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The Relationship between Body Mass Index (BMI) and Degree of Hypertension in Hypertensive Patients

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ABSTRACT

Background: Hypertension is a global health problem that attacks 1.28 billion adults aged 30-79 years. Hypertension is a chronic disease characterized by an increase in systolic blood pressure ≥140 mmHg and/or diastolic ≥ 90 mmHg. Calculation of Body Mass Index (BMI) is a method for determining nutritional status in adults. An increase in the BMI value is followed by an increase in blood pressure, thus increasing the chance of developing hypertension as well as the degree of hypertension. This study aims to determine the relationship between BMI and the degree of hypertension in hypertensive sufferers at Prof. Chairuddin P. Lubis Hospital Medan.
Method: This research uses a cross-sectional design and descriptive-analytical research methods. The samples for this study are 84 people obtained from secondary data of medical records and used simple random sampling techniques. The collected data is analyzed by a statistical program using the Fisher-Exact test with a significance level of $p < 0.05$.
Results: Most hypertension degrees are hypertension stage 2 and the classification of BMI is obese 1. There is a relationship between BMI and the degree of hypertension (p=0.02)
Conclusion: Most of the patients are hypertension stage 2 and obese 1. There is a relationship between BMI and hypertension in hypertensive patients. It means BMI is a risk factor for hypertension
Keywords: Body Mass Index; BMI; degree of hypertension

ABSTRAK

Latar Belakang: Hipertensi adalah masalah kesehatan global yang menyerang 1,28 miliar orang dewasa berusia 30-79 tahun. Hipertensi adalah penyakit kronis yang ditandai dengan peningkatan tekanan darah sistolik ≥140 mmHg dan/atau diastolik ≥ 90 mmHg. Perhitungan Indeks Massa Tubuh (IMT) adalah metode untuk menentukan status gizi pada orang dewasa. Peningkatan nilai IMT diikuti dengan peningkatan tekanan darah, sehingga meningkatkan kemungkinan terkena hipertensi serta derajat hipertensi. Penelitian ini bertujuan untuk mengetahui hubungan antara IMT dengan derajat hipertensi pada penderita hipertensi di Rumah Sakit Prof. Dr. Chairuddin Panusunan. Lubis Medan.
Metode: Penelitian ini menggunakan metode penelitian cross-sectional design dan deskriptif-analitik. Sampel untuk penelitian ini adalah 84 orang yang diperoleh dari data sekunder rekam medis dan menggunakan teknik simple random sampling. Data yang terkumpul dianalisis dengan program statistik menggunakan uji Fisher-Exact dengan tingkat signifikansi $p < 0,05$.
Hasil: Sebagian besar derajat hipertensi adalah hipertensi stadium 2 dan klasifikasi IMT adalah obesitas 1. Ada hubungan antara IMT dan derajat hipertensi (p=0,02)
Kesimpulan: Sebagian besar pasien adalah hipertensi stadium 2 dan obesitas 1. Ada hubungan antara BMI dan hipertensi pada pasien hipertensi. Ini berarti BMI

adalah faktor risiko hipertensi
Keywords: Body Mass Index; BMI; degree of hypertension

1. Introduction

High blood pressure known as hypertension is a chronic disease characterized by an increase in systolic blood pressure ≥140 mmHg and/or diastolic ≥90 mmHg. Hypertension is often called "the silent killer" because it may show no symptoms and usually is realized after more severe symptoms and complications have occurred [1].

The overall global prevalence of adults aged 30-79 years with hypertension is 1.23 billion and the number increases in developing countries. The average prevalence of hypertension in Indonesian citizens aged ≥18 years old is 34.11%. In North Sumatra, 29.19% of the population has hypertension disease. According to age, people with hypertension are more commonly found in older individuals aged ≥75 years (69,53%) and less likely found in younger adults aged 18-24 years (13,22%). The results of Riskesdas (2018) also show that 36.85% of the women population and 31.34% of the male population suffer from hypertension [2].

According to the American Heart Association, the risk factors of hypertension consist of modifiable factors such as unbalanced nutritional diet, especially high salt or sodium intake, smoking, excessive alcohol consumption, sedentary lifestyle, stress, and overweight (obesity). While gender, age, race, and family history of hypertension are unmodifiable factors [3].

Hypertension is influenced by many contributing factors such as vasoconstriction of blood vessels due to overactivity of the sympathetic nervous system. Constricted blood vessels will increase blood pressure since the same amount of blood that flows normally is now trapped in a narrower space and needs higher pressure to circulate the blood to the body [4]. Baroreceptor reflex disorder, activation of chemoreceptor or proopiomelanocortin (POMC) leptin pathway, hyperinsulinemia, and inflammation in hypothalamic or brainstem neurons may also release mediators that increase the sympathetic nervous system [5].

Expansion of blood volume and increased cardiomyocyte strain may stimulate the secretion of cardiac natriuretic peptides that can decrease sodium reabsorption, volume expansion, and blood pressure as a compensatory effect. However, in obese people, there is an increase of endopeptidase neprilysin which degrades natriuretic peptides and increases its reuptake by Natriuretic Peptide Receptor-C (NPR-C). As a result, a deficiency of cardiac natriuretic peptides will increase blood pressure [5].

Body Mass Index is a simple calculation whose formula is BMI = kg/m^2 where a person's weight in kilograms and their height in meters squared. High BMI such as overweight (obesity) plays a direct role and indirect role in increasing blood pressure. In obese individuals, cardiac output is found to be increased due to a higher volume of circulating blood in the larger body [6].

Other mechanisms such as activation of the Renin Angiotensin Aldosterone System (RAAS) and the sympathetic nervous system can cause hypertension indirectly through mediators like hormones, cytokines, and adipokines. Activation of RAAS will release renin and stimulate the formation of angiotensin I into angiotensin II which affects vasoconstriction. Further vasoconstriction will release aldosterone which influences the regulation of sodium and water balance. Obese people have more adipose fat tissue in the body and thus increase the secretion of cytokines that will affect cardiovascular metabolism and insulin resistance. However, the exact mechanism is yet clearly known [6,7].

2. Method

The study was conducted on 84 hypertensive outpatients that were obtained from medical record data of Prof. Dr. Chairuddin Panusunan Lubis Hospital Medan. This research is based on descriptive-analytical research methods with a cross-sectional design. The samples were randomized with a simple random sampling technique and were chosen according to inclusion and exclusion criteria. The inclusion criteria are outpatients with hypertension and aged ≥18 years in 2018-2023. The exclusion criteria are outpatients with secondary hypertension, pregnant women, and athletes.

Each value of blood pressure can be classified into several stages. In this research, the classification of hypertension is based on JNC VIII (2014) such as: Normal: SBP (systolic blood pressure) is lower than 120 mmHg and DBP (diastolic blood pressure) is lower than 80 mmHg, Prehypertension: SBP is 120 to 139

mmHg or DBP is 80 to 89 mmHg, Hypertension stage 1: SBP is 140 to 159 mmHg or DBP is 90 to 99 mmHg, and Hypertension stage 2: SBP is greater than 160 mmHg or DBP is greater than 100 mmHg [8].
Being overweight or obese is one of the several risk factors that may increase the risk of developing hypertension and other unknown health problems. Calculating the BMI can help to determine the relative levels of a person's body fat and weight status which will be categorized according to the Asia Pacific Classification of BMI such as: Underweight: <18,5 kg/m^2, Normal: 18,5-22,9 kg/m^2, and overweight: ≥23 kg/m^2. The overweight category is also divided into three sections such as: At risk: 23,0-24,9 kg/m^2, obesity 1: 25,0-29,9 kg/m^2, and obesity 2: ≥30,0 kg/m^2 [9].

Statistical Analysis
The statistical analysis used to assess the relationship between BMI and the degree of hypertension is the Fisher-Exact test with a significance level of $p < 0.05$. The research can be carried out after the author obtained the Ethical Clearance from the Health Research Ethics Committee of Universitas Sumatera Utara.

3. Results
Based on Table 1, most hypertension degrees are hypertension stage 2, and the classification of BMI is obese 1.

Table 1 Patients' characteristics

Parameter	Frequency	Accuracy (%)
Gender		
Male	34	40.5
Female	50	59.5
Age (year)		
26-35 (early adulthood)	2	2.4
36-45 (late adulthood)	6	7.1
46-55 (early elderly)	7	8.3
56-65 (late elderly)	20	23.8
>65 (seniors)	49	58.3
Diabetes mellitus		
Yes	41	48.8
No	43	51.2
Dyslipidemia		
Yes	17	20.2
No	67	79.8
Degree of hypertension		
Prehypertension	25	29.8
Hypertension stage 1	24	28.6
Hypertension stage 2	35	41.7
Classification of BMI		
Underweight	5	6
Normal	17	20.2
At risk	12	14.3
Obesity 1	32	38.1
Obesity 2	18	21.4

The distribution of samples' gender, BMI, and degree of hypertension according to age are shown in Table 2.

Table 2 Distribution of samples' gender, BMI, and degree of hypertension according to age

Parameter		Age					
		26-35	36-45	46-55	56-65	>65	Total
Gender							
Male	N	2	4	4	6	18	34
	%	2.4	4.76	4.7	7.1	21.4	40.5
Female	N	0	2	30	14	31	50
	%	0.0	2.4	3.6	16.7	36.9	59.5
Total	N	2	6	7	20	49	84
	%	2.4	7.1	8.3	23.8	58.3	100
Degree of hypertension							
Prehypertension	N	1	3	2	3	16	25
	%	1.2	3.6	2.4	3.6	19.0	29.7
Hypertension stage 1	N	0	2	1	9	12	24
	%	0	2.4	1.2	10.7	14.3	28.6
Hypertension stage 2	N	1	1	4	8	21	35
	%	1.2	1.2	4.7	9.5	25	41.7
Total	N	2	6	7	20	49	84
	%	2.4	7.1	8.3	23.8	58.3	100
Classification of BMI							
Underweight	N	0	0	0	1	4	5
	%	0	0	0	1.2	4.7	5.9
Normal	N	0	2	2	3	10	17
	%	0	2.4	2.4	3.6	11.9	20.2
At risk	N	1	1	2	3	5	12
	%	1.2	1.2	2.4	3.6	5.9	14.3
Obesity 1	N	1	2	2	5	22	32
	%	1.2	2.4	2.4	5.9	26.2	38.2
Obesity 2	N	0	1	1	8	8	18
	%	0	1.2	1.2	9.5	9.5	25.7
Total	N	2	6	7	20	49	84
	%	2.4	7.1	8.3	23.8	58.3	100

This research used the Fisher-Exact test with a significance level of $p<0.05$. The P-value shown in Table 3 is 0.02 which means there is a relationship between BMI and degree of hypertension.

Table 3 Relationship between BMI and degree of hypertension

Classification of BMI	Parameter	Degree of hypertension			P-value
		Prehypertension	Hypertension stage 1	Hypertension stage 2	
Underweight	N	3	1	1	0.02
	%	3.6%	1.2%	1.2%	
Normal	N	10	5	2	
	%	11.9%	5.9%	2.4%	
At risk	N	4	2	6	
	%	4.7%	2.4%	7.1%	
Obesity 1	N	6	11	15	
	%	7.1%	13.1%	17.8%	
Obesity 2	N	2	5	11	
	%	2.4%	5.9%	13.1%	
Total	N	25	24	35	
	%	29.8%	28.6%	41.7%	

4. Discussions

Based on the results of the analysis obtained from the medical record of hypertensive outpatients from Prof. Chairuddin P. Lubis Hospital Medan in 2018-2023, the majority of the samples were female which had 50 people (59.5%) and male had 34 people (40.5%). Usually, the prevalence of hypertension is more commonly found in men than women. However, the prevalence of hypertension is increasing in women after entering menopause. It is influenced by the estrogen levels in women that start to decline. High estrogen can maintain normal blood pressure by inhibiting the synthesis of aldosterone hormones which affects blood pressure [10]. In addition, estrogen also affects peripheral body fat distribution such as gluteal and femoral regions. Decreased estrogen influences high-density lipoprotein (HDL) levels and fat distribution which will affect the accumulation of fat in the abdomen and increase the risk of cardiovascular disease [11,12].

According to the research, the number of samples from the age group 26-35 years was 2 people (2.4%), the age group 36-45 years had 6 people (7.1%), the age group 46-55 years had 7 people (the 8.3%), age group 56-65 years had 20 people (23.8%), and the age group >65 years had 49 people (58.3%). The results were similar to the study done by Ekarini et al. [13] who state that there is a relationship between age factors and incidence of hypertension. The majority of people aged >65 years in Western countries for the last two decades have suffered hypertension. The age factor influences the abilities and mechanisms of the body. Furthermore, it is also related to vascular endothelium and loss of vascular elasticity in hypertension. Systolic hypertension can be found especially in older adults [14].

After conducting the study, it was found that the number of patients with underweight BMI was 5 people (6%), normal BMI was 17 people (20.2%), at-risk BMI was 12 people (14.3%), obesity 1 was 32 people (38.1%), and obesity 2 BMI were 18 people (21.4%). The total number of patients with overweight BMI was found to be 62 people (73.8%). People may have a greater risk of developing hypertension when they are obese or have more than 30% of their ideal body weight [15,16].

Based on research data, the age group most commonly found experiencing overweight (BMI ≥23) is the senior group (>65 years) with a total of 35 people (41.67%). The age factor is also related to obesity since the metabolism in the body will decrease and there will be some biological changes in the body such as increased fat levels and declined muscle function. As someone gets older, they tend to have a lack of activity which can trigger a decrease in muscle mass and deceleration of the rate of calories burnt in the body. As a result, energy will accumulate in the body and increase the risk of developing obesity [15,16].

The distribution of samples with hypertension stage 1 was 24 people (28.57%), samples with hypertension stage 2 were 35 people (41.67%), and samples with prehypertension were 25 people (29.76%). There is a study that shows a relationship between BMI and the incidence of prehypertension in adulthood. Apart from that, another bivariate analysis also shows a relationship between the adult age group with the incidence of prehypertension [17]. Prehypertension can develop into hypertension and can occur in young people. There is research that shows young people tend to have smoking habits, excessive alcohol consumption, high sodium diets, and sedentary lifestyles which are risk factors for hypertension [18].

In this study, the patients that have a history of diabetes mellitus were 41 people (48.8%) and patients that have a history of dyslipidemia were 17 people (20.2%). Diabetes mellitus can increase the risk of

hypertension. The plaque caused by diabetes can influence blood flow due to narrowing blood vessels and higher circulation pressure. The research done by Negara [19] shows that there is a relationship between diabetes mellitus and the incidence of hypertension.

Obesity is a predisposing factor for diabetes. Increased fat tissue especially in the abdominal region will increase the secretion of adipokines and other substances that can affect insulin resistance. It corresponds to the study conducted by Suwinawati et al. which states that there is a relationship between obesity and hypertension and the risk of developing diabetes mellitus along with the increasing BMI value [20].

Dyslipidemia is closely related to hypertension. Studies show that there is an association between increasing serum total cholesterol, HDL cholesterol, and LDL cholesterol with an increased risk of hypertension [21]. However, not all people who suffer from hypertension have hypercholesterolemia, and not all people with hypercholesterolemia suffer hypertension [22]. Usually, high levels of cholesterol, LDL, and triglycerides in the blood can be found in someone with a BMI>25 kg/m2 [23]. In this research, the number of samples with a history of dyslipidemia was smaller than expected due to the collected data which used a cross-sectional design without another follow-up done to the patient who came for the first time to the hospital. So further examination is needed for early detection of dyslipidemia.

BMI categories according to Asia Pacific such as overweight (BMI≥23) and obesity (BMI≥25) were found to be dominant in this study. Hypertension stage 1 and 2 groups were dominated by patients with overweight/obesity BMI, while prehypertension was more likely to be found in patients with underweight BMI.

The distribution of hypertensive outpatients at Prof. Dr. Chairuddin Panusunan Lubis Hospital showed an increase in the degree of hypertension also followed by an increase in BMI value. The results analysis test using the Fisher Exact Test showed the results $p=0.02$ ($p<0.05$) which means there is a significant relationship between body mass index and degree of hypertension in hypertensive sufferers at Prof. Dr. Chairuddin Panusunan Lubis Hospital. The study conducted by Gosal et al. [24] also states that there is an influence of BMI on the incidence of hypertension in productive-age people. There is also research evidence that shows an increase of 1 point in body mass index (BMI) followed by an increase of 8% incidence of hypertension. Apart from that, it is also proven that there are significant differences between the group with optimal blood pressure and the group with hypertension stages 1 and 2.

Another research done by Ramadhan et al. [25] also shows the same results. An increase in BMI value is in line with an increase in blood pressure value. Therefore, it increases the chance of developing hypertension as well as the degree of hypertension.

These factors correspond with the study conducted by Zhang et al. [26] who state that higher BMI is increasing the risk of developing hypertension. Other risk factors such as age, history of diabetes mellitus, hypertriglyceridemia, and smoking habits also increase the risk of hypertension. One risk factor may increase two to three times the risk of developing cardiovascular disease. While more than one factor may increase 20 times the risk of developing cardiovascular disease [27].

The strongest factors of the study are the suitable variables of samples which result in a compatible analysis of data and results. In the end, the results of the research are following the hypothesis expected by the author.

5. Conclusions

The study conducted provided valuable insights into many factors that influence hypertension. The results of the research show a significant relationship between BMI and degree of hypertension. Health workers are also expected to be more active in providing education about the risk factors of hypertension to hypertensive or non-hypertensive patients to prevent the incidence of hypertension and its progression. The majority of patients were found to be overweight and needed to maintain their ideal body weight, especially patients with a history of diabetes mellitus and dyslipidemia which can increase the risk of more severe complications. These findings are expected to increase the readers' knowledge and awareness about the importance of BMI and other risk factors of hypertension.

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