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ANALYSIS OF HYPERTENSION RISK FACTORS AMONG DONORERS IN THE PMI BLOOD DONOR

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ABSTRACT
Hypertension remains a global non-communicable disease problem and is a major risk factor for cardiovascular morbidity and mortality. Regular blood donation has been suggested as one strategy that may help reduce blood pressure. The Indonesian Red Cross (PMI) Blood Donor Unit in Banda Aceh City is one of the largest blood donation centers in Aceh Province, serving approximately 2,500 donors per month. This study aimed to determine the association between lifestyle, metabolic, and donation-related risk factors and the incidence of hypertension among blood donors at the PMI Blood Donor Unit in Banda Aceh City. This study employed a quantitative approach with a case–control design. Data were collected from 156 blood donors aged over 41 years who visited the PMI Blood Donor Unit in Banda Aceh City during January 12–17, 2024, consisting of 52 hypertensive donors (cases) and 104 non-hypertensive donors (controls). Participants were selected using accidental sampling. Data were obtained through donor register records and structured interviews, which included demographic characteristics, lifestyle factors, medical history, and donation frequency. Data analysis was performed using univariate analysis to describe respondent characteristics, bivariate analysis using logistic regression to assess associations between risk factors and hypertension, and multivariate logistic regression to identify the most dominant factors associated with hypertension. The results showed that employment status (OR 0.32; 95% CI; $p = 0.013$), poor diet (OR 11.32; 95% CI; $p < 0.001$), smoking status (OR 2.31; 95% CI; $p = 0.018$), moderate physical activity (OR 0.12; 95% CI; $p < 0.001$), diabetes mellitus (OR 4.11; 95% CI; $p = 0.001$), hypercholesterolemia (OR 4.11; 95% CI; $p < 0.001$), donation frequency (OR 0.71; 95% CI; $p = 0.009$), and body mass index (OR 1.22; 95% CI; $p < 0.001$) were significantly associated with the incidence of hypertension among blood donors at the PMI Blood Donor Unit in Banda Aceh City.

Keywords: donors; hypertension; PMI

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INTRODUCTION

Hypertension is a major global risk factor for cardiovascular disease worldwide. The global burden of hypertension is also increasing with the rise in obesity rates and the aging population (Kamhieh-Milz et al., 2016). Hypertension is influenced by various factors, including lifestyle, unhealthy diet, smoking, stress, alcohol consumption, and lack of physical activity. According to data from the WHO website, 1.28 billion adults aged 30-79 years worldwide suffer from hypertension. Most of them live in low- and middle-income areas, 42% of adults with hypertension are diagnosed and treated (WHO, 2023). Based on the results of the 2018 Basic Health Research (Riskesdas), the national prevalence of people with high blood pressure was 34.11% (Riskesdas, 2018). Banda Aceh reported the highest prevalence of hypertension in 2022, with the number of cases reaching a peak of 220,157, ranking it first among other regions in Aceh.

One way to reduce blood pressure is by donating blood regularly. Blood donation is an important aspect of the healthcare system worldwide, as it plays a vital role in saving lives and providing blood products needed for various medical procedures (Housekeeper et al., 2020). Blood donation units as healthcare service centers not only prepare blood products but also interact directly with

millions of people who donate blood each year. Although initially, people only came to donate blood voluntarily, over time, people have realized that there are many health benefits to be gained from donating blood (Hao et al., 2016).

According to WHO (2023), Indonesia experienced an increase in blood donations in 2022 compared to the previous year. In 2021, the number of donations was 85%, and in 2022, it increased to 93%. For the Indonesian Red Cross (PMI) in Banda Aceh City, blood demand has not yet reached 100 percent. Of the 47,599 blood bag requests, the blood donor unit was able to fulfill 42,172 bags. This reflects that the UDD PMI in Banda Aceh City still needs to increase the number of donors to meet the blood demand from hospitals in the Banda Aceh area and its surroundings (Simdondar, 2022). There are many benefits to donating blood, including a simple medical screening that can be used as a guide to assess the donor's health. Screening can also reduce medical costs by enabling early intervention for those with risk factors. Hypertension is one of the donor eligibility criteria screened for when donating blood (DeSimone, Robert A 2022).

Research results by Waode et al., regular donation can provide protection against cardiovascular disease as seen from the average value of total cholesterol and LDL levels which are significantly lower in regular blood donors than non-regular (Rusdiah et al., 2016). According to Desimone, regular blood donation is associated with reduced blood pressure and the risk of non-communicable diseases, which helps reduce cardiovascular risk (DeSimone. Robert A 2022). Studies show that blood donation can reduce the risk of cardiovascular disease by up to 88% compared to never donating (Alharbi et al., 2018). Many studies use blood centers as access points to screen populations for various cardiovascular risk factors such as hypertension, hyperlipidemia and diabetes mellitus. This study aimed to determine the association between lifestyle, metabolic, and donation-related risk factors and the incidence of hypertension among blood donors at the PMI Blood Donor Unit in Banda Aceh City.

METHOD

This study employed a descriptive-analytical design with a case–control approach to identify risk factors associated with hypertension among blood donors. The study was conducted at the Indonesian Red Cross (PMI) Blood Donor Unit in Banda Aceh City. The study population consisted of all blood donors aged over 41 years, totaling approximately 900 donors per month who visited the PMI Blood Donor Unit in Banda Aceh City. The sample size was 156 donors, comprising 52 donors with hypertension (cases) and 104 donors without hypertension (controls). Participants were selected using an accidental sampling technique, in which donors who visited the blood donor unit during the study period and met the inclusion criteria were recruited. The inclusion criteria were donors aged over 41 years, registered as donors at the PMI Blood Donor Unit, present during the data collection period (January 12–17, 2024), and willing to participate in the study.

Data were collected using two sources. Primary data were obtained through structured interviews using a questionnaire to collect information on demographic characteristics, lifestyle factors (dietary habits, smoking status, and physical activity), medical history (diabetes mellitus and hypercholesterolemia), and blood donation frequency. Secondary data were obtained from donor register records, which included blood pressure measurements, body mass index (BMI), blood type, and donor eligibility information.

Data analysis was conducted in several stages. Univariate analysis was used to describe the distribution of respondent characteristics and study variables. Bivariate analysis was performed using logistic regression tests to assess the association between each independent variable and the incidence of hypertension. Variables with a p-value < 0.25 in the bivariate analysis were subsequently included in the multivariate analysis using multiple logistic regression to identify the dominant factors associated with hypertension among blood donors. Statistical significance was

determined at a p-value < 0.05, and the strength of associations was expressed as odds ratios (OR) with 95% confidence intervals (CI).

RESULT

Table 1.
Univariate Analysis of Demographic Factors, Lifestyle Factors, Previous Medical History Factors, Characteristic Factors and the Incidence of Hypertension (n=156)

Variables	f	%	Mean (SD)	Min- Max
Age			51,26 (7,24)	41-76
Donor Gender				
Man	129	82,69		
Woman	27	17,31		
Level of education				
High	116	74,36		
Middle	40	25,64		
Marital Status				
Single	1	0,64		
Married	154	98,72		
Widowed/ Widower	1	0,64		
Employment Status				
Not working	23	14,74		
Employed	133	85,26		
Diet			27,97 (3,84)	22-37
Good	105	67,31		
Bad	51	32,69		
Smoking Status				
No	72	46,15		
Yes	84	53,85		
Physical activity				
Heavy (score > 3000)	9	5,77		
Moderate (score 600-3000)	98	62,82		
Light (score ≤600)	49	31,41		
Diabetes Mellitus				
No	105	67,31		
Yes	51	32,69		
Hypercholesterolemia				
No	105	67,31		
Yes	51	32,69		
Donor Frequency				
Per year			4,46 (1,34)	1-6
Lifetime in years			28,18 (24,71)	1-125
Donor Type				
Whole Blood	156	100,0		
Thrombopheresis	0	0,00		
Donor Type				
Voluntary	156	100,0		
Surrogate	0	0,00		
Blood type				
A	30	19,23		
B	45	28,85		
AB	13	8,33		
O	68	43,59		
Hypertension Incident				
Non-Hypertension	104	66,67		
Hypertension	52	33,33		

Based on the research results in Table 1, it is known that the average age of donors is 51 years, with the majority being male (82.69%). Most donors have a high level of education (74.36%), are married (98.72%), and are employed (85.26%). Donors' diets are generally considered good

(67.31%), but more than half of the donors are smokers (53.85%). The most common physical activity is moderate physical activity (62.82%). Most donors do not have diabetes mellitus and hypercholesterolemia, each at 67.31%. The average frequency of blood donation is four times per year and 28 times in a lifetime, with all donors donating whole blood and being voluntary (100%). The most common blood type is type O (43.59%), and the majority of donors do not have hypertension (66.67%).

Table 2.
Bivariate Analysis of Factors Associated with the Risk of Hypertension Among Donors (n=156)

	Hypertension Incident								
	No Hypertension			Hypertension					
Risk Factors	f	%	Mean (SD)	f	%	Mean (SD)	OR	95% CI	p-value
Age			50,50 (6,49)			52,79 (8,42)	1,04	0,99-1,09	0,066
Donor Gender									
Male	87	83,65		42	80,77		1,22	0,51-2,90	0,654
Female	17	16,35		10	19,23				
Education Level									
High	81	77,88		35	67,31				
Middle	23	22,12		17	32,69		1,71	0,81-3,59	0,156
Marital Status									
Single	1	0,96		0	0,00				
Married	102	98,08		52	100,0		1,00	*omitted*	*omitted*
Widow/Widower	1	0,96		0	0,00		1,00	*omitted*	*omitted*
Employment Status									
Not Working	10	9,62		13	25,00		0,32	0,13-0,79	0,013
Employed	94	90,38		39	75,00				
Dietary Habits							0,68	0,60-0,77	0,0001
Good	88	84,62		17	32,69				
Poor	16	15,38		35	67,31		11,32	5,15-24,88	0,0001
Smoking Status							2,31	1,15-4,63	0,018
No	55	52,88		17	32,69				
Yes	49	47,12		35	67,31				
Physical Activity									0,0001
Severe (score > 3000)	9	8,65		0	0,00				
Moderate (score 600–3000)	79	75,96		19	36,54		0,12	0,05-0,25	
Mild (score ≤ 600)	16	15,38		33	63,46		1	*omitted*	
Diabetes Mellitus							4,11	2,01-8,40	0,0001
No	81	77,88		24	46,15				
Yes	23	22,12		28	53,85				
Hypercholesterol							4,11	2,01-8,40	0,0001
No	81	77,88		24	46,15				
Yes	23	22,12		28	53,85				
Donor Frequency			4,66 (1,33)			4,06 (1,26)	0,71	0,55-0,92	0,009
Donor Type							1	*omitted*	*omitted*
Whole Blood Test	104	100,0		52	100,0				
Thrombopheresis	0	0,00		0	0,00				
Donor Type							1	*omitted*	*omitted*
Voluntary	104	100,0		52	100,0				
Substitute	0	0,00		0	0,00				
Blood Type									
A	20	19,23		10	19,23				
B	28	26,92		17	32,69		1,21	0,46-3,20	0,695
AB	9	8,65		4	7,69		0,89	0,22-3,61	0,869
O	47	45,19		21	40,38		0,89	0,36-2,24	0,810
BMI			25,29 (2,91)			27,75 (4,45)	1,22	1,10-1,36	0,0001

Based on the analysis results in Table 2, it is known that the variables of age, gender, education level, marital status, and blood type do not show a significant relationship with the incidence of hypertension in blood donors. In contrast, there is a significant relationship between employment

status, diet, smoking status, physical activity, diabetes mellitus, hypercholesterolemia, and frequency of blood donation with the incidence of hypertension. Donors who are employed, have moderate physical activity, and donate more frequently tend to have a lower risk of hypertension. Meanwhile, donors with poor diet, smoking habits, diabetes mellitus, and hypercholesterolemia have a higher risk of developing hypertension. These findings suggest that lifestyle factors and metabolic health conditions play a significant role in the occurrence of hypertension among blood donors, compared to demographic factors.

Table 3.
Multivariate Analysis of Factors Associated with the Risk of Hypertension Among Donors (n=156)

Risk Factors	Model 1		Model 2		Model 3		Model 4	
	AOR (95%CI)	P Value	AOR (95%CI)	P Value	AOR (95%CI)	P Value	AOR (95%CI)	P Value
Age	1,03 (0,97-1,09)	0,369	1,04 (0,96-1,12)	0,325	1,03 (0,94-1,12)	0,548	1,03 (0,95-1,12)	0,476
Education Level								
High	1,96 (0,82-4,66)	0,130	1,73 (0,50-5,90)	0,385	1,67 (0,47-5,95)	0,427	1,62 (0,45-5,83)	0,458
Middle								
Employment Status								
Not Working	0,52 (0,16-1,67)	0,271	0,45 (0,09-2,21)	0,325	0,48 (0,09-2,49)	0,379	0,47 (0,09-2,48)	0,373
Employed								
Dietary Habits								
Good			0,64 (0,48-0,85)	0,002	0,66 (0,49-0,88)	0,004	0,66 (0,49-0,87)	0,004
Poor			0,70 (0,12-4,15)	0,694	0,75 (0,12-4,73)	0,759	0,73 (0,12-4,59)	0,739
Smoking Status								
No			3,70 (1,27-10,77)	0,016	3,60 (1,22-10,61)	0,020	3,58 (1,21-10,57)	0,021
Yes								
Physical Activity								
Severe (score > 3000)								
Moderate (score 600–3000)			0,09 (0,03-0,27)	0,0001	0,10 (0,03-0,32)	0,0001	0,11 (0,03-0,33)	0,0001
Mild (score ≤ 600)			Omitted	omitted	omitted	omitted	omitted	
Diabetes Mellitus								
No								
Yes					omitted	omitted	omitted	omitted
Hypercholesterol								
No								
Yes					2,59 (0,87-7,75)	0,088	2,42 (0,79-7,41)	0,121
Donation Frequency							0,89(0,61-1,31)	0,553
BMI	1,23 (1,11-1,38)	0,0001	1,23 (1,06-1,42)	0,005	1,24 (1,07-1,44)	0,005	1,23 (1,05-1,44)	0,007
Pseudo R2	0,1230	0,4842	0,4994	0,5013				

Based on the results of the multivariate analysis in Table 3, it was found that the dominant factors associated with the incidence of hypertension in blood donors differed in each model. In model 1, body mass index (BMI) was the most dominant factor, where an increase in BMI was followed by an increased risk of hypertension when other variables were controlled, with a pseudo R^2 value of 12.30%. In models 2 to 4, moderate physical activity was consistently the most dominant factor associated with the incidence of hypertension, with a hypertension prevention ability of 91%, 90%, and 89%, respectively, when other variables were constant. The pseudo R^2 values in models 2, 3,

and 4 were 48.42%, 49.94%, and 50.13%, respectively, indicating that the combination of variables in the model simultaneously had a fairly strong contribution to the incidence of hypertension in blood donors.

DISCUSSION

Relationship between Age and Hypertension Incidence Among Blood Donors

The analysis results showed that the average age of donors was higher in the incidence of hypertension at 53 years (OR value = 1.03). This means that as age increases, the incidence of hypertension increases (p = 0.085), or H0 is accepted, so it is concluded that there is no relationship between age and the incidence of hypertension among donors. The results of this study are in line with Podungge (2020), showing that p value = 0.317 < from the value of α = 0.05, then Ha is rejected and H0 is accepted so it can be concluded that there is no relationship between age and blood pressure. Increasing age also causes blood pressure to increase. After the age of 40 years, the degenerative process that naturally occurs more often in old age where the artery walls will experience thickening caused by the accumulation of collagen substances in the muscle layer, causing blood vessels to narrow and become stiff (Amanda & Martini, 2018). In their study, respondents aged >59 years, had a prevalence of hypertension 2.61 times higher than older sufferers.

The results of this study are inconsistent with those of Azhari (2017), who found a correlation between age and the incidence of hypertension (p-value = 0.010). As age increases, the likelihood of someone developing hypertension increases. Hypertension is a disease that arises from the interaction of various risk factors. Various studies have found a relationship between various risk factors and the development of hypertension. Loss of tissue elasticity, atherosclerosis, and dilation of blood vessels are factors that cause hypertension in old age. Various studies conducted in Indonesia have shown that people over the age of 20 already have risk factors for developing hypertension.

Hypertension is a multifactorial disease caused by the interaction of various risk factors. Aging causes physiological changes in the body, one of which is thickening of the artery walls due to the accumulation of collagen in the muscle layer, causing blood vessels to narrow and stiffen starting at age 45 (Widjaya et al., 2018). This theory is inconsistent with the results of this study, which stated there was no relationship between age and hypertension. This is because 26.8% of respondents were still under 45 years of age. The researcher's assumption is that the absence of a relationship between age and hypertension may be due to the respondents' age being taken from 41 years old. Therefore, they are at the same risk of developing hypertension.

The Relationship Between Gender and the Incidence of Hypertension Among Blood Donors

The analysis results showed that 83.65% of males were more likely to be without hypertension. Meanwhile, 19.23% of females were more likely to have hypertension (OR = 1.22). This means that females are 1.22 times more likely to have hypertension than males (p = 0.654), indicating that H0 is accepted. Therefore, it is concluded that there is no relationship between gender and hypertension among donors. These results are in line with Nuraeni (2019), which shows that there is no relationship between gender and the incidence of hypertension with a p-value of 0.972. Women will experience an increased risk of hypertension after menopause, namely those over 45 years of age. Women who have experienced menopause have low estrogen levels. In fact, estrogen functions to increase HDL levels, which play a very important role in maintaining healthy blood vessels. Therefore, in menopausal women, decreasing estrogen levels will also be followed by a decrease in HDL levels if not followed by a good lifestyle. Respondents in this study may also experience the effects of decreased estrogen followed by decreased HDL levels. Because low HDL and high LDL will influence the occurrence of atherosclerosis so that blood pressure will be high.

Gender is indeed a factor that influences blood pressure. Research conducted by Wahyuni (2013) found that women are more likely to suffer from hypertension than men. Although gender is a factor that influences high blood pressure, this is likely due to the numerous factors that influence blood pressure, especially in the elderly, in addition to gender, such as age and physical activity.

The Relationship Between Education and the Incidence of Hypertension Among Blood Donors

The analysis showed that those with higher education were 77.88% more likely to be without hypertension. Meanwhile, those with secondary education were 32.69% more likely to have hypertension (OR=1.71). This means that secondary education carries a 1.71 times greater risk of hypertension compared to those with higher education (p=0.156), indicating that H0 is accepted. Therefore, it is concluded that there is no relationship between education and hypertension among donors. This research also aligns with Raihan et al.'s (2014) study, which showed a significant relationship between occupation and increased blood pressure. The study stated that most respondents were housewives, as housework is a contributing factor to reduced physical activity and stress. Housewives tend to be less physically active.

People with higher education are more compliant with antihypertensive medication. They are more health conscious (Matricciani et al., 2013). The risk of hypertension may increase due to a lack of knowledge regarding the minimum duration of regular exercise or healthy lifestyle habits to control blood pressure, as well as healthy lifestyle behaviors that can be adopted to control blood pressure. This proves that education is significantly associated with the incidence of hypertension (Firmansyah et al., 2017). This study also aligns with Ramdhani et al.'s (2013) study, which stated that the relationship between occupation and hypertension is due to the fact that most of the respondents were elderly women and unemployed or housewives. Clougherty et al.'s (2009) study showed that the risk of hypertension can increase when associated with employment. Employment status in Poland has a negative impact on health. Employment status is also a predictor of the risk of certain diseases. Thus, it can be concluded that work is one of the factors that can cause increased blood pressure, which is related to patient compliance in taking medication (Rumball-Smith et al., 2014).

The Relationship Between Marital Status and the Incidence of Hypertension Among Blood Donors

The analysis showed that those with unmarried marital status were 0.96% more likely to have hypertension. Those with married status were 100% more likely to have hypertension. Meanwhile, those with widows/widowers were 0.96% more likely to have hypertension (OR = 1.00). This means that neither married nor widowed are at risk for hypertension.

These results are inconsistent with Renaldi & Wahyuni (2023), who found a relationship between marital status and the incidence of hypertension. Marital status can impact several aspects of life, including psychological well-being. A disharmonious marriage can lead to psychological distress and excessive stress, leading to increased arterial blood pressure. Conversely, a harmonious marriage is more psychologically stable and leads to feelings of joy and happiness (Prasetyaningrum & Gz, 2014). Blood pressure tends to increase in hypertension sufferers who do not have a life partner because there is no one to help control blood pressure in hypertension sufferers and there is no one to remind them to take anti-hypertensive medication regularly and according to doctor's recommendations so that hypertension sufferers do not maintain and pay attention to their blood pressure (Aberhe et al., 2020). The researchers assumed that there was no relationship between marital status and the incidence of hypertension. This was because the majority of respondents were married.

The Relationship Between Employment Status and the Incidence of Hypertension Among Blood Donors

The analysis showed that those who were unemployed were 25.00% more likely to have hypertension. Meanwhile, those who were employed were 90.38% more likely to not have hypertension (OR = 0.32). This means that employed donors prevented hypertension by 68% (p = 0.013), which means H0 was rejected. Therefore, it was concluded that there is a relationship between employment status and hypertension among donors. These results align with Kholifah et al. (2020), who showed a relationship between occupation and the incidence of hypertension. This research aligns with Raihan et al.'s (2014) research, which showed a significant relationship between occupation and increased blood pressure. The study stated that most respondents were housewives, as housework is a contributing factor to reduced physical activity and stress. Housewives tend to be less physically active. This statement aligns with Ramdhani et al.'s (2013) research, which stated that the relationship between occupation and the incidence of hypertension is due to the fact that most of the respondents in the study were elderly women and unemployed or housewives. In research by Clougherty et al. (2009), the risk of hypertension can increase when associated with employment. According to research by Rumball-Smith et al. (2014), employment status in Poland has a negative effect on health. Employment status is also a predictor of the risk of certain diseases. Thus, it can be concluded that employment is one factor that can cause increased blood pressure.

The Relationship Between Diet and the Incidence of Hypertension Among Blood Donors

The analysis showed that those with a good diet were 84.62% more likely to have no hypertension. Meanwhile, those with a poor diet were 67.31% more likely to have hypertension (OR = 11.32). This means that a poor diet is 11 times more likely to have hypertension compared to those with a good diet (p = 0.0001), which rejects H0. Therefore, it is concluded that there is a relationship between diet and hypertension among donors. These results are in line with Gebremichael et al. (2019), which showed that a low-salt diet in hypertensive patients had a significant relationship with uncontrolled hypertension (P value = 0.01). And seen from the OR value = 1.98, which means that hypertensive patients who do not comply with a low-salt diet have a 1.98 times greater chance of experiencing uncontrolled hypertension than hypertensive patients who comply with a low-salt diet (Gebremichael et al., 2019).

The Relationship Between Smoking Status and the Incidence of Hypertension Among Blood Donors

The analysis showed that non-smokers were more likely to have hypertension (52.88%), while smokers were more likely to have hypertension (67.31%) (OR = 2.31). This means that smokers are twice as likely to have hypertension as non-smokers (p = 0.018), rejecting H0. Therefore, it was concluded that there is a relationship between smoking status and hypertension among donors. These results align with those of Unsadi & Suhartomi (2022), who showed a relationship between smoking behavior and the incidence of hypertension, with a p-value of 0.002. Cigarettes contain various harmful substances, one of which can cause hypertension, nicotine. Nicotine can increase sympathetic nervous system activity and contribute to the development of atherosclerosis. Vasoconstriction, activation of the renin-angiotensin system, and sodium and water reabsorption, driven by increased sympathetic activity and cytokines, can lead to severe hypertension. Furthermore, nicotine's bidirectional effects on inflammatory pathways through different nicotinic acetylcholine receptors can alter the immune balance, leading to excessive inflammation and exacerbating hypertension (Zhang et al., 2021).

The results of this study are in line with the results of Nuriani et al. (2021) in the community in Pidie Jaya Regency who reported similar results, where smoking behavior was significantly associated with the occurrence of hypertension, this is reflected in the P value <0.05 (5,9,10). Zhang et al. (2021) reported different results where smoking significantly affected systolic blood pressure

in the community in China (P value <0.001). Lee et al. (2001) reported that quitting smoking can significantly cause an increase in blood pressure. In the study of Lee et al. (2001) reported that in the initial phase of smoking there will be a decrease in blood pressure, this is related to the patient's body weight which tends to be normal, but in the later phase blood pressure increases in line with increasing exposure to cigarettes and is followed by increased food intake resulting in weight gain. From the results of these studies, it can be seen that smoking can significantly cause hypertension, especially in smokers with a long smoking period (Zhang et al., 2021).

The Relationship Between Physical Activity and the Incidence of Hypertension Among Blood Donors

The analysis showed that vigorous physical activity was more common among non-hypertensive individuals (8.65%). Moderate physical activity was more common among non-hypertensive individuals (75.96%). Meanwhile, light physical activity was more common among hypertensive individuals (63.46%) (OR = 0.12). This means that moderate physical activity prevented hypertension by 88% (p = 0.0001), which rejects H0. Therefore, it is concluded that there is a relationship between moderate physical activity and hypertension among donors. This result is in line with Rihiantoro & Widodo (2017), showing that the p value: 0.005. This indicates a relationship between physical activity and the incidence of hypertension. The analysis results also explain the OR value = 2.255 (1.245-4.084) which means that respondents who do light physical activity are at risk of suffering from hypertension by 2.26 times compared to those who do moderate and heavy physical activity. Of the total 34 respondents who do light physical activity, there are 23 respondents (67.6%) who suffer from hypertension and 11 respondents (32.4%) who do not suffer from hypertension. Meanwhile, of the total 30 respondents who do moderate and heavy physical activity, there are 9 respondents (30%) who suffer from hypertension and 21 respondents (70%) who do not suffer from hypertension (Rihiantoro & Widodo, 2017). Lack of activity is a key risk factor for non-communicable diseases such as hypertension. Furthermore, physical inactivity is the fourth leading risk factor for death worldwide. Approximately 3.2 million people die each year due to physical inactivity (Rihiantoro & Widodo, 2017).

Physical activity is generally defined as body movement generated by skeletal muscles and resulting in energy expenditure. For those with one or more risk factors for hypertension, physical activity can prevent an increase in blood pressure. For those with mild hypertension, physical activity can control blood pressure, so pharmacological treatment may no longer be necessary. Regular exercise is ideally 3-5 times a week and for a minimum of half an hour per session with moderate intensity. Recommended exercises for those with hypertension are light in nature, such as walking, jogging, and cycling (Lestari et al., 2020). Physical activity is the physical movement performed by the body's muscles and their supporting systems. Every bodily movement produced by skeletal muscles requires energy expenditure. Lack of physical activity is an independent risk factor for chronic disease and is estimated to cause global mortality overall (Sholihin, 2015).

Physical activity affects blood pressure stability. People who are not physically active tend to have a higher heart rate. This causes the heart muscle to work harder with each contraction. The harder the heart muscle works to pump blood, the greater the pressure placed on the artery walls, thereby increasing peripheral resistance, which causes blood pressure to rise (Harahap et al., 2017). The WHO recommends engaging in moderate-intensity physical activity for 30 minutes per day in 1 week or 20 minutes per day for 5 days in a week with high intensity to obtain optimal results from physical activity or exercise. Epidemiologists divide physical activity into two categories: structured physical activity (sports activities) and unstructured physical activity (daily activities such as walking, cycling, and working) (Hadi, 2020). Lack of physical activity increases the risk of hypertension due to the increased risk of being overweight. Therefore, it can be concluded that the majority of respondents were less active. People who are less physically active also tend to have a higher heart rate, requiring their heart muscle to work harder with each contraction. The harder and

more frequently the heart muscle has to pump, the greater the pressure placed on the arteries (Sari & Susanti, 2016).

The Relationship Between Diabetes Mellitus and Hypertension Incidence Among Blood Donors

The analysis showed that those without diabetes mellitus were more likely to have hypertension (77.88%). Meanwhile, those with diabetes mellitus were more likely to have hypertension (53.85%) (OR=4.11). This means that those with diabetes mellitus are four times more likely to have hypertension compared to those without diabetes mellitus (p=0.0001), or H0 is rejected. Therefore, it is concluded that there is a relationship between diabetes mellitus and hypertension among donors. These results align with those of Kholifah et al. (2020), who showed a p-value of 0.000, thus concluding that there is a relationship between a history of diabetes mellitus and the incidence of hypertension in the Janti Community Health Center in Malang City. A study by Hashemizadeh & Sarvelayati (2013) found that the duration of diabetes also influences the increased risk of hypertension, with individuals with diabetes for 5-10 years having a threefold increased risk of developing hypertension.

Diabetes is a complication, meaning it can trigger other diseases. This is in line with the opinion that DM is a disease characterized by elevated blood sugar levels above normal limits, which occurs due to abnormalities in insulin secretion, insulin function, or both, requiring appropriate and serious treatment (Pratita, 2013). Diabetes Mellitus (DM) is a disease involving pancreatic endocrine hormones, including insulin and glucagon. Its main manifestations include impaired lipid, carbohydrate, and protein metabolism, which in turn triggers hyperglycemia. Indonesia is one of the 10 countries with the highest number of diabetes sufferers (Mihardja et al., 2018).

People with a history of diabetes mellitus (DM) are more likely to have high blood pressure. This is because they experience insulin resistance and hyperinsulinemia, which can increase peripheral resistance and vascular smooth muscle contractility to norepinephrine and angiotensin II (Nuraini, 2015). Diabetes can trigger plaque formation in large blood vessels (atherosclerosis). The impact of plaque is that blood flow will narrow, requiring higher pressure for blood circulation throughout the body.

The Relationship Between Hypercholesterolemia and Hypertension Incidence Among Blood Donors

The analysis showed that those without hypercholesterolemia were more likely to have hypertension (77.88%). Meanwhile, those with hypercholesterolemia were more likely to have hypertension (53.85%) (OR = 4.11). This means that those with hypercholesterolemia were four times more likely to have hypertension compared to those without hypercholesterolemia (p = 0.0001), or H0 was rejected. Therefore, it was concluded that there is a relationship between hypercholesterolemia and hypertension among donors. High cholesterol levels, or hypercholesterolemia, in the blood can trigger hypertension. This is because high cholesterol can cause blockages in peripheral blood vessels, reducing blood supply to the heart (Maratu et al., 2012). High blood cholesterol levels increase the risk of atherosclerosis, which causes fatty deposits (plaque) in the lining of blood vessels, which can easily block blood vessels, resulting in increased peripheral resistance, which in turn increases blood pressure (Salwan et al., 2022).

Hypercholesterolemia is a modifiable risk factor for hypertension. Hypercholesterolemia is a condition characterized by elevated blood cholesterol levels above normal (Suci et al., 2020). Hypercholesterolemia can increase the risk of atherosclerosis, coronary heart disease, pancreatitis (inflammation of the pancreas), diabetes mellitus, thyroid disorders, liver disease, and kidney disease (Yani, 2015). Literature studies and other research indicate that cholesterol levels have a significant relationship with the incidence of hypertension. Harefa's (2020) research shows a

significant relationship between hypercholesterolemia and grade 1 hypertension, where people with hypercholesterolemia have a 1.65 times greater risk of experiencing grade 1 hypertension compared to people with normal cholesterol levels in the working area of the Hiliweto Gido Community Health Center, Nias Regency. The higher a person's total blood cholesterol level, the more it can trigger an increase in blood pressure. This is in line with the results of Feryadi's (2019) research, which found a significant relationship between cholesterol levels and the incidence of hypertension, where respondents with abnormal cholesterol levels had a 2.09 times greater risk of developing hypertension than respondents with normal cholesterol levels in Padang City.

In 2006, doctors examined data from thousands of women and found that the higher the cholesterol levels in middle-aged women, the more susceptible they were to hypertension (Nikolov et al., 2015). A study in Iran by Chehrei et al. (2007), conducted on 250 hypertensive patients and 750 healthy subjects, found a statistically significant difference in total cholesterol levels and the risk of hypertension (p-value <0.001). Similarly, in a study conducted in Zaria, Northern Nigeria by Margarita et al. (2011), this study compared total serum cholesterol levels in 100 hypertensive patients with 50 normotensive subjects, and found a statistically significant difference between total cholesterol levels in hypertensive patients compared to normotensive subjects. Bulpitt et al.'s (1976) study on 698 subjects aged 40-49 years also showed a significant association only between systolic blood pressure and serum cholesterol.

The Relationship Between Donor Frequency and the Incidence of Hypertension Among Donors

The analysis showed that donor frequency was higher in those without hypertension, with a mean OR of 7 times per year (OR = 0.71). This means that the higher the donor frequency, the lower the incidence of hypertension (p = 0.009), or H0 is rejected. Therefore, it is concluded that there is a relationship between donor frequency and the incidence of hypertension among donors. The results of this study are in line with the results of Zheng's study (2020). The study divided donors into two groups, namely high-frequency donors (donating blood ≥8 times per 2 years) and low-frequency donors (donating blood 1-2 times per 2 years). From the study, it was found that high blood donation frequency can reduce iron stores, but there was no significant difference between the blood pressure of donors with high blood donation frequency and blood pressure of donors with low blood donation frequency.

The Relationship Between Blood Type and the Incidence of Hypertension Among Blood Donors

The analysis results show that blood type A is not hypertensive and hypertension is 19.23%. Blood type B is more likely to have hypertension by 32.69%. Blood type AB is more likely to have hypertension by 8.65%. While blood type O is more likely to not have hypertension by 45.19% (OR value = 1.21). This means that blood type B has a 1.21 times risk of hypertension compared to blood type A (p = 0.695) or H0 is accepted, so it is concluded that there is no relationship between blood type B and the incidence of hypertension among donors (OR value = 0.89). This means that blood type AB 11% prevents the incidence of hypertension (p = 0.865) or H0 is accepted, so it is concluded that there is no relationship between blood type AB and the incidence of hypertension among donors (OR value = 0.89). This means that blood type O 11% prevents the incidence of hypertension (p = 0.810) or H0 is accepted, so it is concluded that there is no relationship between blood type O and the incidence of hypertension among donors.

The results of this study are not in line with Fitra, et al (2019), showing that there is a significant relationship between blood type and the incidence of hypertension (P value <0.05) namely p value 0.005. It was found that respondents with blood type O who did not suffer from hypertension were more than respondents who suffered from hypertension (62.2%: 37.8%), while respondents with blood type Non-O who suffered from hypertension were more than respondents who did not suffer

from hypertension (67.0%: 31.3%).

Hypertension is a major factor causing heart and blood vessel disease. Undetected and inadequately treated, persistent high blood pressure can cause damage to the kidneys (kidney failure), heart (coronary heart disease), and brain (stroke). Therefore, efforts are needed to analyze the risk factors for hypertension so that the incidence of hypertension can be controlled. One factor that increases the risk of hypertension is the ABO blood type. Blood type is thought to influence increased blood pressure because individuals with blood type O have a high risk of arterial and venous thrombosis. This mechanism is caused by the Von Willebrand factor (VWF). VWF levels were found to be lower in individuals with blood type O when compared to Non-O blood types (A, B, AB). This condition is thought to affect the pressure load on blood vessels which results in increased blood pressure (BA et al., 2017). According to the AHA (American Heart Association), researchers from the Harvard Study concluded that people with blood type AB have a 23% greater risk of developing heart disease when compared to individuals with blood types B, A, and O. Blood type B has an 11% increase in CHD, followed by blood type A, which is 5%, and the smallest is blood type O (He et al., 2013).

El-sayed & Amin's (2015) research, which stated that blood type O is protected from cardiovascular disease while blood type B followed by A is a risk factor for hypertension. The results of this study are supported by the research of Sharif, S., Anwar, N. Farasat, T., & Naz (2014), which stated that individuals with blood type A (NonO) have a significantly high risk of developing Ischemic Hearth Disease (IHD) (p value <0.05) with the largest IHD risk factor found in hypertension sufferers. Marie and Saidou's research in Africa (2017), also reported that there was a significant relationship between blood type A and the incidence of stroke and coronary artery disease (CAD) (p value <0.0001).

Mishra & Pradhan's (2016) research on the relationship between maternal blood type and gestational hypertension disorders also showed that individuals with blood type A or AB (Non-O) were found to have an increased risk of gestational hypertension disorders compared to individuals with blood type O. The results of this study are also supported by several expert opinions, namely according to Adi (2007), stating that there is a relationship between heart disease and blood type. Foods containing proteins called lectins can agglutinate certain blood type cells. Individuals with blood type A have a weak ability to metabolize animal proteins and fats. Blood clotting (agglutination) will disrupt cell activity in certain body organs, so that nutrients are not properly absorbed to each target by the body. This condition causes the heart muscle to lack nutrition, weakens the heart rate, abnormal fat profiles, and poor heart muscle function. The narrowing of the coronary blood vessels results in blood being blocked from reaching the heart tissue and in the long term results in heart tissue death. Heart disease more often attacks individuals with blood type A who have hypertension.

According to Adi (2007), individuals with blood type A have a weakness in fat metabolism which results in hypercholesterolemia, which is a risk factor for hypertension. High-fat foods contribute to the development of hypercholesterolemia. Hypercholesterolemia can disrupt the function of blood vessel endothelium and lead to the formation of atherosclerosis. High cholesterol levels increase blood vessel pressure. Cholesterol causes blood vessel walls to become thick and stiff, causing the arteries to lose their flexibility and become rigid. As a result, blood vessels do not expand elastically when the heart pumps blood through them, and blood is pushed forcefully through narrow blood vessels, ultimately increasing blood pressure (Price & Wilson, 2006).

Individuals with blood type A tend to have difficulty digesting vitamin B12. This is due to intrinsic factors, namely substances produced by the stomach wall to help absorb vitamin B12 into the blood. Vitamin B12 intake is met from consuming animal protein. Vitamin B deficiency can affect high cholesterol levels in the blood, because vitamin B can lower cholesterol levels (Adi, 2007). This theory is supported by research by Carpeggiani, Coceani, Landi, Michelassi, & Abbate (2010) on ABO blood type alleles as a risk factor for coronary artery disease, which shows that there is a significant relationship between Non-O blood type and a history of ischemic heart disease, hypercholesterolemia and coronary atherosclerosis. According to Siddiqui, Chaudhry, Nigar, & Butt (2011), blood type A was found to have a higher incidence of AP (Angina Pectoris). According to Carpeggiani, Coceani, Landi, Michelassi, & Abbate (2010), individuals with blood type A and B (Non-O) are also more frequently affected by infarction.

Myocardium (IM). Non-O blood type increases the risk of cardiac death in young patients with Myocardial Infarction (<65 years). MI is the most common complication of Coronary Artery Disease (CAD) caused by occlusive thrombus. The increased risk of thrombosis is associated with Non-O blood type which has high von Willebrand factor (vWF) in the blood. Blood types A and B are risk factors for coronary atherosclerosis and the strongest predictors of cardiac death. The results of the study showed that 67.0% of respondents with Non-O blood type (A, B, and AB) suffered from hypertension. This is because individuals with Non-O blood type, namely A, B, AB, have higher vWF levels in the blood which leads to thrombosis in the blood vessels. In addition, individuals with Non-O blood type (A, B, AB) have weaknesses in protein metabolism which results in disorders of the heart muscle. Abnormalities in animal fat metabolism result in an abnormal fat profile which leads to the formation of atherosclerosis. This entire process results in increased pressure in the blood vessels and impaired contractility in the heart muscle and ultimately increases blood pressure. Von Willebrand factor can also trigger the formation of aggregation or adhesion and atherosis leading to endothelial dysfunction which is the initial step in thrombus formation. Non-O blood type increases the risk and severity of venous thrombosis. There is considerable evidence that high von Willebrand factor VIII can represent an important risk factor for VTE (Venous Thromboembolism) (Miñano et al., 2008). The procoagulant vWF is a glycoprotein that mediates thrombosis and adhesion molecules in the blood and has been shown to be associated with coronary heart disease, venous thromboembolism, and atherosclerosis (Larson et al., 2016). There are significant differences in lipid profiles and markers of inflammatory adhesion between individuals with blood type A and O. Blood type O has a more favorable lipid profile and a lower risk of coronary heart disease (Teng, Hsu, Wu, Chou, & Chang, 2013).

ABO blood type has a major influence on hemostasis and is the main determinant of plasma concentration of von Willebrand factor (VWF) (Capuzzo et al., 2016). According to Dharma, Rezeki, & Priatni (2006), stated that the role of WF in hemostasis, if the level is too low can cause bleeding, but if the level is high enough can cause thrombosis. This is reinforced by Faranita, Trisnawati, & Lubis (2016), stating that hemostasis is an important body defense mechanism in stopping bleeding in injured blood vessels. Hemostasis and coagulation are a complex series of reactions that result in controlling bleeding through the formation of platelets and fibrin clots at the site of injury. The hemostasis mechanism has two primary functions: to ensure that circulating blood remains fluid when in the blood vessels, and to stop bleeding in injured blood vessels. Normal hemostasis depends on a good balance and complex interactions between blood vessel components, platelets, coagulation factors, the fibrinolysis system, and inhibitors to maintain blood fluidity in a normal state. The range of vWF values is influenced by many factors. The vWF value can be influenced by lifestyle and environment, such as age, smoking, hypertension, and diabetes. The level of vWF factor is also influenced by genetic factors, such as blood type and genetic polymorphisms. Increased WF levels can also be caused by endothelial damage. Non-O blood type is known to have 25% higher vWF levels than blood type O. In the coagulation process, thrombin can stimulate vWF secretion. So the higher the coagulation activation, the more vWF is secreted

into the plasma which is the initial step in thrombus formation (Dharma et al., 2006). The results of the study showed that 62.2% of respondents with blood type O did not suffer from hypertension. This is because individuals with blood type O have abnormalities in blood clotting. Individuals with blood type O have the lowest vWF levels compared to other blood types, namely A, B, and AB. The low level of vWF in the body of a person with blood type O causes there to be no blood deposits on the walls of blood vessels, but it is difficult in the blood clotting process. This causes blood type O to have very low coagulability compared to other blood types. Blood type O has a lower risk of hypertension compared to non-O blood types (A, B, and AB). Researchers assume there's no link between blood type and hypertension due to other factors, such as donor frequency. It's possible that blood types A, B, AB, and O have similar rates of donation. Therefore, there's no link between blood type and hypertension.

CONCLUSION

There is a significant relationship between occupation, diet, smoking status, physical activity, diabetes mellitus, hypercholesterolemia, donation frequency, and body mass index (BMI) with the incidence of hypertension in blood donors at the Indonesian Red Cross Blood Donor Unit in Banda Aceh. The most dominant factors associated with the incidence of hypertension are moderate physical activity, smoking status, and BMI. Therefore, it is recommended that the Indonesian Red Cross Blood Donor Unit in Banda Aceh increase promotive and preventive efforts through continuous education regarding healthy eating patterns, increasing physical activity, and controlling smoking habits for donors, as well as implementing regular health monitoring that includes checking for hypertension risk factors. In addition, the unit management is expected to utilize donor health data for routine program evaluations to support hypertension prevention and maintain the health quality of blood donors.

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