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RESEARCH ARTICLE
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Relationship Between Body Mass Index and Skinfold Thickness with Blood Pressure in Medical Students

Salma Arini Putri[1], Choesnan Effendi[2], Asami Rietta Kumala[3(CA)]
[1]Faculty of Medicine, Universitas Hang Tuah Surabaya, Indonesia; salmaariniputrisutrisno@gmail.com
[2]Department of Physiology, Faculty of Medicine, Universitas Hang Tuah Surabaya, Indonesia; choesnaneffendi@yahoo.co.id
[3(CA)]Department of Physiology, Faculty of Medicine, Universitas Hang Tuah Surabaya, Indonesia; asami.kumala@gmail.com (Corresponding Author)

ABSTRACT

The prevalence of obesity in women in Indonesia is increasing. Obesity is characterized by excess BMI and fat mass in the body. High body fat mass is associated with metabolic diseases and blood pressure (BP). The research design was cross-sectional, involved the students of the Faculty of Medicine, Universitas Hang Tuah Surabaya in July 2019. Sampling was done using stratified random sampling with 48 female volunteers who were grouped into 16 volunteers each semester. In students of Semester II, the average BMI was 21.2±2.4 kg/m^2, Skinfold Thickness (SFT) 54.6±9.9 mm, BP 109±9.6/71±8.3 mmHg. In students of Semester IV, the average BMI was 23±3.5 kg/m^2, SFT 48±14.10 mm, BP 109±9.7/77±7 mmHg. In students of Semester VI, the average BMI was 24.33±4.72 kg/m^2, SFT 69.87±21.54 mm, BP 122±8.9/84±11mmHg. The correlation coefficient of SFT and Systolic Blood Pressure (SBP) was 0.697, SFT and Diastolic Blood Pressure (DBP) was 0.362, BMI and SBP was 0.355, while BMI and DBP 0.171. There was a correlation between SFT and SBP and DBP, BMI and SBP in female students of semester II, IV and VI.

Keywords: skinfold thickness (SFT); body mass index; blood pressure

INTRODUCTION

College students are categorized as adults. In this phase an increase in physical endurance and work productivity occurs. Increased activity and social life among students will influence their diet[(1)]. Fast food diets that tend to be high in fat often result in unbalanced health and nutritional status. In the long term this habit will lead to overweight and obesity which may cause several diseases. Not only diet, decreased activity can also result in a buildup of calories stored by the body in the form of fat in various places.

Obesity is a multifactorial disease that occurs due to excessive accumulation of fat tissue, which can interfere with health. The main factor is the imbalance of energy intake and energy output[(2)]. Based on data from the World Health Organization (WHO) obesity worldwide has increased quite rapidly to more than double since 1980. In 2014, more than 1.9 billion adults aged ≥18 years were overweight and more than 600 million people in the were obese[(3)]. According to the Republic of Indonesia Health Data, from 2013 to 2018 there was an increase in the incidence of obesity in Indonesia, from 14.8% to 21.8%. The central obesity rate for women who have an abdominal circumference >80 cm in 2018 was 31% and is increasing every year[(4)]. In 2008 Japan imposed sanctions in the form of taxes for individuals who were overweight and obese, so that the incidence of overweight and obesity in the country decreased. This method might be applied in Indonesia to reduce the incidence of overweight or obesity.

According to research, an increased incidence of obesity can be related to blood pressure. This correlation is caused by activation of the sympathetic nervous system (SNS), the amount of intra-abdominal and intra-vascular fat, sodium retention which causes an increase in renal reabsorption, and the renin-angiotensin system which is considered to have an important function in the pathogenesis of obesity associated with hypertension[(5)].

METHODS

This study was an observational analytic study with a cross-sectional design. The research subjects were active female students of semester II, IV and VI of the Faculty of Medicine, Hang Tuah University, Surabaya.

Subjects were selected by stratified random sampling and a total of 48 samples were obtained, with 16 samples in each semester.

This study used a questionnaire to determine the students' the daily activities (moderate, light and heavy activities), fat eating habits and exercise index. After that a blood pressure measurement was done using the Riester mercury sphygmomanometer. To determine the BMI, weight and height measurements were carried out using weight and height measurement tools of TB-GEA ZT-120. Whereas SFT was measured using a digital skinfold caliper with an accuracy of 0.1 mm. Measurements were made 3 times with a maximum difference of 1 mm. After that, average calculation was done to the obtained results.

RESULTS

Table 1 shows the trend of increasing BMI in each semester

Table 1. Descriptive data of body mass index, skinfold thickness, systolic and diastolic blood pressure

Group	Body mass index (kg/m^2)	Skinfold thickness (mm)	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Semester II	21.2 ± 2.4	54.6 ± 9.9	109 ± 9.6	71 ± 8.3
Semester IV	23 ± 3.5	48 ± 14.1	109 ± 9.7	77 ± 7
Semester VI	24.3 ± 4.7	69.8 ± 21.5	122 ± 8.9	84 ± 11

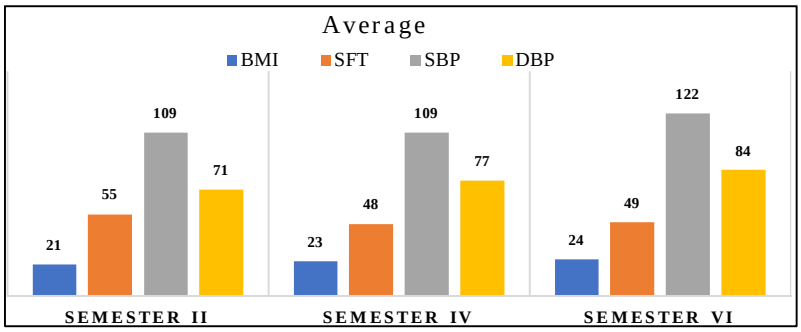

Figure 1. Descriptive data of body mass index, skinfold thickness, systolic and diastolic blood pressure

Table 2 shows that BMI in each semester was normal. But the higher the semester, the higher the obesity rate. Table 3 shows the higher the semester, the total fat in the body increased. Table 4 shows that the incidence of hypertension increased each semester.

Table 2. Classification of body mass index of female students of semester II, IV, and VI based on WHO

Classification	Semester II		Semester IV		Semester VI	
	n	%	n	%	n	%
Underweight	2	12.5%	0	0	2	12.5%
Normal	12	75%	13	81.3%	9	56.3%
Overweight	2	12.5%	2	12.5%	2	12.5%
Obesity	0	0	1	6.3%	3	18.8%
Total	16	100%	16	100%	16	100%

Table 3. Classification of total body fat of female students of semester II, IV, and VI based on body fat measurement chart for women

Classification	Semester II		Semester IV		Semester VI	
	n	%	n	%	n	%
Ideal	0	0	5	31.25%	3	18.75%
Average	14	87.5%	9	56.25%	2	12.5%
Overfat	2	12.5%	2	12.5%	11	68.75%
Total	16	100%	16	100%	16	100%

To prove the correlation between BMI and SFT and BP, a statistical test using the Spearman correlation test was performed, and the results, as shown in table 5, show that there was a correlation between BMI and SBP (P-value = 0.016; r = 0.346), between SFT and SBP (P-value = 0.001; r = 0.729) and between SFT and

DBP (P-value = 0.014; r = 0.353). To prove the correlation of BMI and SFT, the Pearson correlation test was performed and the results showed (P-value = 0.001; r = 0.623) which indicated a strong correlation.

Table 4. Description of the frequency of occurrence of hypertension based on systolic blood pressure and diastolic blood pressure

		SBP		DBP	
Semester	Classification	n	%	n	%
Semester VI	Normal	5	31.3%	7	43.8%
	Pre Hypertension	11	68.8%	5	31.3%
	Hypertension	-	-	4	25%
Semester IV	Normal	13	81.3%	13	81.3%
	Pre Hypertension	3	18.8%	2	12.5%
	Hypertension	-	-	1	6.3%
Semester II	Normal	14	87.5 %	15	93.8%
	Pre Hypertension	2	12.5%	1	6.3%
	Hypertension	-	-	-	-
Total		48	100%	48	100%

Tabel 5. The correlation between BMI and skinfold thickness and sistolic and diastolic blood pressure

		SBP	DBP
Body Mass Index	Correlation coefficient	0.346	0.147
	Sig. (2-tailed)	0.016	0.318
	N	48	48
Skinfold Thickness	Correlation coefficient	0.729	0.353
	Sig. (2-tailed)	0.001	0.014
	N	48	48

		Body Mass Index	Skinfold Thickness
Body Mass Index	Pearson Correlation	1	0.623
	Sig. (2-tailed)		0.001
	N	48	48

DISCUSSION

This research involved 48 female volunteers consisting of 16 female students from each semester. Based on the data obtained, students of semester VI had the highest average Body Mass Index (BMI) and Skinfold Thickness (SFT), which were 24.33 kg/m^2 and 69.87 mm. The high BMI and SFT in semester VI was due to female college students having sedentary life patterns and consuming fast food more often. According to data from the questionnaire, each semester the students had a different activity pattern. In semester II and IV, they did more activities than in semester VI. This situation affected the body weight. Consumption of foods with too high calories can cause weight gain which will affect BMI[(6)]. In the sixth semester group, the gap between dinner and bedtime was less than 3 hours. Because of these habits, the body would metabolize food and store food energy in the form of triglycerides in adipose tissue under the skin[(7)].

In this study, linear results with strong correlation show that the higher the BMI, the higher the SFT (r = 0.632). The results of this study are in line with previous research conducted at Padjajaran University which found that there was a strong correlation between BMI and Body Fat percentage, with a correlation strength value of 0.70[(8)]. Based on statistical test results, it was found that the correlations between SFT and SBP (p = 0.001) and SFT and DBP (p = 0.014) were significant. This is in line with research in Madrid which concluded that there was a significant relationship (p <0.001) between SFT and DBP and SBP in children aged 3-5 years[(9)].

Increased adipose tissue in obese people will affect the decline in endothelial function of blood vessels. This endothelial has a functional role in producing and releasing nitric oxide (NO). Lack of NO availability causes increased vascular permeability, inflammation, adhesion, and thrombosis and reduced vasodilation function. This will affect the occurrence of cardiovascular disease such as hypertension. Another mechanism, the release of IL-6, will also trigger inflammation and increase the prothrombin activator inhibitor-1 from adipose cells that play a role in the occurrence of endothelial coagulation and dysfunction thereby increasing risk factors for hypertension and spurring cardiovascular disorders[(10,11)].

Excessive fat mass under the skin will affect the emergence of metabolic syndrome, one of which is hypertension. Body fat increases blood pressure by increasing the production of angiotensinogen (angiotensin II precursor)[(12)]. Angiotensinogen produced by adipose tissue will affect the Renin Angiotensin System (RAS) by increasing the action of the renin enzyme to convert the Angiotensinogen to Angiotensin I. Furthermore, by

Angiotensin Converting Enzyme (ACE), Angiotensin I is converted to Angiotensin II which causes vasoconstriction of blood vessels to cause an increase in blood pressure. Angiotensin II also stimulates the release of aldosterone from the glomerulosa zone of the adrenal glands which can increase blood pressure through sodium and water retention[13]. The accumulation of fat under the skin has a role in the occurrence of hyperleptinemia which affects the increase in blood pressure. Long-term renal sympathetic stimulation by leptin results in an increase in blood pressure through constricting activity and an increase in sodium reabsorption in the kidney tubules. In addition, leptin will stimulate profibriogenic cytokines in the kidneys that are augmented by Angiotensin II. This plays a role in increasing blood pressure. Leptin also increases endothelin release (ET)-1 which is a vasoconstrictor released mainly by endothelial cells[14]. Obese people will be more prone to hypertension, and most people with hypertension are also obese. In obesity there is an abnormality in the arterial pressure control mechanism which can increase blood pressure and excretion of sodium and water through the pressure of natriuresis and diuresis. As long as sodium and water excretion exceeds intake, there will be an increase in renal tubular reabsorption resulting in a decrease in extracellular fluid volume and cardiac output until blood pressure returns to normal. Conversely, when blood pressure drops, the kidneys will hold salt and water until arterial pressure returns to normal. Pressure natriuresis is the main key feedback system that stabilizes blood pressure and body fluid volume. In addition, several other mechanisms can also explain hypertension in obesity, including activation of the Sympathetic Nervous System (SNS), Renin-Angiotensin System (RAS), and glucocorticoid fatty tissue, changes in renal structure, insulin resistance, hyperleptinemia, and vascular endothelial dysfunction[15].

CONCLUSION

The higher the semester level of the female students in the Faculty of Medicine of Hang Tuah University in Surabaya, the higher the average value of BMI, SFT and BP. In this study, linear results were obtained, that the higher the BMI, the higher the SFT and BP.

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