Association Between Body Mass Index, Physical Activity, Stress Level, and Hypertension in Kalirejo Residents

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ABSTRACT

Background: *Hypertension is amongst the top 10 non-communicable diseases and is the leading cause of premature death worldwide. Multiple factors contribute to the occurrence of hypertension. Risk factors include modifiable ones, such as lifestyle, smoking habits, sleeping patterns, caffeine consumption, physical activity, high-sodium diet, and stress levels. On the other hand, factors such as gender and age are non-modifiable. A primary survey in Kalirejo, Lawang, showed that hypertension is the leading health issue. This research aims to analyze the association between body mass index, physical activity level, and stress level with hypertension in Kalirejo, Lawang.*

Method: *This research is a correlative analytical descriptive study using the cross-sectional method that involves 99 residents aged ≥ 45 years old in Kalirejo.*

Results: *This study revealed that the largest age group in Kalirejo is elderly people, with most respondents being female, non-smokers, and with no family history of hypertension. A majority of the respondents consume caffeine and use minimal salt. The largest BMI distribution is within the normal category (41.4%). High physical activity is found to be more frequent (45.5%), and stress level is primarily low (62.6%). Bivariate analysis shows a significant association between BMI and hypertension ($p<0.05$). Meanwhile, physical activity and stress levels are irrelevant to the occurrence of hypertension. This study discovered that there is a significant association between BMI and hypertension, and a non-significant association between physical activity and stress level with hypertension, respectively, among pre-elderly and elderly residents in Kalirejo.*

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INTRODUCTION

Hypertension is a serious medical condition because it significantly increases the risk of heart disease, cerebrovascular disease, kidney disease, and other diseases. Hypertension is defined as a condition when the measured systolic pressure is ≥140 mmHg or the measured diastolic pressure is ≥90 mmHg. Globally, the prevalence of hypertension is estimated at 1.28 billion or 22% of the world's population aged over 30 years, making it one of the leading causes of premature death worldwide.[1]

In Indonesia, the prevalence of hypertension reached 63.309.620 people or 34.1% at the age of more than 18 years, with a death rate due to hypertension of 427.218 deaths.[2] According to a preliminary study conducted in Kalirejo, Lawang, the incidence of hypertension is 55%. This incidence is above the national hypertension prevalence.[2] Hypertension is associated with a significant global cardiovascular burden and early death.[3] Efforts to prevent morbidity and mortality are a top global priority. Prevention of morbidity and mortality will have a better outcome if done early, which can be attempted through risk factor modification.

The risk factors for hypertension are divided into non-modifiable and modifiable risk factors. Non-modifiable risk factors include a family history of hypertension, age >65 years, and the presence of other comorbidities, including diabetes and kidney disease. Modifiable risk factors include diet, physical activity, consumption of alcohol and cigarettes, psychosocial stress, and obesity.[4,5] Obesity is a reasonably consistent risk factor for hypertension across all age groups and ethnicities. The results of Riskesdas in the last three series in 2007, 2013, and 2018 found an increase in the prevalence of obesity, namely 10.5%, 14.8%, and 21.8%, respectively, and this needs to be addressed appropriately.[2] Physical activity is a risk factor for hypertension because it can affect blood pressure stability.

Individuals with less physical activity are more at risk of experiencing hypertension compared to individuals with sufficient physical activity.[6,7]

Chronic psychosocial stress has recently been found to contribute to the development of hypertension. Acute stress that occurs repeatedly until it becomes chronic can cause continuous stimulation of the sympathetic nervous system and cause persistent increases in blood pressure.[8] Chronic psychological stress may be involved in a distorted lifestyle, psychological stress, and long-term stress contribute to increasing blood pressure. Problems of stress are common among patients in modern society. Viewing psychosocial stress as the etiology of elevated blood pressure helps individualized approaches and achieve 24-hour blood pressure control.[9]

The modifiable risk factors for hypertension in different population groups make it possible to produce different pictures of the dominance of different risk factors so that similar studies with different subjects still need to be carried out, both for academic purposes and for the formulation of policies by the government. Therefore, this study aims to prove the association between body mass index, level of physical activity, and stress levels with the incidence of hypertension in Kalirejo, Lawang. Hopefully, our results can capture the demographical and behavioral factors contributing to the incidence of hypertension in Kalirejo.

METHOD

An analytical observational study with a cross-sectional design was conducted from February 18th - 25th, 2023. The population was residents of Kalirejo, Lawang, aged ≥ 45 years old, while the sample was people that willing to participate after being given an explanation about the purpose of this study and signed an informed consent. Consecutive sampling was used to conduct the samples. The minimum number of samples was 96, determined using the Snedecor and Cochran formula.

Independent variables in this study were age, gender, family history of hypertension (first-degree relative), smoking, sodium diet, caffeine consumption, body mass index, physical activity, and stress level. The dependent variable was blood pressure, and it was categorized into hypertension and normal. All independent variables, except body mass index, were conducted during a direct interview between the subject and the researchers' team. Age was classified into two different groups: pre-elderly (45 - 59 years old) and elderly (≥60 years old). Body mass index was determined after weight and height measurement using the Onemed scale and stature meter. Global Physical Activity Questionnaire (GPAQ) and Perceived Stress Level (PSS-10) questionnaire were used to measure physical activity and stress levels. Blood pressure was measured twice within a five-minute interval using an Omron digital blood pressure monitor.

The GPAQ questionnaire consists of 16 questions and is grouped into 4 sections. The questions are related to activity at work, travel to and from places, recreational activities, and sedentary behavior. The answers were converted into a scoring system, and then classified into mild, moderate, and high physical activities. The PSS-10 questionnaire consists of 10 questions. Respondents were asked to convey how often they felt and thought about the situation at each question. The answers were converted into a scoring system, and then classified into mild, moderate, and high stress levels. This study design has been approved by the Ethical Committee Faculty of Medicine Universitas Airlangga with the registered number 51/EC/KEPK/FKUA/2023.

RESULTS AND DISCUSSION

Characteristics of The Participants

A total of 26 (26.3%) males and 73 (73.7%) females participated in this research. Of 99 participants, 39 (39.4%) were categorized as pre-elderly, and 60 (60.6%) were categorized as elderly. Most participants had no family history of hypertension (1st-degree relatives) 56 (56.6%). The majority of the participants have no smoking activity (75.8%), sodium consumption ≤1 tsp (76.8%), daily caffeine consumption (70.7%), normal BMI (41.4%), low physical activity (45.5%) and low-stress level (62.6%).

The subjects of this study are predominantly elderly, similar to the findings of prior studies.[10] The more dominant sex in this study is female, which is linear to the 2020 health profile report of the Kalirejo area. In line with a previous study, there are more female hypertensive patients compared to males.[11] Most of the subjects in this study have no family history of hypertension.[12] There are more non-smoking hypertensive respondents compared to smoking respondents.[12,13] Similarly, this study found the same results. This study discovered that most of the respondents who suffer from hypertension consume ≤ 1 tsp (≤ 2400 grams) of salt daily, and consume caffeine, which is in accordance with prior findings.[14,15]

This study shows that the most common BMI category of the respondents was normal. Meanwhile, among the respondents with hypertension, the most common BMI category was obesity. The previous studies support this result. This study found that there were more hypertensive patients than those without hypertension among the light activity group of respondents. The results of this study are following the previous study. Meanwhile, the stress level was dominated by low stress levels. Obesity is a modifiable risk factor for hypertension.[14]

This study shows a significant relationship between body mass index and the prevalence of hypertension with a p-value of 0.017 (p-value = 0.05). This study is in line with the previous studies.[16–18] Visceral adipose tissues trigger the release of free fatty acids resulting in hyperinsulinemia and increased insulin resistance. Insulin resistance causes systemic vascular vasoconstriction resulting in hypertension. Increased insulin levels are responsible for promoting lumbar SNA through activation of brain receptor patterns.[19] This condition causes leptin resistance, leading to hypertension.[19] Obesity also causes activation of the RAAS and renal sympathetic nerves resulting in impaired natriuresis which leads to the occurrence of hypertension.[19]

Table 1. Characteristics of the participants

Characteristics	f	%
Age		
Pre-elderly	39	39.4
Elderly	60	60.6
Sex		
Male	26	26.3
Female	73	73.7
Family history of hypertension (1st-degree relatives)		
Yes	43	43.4
No	56	56.6
Smoking		
Yes	24	24.2
No	75	75.8
Sodium diet		
≤1 tsp	76	76.8
>1 tsp	23	23.2
Caffeine consumption		
Yes	70	70.7
No	29	29.3
Body mass index		
Severely underweight	1	1.0
Underweight	4	4.0
Normal	41	41.4
Overweight	17	17.2
Obese	36	36.4
Physical activity		
Low	45	45.5
Moderate	23	23.2
High	31	31.3
Stress level		
Low	62	62.6
Moderate	36	36.4
High	1	1.0

Table 2. Association between the characteristics of the sample study and hypertension occurrence

Characteristics	Hypertension occurrence		f (%)	p-value
	Hypertension f (%)	Normal f (%)		
Age				
Pre-elderly	23 (35.9)	16 (45.7)	39 (39.4)	0.341
Elderly	41 (64.1)	19 (54.3)	60 (60.6)	
Sex				
Male	19 (29.7)	7 (20.0)	26 (26.3)	0.295
Female	45 (70.3)	28 (80.0)	73 (73.7)	
Family history of hypertension (1st-degree relatives)				
Yes	31 (48.4)	12 (34.3)	43 (43.4)	0.174
No	33 (51.6)	23 (65.7)	56 (56.6)	
Smoking				
Yes	18 (28.1)	6 (17.1)	24 (24.2)	0.223
No	46 (71.9)	29 (82.9)	75 (75.8)	
Sodium diet				
≤1 tsp	46 (71.9)	30 (85.7)	76 (76.8)	0.119
>1 tsp	18 (28.1)	5 (14.3)	23 (23.2)	
Caffeine consumption				
Yes	46 (71.9)	24 (68.6)	70 (70.7)	0.73
No	18 (28.1)	11 (31.4)	29 (29.3)	
Body mass index				
Severely underweight	0 (0)	1 (2.9)	1 (1.0)	0.024*
Underweight	1 (1.6)	3 (8.6)	4 (4.0)	
Normal	24 (37.5)	17 (48.6)	41 (41.4)	
Overweight	12 (18.8)	5 (14.3)	17 (17.2)	
Obese	27 (42.2)	9 (25.7)	36 (36.4)	
Physical activity				
Low	28 (43.8)	18 (51.4)	46 (46.5)	0.698
Moderate	17 (26.6)	6 (17.1)	23 (23.2)	
High	19 (29.6)	11 (31.5)	30 (30.3)	
Stress level				
Low	40 (62.5)	22 (62.9)	62 (62.6)	0.928
Moderate	23 (35.9)	13 (37.1)	36 (36.4)	
High	1 (1.6)	0 (0)	1 (1.0)	

Association Between Age and Hypertension

Table 2 shows that the participants who had hypertension were mostly elderly (64.1%). From Chi-square analysis, there is no significant association between age and hypertension in this study with p-value = 0.341 (<0.05). Based on the distribution of the incidence of hypertension, the study shows that most study subjects have hypertension. This result is supported by the study of Basic Health Survey 2018 of Indonesia, data shows that the prevalence of hypertension in Indonesia was 34.1% at the age of over 18 years.[2] Meanwhile, the global prevalence of hypertension is 22%.[1] This result aligns with a prior study that reported a higher percentage of elderly respondents with hypertension at 58% compared to the pre-elderly category at 42%.[10] Murphy et al. claimed that hypertension prevalence rises with age, with the prevalence among elderly subjects being up to 64% and only 45% being aware of it.[20]

Association Between Sex and Hypertension

Table 2 shows that the participants who had hypertension were predominantly female (70.3%). From Spearman's analysis, there is no significant association between sex and hypertension in this study with p-value = 0.295 (<0.05). Based on the study that had been done, most of the subjects in this study are female. This result is consistent with Health Profile of Kalirejo in 2020, which reported that the population of the Kalirejo area is female-dominated. Consistently, most of the respondents with hypertension in this study are female. A previous study conducted in Ibnu Sina hospital reported similar findings to this study.[11]

Association Between Family History of Hypertension and Hypertension

Table 2 shows that the participants who had hypertension had no family history of hypertension (51.6%). From Spearman's analysis, there is no significant association between a family history of hypertension and hypertension in this study with p-value = 0.174 (<0.05). Based on the collected data on familial medical history, most of the subjects, with or without hypertension, do not have a familial history of hypertension. This result is in accordance with a previous study in Palembang, which stated that 51.4% of the study respondents do not have any familial history of hypertension.[12]

Association Between Smoking and Hypertension

Table 2 shows that the participants who had hypertension had no smoking activity (71.9%). From Spearman's analysis, there is no significant association between smoking and hypertension in this study with p-value = 0.223 (<0.05). Smoking is a proven risk factor for cardiovascular diseases. Smoking and secondhand smoke exposure are known to increase the risk of plaque buildup inside the arteries. Thus, causing blood pressure elevation. The majority of the respondents with hypertension in this study are non-smokers at 71.9%, compared to 21.8% of the respondents who smoke. The non-smoker subjects (60 respondents) suffer from hypertension compared to the subjects who smoke (31 respondents).[12] Similar findings were reported in a previous study where more non-smoker subjects (71 respondents) suffer from hypertension compared to those who don't smoke (11 respondents).[13]

Association Between Sodium Diet and Hypertension

Table 2 shows that the participants who had hypertension had <1 tsp sodium diet (71.9%). From Spearman's analysis, there is no significant association between sodium diet and hypertension in this study with p-value=0.119 (<0.05). Salt intake is known to be one of the factors that contribute to hypertension. Therefore, the Indonesian Health Ministry recommends ≤ 2400 g of daily salt intake, which equals to ≤ 1 tsp. Based on the data collected, most of the respondents who suffer from hypertension consume ≤ 1 tsp (≤ 2400 g) of salt daily, which conforms to the Indonesian Health Ministry's recommendation. On the other hand, a number of subjects (18 respondents) consume excessive salt daily (> 1 tsp or > 2400 g/day). A similar result was reported in 2021 by Khasanah, in which that study found that 100% of the respondents consume adequate salt intake daily and that none have an excessive salt intake.[14]

Association Between Caffeine Consumption and Hypertension

Table 2 shows that the participants who had hypertension had caffeine consumption (71.9%). From Spearman's analysis, there is no significant association between caffeine consumption and hypertension in this study with p-value = 0.73 (<0.05). This study found that 65.7% of the respondents who consume caffeine suffer from hypertension. On the other hand, a smaller percentage of 34.3% of caffeine-drinker do not suffer from hypertension. This result is in line with a prior study where 79.2% of the respondents who consume caffeine have hypertension and only 20.8% of the respondents do not have hypertension.[15]

Association Between Body Mass Index and Hypertension

Table 2 shows that the hypertension participants had an obese body mass index (42.4%). From Spearman's analysis, there is a significant association between body mass index and hypertension in this study with p-value = 0.024 (<0.05). Body mass index is strongly associated with hypertension. In a cross-sectional survey conducted in Italy, which involved participants of normal, overweight, and obese BMI, it was discovered that increased blood pressure is linear with increased BMI level. The study grouped the participants' BMI status into normal, overweight, and obese. The obese category was further divided into obese class I, class II, and class III. Among those BMI categories, the prevalence of hypertension was 45% among those with normal BMI and 67% among overweight respondents. The joint percentage for participants with class I and class II obesity were 79%. Meanwhile, the prevalence of hypertension among class III obesity participants was up to 87%.[17] This research is supported by previous studies which showed that there was a significant relationship between BMI and the incidence of hypertension. Based on the Chi-Square test, a p-value of 0.010 was obtained (p-value <0.05) and a correlation coefficient of 0.424.[16] Other studies have also shown a direct relationship between BMI and hypertension, starting from the overweight population with an odds ratio of 2.49 (95% CI 1.51-2.78) to class III obesity with an odds ratio of 8.58 (95% CI 3.87-19.00).[17] Other studies that support the relationship between BMI and hypertension state that BMI significantly supports the incidence of essential hypertension with an odds ratio of 1.42.[18] A study based on the South Asian population reported higher odds of hypertension for overweight and obese people with an odds ratio of 2.72 (95% CI 2.00-3.68), 3.03 (95% CI 2.96-3.11), and 3.62 (95% CI 2.97-

4.41) for people with obesity in Bangladesh, India, and Nepal respectively.[21]

Visceral adipose tissue triggers the release of free fatty acids resulting in hyperinsulinemia and increased insulin resistance. Insulin is a vasodilator hormone. If insulin resistance occurs, systemic vascular vasoconstriction will result in hypertension. Increased insulin levels are responsible for promoting lumbar SNA by activating brain receptor patterns, which are directly involved in increasing blood pressure. In addition, this condition causes leptin resistance, which causes local inflammation, increased arterial stiffness, and endothelial dysfunction, leading to hypertension. Obesity also plays a role in perirenal adipose tissue, which causes RAAS activation and renal sympathetic nerves activation, resulting in impaired natriuresis and hypertension.[19]

Association Between Physical Activity and Hypertension

Table 2 shows that the participants who had hypertension had low physical activity (43.8%). From Spearman's analysis, there is no significant association between physical activity and hypertension in this study with p-value = 0.698 (<0.05). Physical inactivity is a risk factor for multiple health issues, namely stroke, heart attack, and hypertension.[22] Lifestyle modification is an essential part of hypertension intervention.[23] This study shows that there is an insignificant association between physical activity levels and hypertension in Kalirejo, with a p-value of 0.549 (>0.05). This finding is in accordance with another studies.[24,25] Both reported no association between the level of physical activity and hypertension. The association between physical activity levels and hypertension is insignificant due to the multifactorial nature of hypertension itself.[26] Therefore, the contribution of each of those factors to the occurrence of hypertension is indeterminable due to their interactions.

Association Between Stress Level and Hypertension

Table 2 shows that the hypertension participants had low stress levels (62.5%). From Spearman's analysis, there is no significant association between stress level and hypertension in this study with p-value = 0.928 (<0.05). Stress is one of the modifiable risk factors of hypertension. This study has no association between stress level and the incidence of hypertension in the elderly, with a p-value = 0.928 (<0.05). This study aligns with the study that Mokti and Abdul Rahime conducted in 2022, where there is no significant relationship between stress and hypertension in bivariate analysis.[27] Another study conducted by Husnaniyah and Melita in 2022 also found no significant relationship between stress and hypertension in the elderly, with a p-value (<0.05) = 0.08.[28] A study conducted by Rina et al in 2018 also showed that there was no significant relationship between stress and hypertension in the elderly.[29] Based on the statistical test results using chi-square, the study from Rina et al obtained a p-value (<0.05) = 0.71, translating into no significant relationship between stress and hypertension.

Various stress domains can affect a person's blood pressure, such as occupational stress, socioeconomic status, and anxiety & depression. There are also multiple mechanisms in the pathophysiology of hypertension induced by stress. One of which is, the involvement of the sympathetic nervous system in stress response, which can cause the elevation of heart rate, cardiac output, and blood pressure.[30] The other example of a mechanism is through the Hypothalamus-Pituitary-Adrenal (HPA) axis. According to the literature from Liu et al in 2017, psychosocial stress promotes transient elevation in blood pressure. The mechanism underlying it is through a cascade of changes in the nervous, cardiovascular, endocrine, and renal systems because of a perception of an acute stress. Many studies show that the body's response to acute stress is temporary and will return to normal limits if the stressor is removed. However, if an acute stress response is sustained, it can become maladaptive. Chronic sympathetic nervous system stimulation of the cardiovascular system can lead to persistent elevation in blood pressure, vascular hypertrophy, and plaque formation.[31]

The insignificant relationship between stress levels and the incidence of hypertension in this study could be caused by respondents who did not experience exposure to stress or serious problems that could cause prolonged stress. This study measured the relationship between stress and hypertension using the PSS-10 questionnaire, and this questionnaire only measured the stress level based on the stressor from the previous month, which can lead to an insignificant relationship between stress level and incidence of hypertension, because the exposure of stress to the respondent may not be enough to cause elevation of blood pressure. Besides that, other factors could influence the relationship between stress levels and hypertension, such as work, economic status, marital status, race, and comorbid conditions.

The level of stress on hypertension, especially in chronic cases has more significant effect than the effects of acute stress[30], but the relationship between chronic stress and long-term hypertension is still controversial.[31] An example of chronic stress is high job strain. It can cause occupational stress, and the exposure from that can be long-term, therefore, can cause a significant effect on blood pressure.

CONCLUSION

There is a significant relationship between body mass index and the incidence of hypertension in Kalirejo Village, Lawang District, Malang Regency. However, there was no significant relationship between physical activity and stress levels with the incidence of hypertension in Kalirejo Village, Lawang District, Malang Regency. Future researchers are expected to be able to conduct research at the same time longer so that respondents can be more open to filling out the questionnaire for stress variable. Residents in Kalirejo are expected to adopt a healthy lifestyle to prevent a high body mass index to reduce the risk of hypertension. The public health center is expected to provide more education or information related to hypertension to the residents of Kalirejo Village so that it is hoped that the residents can avoid the risk factors for hypertension.

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Conflict of Interest

The authors declare there is no conflict of interest.

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