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### The Role of Subcutaneous Fat Composition on Blood Pressure: A Study on Students Aged 15-18 at Kalam Kudus II Senior High School Jakarta, Indonesia

Marendra Shinery Kartolo<sup>1</sup>, Alexander Halim Santoso<sup>2\*</sup>, Yohanes Firmansyah<sup>3</sup>

<sup>1</sup>Faculty of Medicine, Universitas Tarumanagara, Jakarta, Indonesia

<sup>2</sup>Department of Nutrition, Faculty of Medicine, Universitas Tarumanagara, Jakarta, Indonesia

<sup>3</sup>Department of Physiology, Faculty of Medicine, Universitas Tarumanagara, Jakarta, Indonesia

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##### \*Corresponding author:

Alexander Halim Santoso

##### E-mail address:

[alexanders@fk.untar.ac.id](mailto:alexanders@fk.untar.ac.id)

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#### ABSTRACT

**Background:** Hypertension is one of the leading causes of death worldwide. There was an increase in the prevalence of hypertension in children and adolescents  $\leq 19$  years of age from 2000 to 2015. Body mass index (BMI) and subcutaneous fat distribution are linked to blood pressure variations. **Methods:** The cross-sectional study was carried out at Kalam Kudus II Senior High School Jakarta from June – August 2023. The inclusion criteria in this study included students of Kalam Kudus II Senior High School Jakarta, aged 15-18 years, registered as active students at the time the study was conducted, physically and spiritually healthy, and willing to participate in the study. The exclusion criteria for this study include students who refused participation, did not obtain permission from their parents, or students with medical disorders that affect anthropometric results and blood pressure. Data was taken from direct measurement and performed multivariate testing using the double linear regression test enter method in SPSS. The statistical significance is 0.05. **Results:** An analysis of 102 students found that only BMI had a significant relationship with systolic blood pressure, and no anthropometric variable had a meaningful relationship with diastolic pressure. **Conclusion:** There are many ways and factors for measuring body composition. It is important to test the body composition and BMI of adolescents to reduce the risk of hypertension later in the day.

#### 1. Introduction

Hypertension is one of the leading causes of death worldwide. The number of people suffering from hypertension in the world is estimated at 1.39 billion and there are 10.4 million deaths each year.<sup>1</sup> Based on the results of the Basic Health Research (RISKESDAS) conducted by the Ministry of Health in 2018, the prevalence of hypertension in the age group of  $\geq 18$  years has reached 34.11%.<sup>2</sup> There has been an increase in the prevalence of hypertension from 2000 to 2015 among the age group of 15-18 years.<sup>3</sup> This may be due to the increased prevalence of obesity in that age group.<sup>4</sup> RISKESDAS data showed that the

prevalence of obesity among teenagers aged 16-18 increased from 1.6% in 2013 to 3.8-4.3% in 2018.<sup>2</sup> The measurement of body mass index (BMI) has been widely used for the representation of individual nutritional status and BMI has been shown to have a relationship with blood pressure, cardiometabolic risk, and mortality. However, the inadequacy of BMI is that it cannot reflect body composition and body fat distribution.<sup>5</sup> This is important because fat distribution has different blood pressure indicators, especially abdominal fat, which is closely related to blood pressure.<sup>6,7</sup>

Fat mass and muscle mass are two important components of body composition. Several studies in adult populations have proven a relationship between total body fat mass and the increased prevalence of hypertension.<sup>5,8</sup> The central fat distribution is associated with increased blood pressure or hypertension, but the accumulation of fat in the limbs, especially in the lower limbs has a backward link with the occurrence of elevated blood pressure and hypertensive diseases in the adult population.<sup>5</sup> There is evidence that BMI measurements are superior in determining the percentage of fat in children and adolescents compared to subcutaneous fat density measurements.<sup>9</sup> The fatty tissue underneath the skin is called subcutaneous fat tissue, whereas the tissue covering the organ is called visceral adipose tissue.<sup>10,11</sup>

The subcutaneous fat thickness is estimated to be 50% of the total body fat. Subcutaneous fat measurements can be used as a filter against hypertension. Minimum subcutaneous fat measurements are performed at 3 locations, including: subcapsular, triceps, biceps, suprailiacal, and abdominal.<sup>9</sup> Overweight and obesity in teenagers are common risk factors for hypertension in adolescents.<sup>12</sup> A skinfold caliper is a measuring tool for measuring the thickness of subcutaneous fat tissue at a specific location to predict total fat. The advantages of a skinfold caliper include reliability, affordability, practicality, speed to implement and evaluate, validity, and non-invasiveness.<sup>13</sup> The accuracy and precision of this method depend on the inspector's technical skills, the type of skinfold caliper, and the examination sample.<sup>14</sup> In this study, the researchers investigated the relationship between the mass of subcutaneous fat in different body locations and blood pressure variations.

## 2. Methods

The study was conducted at Kalam Kudus II Senior High School Jakarta from June – August 2023. The sample in this study was male or female students who attended school at Kalam Kudus II Jakarta in the age range of 15 to 18 years. The sample sampling

technique used in this study is consecutive sampling. From the large sample calculation obtained, the minimum sample size is 100 people, with the assumption that the number of free variables is as many as 10 variables with the rule of thumb formula of 10. The criteria for inclusion in this study are students of Kalam Kudus II Senior High School Jakarta, aged 15-18 years, registered as active students at the time of the study, physically and mentally healthy, and willing to participate in the study by signing informed consent. The exclusion criteria in this research include students who refused participation, did not obtain permission from their parents, students with medical disorders including chronic disease, genetic disorder, endocrine disorder, nervous disorder, infection, taking antihypertensive drugs, being on a diet program, smoking, alcohol consumption, vertebral abnormalities, malnutrition, and genetic disturbances.

The variables in this study were divided into two groups: free variables and dependent variables. Free variables included 10 anthropometric variables of subcutaneous fat in the triceps, biceps, suprailiacal, umbilical, weight, height, body mass index, mid-upper arm circumference, abdominal circumference, and hip circumference. The dependent variables in this study are systolic blood pressure and diastolic pressure. The entire examination protocol has been adapted to generally applicable medical standards. The statistical tests in this study are univariate and multivariate. Univariate presentations are proportional presentations (%) for qualitative data and centralized data spreads for quantitative data. The multivariate test method uses a double linear regression test with an enter method. The type 1 error rate set in this study is 5% with the strength of the study being 80%.

## 3. Results

The study included 102 respondents who met the inclusion criteria. The entire demographic characteristics and variables of the study are examined in Table 1. The study included 10 anthropometric variables such as subcutaneous fats

located at the triceps, biceps, suprailliacal, umbilical, body weight, height, body mass index, mid-upper arm circumference, abdominal circumference, and hip circumference that are thought to play a role in affecting systolic and diastolic blood pressure. Test

results with double linear regression using the enter method revealed that only the variable body mass index significantly affects systolic blood pressure (B: 4,201; p-value: 0,033) (Table 2).

Table 1. Characteristics of respondents among students at Kalam Kudus II Senior High School Jakarta.

Parameter	N (%)	Mean (SD)	Med (Min-Max)
Gender			
Male	54 (52,9%)		
Female	48 (47,1%)		
Age (years)		16,16 (0,64)	16 (15 - 18)
Systolic blood pressure (mmHg)		116,21 (18,81)	110 (80 - 165)
Diastolic blood pressure (mmHg)		72,25 (9,51)	70 (60 - 100)
Triceps fat (%)		18,31 (6,28)	17,3 (6,3 - 36,5)
Biceps fat (%)		14,73 (5,81)	14,0 (3,1 - 29,8)
Suprailliacal fat (%)		18,69 (6,24)	18,1 (5,5 - 33,8)
Umbilical fat (%)		18,93 (6,47)	18,65 (5,0 - 36,0)
Weight (kg)		64,96 (18,99)	61,20 (36,5 - 130,2)
Height (cm)		163,26 (9,59)	162,8 (141,5 - 191)
Mid-upper arm circumference (cm)		27,44 (4,51)	27 (20 - 45)
Abdominal circumference (cm)		82,77 (12,49)	80,3 (62 - 116,6)
Hip circumference (cm)		94,86 (13,62)	95,45 (18,5 - 132,0)
Body mass index (kg/m <sup>2</sup> )		23,75 (5,87)	22,7 (15,39 - 45,86)

Table 2. Regression analysis of all anthropometric variables of systolic and diastolic blood pressure at Kalam Kudus II Senior High School Jakarta.

Variables	Adjusted p-value*	Adjusted p-value**
Triceps fat (%)	0.774	0.472
Biceps fat (%)	0.16	0.101
Suprailliacal fat (%)	0.534	0.149
Umbilical fat (%)	0.289	0.202
Weight (kg)	0.407	0.7
Height (cm)	0.084	0.978
Mid Upper arm circumference (cm)	0.575	0.95
Abdominal circumference (cm)	0.828	0.532
Hip circumference (cm)	0.172	0.562
Body mass index (kg/m <sup>2</sup> )	0.033	0.554

\*systolic blood pressure;\*\*diastolic blood pressure.

#### 4. Discussion

The study measured ten variables that included the percentage of subcutaneous fat (triceps, biceps, suprailliacal, and umbilical), body weight, height, mid-upper arm circumference, abdominal circumference, hip circumference, and body mass index. The study found no significant relation between triceps fat,

biceps fat, suprailliacal fat, umbilical fat, mid-upper arm circumference, abdominal circumference, and hip circumference to systolic and diastolic blood pressure, and only the BMI factor had a significant relationship with systolic blood pressure. This study was inconsistent with the study of He. H et al. (2021), concluded that the variable of the percentage of

subcutaneous fat was linked with increased systolic and diastolic blood pressure in children and adolescents aged 7-18 years in South China. This study has contradictory results to the Zhao et al. study (2022) which showed that the abdominal fat mass variable is a dominant contributor to systolic and diastolic blood pressure.<sup>5</sup> These differences may be due to differences in the populations studied. In addition, the skinfold caliper measurement is not specific to male or female due to the difference between the percentages of fat mass and muscle mass of male and female.<sup>16</sup> Research by Lewandowski et al. (2022) showed that there was a significant difference between the fat thickness measured using a skinfold caliper and ultrasound in a population of females with normal weight.<sup>17</sup>

Among the variables used, only BMI had a significant correlation with systolic blood pressure. A previous study that followed up on 2159 teenagers aged 13 to 17 found that a decrease in BMI would reduce the risk of hypertension by 44% by the age of 17.<sup>18</sup> There are pros and cons to a superior preference between the use of a skinfold caliper, abdominal circumference, hip circumference, and BMI to predict hypertension in adolescents. A study by Devi et al. (2019) revealed that abdominal circumference is the strongest predictive factor for increased systolic blood pressure, while BMI and skinfold triceps are predictive factors for increased diastolic blood pressure.<sup>19</sup> The same goes for a study by Kuciene et al. (2019) that concluded that BMI is better as a predictor of hypertension than the ratio of abdominal circumference and height. Further research is needed to control these factors.

## 5. Conclusion

This study concluded that only BMI factors have a significant relationship with systolic blood pressure. Regardless of the method of measurement, it is essential to examine the body composition and BMI of adolescents to reduce the risk of hypertension later in the day.

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