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The Association between Lifestyle and Nutritional Status with the Incidence of Hypertension in the Kayu Manis Community Health Centre Working Area

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ABSTRACT

Hypertension was a non-communicable disease that contributed to high mortality rates, with cases continuing to increase, including in the working area of the Kayu Manis Community Health Centre, Bogor City. This study aimed to analyze the association between lifestyle, and nutritional status with the incidence of hypertension. This study used a cross-sectional design with 76 subjects aged 30-49 years using purposive sampling techniques. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ). High sodium and fat consumption habits were assessed using the FFQ questionnaire, while smoking, alcohol, and coffee consumption habits were assessed through interviews using questionnaires. Nutritional status was assessed using anthropometric measurements consisting of weight and height measurements. Data were processed and analyzed using Microsoft Excel 2019 and SPSS 26 for Windows. The statistical test used is the Spearman test. The results showed a significant association between physical activity (p=0.002), sodium consumption (p=0.002), fat consumption (p=0.004), and nutritional status (p=0.003) with the incidence of hypertension. Conversely, no significant association was found in the frequency of alcohol and coffee consumption, and duration of smoking. The implications of these findings required lifestyle modification interventions.

Key Messages:

- In practical terms, this study provided evidence-based guidance for the Kayu Manis Community Health Centre to focus its hypertension intervention program specifically on limiting sodium and fat intake and increasing physical activity.
- The contextual novelty of this study showed that common risk factors such as smoking, coffee consumption, and alcohol were not found to be significant in this population, emphasizing that nutrition status management was a far more crucial educational priority.
- The implications of these findings highlighted the urgency for primary health policymakers to strengthen integrated noncommunicable disease (NCD) screening programs, particularly those related to controlling diabetes mellitus and obesity comorbidities, in order to prevent cardiovascular complications in the community.

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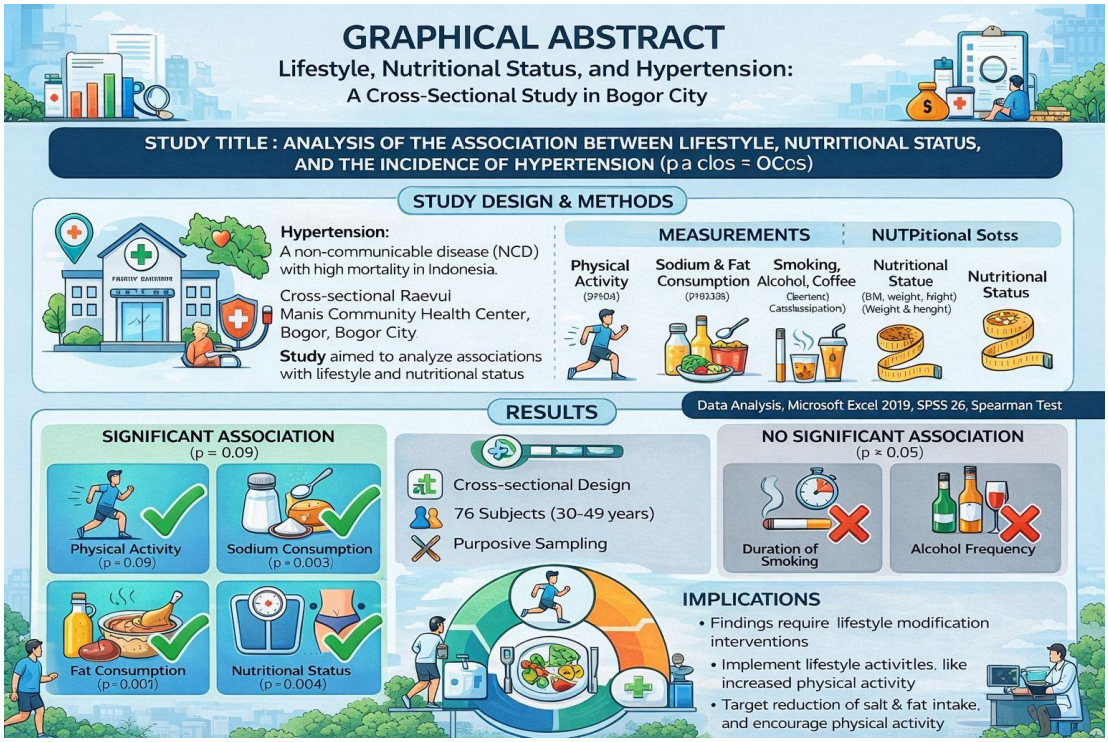
GRAPHICAL ABSTRACT



INTRODUCTION

The shift in disease patterns from infectious diseases to non-communicable diseases (NCDs) reflected the impact of current living conditions. Hypertension remained a significant global health challenge, contributing to a substantial burden of cardiovascular diseases and premature mortality worldwide (1). According to the World Health Organization, the prevalence of hypertension has continued to rise, particularly in low- and middle-income countries, where access to early detection and management was often limited (1,2). In Indonesia, national data reflected this trend, showing that hypertension was one of the most prevalent non-communicable diseases across various demographics (3–5).

One of the risk factors for non-communicable diseases (NCDs) in Indonesia was hypertension, with a prevalence of 30.8% (4). Based on data from the Bogor City Health Office (2020), hypertension ranked second among the most common diseases in Bogor City. The trend of hypertension incidence in the Kayu Manis Community Health Centre's work area continued to increase from 2016 to 2020 (6). Furthermore, Tanah Sareal District recorded the highest early detection rate for hypertension in Bogor City, at 88.1% (6). Specifically, the prevalence of hypertension in the Kayu Manis Community Health Centre's work area reached 14.06%. Hypertension was a risk factor for serious diseases that could potentially lead to fatal complications if not promptly treated.

A complex interplay of various factors influenced the development of hypertension. Extensive literature has identified several risk factors, including non-modifiable factors such as age, as well as modifiable lifestyle factors such as physical inactivity, high sodium intake, and excessive fat consumption. Additionally, nutritional status, often measured by Body Mass Index (BMI), was frequently linked to elevated blood pressure levels (7–10). While these general risk factors were well documented at the national level, their impact can vary significantly across local environmental, social, and dietary contexts. Excessive alcohol consumption could have serious long-term health consequences, ultimately increasing blood pressure (8,11). Excessive coffee consumption could inhibit the hormones that kept arteries dilated, leading to increased adrenaline levels and, in turn, higher blood pressure (12). Smoking could increase blood pressure because the chemicals in cigarettes damaged the lining of arterial walls, triggered plaque formation (atherosclerosis), and narrowed blood vessels, resulting in increased blood pressure (13).

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Despite the wealth of national-level data, there was a notable research gap regarding the specific dynamics of hypertension in smaller, localised urban areas. In particular, the working area of the Kayu Manis Community Health Centre presented a unique case due to its specific population density and local lifestyle patterns. However, detailed data on the drivers of hypertension in this area remained scarce. Understanding these local variations was crucial to developing targeted public health interventions that reflected the community's actual needs. Therefore, localized research was required to ensure that the study population accurately reflected the unique characteristics of the Kayu Manis area.

This study employed a cross-sectional design to provide a snapshot of the current health landscape in this region. Given the nature of this study design, the focus was placed on identifying statistical links between variables. It was important to note that this approach aimed to identify associations rather than establish causal relationships. By clarifying these associations, the study sought to provide a foundation for more effective, evidence-based health policies at the Community Health Centre level. Therefore, this study aimed to analyze the association between lifestyle factors and nutritional status with the incidence of hypertension in the working area of the Kayu Manis Community Health Centre.

METHODS

Research Design, Time, and Place

This study used a cross-sectional study design. It was conducted in the Kayu Manis Community Health Centre working area from January to July 2024. The location was chosen as the research site based on data showing that the prevalence of hypertension in the Kayu Manis Community Health Centre was the highest in the Tanah Sareal District at 14.06%.

Population and Sample

The population of this study was the community in the working area of the Kayu Manis Community Health Centre. The research sample was selected purposively, comprising 76 subjects. Subjects were selected based on predetermined inclusion criteria, namely residents in the working area of the Kayu Manis Community Health Centre who were aged 30-49 years, able to communicate well, able to fill out questionnaires and were literate, did not have hearing or writing impairments, could be measured for height and weight, and were willing to be interviewed. Exclusion criteria included subjects who were unwilling or uncooperative to participate in the study.

In conducting this study, the sampling method used was purposive sampling, a non-probability sampling method. Based on Lemeshow's (1997) formula, the sample size was 76 subjects. This calculation used a 95% confidence interval, an estimated hypertension prevalence of 27.2% in the ≥ 18 age group, and a sampling error of 10%. The Kayu Manis Community Health Centre's working area covers three areas: Kayu Manis, Kencana, and Cibadak. Subjects were evenly distributed across these three areas. The Kayu Manis Community Health Centre serves three sub-districts: Kayu Manis, Kencana, and Cibadak. Subjects were selected from these three sub-districts using purposive sampling, for a total of 76.

Data Collection and Analysis

Data collection in this study used primary data, which covered various aspects such as age, gender, income, occupation, and education; lifestyle (physical activity, consumption habits of foods high in sodium and fat, alcohol, coffee, and smoking habits); nutritional status; and hypertension (blood pressure). This primary data was obtained through interviews using questionnaires. Physical activity was measured using the International Physical Activity Questionnaire (IPAQ) to assess subjects activity over the past 7 days. IPAQ categorises physical activity into low, moderate, and heavy. In this instrument, subjects report the frequency and duration of their physical activity to assess endurance, intensity, and overall activity. All data are then analysed in MET-minutes per week, with metabolic rates of 3.3 METs for walking, 4 METs for moderate activity, and 8 METs for vigorous-intensity activity. Total weekly energy expenditure is calculated by adding the METs obtained from these three activity categories using the formula, Total Physical Activity (MET) = Walking METs + Moderate METs + Heavy METs. Based on this calculation, subjects' physical activity levels are classified into three levels: low (<600 MET-minutes/week), moderate (600-1499 MET-minutes/week), and heavy (≥1500-3000 MET-minutes/week) (14).

Frequency of sodium and fat consumption was measured using a Food Frequency Questionnaire (FFQ)

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to determine how often subjects consumed these foods over days, weeks, months, or years. The FFQ data processing began by converting subjects meal frequencies from various time units (daily, weekly, monthly, and yearly) into times/week units to ensure uniformity of data, particularly for food groups containing sodium and fat. Data validation and cleaning were then performed to detect any irrational intake reporting, such as under- or over-reporting, to ensure research accuracy. In the final stage, the average consumption frequency for each food group was calculated, which was then categorized into low (<3x/week) and high (≥3x/week) (15).

Nutritional status was measured through anthropometry, including weight and height, using digital scales and a stadiometer with an accuracy of 0.1 kg and 0.1 cm. nutritional status is determined based on body mass index with classification of underweight (17-18.4 kg/m^2), normal (18.5-25 kg/m^2), overweight (≥25-27 kg/m^2), obese (≥27 kg/m^2) (16). The diagnosis of hypertension is established by medical personnel using a manual sphygmomanometer. In medical practice, manual sphygmomanometers were recognized as having superior validity and accuracy because they were able to capture blood pressure fluctuations in real-time (17). Before the measurement begins, the officer explains the importance of relaxation to maintain stable blood pressure values. The subject is asked to sit quietly for approximately five minutes before the examination. Measurements are taken twice with an interval of two minutes. If the difference between measurements is≥10 mmHg, a repeat measurement is performed. The final results were then classified referring to the Joint National Committee (JNC) VII with the categories normal (<120/<80 mmHg), categories pre-hypertension (120-139/80-90 mmHg), stage 1 hypertension (140-159/≥90-99 mmHg), stage 2 hypertension (>160/>100 mmHg) (18). This study was approved by the Research Ethics Committee Involving Human Subjects by the National Research and Innovation Agency (BRIN) in the Kayu Manis Community Health Centre Working Area with Number 146/KE.03/SK/07/2024.

The data will be edited and coded before processing and analysis in Microsoft Excel 2019 and SPSS 26.0 for Windows. Data analysis methods include univariate and bivariate analysis. Univariate analysis is performed to examine the distribution of data for each variable. In contrast, bivariate analysis uses Spearman's test to examine the association between lifestyle factors and nutritional status with the incidence of hypertension. Variables with a significance value (p-value< 0.05) were considered significantly associated, indicating that a relationship existed between the independent and dependent variables.

RESULTS

The subjects in this study were adults aged 30-49 years in the Kayu Manis Community Health Centre working area, with 76 subjects participating in this study. The characteristics of the subjects in this study can be seen from their gender, age, education, occupation, and income. The distribution of subjects based on variables is presented in Table 1.

Table 1. Distribution of subject based on variable

Variable	n	%
Age		
30-33 years	12	15.8
34-37 years	13	17.1
38-41 years	16	21.1
42-45 years	16	21.1
46-49 years	19	25
Median (Q1-Q3)	41 years (35-46 years)	
Gender		
Male	28	36.8
Female	48	63.2
Education Levels		
No School	1	1.3
Elementary School	35	46.1
Junior High School	14	18.4
Senior High School	24	31.6
Higher Education Institution	2	2.6

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Variable	n	%
Occupation		
Unemployed/homemakers	43	56.6
Private Employee	3	3.9
Self-employee	11	14.5
Farmers/Laborers	19	25
Income (Rupiah/bulan)		
< Bogor City Minimum Wage (< Rp. 4.805.057)	71	93.4
≥ Bogor City Minimum Wage (≥ Rp.4.805.057)	5	6.6
Median (Q1-Q3)	Rp.1.500.000 (Rp.600.000-Rp.3.500.000)	

Table 1 showed that most subjects were female (63.2%), were aged 46–49 years (25%), and had an educational level of elementary school (46.1%). More than half of the subjects were unemployed or homemakers (56.6%) and had incomes below the minimum wage in Bogor City (93.4%). Hypertension was more prevalent in the late-adult to early-elderly age group, with a median age of 41 years.

In terms of education, the majority of subjects had a elementary school of education. This indicated that most subjects likely had limited health knowledge, which affected their understanding of healthy lifestyles, nutritional management, and hypertension prevention. The distribution of occupations showed that most subjects were unemployed/homemakers, followed by farmers or labourers. The distribution of income showed that almost all subjects had an income below the Bogor City Minimum Wage, with a relatively low median income. This indicated economic limitations that could have affected the quality of food consumption, the fulfilment of nutritional needs, and access to hypertension prevention and control efforts.

Table 2. Distribution of subjects based on physical activity level, sodium, and fat consumption habits

Variable	n	%
Physical Activity Level		
Light (<600 MET)	51	67.1
Moderate (600-<1500 MET)	24	31.6
Heavy (≥1500-3000 MET)	1	1.3
Median (Q1-Q3)	520 MET (427-673 MET)	
Sodium Consumption		
Low (<3x/weeks)	17	22.4
High (≥3x/weeks)	59	77.6
Median (Q1-Q3)	4 x/weeks (3.0-5.0 x/weeks)	
Fat Consumption		
Low (<3x/weeks)	22	28.9
High (≥3x/weeks)	54	71.1
Median (Q1-Q3)	3 x/weeks (3.0-5.0 x/weeks)	

Table 2 showed that proportion of subjects with low physical activity (67.1%) and high sodium (77.6%) and fat consumption (71.1%). These conditions indicated a tendency toward unhealthy lifestyle patterns that could contribute to changes in nutritional status and an increase in the incidence of hypertension.

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Table 3. Distribution of subjects based on alcohol and coffee consumption habits

Variable	n	%
Alcohol Consumption		
Ever	2	2.6
Never	74	97.4
Frequency of alcohol consumption		
None	74	97.4
Rarely (<3x/weeks)	2	2.6
Frequently (≥3x/weeks)	0	0
Coffee Consumption		
Ever	43	56.6
Never	33	43.4
Frequency of coffee consumption		
None	33	43.4
Rarely (1-2x glasses/day)	42	55.3
Frequently (>3x glasses/day)	1	1.3

Most subjects did not have a habit of consuming alcohol in Table 3. This condition indicated that alcohol consumption was not a dominant behavior in the community in the working area of the Kayu Manis Community Health Centre; therefore, this factor was likely to have a relatively small contribution to hypertension incidence in the study population. Most subjects never consumed alcohol (97.4%). A total of 2.6% still consumed alcohol, although only occasionally. Low alcohol consumption might also have reflected social and cultural factors, as well as good public health awareness in avoiding behaviors that posed a risk to cardiovascular health.

In contrast, coffee consumption was a fairly common habit among subjects, although most consumed it relatively infrequently or in moderate amounts. This pattern showed that coffee was part of the community's daily life but was not consumed excessively by most subjects. Most subjects (56.6%) consume coffee, while the rest (43.4%) do not. Coffee consumption is categorised as rarely (1-2 cups/day) or frequently (more than 3 cups/day). More than half of the subjects have rarely coffee consumption (55.3%).

Table 4. Distribution of subjects based on smoking habits

Variable	n	%
Smoking Status		
Smoker	16	21.1
Non-smoker	60	78.9
Duration of Smoking		
Never	60	78.9
<120 months	3	3.9
≥120 months	13	17.2

Based on the distribution of subjects' smoking status in Table 4, most subjects were non-smokers (78.9%), while the rest were smokers (21.1%). Most of the subjects who smoked, 17.2% had smoked for more than 10 years (120 months). Subjects also mentioned that they often smoked after eating or while working.

Table 5. Distribution of subjects based on nutritional status

Nutritional Status	n	%
Underweight (17-18.4 kg/m^2)	1	1.3
Normal (18.5-25 kg/m^2)	30	39.5
Overweight (≥25-27 kg/m^2)	21	27.6
Obese (≥27 kg/m^2)	24	31.6
Median (Q1-Q3)	25.69 kg/m^2 (22.33-28.14 kg/m^2)	

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Table 5 showed that most had a body mass index in the normal to overweight range, with a tendency toward overweight and obesity. This condition showed that nutritional problems were a fairly prominent characteristic among subjects in the Kayu Manis Community Health Centre working area. The median body mass index in the overweight category also reinforced the picture that, in general, subjects tended toward excessive nutritional status.

Table 6. Distribution of subjects based on hypertension classification

Blood Pressure	n	%
Normal (<120/<80 mmHg)	26	34.2
Pre-hypertension (120-139/80-90 mmHg)	28	36.8
Stage 1 hypertension (140-159/≥90-99 mmHg)	16	21.1
Stage 2 hypertension (>160/>100 mmHg)	6	7.9

Table 6 showed that most were in the pre-hypertension category, followed by those with normal blood pressure, stage 1 hypertension, and a small number with stage 2 hypertension. This condition showed that the majority of subjects were already at a stage of increased blood pressure that was at risk of developing into hypertension if not controlled early on. In addition, there were still subjects who had stage 1 and stage 2 hypertension, indicating quite serious cardiovascular health problems in part of the study population.

Table 7. The association between lifestyle, nutritional status with the incidence of hypertension

Variable	Hypertension Incidence								*p-value*	*r*
	Normal		Pre-hypertension		Stage 1 Hypertension		Stage 2 Hypertension			
	n	%	n	%	n	%	n	%		
Physical Activity Level										
Light	8	30.8	25	89.3	14	87.5	4	66.7		
Moderate	17	65.4	3	10.7	2	12.5	2	33.3	0.002*	-0.354
Heavy	1	3.8	0	0	0	0	0	0		
Sodium Consumption										
Rarely	10	38.5	5	12.5	2	12.5	0	0	0.002*	0.351
Often	16	61.5	23	82.1	14	87.5	6	100		
Fat Consumption										
Rarely	9	34.6	11	39.3	0	0	2	33.3	0.004*	0.327
Often	17	65.4	17	60.7	16	100	4	66.7		
Frequency of alcohol consumption										
None	25	100	28	96.5	15	93.7	6	100		
Rarely	0	0	1	3.4	1	6.2	0	0	0.973	-0.006
Frequently	0	0	0	0	0	0	0	0		
Frequency of coffee consumption										
None	12	46.1	12	42.8	8	50	1	16.6	0.705	0.044
Rarely	14	53.8	15	53.5	8	50	5	83.3		
Frequently	0	0	1	3.5	0	0	0	0		
Duration of Smoking										
Never	19	73	21	75	15	93.7	5	83.3		
<120 months	2	7.69	1	3.57	0	0	0	0	0.337	0.112
≥120 months	5	19.2	6	21.4	1	6.2	1	16.6		
Nutritional Status										
Underweight	1	3.8	0	0	0	0	0	0		
Normal	15	57.7	10	35.7	4	25	1	16.7	0.003*	0.332
Overweight	8	30.8	7	25	3	18.8	3	50		
Obese	2	7.7	11	39.3	9	56.3	2	33.3		

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The results of the study in Table 7 showed that physical activity was significantly associated with hypertension incidence ($p = 0.002 < 0.05$), with a correlation of $r = -0.354$, indicating a moderate negative association. This meant that the more physical activity a person engaged in, the lower the risk of hypertension. Conversely, low physical activity increased the risk of hypertension. For the sodium consumption variable, a p-value of 0.002 (< 0.05) was obtained, with an r-value of 0.351, indicating a significant, moderate, positive association .

Furthermore, fat consumption also showed a significant association with the incidence of hypertension ($p = 0.004 < 0.05$) with a value of $r = 0.327$, indicating a positive correlation with moderate strength. This meant that the higher the fat consumption, the greater the likelihood of a person developing hypertension. In contrast to the previous variable, the frequency of alcohol consumption did not show a significant association with the incidence of hypertension ($p = 0.973 > 0.05$; $r = -0.006$).

Similarly, the variables of coffee consumption frequency ($p = 0.705 > 0.05$; $r = 0.044$) and smoking duration ($p = 0.337 > 0.05$; $r = 0.112$) did not show a significant association with hypertension incidence. The very weak correlation values indicated that these two factors were not dominant correlates of hypertension in this study population, although they may be associated theoretically. Meanwhile, the nutritional status variable showed a significant association with hypertension incidence ($p = 0.003 < 0.05$), with a value of $r = 0.332$, indicating a moderate positive correlation.

DISCUSSION

Increasing age was a factor that potentially influenced the occurrence of hypertension due to physiological changes such as decreased blood vessel elasticity and increased peripheral resistance (19). The age distribution, which tended to be in the late productive age group, indicated that the risk of hypertension began to increase in this phase of life, underscoring the importance of lifestyle factors and nutritional status. Women were more likely to be identified or utilize health services in the study area, or had a particular vulnerability to hypertension related to hormonal changes, especially in adulthood and approaching menopause (20,21). This difference in distribution also affected the relationship between lifestyle, nutritional status, and hypertension incidence, due to biological and behavioural factors that differed between men and women. A relatively low level of education was often associated with suboptimal health behaviours, such as an unbalanced diet and irregular physical activity, which potentially increased the risk of hypertension (22). A relatively low socioeconomic status, which could have affected the ability to meet balanced nutritional needs, access to health services, and the implementation of a healthy lifestyle. In addition, employment conditions could have also been related to physical activity and stress levels, which were important risk factors for hypertension (22,23). Overall, the characteristics of the subjects indicated that age, gender, education level, occupation, and income were potential factors contributing to lifestyle patterns and nutritional status, which were further associated with the incidence of hypertension in the working area of the Kayu Manis Community Health Centre.

Most subjects had low levels of physical activity in Table 2. This condition indicated that the majority of subjects tended to low sufficient physical activity in their daily lives, thereby potentially increasing the risk of hypertension. The study found that higher physical activity was associated with a lower incidence of hypertension. The negative correlation value indicated that low physical activity was associated with an increased risk or degree of hypertension, where the majority of patients with stage 1 hypertension (87.5%) and stage 2 hypertension (66.7%) had low physical activity. Physiologically, physical activity lowers blood pressure by increasing blood vessel elasticity, improving endothelial function, decreasing peripheral resistance, increasing insulin sensitivity, promoting weight control, and decreasing sympathetic nervous system activation (24). In addition, regular physical activity increased nitric oxide release, a vasodilator that helped lower blood pressure (25–27). At the same time, a sedentary lifestyle decreased cardiovascular efficiency and increased arterial stiffness (28).

The findings of this study were in line with the World Health Organization's recommendation that a minimum of 150 minutes of physical activity per week could reduce the risk of cardiovascular disease, including hypertension, and maintain blood vessel elasticity (29). Regular physical activity could reduce the risk of hypertension by 20–30% (30). This indicated that physical activity was an important protective factor in the prevention and control of hypertension. These findings were also consistent with research in Indonesia, which found a significant association between physical activity and hypertension (31,32). However, another study found a weaker association because age and dietary patterns were more dominant factors influencing the incidence of

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hypertension (33). These differing results indicated that the effect of physical activity on hypertension might have been influenced by subject characteristics, other risk factors, and varying social environmental conditions.

The study found that the higher the sodium intake, the higher the incidence of hypertension. The research data showed that 36.8 % of subjects with pre-hypertension and 21.1% of subjects with the stage 1 hypertension had a habit of frequent sodium consumption, indicating that high salt intake was a dominant risk factor.

The subjects' sodium consumption patterns showed that most subjects often consumed foods high in sodium. The most frequently consumed foods among the subjects were MSG, salt, packaged broth, instant seasonings, and soy sauce. In addition, the majority of subjects were from the Sundanese culture, which generally consumes salted fish. High sodium consumption reflected unhealthy eating patterns, such as the habit of consuming salty or processed foods, or excessive salt use in cooking. High sodium consumption was known to increase fluid retention and blood volume, thereby increasing blood pressure and the risk of hypertension. This indicated that sodium consumption patterns were an important factor in the relationship between lifestyle and the incidence of hypertension in the study subjects.

Physiologically, excess sodium causes fluid retention by shifting fluid from intracellular to extracellular compartments, thereby increasing blood volume (hypervolemia) and increasing arterial pressure. In addition, excessive sodium consumption increased blood vessel stiffness and reduced kidney function in regulating fluid balance. It disrupted the balance of the renin-angiotensin-aldosterone system (RAAS), triggering water retention and elevating blood pressure (34,35). These findings were supported by a meta-analysis, which showed that high sodium intake was directly associated with higher blood pressure and increased cardiovascular disease risk (36,37). Intervention studies also showed that sodium restriction effectively lowered systolic blood pressure and was an important non-pharmacological intervention in the management of primary hypertension (35,38,39). In Indonesian society, high sodium consumption generally comes from processed foods, fast food, and excessive use of salt in cooking, making it a significant risk factor for hypertension at the community level (40–42).

Research results showed that increased fat consumption was associated with a higher incidence of hypertension. Research data showed that 100% of subjects with stage 1 hypertension frequently consumed fat, indicating that a high-fat diet was an important risk factor. High fat consumption, especially saturated and trans fats, can cause dyslipidemia, atherosclerosis, elevated cholesterol levels, and decreased blood vessel elasticity, leading to increased blood pressure (43–45). Physiologically, excess fat triggers the accumulation of cholesterol plaque on the walls of blood vessels, narrowing the lumen and decreasing arterial compliance, so the heart has to pump harder to maintain blood flow (8,46,47). In addition, excessive fat intake triggered chronic inflammation and endothelial dysfunction, exacerbating elevated blood pressure. High fat consumption also contributed to weight gain and insulin resistance, which were additional risk factors in the development of hypertension in various age groups (48,49).

These findings showed that a high-fat diet increased blood pressure through chronic inflammation and insulin resistance (50–52). In the study population, the habit of consuming high-fat foods, such as fried and fast foods, might have strengthened the association between fat intake and hypertension incidence, underscoring the importance of dietary control in hypertension prevention efforts.

The results of the study showed that the higher the status of excess nutrition (overweight and obesity), the higher the incidence of hypertension. In the stage 1 hypertension group, the highest prevalence was found in the severely obese category (56.3%), confirming that an increase in Body Mass Index (BMI) was directly proportional to the risk of increased blood pressure. This condition showed that excess nutritional status was an important risk factor in the development of hypertension (53–56).

Physiologically, obesity increases blood pressure through several mechanisms, including increased blood volume to supply adipose tissue, insulin resistance, activation of the renin-angiotensin-aldosterone system, and structural compression of the kidneys by body fat. Adipose tissue also functioned as an endocrine organ, releasing proinflammatory cytokines such as TNF-α and IL-6, which drove chronic inflammation and vascular dysfunction (54,57–59). In addition, increased body mass burdened the heart and elevated peripheral resistance, leading to a persistent rise in blood pressure. Therefore, weight control through nutritional management and a healthy lifestyle was a key strategy for preventing and controlling hypertension (54,60). Additionally, obesity was a significant risk factor for cardiovascular disease globally. In the context of this study, changes in diet and sedentary lifestyles likely contributed to increased overweight status and hypertension incidence in the population (61,62).

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The results of the study showed that the frequency of alcohol consumption, frequency of coffee consumption, and duration of smoking were not significantly associated with the incidence of hypertension. This suggested that these three variables were not factors related to the incidence of hypertension among subjects in the work area of the Kayu Manis Community Health Centre. The demographic characteristics of the subjects, most of whom were Muslim, also influenced these findings, given the existence of religious values and social norms that prohibited alcohol consumption in this society (63). The insignificant results were likely influenced by subject characteristics, such as low alcohol consumption and varying coffee consumption frequency, as well as the presence of other variables more strongly associated with hypertension, such as physical activity, sodium intake, fat consumption, and nutritional status.

Theoretically, excessive alcohol consumption could increase blood pressure through stimulation of the sympathetic nervous system, increased cortisol levels, and vasoconstriction of blood vessels (64). However, a recent systematic review and meta-analysis showed that the increased risk of hypertension primarily occurred with heavy or chronic alcohol consumption, while low consumption showed no significant association (65). In the context of this study, most subjects did not consume alcohol or consumed only small amounts, which did not have a significant impact on blood pressure. Sociocultural factors might also have influenced the low alcohol consumption observed.

Frequency of coffee consumption also did not show a significant association with the incidence of hypertension. Caffeine in coffee can temporarily increase blood pressure by stimulating the sympathetic nervous system, but this effect is acute, and the body can develop tolerance to long-term caffeine exposure (66). Moderate coffee consumption did not increase the risk of hypertension, likely due to the presence of antioxidants such as polyphenols, which have cardioprotective properties. Furthermore, the response to caffeine was influenced by genetic factors, the type of coffee, and individual consumption patterns, so the association between coffee consumption and hypertension remained inconsistent across studies (67,68).

Smoking duration in this study also did not show a significant association with the incidence of hypertension. Physiologically, nicotine in cigarettes could cause vasoconstriction, increased heart rate, and activation of the sympathetic nervous system, which could potentially increase blood pressure (69,70). However, the association between smoking and hypertension was not always significant after controlling for confounding factors such as obesity, diet, and physical activity (71–73). This suggested that the effect of smoking on hypertension was complex and influenced by various other factors.

The discrepancy between the current findings and some previous literature, which often identified smoking and coffee consumption as significant risk factors for hypertension, could be largely explained by physiological tolerance and relatively low levels of exposure. In the case of coffee, habitual intake allowed the body to develop a tolerance to the acute pressor effects of caffeine, while moderate consumption might even counteract blood pressure spikes through the cardioprotective properties of antioxidants (74,75). Similarly, the lack of a significant association with smoking duration was likely due to a low cumulative exposure or low daily cigarette consumption among the subjects, which might not have reached the critical threshold required to induce chronic vascular damage. Consequently, in this study population, the individual effects of coffee and smoking exposure were likely overshadowed by more dominant metabolic and dietary factors, such as high sodium intake and obesity.

This study highlighted that low physical activity, high sodium and fat consumption, and excess nutritional status (overweight and obesity) were key variables significantly associated with a higher incidence of hypertension in the Kayu Manis Community Health Centre working area. Conversely, the frequency of alcohol and coffee consumption, as well as smoking duration, did not show significant associations, largely reflecting the specific socio-cultural and demographic characteristics of the population. These findings underscored the critical need for targeted, community-based health interventions. Healthcare providers should prioritise practical lifestyle modifications, specifically promoting regular physical activity, weight management, and culturally tailored dietary education to reduce the intake of high-sodium and high-fat foods as primary strategies for hypertension prevention and control.

CONCLUSION

This study found that physical activity, sodium and fat consumption, and nutritional status are factors associated with hypertension in the Kayu Manis Community Health Centre working area. In contrast, alcohol and

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coffee consumption frequency, as well as smoking duration, showed no significant association with hypertension incidence.

Practical recommendations from this study that could be implemented to reduce the risk of hypertension included the government, through community health centers, providing nutrition education to make the public more aware of controlling and reducing the consumption of foods high in fat and sodium, regular monitoring of nutritional status, and increasing physical activity by exercising at least 3 times a week for 30-60 minutes, as well as limiting the consumption of alcohol, coffee, and smoking. In addition, the public was encouraged to have regular health checks at the nearest health centre to help control blood pressure. Recommendations for further research included using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) or a 2x24-hour recall method to assess sodium and fat intake for each subject.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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