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The risk factors of sodium, potassium intake, and physical activity on hypertension in the elderly

Annisa YOLANDA, Fivi Melva DIANA, Putri Aulia ARZA

Department of Nutrition, Faculty of Public Health, Universitas Andalas, Padang, West Sumatra, Indonesia.

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ABSTRACT

Introduction: Hypertension is called a *silent killer* because many people with hypertension but do not realize that they have it (no signs or symptoms). This study aimed to determine the characteristics of respondents and the risk factors for sodium intake, potassium, and physical activity on hypertension in the elderly.

Methods: Case-control study design with age and gender matching. *Nonprobability sampling* technique. *The* number of case group samples (33 people) is the same as the control (33 people). Sodium and potassium intake data using *food recall* form, and physical activity data with GPAQ *(Global Physical Activity Questionnaire)*. Data analysis with chi-square test, significant ($p < 0.05$). OR>1 is a risk factor.

Results: The results of this study showed: that the family history of hypertension in the case group was more (54.5%) than the control (18.2%). The highest level of education in the case group was elementary school (33%) compared to the control (24.2%). Most respondents did not work in the case group (48.5%) almost as much as the control (51.5%). Most respondents did not smoke in the case group (84.8%) almost as much as the control (81.8%). Statistical test results showed that respondents with more sodium intake had a 5.46 times risk of developing hypertension compared to respondents with adequate sodium intake (p=0.003; OR = 5.46), on the other hand, the results of this study showed that potassium intake was not a risk factor for hypertension. Respondents in the low physical activity category had 5.95 times the risk of hypertension compared to respondents in the high physical activity category (p=0.004; OR=5.95).

Conclusion: Sodium intake and physical activity are risk factors for hypertension. Elderly people are advised to do physical activity for 30 minutes per day to overcome hypertension.

KEYWORDS

Sodium intake, potassium intake, physical activity, hypertension.

INTRODUCTION

Hypertension is often referred to as a *silent killer* because many people with hypertension do not realize that they have it (no signs or symptoms)[1]. Hypertension is characterized by systole blood pressure ≥ 140 mmHg and diastole ≥ 90 mmHg[2].

The P2PM (Disease Prevention and Control) report in 2022 shows that the prevalence of hypertension in Indonesia has increased from 25.8% to 34.1% [1]. The West Sumatra Province report from the Basic Health Research (Riskesdas) in 2018 revealed that the prevalence of hypertension based on population aged ≥18 years in each District/City in West Sumatra Province was 25.16%. Among them, Sawah Lunto city had the highest prevalence at 33.11%, while the lowest was in Mentawai Islands at 17.18%. Agam district ranked among the top ten districts with the highest prevalence of hypertension in West Sumatra Province, with a prevalence of 27.07%[3]. Based on the report from the Agam District Central Statistics Agency in 2023, it is shown that the number of blood pressure measurements for population aged 18 years and over and the hypertension condition by gender and Sub-District in Agam District in 2022, in the Ampek Angkek subdistrict within the Working Area of Puskesmas Magek, had a higher number of hypertension cases, with 789 cases, compared to Palupuh (329), Baso (641), and Banuh Ampu (261)[4].

The causes of hypertension are diverse and involve multiple factors such as chronic stress, obesity, environmental fac-

Correspondencia:
Fivi Melva Diana
fividiana0503@ph.unand.ac.id

tors, genetics, excessive sodium intake, potassium and lack of physical activity, low birth weight, and others[5-8]. The results of research by Wibowo and Wahyono in 2018 stated that the cause of hypertension is sodium intake[9]. In 2019, Fauzan demonstrated a significant relationship between physical activity and hypertension ($p < 0.05$) (OR: 4.00) [10].

Risk factors that cause hypertension are non-modifiable risk factors and modifiable risk factors. Non-modifiable such as age, race, heredity, and gender, while modifiable such as lack of exercise or physical activity, alcoholism, obesity, and smoking[11].

Uncontrolled hypertension is at risk of increasing the occurrence of heart disease, stroke, and kidney failure[1]. Therefore it is necessary to conduct research with the aim: (1) to determine the characteristics of respondents, (2) the relationship between sodium intake and hypertension, (3) the relationship between potassium intake and hypertension, and (4) the relationship between physical activity and hypertension in the elderly in the working area of the Magek health center, Agam district in 2022.

METHODS

This study was conducted in February 2022-March 2022. The research location is in the working area of the Magek Health Center, Agam Regency. This research design is a *case-control study*, with age and gender *matching*, and the ratio of case and control groups is (1: 1). The number of samples in the case group was 33 people and the control group was 33 people. *Non-probability sampling* technique. The sample formula used is:

$$n = \frac{\left\{Z_{1-\alpha/2}\sqrt{2\,P\,(1-P)} + Z_{1-\beta}\sqrt{P_1(1-P_1) + P_2(1-P_2)}\right\}^2}{(P_1 - P_2)^2}$$

Description:

n = Sample size

$Z_{1-\alpha/2}$ = Level of significance = 95% = 0.05 = 1.96

$Z_{1-\beta}$ = Power

$P_1 = \frac{OR\,X\,P_2}{(1-P_2)+(ORXP_2)}$

P_2 = Estimated proportion of exposure in known control group = 0.52

$P = \frac{1}{2}(P_1 + P_2)$

OR = Odds Ratio

This research has obtained informed consent approval from the respondents. The research data consisted of primary and secondary data. Primary data consisted of respondent characteristics, sodium intake, potassium intake, and physical activity. Sodium and potassium intake data were obtained from interviews with 2x 24-hour *food recall forms* and physical activity data were obtained with GPAQ *(Global Physical Activity Questionnaire)*. Secondary data were obtained from Magek Health Center documents. Data analysis used the *Chi-square* test with a significance level of α (0.05) 95% confidence level.

RESULTS

This study comprises age, gender, family history of hypertension, education, occupation, smoking, sodium intake, potassium intake, and physical activity. The results of the data analysis of these variables can be seen in Tables 1, 2, and 3.

Table 1 shows that there were as many respondents in the case group as 11 people (33%) and the control group as 11 people (33%) based on age category. The female gender in the case group was almost the same 17 people (51.5%) with 16 men (48.5%) in the control. Family history of hypertension in the case group was 18 people (54.5%) compared to 6 people (18.2%) in the control group. The highest level of education in the category of elementary school graduates in the case group was 11 people (33%) while the control group amounted to 8 people (24.2%). Most respondents did not work in the case group 16 people (48.5%) almost as much as the control 17 people (51.5%). Most respondents did not smoke in the case group as many as 28 people (84.8%), almost as many as the control group of 27 people (81.8%).

Table 2 shows that the number of respondents with more sodium intake category was 25 people (75.8%) in the case group higher than the control group of 12 people (36.4%). The number of respondents with less potassium intake category in the case group was 26 people (78.8%) higher than the control of 20 people (60.6%), and the physical activity of respondents in the low category in the case group was higher in 28 people (84.8) than the control of 16 people (48.5%).

Table 3 shows that respondents who have sodium intake are more at risk of 5.46 times experiencing hypertension compared to respondents who have adequate sodium intake (OR = 5.46), while potassium intake is not a risk factor for hypertension. Respondents with a low physical activity category had a 5.95 times risk of hypertension compared to respondents with a high physical activity category (OR=5.95).

Table 4 shows that the case group consumed the most sodium-containing foodstuffs from salted fish. Fat consumption was mainly attributed to chicken meat chicken meat, fried instant noodles (indomie), and chicken eggs. Additionally, the highest fiber intake was observed from white bread, fried instant noodles indomie, and mieses toast.

Table 5 illustrates that the case group obtained potassium from various food sources, including rice, potatoes, tilapia, peanuts, corn, bananas, chayote, cucumber, spinach, fried tempeh, and fried bananas. Fat intake in the case group mainly came from peanuts, fried tempeh, and fried bananas. Additionally, fiber was sourced from the consumption of corn, peanuts, and fried bananas in the case group.

Table 1. Frequency distribution of respondent characteristics in the case and control groups

Respondent Characteristics	n	%	n	%
Age				
age (45-59)	11	33.3	11	33.3
Seniors (60-74)	11	33.3	11	33.3
Older Seniors (75-90)	11	33.3	11	33.3
Gender				
Man	16	48.5	16	48.5
Woman	17	51.5	17	51.5
Family History of Hypertension				
There is	18	54.5	6	18.2
There isn't any	15	45.5	27	81.8
Education				
Not completed in primary school	6	18.2	10	30.0
Finished elementary school	11	33.3	8	24.2
Finished high school	4	12.1	4	12.1
Finished high school	11	33.3	8	24.2
Finished PT	1	3.0	3	9.1
Work				
Not working/RT	16	48.5	17	51.5
Farmer	7	21.2	11	33.3
Laborer	2	6.1	0	0.0
Civil servants/private employees	1	3.0	2	6.1
Self-employed	7	21.2	3	9.1
Smoke				
No	28	84.8	27	81.8
Yes	5	15.2	6	18.2
Total	33	100.0	33	100.0

DISCUSSION

Respondent characteristics (age, gender, family history of hypertension, education, occupation, smoking, sodium intake, potassium intake, and physical activity)

Table 1 shows that the number of respondents in the middle age group category (45-59), the elderly (60-74), and the elderly (75-90) is as much as the control. This is in line with Rambing *et al.,* 2021, which shows that there is a significant relationship between age and hypertension (p=0.01) [12].

Increasing age is a strong and non-modifiable risk factor for hypertension. As arteries age, their elasticity or flexibility decreases. The heart, blood vessels, and hormones will naturally change with age and will trigger hypertension in the presence of other factors. People who have an age above 40 years have a higher risk of suffering from hypertension than people who have an age below 40 years[13]. A person's blood pressure tends to increase with age, especially systolic blood pressure, systolic blood pressure will continue to increase during a person's life, while diastolic blood pressure will tend to be constant after entering the age of 40 years[13].

Table 2. Frequency distribution of sodium intake, potassium intake, and physical activity of respondents in the case and control groups

Variable	Case		Control	
	n	%	n	%
Sodium intake				
More (≥ 1500 mg)	25	75.8	12	36.4
Sufficient (< 1500 mg)	8	24.2	21	63.6
Potassium Intake				
Less (< 4700 mg)	26	78.8	20	60.6
Sufficient (≥ 4700 mg)	7	21.1	13	39.4
Physical Activity				
Low (< 3000 MET, not including vigorous activity)	28	84.8	16	48.5
High (≥ 3000 MET, ≥ 7 days/week)	5	15.2	17	51.5

Table 3. Relationship between sodium intake, potassium intake, and physical activity with hypertension

Independent Variable	Hypertension				*p-value	OR
	Case		Control			
Sodium Intake						
More (≥ 1500 mg)	25	75.8	12	36.4	0.003	5.46(1,883-15,884)
Sufficient (< 1500 mg)	8	24.2	21	63.6		
Potassium Intake						
Less (< 4700 mg)	26	78.8	20	60.6	0.106	2.4(0.813-7.168)
Sufficient (≥ 4700 mg)	7	21.2	13	39.4		
Physical Activity						
Low (< 3000 MET, no including vigorous activity)	28	84.8	16	48.5	0.004	5.95(1,845-19,193)
High (≥ 3000 MET, ≥ 7 days/week)	5	15.2	17	51.5		

*A Chi-square test is significant if $p < 0.05$, where an odds ratio (OR) greater than 1 indicates a risk factor.

This study also shows that the female sex of the case group is almost as much (not too far) as the control sex (male). This is in line with Rahmadani in 2020 showing the number of female respondents as many as 17 people (22.4%) is not too far from men as many as 21 people (27.6%) [14]. The majority of respondents were women, but the difference in the number of women and men was not too far (Table 1). The majority of respondents in the age group ≥45 years (33.00%) (Table 1). The majority of respondents in this study had a family history of hypertension (54.5%) in cases while controls (18.2%) (Table 1).

Female or male gender or have an equal chance of developing hypertension during their lifetime. However, men are more at risk of hypertension than women when they are 46 years old. Conversely, when age ≥ 65 years, women are more at risk of hypertension than men. Some hormones influence this condition. Women entering menopause are more at risk of obesity, which will increase the risk of hypertension[15].

Table 4. Food sources containing sodium, fat and fiber consumed by the case group

Food Source	n	%	mg	Energy (Kcal)	Fat (gr)	Fiber (gr)
Fresh bread	5	15.1	573.5	233.8	2	1.9
Mieses toast	4	12.1	933.6	152.6	2.1	1.7
Chicken egg	9	27.2	469	168.9	10.9	0
Salted fish	24	72.7	832.1	104.8	1.9	0
Chicken meat	7	21.2	93.5	321.3	17.7	0
Shrimp crackers	2	6	67.3	94.3	1.4	0
Indomie	3	9	1260	320	12	2
Fried Indomie	2	6	622.5	285	10.9	1.9
Meatball noodles	2	6	570	114	2.3	0.1

Table 5. Food sources containing potassium, fat and fiber consumed by respondents in the case group

Food Source	n	%	mg	Energy (Kcal)	Fat (gr)	Fiber (gr)
Rice	33	100	214.4	931.6	1.5	2.2
Potatoes	6	18.1	277	76.6	0	0.9
Tilapia	9	27.2	190.6	77.6	0.8	0
Groundnut	4	12.1	298.5	56.7	13.7	2.4
Corn	3	9	471	346.9	4.3	8.8
Bananas	13	39.3	902.1	386.6	0.6	7.3
Siamese gourd	4	12.1	126.4	9	0.4	0.4
Cucumbers	5	15.1	151.9	18.2	0.2	1.7
Spinach	14	24.4	278.9	20.3	0.2	0.3
Fried tempeh	2	6	174.2	168.5	11.9	0.7
Fried banana	12	36.3	431.6	221.2	14.9	2.4

Table 1 shows data on other characteristics supporting the results of this study, namely a family history of hypertension in the case group more than the control. The education level of the case group graduated from elementary school and graduated from high school more than the control. Most respondents did not work in the case group almost as much as the control, most respondents did not smoke in the case group almost as much as the control.

A family history of hypertension is an important non-modifiable factor among several risk factors for hypertension[16]. A family history of hypertension has a 3.6 times greater risk of developing hypertension compared to those without a family history of hypertension. In 70-80% of cases of essential hypertension, there is a family history of hypertension. If there is a history of hypertension in both parents, the likelihood of essential hypertension is greater. Hypertension is also commonly found in monozygotic twins (one egg) if one of them has hypertension. Individuals with both hypertensive parents will experience a 50-57% chance of hypertension, while if one has hypertension, the chance of hypertension is 4-20%.

Individuals with genetic traits of primary (essential) hypertension if left naturally without therapeutic intervention, together with the environment will cause hypertension to develop, and within 30-50 years there will be signs and symptoms of hypertension with possible complications[17,18].

Relationship between sodium intake and hypertension

Table 2 shows that the number of respondents with more sodium intake category was 25 people (75.8%) in the case group higher than the control group of 12 people (36.4%). The statistical test results showed that respondents who consumed sodium had a risk of 5.46 times suffering from hypertension (OR = 5.46). This is in line with Silaen in 2018 showing that respondents who consume sodium have a risk of 5.598 times suffering from hypertension compared to those who do not consume sodium (OR = 5.598) [19]. Gautami & Kumala in 2021 showed that 43 out of 66 elderly individuals experienced hypertension (65.2%). The mean sodium intake was 1942.43 mg, and the majority of 50 (75.8%) subjects were classified as having high sodium intake[20].

The relationship between sodium intake and hypertension is well-established in scientific research. High sodium intake is associated with an increased risk of developing hypertension, also known as high blood pressure. Excessive sodium consumption can lead to fluid retention in the body, causing an increase in blood volume and subsequently elevating blood pressure. Excess sodium ingested is rapidly absorbed in the intestines, leading to an increase in plasma osmolality. This stimulates the sensation of thirst and prompts water consumption, increasing in intravascular volume. To counterbalance and control this volume increase, the kidneys respond by eliminating excess sodium and water. To eliminate this excess, blood pressure must be increased to enhance the filtration pressure in the glomeruli, thereby increasing the filtration and urinary sodium excretion burden. Under normal conditions, there is a balance between renal perfusion pressure (approximately 100 mmHg) and urinary sodium elimination (approximately 100–120 mEq). This balance is disrupted by excessive sodium consumption in conjunction with various factors affecting the anatomical and functional integrity of the kidneys, resulting in hypertension[21].

Relationship between potassium intake and hypertension

Table 3 shows that the number of respondents with insufficient potassium intake category in the case group was 26 people (78.8%) higher than the control category of 20 people (60.6%). Statistical test results showed that there was no relationship between potassium intake and hypertension (p=0.181). This is in line with Fitri in 2018 which shows there is no relationship between potassium intake and hypertension (p>0.05) [22]. These results are in line with Putri & Kartini in 2014 which showed that there was no significant relationship between potassium intake and hypertension, (p>0.05) [23].

Potassium helps to offset the effects of sodium on blood pressure. Sodium tends to increase blood pressure by causing the body to store water and increase blood volume. On the other hand, potassium helps reduce blood pressure by offsetting the effects of sodium and also by controlling muscle contraction, including muscles in the walls of blood vessels. Increasing potassium intake has a significant antihypertensive effect and reducing sodium consumption can lower blood pressure. So, a balanced ratio of sodium and potassium consumption (1:1), can help maintain an optimal electrolyte balance in the body, which contributes to healthy blood pressure[21].

Potassium deficiency increases blood pressure. Increasing potassium intake can balance the sodium-potassium ratio in the body, thereby helping to lower blood pressure and reduce the risk of hypertension. Potassium-rich foods include fruits such as bananas, oranges, and avocados, as well as vegetables such as potatoes, spinach, and beans[21].

Relationship between physical activity and hypertension

Table 3 shows that the low physical activity of respondents in the case group was higher at 28 people (84.8%) than the control group at 16 people (48.5%). Statistical test results showed that respondents with low physical activity had a 5.95 times the risk of developing hypertension compared to those with sufficient physical activity (OR=5.95). The results of this study align with Atun in 2014, less physical activity has a 4.9 times greater risk of suffering from hypertension than sufficient physical activity (OR = 4.9) [24].

Physical activity greatly affects blood pressure stability. People who do not do physical activity tend to have a higher heart rate frequency, so the heart muscle works harder with each contraction. The harder the heart muscle tries to pump blood, the more blood pressure is put on the artery walls, causing blood pressure to rise. Physical activity improves blood flow to the heart, arterial flexibility, and arterial function. Physical activity also slows down atherosclerosis and reduces the risk of heart attack and stroke. Various studies have shown that prolonged television viewing (inactivity) is associated with an increased prevalence of obesity which increases the risk of hypertension. Low physical activity (lack of) such as laziness / lazy exercise causes overweight can trigger the risk of hypertension. Moderate to high physical activity will reduce the likelihood of obesity, thereby reducing the risk of hypertension[25,26].

LIMITATIONS OF THE STUDY

The sample size used in this research is very small. This research is still on a local scale.

CONCLUSIONS

From the results of this study, it can be concluded that: the number of respondents in the middle age group (45-59), elderly (60-74), and very elderly (75-90) in the case group is the same as the control group. The distribution of females and males in the case group is not significantly different from the control group. The family history of hypertension in the case group is higher than in the control group. The level of education completed at the college level is lower in the case group compared to the control group. The number of respondents who are not employed is higher in the control group than in the case group. The number of non-smoking respondents is higher in the case group compared to the control group. Respondents with higher sodium intake are at a 5.46 times higher risk of experiencing hypertension compared to those with sufficient sodium intake. Potassium intake is not a risk factor for hypertension. Respondents with low physical activity are at a 5.95 times higher risk of experiencing hypertension compared to those with high physical activity. Therefore, it is recommended for the elderly to engage in physical activity for 30 minutes per day to manage hypertension.

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