RELATIONSHIP BETWEEN BODY MASS INDEX AND BLOOD PRESSURE IN THE ELDERLY

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ABSTRACT

Excessive fat in the body can cause the risk of obesity. A simple measurement is used to determine the condition of body fat using the Body Mass Index (BMI). The bigger the body mass, the bigger the volume of blood needed to supply oxygen and food to the tissues of the body, thereby increasing blood pressure. Blood pressure is the force exerted by the walls of the arteries by pumping blood away from the heart. Increased blood pressure is also caused by age because entering old age can cause a decrease in the cardiovascular system, which causes increasing blood pressure. The study's objective is to investigate the relationship between body mass index and blood pressure in the elderly in the Integrated Monitoring Centre (Posbindu) of Klinyo Margoluwih Sleman. Observational analysis was done with a cross-sectional design. The research sample was taken using a total sampling technique with a number of samples of 70 people. The research instruments used were a digital scale, microtome stature meter, and aneroid sphygmomanometer. Data analysis used univariate analysis and bivariate analysis, namely the Spearman correlation test. Spearman Rank correlation test shows a significant relation between BMI and blood pressure in the elderly (r = 0.788, p = 0.000). There is a significant relationship between BMI and blood pressure where the increase in BMI is in line with the increase in blood pressure in the elderly because the heavier the body mass, the more blood is needed to supply oxygen in the body tissues; this means that the volume of blood circulating through the blood vessels increases, putting more pressure on the arterial walls.

ABSTRAK

Lemak yang berlebihan dalam tubuh dapat menyebabkan timbulnya risiko obesitas. Untuk mengetahui kondisi lemak tubuh dilakukan pengukuran sederhana menggunakan Indeks Massa Tubuh (IMT). Semakin besar massa tubuh maka semakin meningkat volume darah yang dibutuhkan untuk memasok oksigen dan makanan ke jaringan tubuh sehingga menaikkan tekanan darah. Tekanan darah adalah kekuatan yang dihasilkan dinding arteri dengan memompa darah dari jantung. Peningkatan tekanan darah juga disebabkan oleh faktor usia karena saat memasuki usia tua akan mengalami penurunan sistem kardiovaskular yang mengakibatkan tekanan darah meningkat. Tujuan penelitian ini adalah untuk mengetahui hubungan indeks massa tubuh terhadap tekanan darah pada lansia di Posbindu Klinyo Margoluwih Sleman. Analitik observasional dengan rancangan cross sectional. Sampel penelitian diambil dengan teknik total sampling dengan jumlah sampel 70 orang. Instrumen penelitian menggunakan timbangan digital, microtoise staturemeter dan sphygmomanometer aneroid. Analisis data menggunkan analisis univariat dan analisis bivariat yaitu uji korelasi Spearman. Uji korelasi Spearman Rank menunjukan bahwa terdapat hubungan yang signifikan antara IMT terhadap tekanan darah pada lansia (r=0,788, p = 0,000). Terdapat hubungan yang signifikan antara IMT dengan tekanan darah dimana peningkatan IMT sejalan dengan peningkatan tekanan darah pada lansia karena semakin berat massa tubuh, maka semakin banyak darah yang dibutuhkan untuk mensuplai oksigen pada jaringan tubuh, hal ini berarti volume darah yang bersirkulasi melalui pembuluh darah semakin banyak sehingga memberikan tekanan yang lebih besar pada dinding arteri.

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INTRODUCTION

Excessive fat in the body can cause health risks, one of which is obesity or overweight (Ulumuddin & Yhuwono, 2018). Obesity is a condition where a person has a body weight that is heavier

than his ideal body weight due to the accumulation of body fat (Utami, Rosida, & Nurhayati, 2021). Based on data from the World Health Organization, in 2016, obesity worldwide has increased quite rapidly to more than double. Riskesdas (2018), the proportion of obesity in adults aged ≥18 years in Yogyakarta City was 26.9% or exceeding the national number of 21.8% (Dinas Kesehatan Daerah Istimewa Yogyakarta, 2019).

Body Mass Index (BMI) is a simple measurement that is often used to determine the condition of body fat (Hutahaean & Lestari, 2021). The bigger the body mass, the bigger the blood volume needed to supply oxygen and food to body tissues, thereby increasing blood pressure (Y. A. Utami, Hansah, & Putra, 2020).

Blood pressure is the force generated by the arterial walls by pumping blood from the heart (Nugraheni, Mulyani, Cahyanto, Musfiroh, & Sukamto, 2019). High blood pressure is a condition of increased blood pressure marked by an upper limit (systole) and a lower limit (diastole) as a result of the heart working harder to pump blood to fill the body's oxygen needs (Supriyono, 2019). According to Supriyono et al. (2019), hypertension is one of the factors causing cardiovascular disease, where cases of hypertension are often found in people with diabetes mellitus, dyslipidemia, and obesity. Obese patients have the potential to suffer from hypertension caused by veins or arteries filled with "fat rust" (Ulumuddin & Yhuwono, 2018).

World Health Organization (WHO) in 2015 about 1.13 billion people in the world have hypertension, meaning that 1 in 3 people in the world is diagnosed with hypertension. The number of people with hypertension continues to increase every year; it is estimated that by 2025, there will be 1.5 billion people affected by hypertension, and it is estimated that every year, 9.4 million people die from hypertension and its complications. The increasing prevalence of hypertension is caused by population growth, unhealthy diet, harmful use of alcohol, smoking, lack of physical activity, overweight/obesity, prolonged stress and aging (elderly) (Zekewos, Egeno, & Loha, 2019). The efforts of the government in dealing with hypertension cases are weight loss programs, namely physical activity including aerobic exercise, reducing salt and fat intake and also the Dietary Approach to Stop Hypertension (DASH) program (Nugroho, Triandhini, & Haika, 2019).

Increasing age is at risk for various health problems because in old age various setbacks arise in the body's organs where the disease that is often found in the elderly is hypertension (Rahmatillah, Susanto, & Nur, 2020). Physiotherapy in dealing with hypertension in the elderly is in the form of non-pharmacological therapy, namely the provision of breath relaxation to lower blood pressure. Breath relaxation is a breathing exercise that eases the airway and relaxes respiratory muscle tension (Nisa & Nurhayati, 2020).

The classification of the elderly based on the World Health Organization under the United Nations (2015) in Dyussenbayev (2017) is as follows: Middle age 45-60 years; Elderly age 61-75 years; Senile age 76-90 years; Long-livers >91 years. The number of hypertension in the elderly, according to the results of Riskesdas (2013), starting from the elderly and the old elderly was 45.6% (55-64 years), 58.9% (65-74 years), and 62.6% (>75 years). Obesity is a risk factor for hypertension with a risk of 2.16, meaning that obese respondents have a risk of developing hypertension 2.16 times greater than respondents who are not obese (normal BMI). This study aims to determine the relationship between body mass index and blood pressure in the elderly at Integrated Guidance Post Klinyo Margoluwih Sleman.

METHOD
Types of research
This study used an observational analytic method with a cross-sectional design because the data for the independent and dependent variables were collected once.

Research Location and Time
This research was condcted in Posbindu Klinyo Margoluwih Sleman, Yogyakarta. This study was conducted in May 2022.

Population and Sample

The research population consisted of 70 elderly people in Padukuhan Klinyo. The sampling technique used was total sampling, which involved sampling the entire population with 70 respondents.

Data collection

This study's variables consisted of the independent variable, body mass index (BMI); the bound variable, blood pressure; and the confounding variables, physical activity, diet, and workload, which affect BMI. The exclusion criteria have controlled the confounding variables.

The measurement of BMI has used a calibrated scale for body weight and a microtome stature meter calibrated for height. BMI calculation has used the formula weight $(kg)/(height(m))^2$. According to Ulumuddin & Yhuwono (2018), the results of measuring BMI are: underweight <18.5; normal 18.5 - 22.9; overweight 23.0 - 24.9; obese >24.9. Blood pressure measurement using a calibrated aneroid sphygmomanometer. The results of measuring blood pressure according to the 2020 International Society of Hypertension Global Hypertension Practice Guidelines are Normal <130/<85 mmHg; pre-hypertension 130-139/85-89 mmHg; grade I hypertension 140-159/90-99 mmHg; grade II hypertension 160/≥100 mmHg.

Processing and analysis of data

Data analysis techniques in this study used univariate analysis and bivariate analysis, namely the Spearman correlation test because the two data groups were obtained using an ordinal scale (interpretation). To identify the high and low correlation coefficient, according to Sugiyono (2013), the correlation interval value with the level of the relationship is: 0.00 - 0.199, the relationship level is very low; 0.20-0.399 relationship level is low; 0.40-0.599 moderate relationship level; 0.60-0.799 level of strong relationship; 0.80-1.00 level of relationship is very strong. Researchers observed the relationship between body mass index and blood pressure in the elderly at Integrated Guidance Post Klinyo, Margoluwih, Sleman.

RESULT

The characteristics of respondents are shown in Table 1.

Table 1.
Characteristics of respondents

Description	Frequency	Percentage
Gender		
Male	19	27,1
Female	51	72,9
Age		
45 – 60 years	51	72,9
61 – 75 years	19	27,1
Family history of hypertension		
No	26	37,1
Yes	44	62,9
Body mass index		
Normal	16	22,9
Overweight	13	18,6
Obese	41	58,6
Blood pressure		
Normal	9	12,9
Pre Hypertension	18	25,7
Hypertension I	25	35,7
Hypertension II	18	25,7

The characteristics of the respondents are gender, age, family history of hypertension, body mass index, and blood pressure. Characteristics of respondents, namely gender, more women than men. There are 51 respondents (72.9%) for women, while 19 are men (27.1%). Judging from the elderly category, the majority are in the middle age category, with 51 respondents (72.9%). The majority of elderly people in Klinyo Village have a family history of hypertension, 44 people (62.9%). The elderly in Klinyo Village suffer the most from obesity, 41 respondents (58.6%) and the blood pressure category in the elderly majority has level I hypertension blood pressure, 25 respondents (37.7%), while pre-hypertension and level II hypertension are the same, namely 18 respondents (25.7%).

Correlation test using Spearman rank to find out the relationship between body mass index and blood pressure in the elderly, obtain the $p = 0.000$ ($p < 0.05$), then H1 is accepted, and H0 is rejected. Thus, it can be stated that there is a significant relationship between Body Mass Index (BMI) and blood pressure in the elderly at Posbindu Klinyo Margoluwih Sleman by controlling for confounding variables, such as physical activity, diet, lifestyle changes and workload. The correlation coefficient value is 0.788, which is included in the category of a strong relationship. The results of the correlation test are shown in Table 2.

Table 2.
Correlation test result between body mass index and blood pressure in the elderly (spearman rank)

N	Sig. (2-tailed)	Correlation
70	0,000	0,788

In the distribution of the relationship between BMI and blood pressure, of 16 respondents with normal BMI, the majority have normal blood pressure, 9 people (12.9%). Of the 13 respondents with overweight BMI, the majority have pre-hypertensive blood pressure 9 people (12.8%). Of the 41 respondents who have obese BMI, the majority have level I hypertension blood pressure 20 respondents (28.6%). The results of the distribution of the relationship between BMI and blood pressure are shown in Table 3.

Table 3. Distribution of BMI's relationship to blood pressure

| BMI | Blood Pressure | | | | | | | | Total | |
| | Normal | | Pre Hypertension | | Hypertension I | | Hypertension II | | | |
	f	%	f	%	f	%	f	%	f	%
Normal	9	12,9	6	8,6	1	1,4	0	0	16	22,9
Overweight	0	0	9	12,8	4	5,7	0	0	13	18,6
Obese	0	0	3	4,3	20	28,6	18	25,7	41	58,6
Total	**9**	**12,9**	**18**	**25,7**	**25**	**35,7**	**18**	**25,7**	**70**	**100**

A correlation test is also done on the characteristics of other respondents, such as age, gender (number of females), and family history of hypertension. A correlation test has been conducted between the characteristics of respondents and blood pressure. The results of the correlation test are shown in Table 4.

Table 4.
Correlation test results (spearman rank)

Characteristics	Sig. (2-tailed)	Correlation
Age (45-60 years)	0,000	0,606
Gender (number of females)	0,002	0,372
Genetics	0,000	0,565

From the data in Table 4, it is obtained that the value of p = 0.000 indicates a significant relationship between age and blood pressure with a correlation coefficient value of 0.606 with a positive direction, which is included in the level of a strong relationship. It is obtained that the value of $p = 0.002$ indicates a significant relationship between gender and blood pressure with a correlation coefficient value of 0.372 with a positive direction, which is included in the low level of relationship. It is obtained that the value of $p = 0.000$ shows a significant relationship between genetics and blood pressure, with a correlation coefficient value of 0.565 and a positive direction included in the medium level of the relationship.

DISCUSSION

This study aims to determine the relationship between body mass index and blood pressure in the elderly at Integrated Guidance Post Klinyo Margoluwih Sleman. There is a positive correlation between body mass index and blood pressure in the elderly and a strong relationship between them. Supported by previous research with a value of p = 0.000 (OR = 5.234; 95% CI = 3.090-8.865), which means that there is a significant relationship between body mass index and blood pressure (Dewi, Furqon, & Danial, 2020). This detection can be explained using the theory of body mass index related to blood pressure by Guyton & F (2014) in Dewi et al (2020), where a person who is obese can affect blood pressure due to an increase in cardiac output and total vascular resistance along with an increase in body weight.

The relationship between BMI and blood pressure in the elderly at Integrated Development Post Klinyo Margoluwih, Sleman, with 70 respondents, where the majority of 16 respondents with normal BMI have normal blood pressure, as many as 9 respondents (12.9%). Of 13 respondents with overweight BMI, the majority have pre-hypertension blood pressure, and as many as 9 respondents (12.8%). Of 41 respondents who have a BMI obese, the majority have hypertension blood pressure level I, as many as 20 respondents (28.6%). Most of the respondents who have obese body mass have high blood pressure. The elderly at Integrated Development Post Klinyo respondents with the most obesity in their body mass experience level I hypertension. This means that when there is an increase in body weight, the pressure of the heart and blood vessels will also increase because the bigger a person's body mass index, the more fat in the body, which results in fat accumulation in the blood vessels.

According to Sheps's (2020) theory, being overweight increases the heart rate and insulin levels in the blood. The heavier the body mass, the more blood is needed to supply oxygen in food to the tissues of the body; this indicates that the volume of blood circulating through the blood vessels increases, thus putting greater pressure on the arterial walls.

The amount of body mass causes the heart to work extra, supplying oxygen and food to the body tissues carried by the blood. When blood pressure continues to pump extra for a long period of time, it causes the blood vessels to become stiff, which can increase blood pressure. In addition, sympathetic nerve activity can also increase due to leptin production produced by fat cells.

Leggio et al. (2017) stated that an increase in leptin in obese people can increase the risk of hypertension, where leptin can cross the blood vessel barrier in the brain and enter the arcuate nucleus, resulting in increased activation of the sympathetic nervous system. Excess fat in the body not only causes fat accumulation in the blood vessels, but the fat will also cause an increase in the production of leptin, which is responsible for stimulating sympathetic nerve activity, which will increase blood pressure.

Another mechanism in someone who is obese that can affect blood pressure is the level of angiotensin II and aldosterone, which increases up to three times in obese people. This will cause salt retention and increase water reabsorption by the kidneys (Guyton & F, 2014; Dewi et al., 2020). This makes it difficult for the kidneys to excrete sodium, causing excess sodium and water in the body. Besides that, an increase in blood pressure occurs due to the inhibition of vasodilation of blood vessels so that blood vessels are always constricted, which, when this continues for a long time, will cause increasing blood pressure.

The body's compensation against factors that cause increasing blood pressure is also different for each individual. The study results show that there is a normal BMI, but the blood pressure is hypertension. Besides being influenced by internal factors, hypertension can also be caused by excessive

fat consumption, which causes fat accumulation in the blood vessels. Fat accumulation in the blood vessels causes the heart to work extra to pump blood throughout the body.

In addition, because of high body mass, the researchers have found that the increase in blood pressure in the elderly in Klinyo Village was related to internal factors such as age, gender and family history of hypertension. There is a positive correlation between age and blood pressure in the elderly because, in old age, the body experiences a decrease in metabolic processes and a decrease in the cardiovascular system, both of which are associated with an increase in blood pressure in the elderly. The decrease in metabolic processes causes an imbalance in the body, where calories in the body accumulate and become fat, making it easy for the elderly to get cardiovascular disease.

The elderly have the potential to have BMI in the obesity category because the metabolic process decreases and is not matched by increasing physical activity or a decrease in the number of meals; the excessive calories will be converted into fat, which results in obesity, which will consequently lead to increasing blood pressure. Besides that, a decrease in the cardiovascular system in the elderly causes blood vessels to lose flexibility or become stiff. These detections can be explained by the theory by Liao et al. (2017) that the elderly experience a decrease in the atrial longitudinal systolic stretch, which loses flexibility and becomes stiff. Because of this, blood at each heartbeat is forced to pass through narrower blood vessels than usual, causing an increase in blood pressure. The older a person is, the greater the risk of experiencing increasing blood pressure (Hamzah, Khasanah, & Norviatin, 2019).

Gender is also one of the factors that can affect the blood pressure. The results of the research that the researchers have done show the elderly are dominated by female respondents with a BMI level in the obese category suffered by women, which affects blood pressure. The obese category dominated by females happens because the production of hormones in the bodies of women and men is different. When women are in menopause, there is a decrease in estrogen levels in the body, which affects obesity. The theory by Falah (2019) states that this estrogen increases High-Density Lipoprotein (HDL) levels, which plays a vital role in maintaining healthy blood vessels. In postmenopausal women, decreased HDL levels follow estrogen levels. The impact that can be caused when HDL is low and Low-Density Lipoprotein (LDL) is high is the occurrence of atherosclerosis so that blood pressure will be high.

The 2017 Hypertension Guidelines in Ramirez & Sullivan (2018) showed that the prevalence of hypertension increased significantly and strongly between women and men in all age groups in the United States. Thus, it was concluded that men had a higher prevalence than women before menopause, but after menopause, women showed an increase in prevalence faster than men, so the increase in the prevalence of women is higher than that of men in the United States.

The researchers have also found that there is a positive correlation between a history of family hypertension and increasing blood pressure in the elderly in Klinyo Village. For people who have a history of family hypertension, the Renin Angiotensin Aldosterone system will be more sensitive than the people who have no history of family hypertension. The sympathetic nerves will be more sensitive, which causes vasoconstriction in blood vessels; disruption of the natriuretic peptide hormone causes it to be less sensitive, whereas natriuretic peptide works for Na+ excretion and impaired Na^+-K^+ transport. Supported by research by Suparta & Rasmi (2018), an increase in blood pressure due to a family history of hypertension occurs because it is associated with increased intracellular sodium levels and a low potassium-to-sodium ratio. Individuals with parents with hypertension have a two-fold greater risk of developing hypertension than people without a history of hypertension.

Hypertension is at risk of death if it is not treated. Physiotherapy can be therapy based on the cause of hypertension. In this case, the cause of hypertension is excessive body mass or obesity. Physiotherapy plays a role in helping the hypertension patient lose weight. When the weight of the hypertension patient is lost, it is also followed by a decreasing blood pressure of the hypertension patient.

CONCLUSION

There is a significant relationship between Body Mass Index and Blood Pressure in the Elderly at Integrated Guidance Post Klinyo Margoluwih Sleman (r=0.788, p=0.000). BMI is related to blood pressure in the elderly due to an increase in cardiac output and total vascular resistance, along with an increase in a person's body weight. Besides that, the elderly have the potential to experience BMI in the obesity category because of a decreased metabolic process not matched by an increase in physical

activity or a decrease in the amount of food then excess calories will be converted into fat, which results in obesity which consequently can cause increasing blood pressure.

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