ORIGINAL RESEARCH REPORT

Body Mass Index with Systolic and Diastolic Blood Pressure at a Public Health Center in Surabaya, Indonesia

Bella Patricia Simanjorang[1*], Florentina Sustini[2], Sundari Indah Wiyasihati[3]
[1]Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.
[2]Department of Public Health and Preventive Medicine, Faculty of Medicine, Universitas Airlangga.
[3]Department of Physiology and Biochemistry, Faculty of Medicine, Universitas Airlangga.

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***Corresponding author**:
Bella Patricia S.
bellaptrcia@gmail.com

ABSTRACT

Background: Body Mass Index (BMI) is an indicator of body fat. It is classified as underweight, normal, overweight, and obese. Obesity is a risk factor for hypertension (systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg). **Objective:** To analyze the correlation between BMI with systolic and diastolic blood pressure. **Material and Method:** This was an observational research with a cross-sectional design, and the samples consisted of 60 individuals aged 35 to 59 selected using accidental sampling. Blood pressure was the dependent variable whereas BMI was the independent variable. Data were analyzed using Pearson and Spearman correlation tests. **Result:** There were 44 females (73.3%) and 16 males (26.7%). The largest age groupings were between 45-49 and 50-54 years (31.7%), while the smallest was between 55-59 years (5%). Thirty-three samples (55%) were overweight (>25 kg/m^2), 32 samples (53.4%) had systolic blood pressure above normal (≥120 mmHg), and 42 samples (70%) had diastolic blood pressure above normal (≥80 mmHg). The Pearson correlation test between BMI and systolic blood pressure showed a weak correlation (p=0.009 r=0.336). The Spearman correlation test between BMI and diastolic blood pressure showed a weak correlation (p=0.013 r=0.321). **Conclusion:** There was a weak correlation between BMI with systolic blood pressure, and there was a weak correlation between BMI with diastolic blood pressure in this study.

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Highlights

1. The Body Mass Index (BMI) measures how much fat the body carries.
2. Obesity and overweight are characterized by an excessive buildup of fat that may be detrimental to health.

BACKGROUND

The Body Mass Index (BMI) is the presently used measure for determining anthropometric height/weight features in humans and for categorizing (grouping) (Nuttall, 2015). Although BMI is not a direct assessment of body fat, it is the most used approach since it is more practical than direct

measurement (Kushner, 2015). BMI is classified into underweight, normal, overweight and obesity for adults (Centers for Disease Control and Prevention (CDC), 2022). BMI is one of the measures of nutrition based on a person's weight and height according to gender and age group (Saputri, et al., 2020).

Obesity is a significant risk factor for essential hypertension, diabetes, and other morbidities that contribute to the development of kidney disease because it primarily increases tubular reabsorption to worsen pressure natriuresis and promote volume expansion by activating the SNS and RAS (Jiang, et al., 2016). Obesity incidence is rising among Indonesians over the age of 18, rising from 7.8% in 2010 to 19.7% in 2013. Obesity prevalence in East Java is higher than the national average (>19.7%) and has increased since 2010 (Oddo, et al., 2019). Obesity and overweight are described as excessive fat accumulation that may adversely affect health. In adults, overweight is diagnosed when the body mass index (BMI) is >25, obesity is diagnosed when the BMI is >30 kg/m^2 (Rahmawan., et al. 2020).

Hypertension is a category in blood pressure classified by The Seventh Report of the Joint National Committee (JNC 7), which is defined as systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg (U.S. Department of Health and Human Sciences, 2003). According to the World Health Organization (WHO), hypertension is a severe disease that affects 22 percent of the global population. In Southeast Asia, 25% of the population is affected by hypertension (World Health Organization, 2020). In Indonesia, hypertension reached 25.8% in 2013 and was the third leading cause of mortality. Meanwhile, the incidence of hypertension in Indonesia is seeking to raise, reaching 34,11 percent among persons older than 18 years old (Khasanah, 2022).

The level of body fat can affect blood pressure because of its capability in altering the sympathetic nervous system, renal mechanism, insulin and leptin activity, and vascular structure and function (DeMarco, et al., 2014). Increases in free fatty acid, insulin resistance, hyperinsulinemia, and hyperleptinemia are the underlying processes that enhance sympathetic activation, vascular tone, endothelial dysfunction, and salt retention in the kidneys (Kotsis, et al., 2010).

Indonesian society spread across urban and rural areas that have different characteristics (Mardiansjah, et al., 2021). Surabaya, a city in Indonesia, has urban features and is anticipated to reflect the population of urban communities in terms of lifestyle and lifestyle-related disorders. Public Health Center (*Puskesmas*) Mojo is a health center situated in the urban region of Surabaya, with the majority of its citizens aged 45-59 (Puskesmas Mojo Surabaya, 2015).

OBJECTIVE

The purpose of this study was to analyze the correlation between BMI with systolic and diastolic blood pressure.

MATERIAL AND METHOD

This study was analytic observational with cross-sectional design. People between the ages of 35 and 59 who visited Puskesmas Mojo Surabaya between February and March 2016 were randomly selected to provide 60 samples. Blood pressure was the dependent variable whereas BMI was the independent variable.

Data collections which were body weight, height, blood pressure and the selection of samples that met the inclusion criteria carried out by weight scale, stature meter, mercury sphygmomanometer, and questionnaire. The inclusion criteria were 35-59 years old, not just doing heavy physical work, did not have chronic disease or family history of metabolic disease and or heart disease, was not currently taking any medication (flu drugs, antihistamines, antidepressants, steroids, hormonal, alcohol), not an athlete or a bodybuilder, and not pregnant.

Data presentation was used the BMI classification according to the Ministry of Health, Republic of Indonesia (2013) and blood pressure using classification according to JNC 7 (U.S. Department of Health and Human Services 2004). The statistical tests used were the Pearson correlation test for the correlation between BMI and systolic blood pressure and the Spearman correlation test for the correlation between BMI and diastolic blood pressure because the distributions of BMI and systolic blood pressure were normal but diastolic blood pressure was not normal.

RESULT

Characteristics of samples

The minimum BMI from 60 samples was 18.42 kg/m2, the maximum was 36.21 kg/m2, the mean was 26.1 kg/m2, and the standard deviation was 4.31 kg/m2. Minimum systolic blood pressure from 60 samples was 90 mmHg, the maximum was 140 mmHg, the mean was 117 mmHg, and the standard deviation was 14.65 mmHg. Minimum diastolic blood pressure from 60 samples was 60 mmHg, the maximum was 90 mmHg, the mean was 78,67 mmHg, and the standard deviation was 8,92 mmHg. Characteristics of samples can be seen in Table 1.

Relationship between BMI and blood pressure

The majority of samples in this research had a normal BMI (18.5-25.0 kg/m2), and the majority also had normal systolic blood pressure (120 mmHg) (Table 2). The most prevalent diastolic blood pressure group in this research was prehypertension (80-89 mm Hg) (Table 3).

Statistical analysis

The results of Pearson correlation test between BMI and systolic blood pressure showed that both variables had weak correlation (p=0.009, r=0.336), while the result of Spearman correlation test between those variables also showed weak correlation (p = 0.013, r = 0.321).

Table 1. Characteristic of samples

Sample characteristics	n	%
Gender		
Females	44	73.3
Males	16	26.7
Age group (Year)		
35-39	5	8.3
40-44	14	23.3
45-49	19	31.7
50-54	19	31.7
55-59	3	5.0
BMI (kg/m2)		
17.0 – 18.4 (Underweight)	1	1.7
18.5 – 25.0 (Normal)	26	43.3
25.1 – 27.0 (Overweight)	10	16.7
>27.0 (Obesity)	23	38.3
Systolic blood pressure (mmHg)		
<120 (Normal)	28	46.6
120-139 (Prehypertension)	22	36.7
140-159 (Hypertension stage 1)	10	16.7
Diastolic blood pressure (mmHg)		
<80 (Normal)	18	30.0
80-89 (Prehypertension)	27	45.0
90-99 (Hypertension stage 1)	15	25.0
Total	60	

Table 2. Correlation between BMI and systolic blood pressure

		Systole (mmHg)						Total	
		<120		120-139		140-159			
		n	%	n	%	n	%	n	%
BMI (kg/m^2)	17.0-18.4	1	100.0	0	0.0	0	0.0	1	1.7
	18.5-25.0	13	50.0	13	50.0	0	0.0	26	43.3
	25.1-27.0	6	60.0	2	20.0	2	20.0	10	16.7
	>27.0	8	34.8	7	30.4	8	34.8	23	38.3
	Total	28	46.6	22	36.7	10	16.7	60	100.0

Table 3. Correlation between BMI and diastolic blood pressure

		Diastole (mmHg)						Total	
		<80		80-89		90-99			
		n	%	n	%	n	%	n	%
BMI (kg/m^2)	17.0-18.4	1	100.0	0	0.0	0	0.0	1	1.7
	18.5-25.0	8	30.8	16	61.5	2	7.7	26	43.3
	25.1-27.0	4	40.0	5	50.0	1	10.0	10	16.7
	>27.0	5	21.7	6	26.1	12	52.2	23	38.3
	Total	18	30.0	27	45.0	15	25.0	60	100.0

DISCUSSION

This research showed that a person's systolic blood pressure (p= 0.009, r= 0.336) and diastolic blood pressure (p= 0.013, r= 0.321) increased when their BMI increased. Any increase in BMI by 1 kg/m^2 is associated with an increase in systolic blood pressure of 1.143 mmHg and a rise in diastolic blood pressure of 0.612 mmHg.

The BMI is an index of body fat, thus if the body fat changes, so will the BMI. Changes in body fat may affect the sympathetic nervous system, renal mechanism, insulin and leptin activity, as well as the structure and function of blood vessels (Després, 2012). All of that can affect blood pressure. The underlying mechanisms are the increase of free fatty acid, insulin resistance, hyperinsulinemia, and hyperleptinemia, which increase sympathetic stimulation, vascular tone, endothelial dysfunction, and sodium retention in the kidney (Mendizábal, et al., 2013).

A study from Kurniawan et al., (2021) found that in adults aged 20-61 the correlation between BMI and systolic blood pressure had p= 0.001 r= 0.362, and between BMI and diastolic blood pressure had p= 0.001 r= 0.297. According to a research conducted on Punjabi women between the ages of 18 and 50, there was also an association between BMI and blood pressure, with p=0.01 r=0.35 for diastolic blood pressure and p=0.01 r=0.30 for systolic blood pressure (Dua, et al., 2014). Similarly, a study of 40-44-year-old women in Troms reported a link between BMI and systolic blood pressure (p= 0.0002, r= 3.98) and a correlation between BMI and diastolic blood pressure (p= 0.004, r= 2.04) (Emaus, et al., 2011).

Previous studies have found a positive correlation between BMI and blood pressure which showed an increasing chart (linearity) at the age of 35-55 years (Landi, et al., 2018). Similar study has also been conducted in Indonesia, although the outcomes are different. One research revealed a slight correlation (Sarah, 2013), whereas another study found none (Destyana, et al., 2009).

In this research, the low correlation between BMI and systolic blood pressure and BMI and diastolic blood pressure may have been influenced by other variables that were not controlled. That factors may affect BMI and or blood pressure, such as exercise habit, the type of food consumed, respondent psychological factor, smoking, and alcohol drinking habit (Ng, et al., 2020).

With the finding of the correlation between BMI and diastolic and systolic blood pressure, the authors seek to increase public awareness of BMI score since obesity is a risk factor for hypertension. The findings of this investigation are anticipated to contribute to the advancement of hypertension-related understanding.

Strength and limitations

This study is anticipated to serve as a foundation for future research on the relationship between BMI and systolic and diastolic blood pressure. We urge that future research incorporate a bigger sample size and additional factors in order to provide a more accurate representation of the population, resulting in more precise findings.

CONCLUSION

There was a correlation between BMI and systolic blood pressure and the strength of the correlation was weak, and there was a correlation between BMI and diastolic blood pressure and the strength of the correlation was also weak.

Acknowledgment
None

Conflict of Interest
All authors have no conflict of interest.

Ethic Consideration
The research protocol was approved by the Committee on Medical Research Ethics in the Faculty of Medicine, Universitas Airlangga (326/EC/KEPK/FKUA/2015).

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Author Contribution
All authors have contributed to all processes in this research, including preparation, data gathering, analysis, drafting, and approval for publication of this manuscript.

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