Low-Normal BMI**	179.12 (40.83)
High BMI***	182 (109-326)
Normal Total Body Fat***	183.08 (42.37)
High Total Body Fat**	184.73 (43.38)
HDL-Cholesterol***	49 (25-107)
Low-Normal BMI**	52.71 (181.23)
High BMI***	47.50 (25-107)
Normal Total Body Fat***	50 (25-107)
High Total Body Fat**	44.32 (10.59)
LDL-Cholesterol***	111 (53-229)
Low-Normal BMI**	110.64 (36.87)
High BMI***	111 (55-229)
Normal Total Body Fat***	110 (54-229)
High Total Body Fat**	122.36 (40.38)

* Percentage.
**Mean
***Median and minimum–maximum

This research have been approved by Etic Committee Research Module of Faculty of Medicine Universitas Indonesia No. 115/UN2.F1.D1/KBK/PDP.01/2016.

Results

From the data collected from 140 patients, the data of only 128 subjects passed through the exclusion criteria. The proportion of female subjects (55.5%) was higher than that of male subjects (44.5%), and the mean age was 55.24±12.68 years. BMI data were classified according to the WHO category for Asians (2004), and total body fat was adjusted to normal values as <25% for males or <35% for females. The characteristics of the study subjects and the research variables are shown in Table 1.

As shown in Table 1, the mean or median values of total body fat, triglycerides, total cholesterol, and HDL cholesterol are still within normal limits, whereas the mean or median values of BMI and LDL cholesterol are above the optimal value. There were 86 subjects (67.2%) with a high BMI. However, the total body fat data of only 22 subjects (17.2%) were included in the high category. It was also found that the distribution of parameters of serum lipid profile varied in each category of BMI or total body fat. The Pearson correlation test was used for data analysis because the data distribution and transformation were normal. Results of the correlation analysis are presented in Table 2.

Table 2. Correlation of BMI and Total Body Fat with Serum Lipid Profile

Serum Lipid Profile	BMI		Total Body Fat	
	r	p	r	p
Triglycerides	0.100	0.263	0.109	0.222
Total Cholesterol	0.072	0.417	0.117	0.187
HDL Cholesterol	-0.150	0.092	-0.053	0.552
LDL Cholesterol	0.128	0.150	0.130	0.144

The correlation coefficient (r value) of BMI and total body fat with all parameters of serum lipid profile showed a very weak association. There was a positive correlation of BMI and total body fat with the levels of triglycerides, total cholesterol, and LDL cholesterol. Meanwhile, the correlation with HDL cholesterol indicated a negative trend.

However, all these correlations of BMI and total body fat with the parameters of serum lipid profile were not statistically significant (p>0.05). In other words, BMI and total body fat could not represent the lipid levels in the blood.

Discussion

Distribution of Subjects' Characteristics

There was a total of 128 study subjects in this study, which was consistent with the minimum number required for a correlational research. The study sample showed a predominance of females (55.5%), and the age range was 18–85 years.

BMI categorization was based on the WHO[7] classification for Asians 2004. In this study, the mean BMI was 24.90 kg/m^2, which indicated the overweight category according to the WHO classification. Subjects who were overweight and obese comprised 67.2% of the study sample, including 55.81% of females and 44.19% of males. This result was still higher than the 2013 Riskesdas data in Indonesia, which reported a prevalence of 13.3% overweight and 15.4% obesity, however the Riskesdas 2013 had used a different classification for BMI, which was obtained from the WHO[8] International (2000) classification.

The mean total body fat in this study was 23.7%, and almost 82.8% of the subjects had a normal total body fat proportion. The total body fat value was categorized as normal and high according to sex. An individual's total body fat is considered to be high if the proportion of body fat is >25% for men and >35% for women.[5] The mean total body fat in this study was still considered as normal.

The mean total cholesterol level in this study was 183.36 mg/dL, which was within the normal limit. In total, 32% of the study subjects had high total cholesterol levels, which included 13 men and 28 women. This proportion was not much different from the prevalence of high total cholesterol according to the 2013 Riskesdas data (35.9%).[8] The levels of triglycerides, HDL cholesterol, and LDL cholesterol showed an abnormal distribution in this study. The median values of each parameter were 107.5, 49, and 111 mg/dL, respectively.

Correlation between BMI and Serum Lipid Profile

According to the Pearson correlation analysis, the correlation coefficients between BMI and the levels of triglycerides, total cholesterol, HDL cholesterol, and LDL-cholesterol were 0.100, 0.072, −0,150, and 0.128, respectively, and the association between BMI and serum lipid profile was not significant (p>0.05). The relationship between BMI and the levels of triglycerides, total cholesterol, and LDL cholesterol showed a positive trend, whereas that between BMI and HDL cholesterol showed a negative trend. This is consistent with the role of HDL cholesterol, which has an antiatherosclerotic effect.[9] Furthermore, the results of the correlation between BMI and serum lipid profile were also not significant in each BMI category.

An earlier study conducted by Sitepu[10] in Surabaya also demonstrated a similar result, i.e. no significant relationship between BMI and serum lipid profile (p>0.05). Choi et al[11] reported a contradictory result indicating the presence of a positive correlation between BMI and serum lipid profile in the South Korean population. The correlation coefficients between BMI and the levels of triglycerides, total cholesterol, HDL cholesterol, and LDL cholesterol in their study were 0.11, 012, −0,17, and 0.09 in male subjects and 0.22, 0.26, −0.27, and 0.18 in female subjects, respectively. The authors also found a stronger correlation coefficient than that reported by Hu et al[12] who demonstrated only a positive relationship with triglycerides and a negative relationship with HDL cholesterol in a significant manner.[11,12] Another study conducted by Lichtash et al[13] in the Mexican American population also indicated a significant relationship (p<0.001) between BMI and the levels of triglycerides (r=0.32) and HDL cholesterol (r=−0.27). However, there was no significant association between BMI and LDL cholesterol (r=0.033, with p=0.40).[13]

Another study conducted by Koampa et al[14] with 69 subjects in Prof. Dr. R. D. Kandou Hospital in Manado showed that no correlation between all categories of BMI with with total cholesterol, LDL cholesterol levels, and the levels of triglycerides, however, there was significant correlation between each BMI category and HDL cholesterol.[14]

Correlation between Total Body Fat and Serum Lipid Profile

In this study, the correlation coefficients between total body fat and the levels of triglycerides, total cholesterol, HDL cholesterol, and LDL cholesterol were 0.109, 0.117, −0.053, and 0.130, respectively, and the p value was >0.05, implying no relationship between total body fat and serum lipid profile. Like the relationship between BMI and lipid profile, the relationship between total body fat and the levels of triglycerides, total cholesterol, and LDL cholesterol was positive, whereas HDL cholesterol levels showed a negative relationship with total body fat. This result is consistent with the antiatherosclerotic effect of HDL cholesterol.[9] The relationship between total body fat and serum lipid profile was not significant in each category of total normal and high body fat.

Lichtash et al[13] also stated that there was no relationship between total body fat and serum lipid profile. However, there was an association between total body fat and the levels of triglycerides (r = 0.26) and HDL cholesterol (r = −0.26) in male subjects and between total body fat and triglyceride levels (r = 0.21) in female subjects.[13]

This result was contradictory to that reported by Choi et al[11] who demonstrated an association between total body fat and serum lipid profile. The correlation coefficients between total body fat and the levels of triglycerides, total cholesterol, HDL cholesterol, and LDL cholesterol were 0.28, 0.33, −0.34, and 0.31 in male subjects and 0.25, 0.32, −0.29, and 0.21 in female subjects, respectively.[11]

Correlation between BMI and Serum Lipid Profile and between Total Body Fat and Serum Lipid Profile

In this study, there was no association of BMI and total body fat with serum lipid profile. Regarding the comparison, the correlation coefficient between total body fat and serum lipid profile was greater than that between BMI and the levels of triglycerides (r=0.100 and r=0.109), total cholesterol (r=0.072 and r=0.117), and LDL cholesterol (r=0.128 and r = 0.130). However, in case of HDL cholesterol, the correlation coefficient for BMI (r=−0.150) was greater than that for total body fat (r=−0.053). According to Choi et al,[11] the correlation coefficient between BMI and serum lipid profile was greater in women than in men, whereas between total body fat and serum lipid profile was greater in men than in women.[11] A similar result was reported by Wang et al[15] who described women have greater high-density lipoprotein (HDL) cholesterol concentration and lower low-density lipoprotein (LDL) cholesterol, very low-density lipoprotein (VLDL) cholesterol, total plasma triglyceride, and VLDL triglyceride concentrations (both during fasted and fed conditions) than age-matched men.

According to Lichtash et al,[13] there was a relationship between BMI and triglyceride levels and between BMI and HDL cholesterol levels, whereas the relationship between BMI and total body fat was not significant. However, they found a correlation between total body fat and triglyceride levels and between total body fat and HDL cholesterol levels in male subjects and between total body fat and triglyceride levels in female subjects. When compared with the correlation coefficient, BMI showed a stronger relationship than total body fat with triglyceride levels in both male and female subjects.[13]

The absence of a relationship of BMI and total body fat measured using the impedance method with the serum lipid profile can be due to the dynamic nature of serum profile. Serum lipid profile describes the state of lipids in the blood at only one time point. It is different from body fat that functions as a fat reserve. Lipid deposits in the form of triglycerides in the adipose tissue are a reflection of the long-term imbalance between intake and energy expenditure.[16] However, in a state of obesity or excess body fat, the regulatory mechanisms of lipid storage in the adipose tissue start getting disrupted, one among which is through the mechanism of insulin resistance. Insulin inhibits the process of lipolysis through the hormone-sensitive lipase (HSL) pathway. Insulin resistance, especially in the abdominal or visceral adipose tissue, increases the rate of lipolysis in the adipose tissue. Moreover, in obese individuals, there is dysregulation in the form of upregulation of lipoprotein lipase (LPL) in the adipose tissue. This can also increase the rate of lipolysis so that more triglycerides are broken down into free fatty acids. Consequently, more free fatty acids are released into the serum. This increases the uptake of liver free fatty acids, which are later produced as VLDL. This ultimately causes dyslipidemia. It requires only a short time to reach the stage of insulin resistance.[17] The compartment of excess fat deposition also affects insulin resistance. For instance, the presence of excess fat in the abdominal or visceral compartment is associated with a higher risk of developing insulin resistance and dyslipidemia than the subcutaneous compartment.[18-20]

In this study, there was no relationship, possibly due to the lack of consideration of the disease history and the subjects' treatment. Another reason may be the subjects' clinical condition or the subjects undergoing dyslipidemia treatment or consuming drugs that could affect the serum lipid profile. Further research is required to determine the BMI cut off value and the total fat body for the Indonesian population, including healthy subjects or patients with various diseases.

Conclusion

The mean LDL cholesterol levels were quite high in subjects with high total body fat. There was no correlation of BMI and total body fat with serum lipid profile.

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