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Association of Age, Physical Activity, Dietary Patterns, and Smoking Behavior with Hypertension Among Residents of Plosojenar Village, Ponorogo

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ABSTRACT

Background: Hypertension is an increasing global health concern, including particularly among adults in community settings. At this stage of life, unhealthy lifestyle habits such as low physical activity and high intake of salty or processed foods directly increase the risk of early hypertension.
Objectives: This study aims to analyze the relationship of age, physical activity, diet, and smoking habits with the incidence of hypertension in Plosojenar Village, Ponorogo.
Methods: This study employed an observational analytic design with a case-control method involving 154 respondents, consisting of 77 individuals with hypertension and 77 individuals in the control group. Data were collected through interviews and questionnaires, then analyzed using the chi-square test. The physical activity questionnaire included three items related to exercise, daily physical movement, and routine activities. The dietary pattern questionnaire included seven items related to high-fat foods, fried foods, fast food, instant food, salted foods, fruit intake, and coffee consumption.
Results: The study showed that age above 45 years (p-value 2.2E-16, OR 71.191710) and lack of physical activity (p-value 3.8E-03, OR 15.73508) was significantly associated with hypertension. Dietary patterns also showed a significant effect (p-value 1.8E-02), although with a more moderate strength of association. In contrast, smoking habits did not show a significant relationship with the incidence of hypertension (p-value 6.2E-01).
Conclusions: Age and physical activity are the main risk factors for hypertension in Plosojenar Village. Therefore, public health interventions should focus on prevention through promoting physical activity and improving diet. With 77 cases of hypertension, including one adolescent case, early prevention efforts and risk management in vulnerable groups are necessary to reduce the future prevalence of hypertension.

Keywords: Age, Diet, Hypertension, Physical Activity, Smoking Habits

INTRODUCTION

High blood pressure or hypertension is one of the most increasingly prevalent global health problems. The World Health Organization (WHO) reports that more than 33% of adults aged 30-79 years suffer from hypertension (WHO, 2023). Indonesia had the second-highest prevalence of hypertension among Southeast Asian countries based on control status in 2019 for individuals aged 30–79 years, with 40% of adults having hypertension and the lowest proportion of individuals with controlled hypertension. The trend of increasing hypertension has been observed in recent decades, particularly in developing countries (Schutte et al., 2021). Beyond affecting adult and elderly populations, the condition is now beginning to affect adolescents (Bell, Samuel and Samuels, 2019; Nugent *et al.*, 2022). Adolescents face a growing risk

of hypertension due to modern lifestyle factors, particularly insufficient physical activity (Gallant et al., 2022), consumption of high-sodium foods (Kolahdooz et al., 2020), and stress (Wieniawski & Werner, 2022). Although advancements in research and technology have substantially strengthened efforts to prevent and manage hypertension, the condition continues to show a steady increase in prevalence. This trend is particularly concerning, as the onset of hypertension at a young age is associated with a heightened risk of developing severe complications later in life. These circumstances suggest that hypertension remains a significant public health challenge that has not yet been effectively addressed.

Hypertension arises from the interplay of multiple determinants, including genetic predisposition, advancing age, lifestyle behaviors, and comorbid health conditions (Kokubo et al., 2019; Said et al., 2019). Lifestyle practices that are considered detrimental such as inadequate dietary patterns, insufficient engagement in physical activity, and tobacco use, are known to elevate an individual's susceptibility to hypertension. Moreover, advancing age has been consistently associated with a heightened likelihood of developing high blood pressure (Mamdouh et al., 2022). Limited physical activity may, in particular, contribute to excessive weight gain, which further amplifies the risk of hypertension (Speer et al., 2021). When these contributing factors are not effectively managed, blood pressure levels tend to escalate, ultimately increasing the risk of adverse health outcomes.

Effective hypertension control is essential, as inadequate management can precipitate a range of severe complications that threaten overall health and may ultimately result in mortality. Among the most frequently reported adverse outcomes are coronary heart disease, cerebrovascular events, renal dysfunction, and structural damage to the vascular system (Lu et al., 2023; Masenga & Kirabo, 2023; Simonetto et al., 2019). Persistently elevated blood pressure forces the myocardium to work beyond its normal capacity, a condition that may lead to ventricular hypertrophy and progressive cardiac dysfunction (Tran et al., 2019). Furthermore, hypertension represents one of the principal risk factors for stroke, particularly particularly hemorrhagic strokes causedby the rupture of cerebral blood vessels (Buonacera et al., 2017; Turana et al., 2021). Beyond its clinical consequences, hypertension also contributes to reduced work capacity and productivity, and ultimately influencing an individual's socioeconomic well-being (Hird et al., 2019; MacLeod et al., 2022; Wierzejska et al., 2020).

The prevalence of hypertension in Indonesia has shown a decline. According to Indonesian Health Survey data, the prevalence of hypertension in 2023 decreased to 30.8% from the previous 34.1% reported in the 2018 Basic Health Research (*Riskesdas*) (BKPK Kemenkes, 2023). This decrease reflects improvements in public awareness of healthy lifestyle patterns and in increased access to healthcare services. Nevertheless, efforts to prevent and control hypertension must continue to be reinforced to maintain this positive trend.

Given both the substantial prevalence of hypertension and the severity of its associated consequences, the condition warrants prioritization as a critical public health issue. Notably, hypertension is increasingly identified not only among adults but also within younger populations, reflecting an epidemiological shift that underscores the necessity of early preventive interventions. In Plosojenar Village, Ponorogo, the prevalence among adults has reached 2.64% (77 of 2,916 adults), and although the proportion among adolescents remains low, the emergence of hypertension at 0.03% in this age group signals an early pattern. This trajectory reinforces the importance of closely assessing community lifestyle behaviors, particularly those that may predispose individuals to premature hypertension. Accordingly, the present study seeks to examine the associations between age, levels of physical activity, dietary habits, and smoking behavior and the occurrence of hypertension among residents of Plosojenar Village, Ponorogo.

METHODS

This research utilizes a case–control approach as part of an analytic observational design. Data collection procedures were carried out in January 2024. Eligible participants were individuals aged 18 years or older who resided in Plosojenar Village and agreed to take part in all phases of the study. Based on these inclusion parameters, a total of 2,916 individuals formed the population from which the study sample was drawn.

The case group comprised all elderly individuals diagnosed with hypertension in Plosojenar Village, identified through secondary data obtained from the village midwives and community health nurses. A total of 77 respondents were included using a total sampling approach, whereby every eligible hypertensive elderly resident was selected as a case. In contrast, the control group consisted of village residents with no prior diagnosis of hypertension, was selected through a simple random sampling procedure. Individuals with a known history of hypertension or cardiovascular disease were excluded from the control group. Both groups were matched at a 1:1 ratio, resulting in an overall sample of 154 participants. The variables assessed in this study included age, level of physical activity, dietary behaviors, and smoking patterns. Information from both case and control respondents was gathered through face-to-face interviews using

structured, printed questionnaires. Data analysis was performed using R Studio, employing chi-square tests statistical tests to examine associations between variables.

Age was classified into two groups, namely 18–45 years and >45 years. Physical activity, dietary patterns, and smoking behavior were categorized into positive and negative categories. Physical activity and dietary behaviors were assessed using a four-point Likert scale, whereas smoking habits were evaluated using the smoker classification proposed by Mu'tadin (2002). The physical activity instrument consisted of three items that assessed participation in exercise, engagement in daily activities involving bodily movement such as house cleaning, and other routine physical tasks. These items were specifically developed for the present study and underwent both validity and reliability assessments prior to data collection, with all items confirmed to meet the required psychometric standards. The possible scores for the physical activity variable ranged from 3 to 12, with scores of 3–7 designated as negative and scores of 8–12 considered positive. The dietary pattern questionnaire comprised seven items addressing the intake of high-fat foods—including such as coconut milk–based dishes and certain meats fried foods outside of main meals, fast foods, instant foods, salted foods, fruit consumption, and coffee intake. Similar to the physical activity instrument, the dietary items were developed exclusively for this study and were subjected to validity and reliability testing, all of which met the required criteria prior to implementation. Scores for dietary patterns ranged from 7 to 28. Values of 7–17 were categorized as negative dietary patterns, whereas scores of 18–28 were categorized as positive. Smoking behavior was assessed by categorizing respondents as non-smokers, light smokers (approximately 10 cigarettes per day), moderate smokers (11–21 cigarettes per day), heavy smokers (21–30 cigarettes per day), and very heavy smokers (more than 31 cigarettes per day). Each category was assigned a score ranging from 1 to 4. Smoking behavior was evaluated for the period before and after the onset of hypertension. The total possible score for this variable ranged from 2 to 8, with scores of 2–5 were classified as negative and scores of 6–8 classified as positive. This research was declared ethically appropriate by the Health Research Ethics Committee of the Faculty of Public Health, Airlangga University, under approval number 237/EA/KEPK/2023.

RESULTS AND DISCUSSION

The following table presents the analysis of the relationship between age, physical activity, dietary patterns, and smoking habits and the incidence of hypertension in the community of Plosojenar Village, Ponorogo. This analysis was conducted to identify risk factors that are significantly associated with hypertension based on data obtained from case and control groups. The studied variables were categorized as described in the methods chapter.

Table 1. Results of Analysis of the Relationship between Age, Physical Activity, Diet, and Smoking Habits with Hypertension in the Community of Plosojenar Village, Ponorogo.

Variable	Group		P value	OR	95% CI	
	Case	Control			Lower	Upper
Age (Years)						
18-45	2	51	2.2E-16	71.19170	16.76598	643.68458
>45	75	26				
Physical Activity						
Negative	23	2	3.8E-03	15.73508	3.63613	143.28624
Positive	54	75				
Diet						
Negative	1	9	1.8E-02	0.10057	0.00224	0.75825
Positive	76	68				
Smoking Habits						
Negative	1	3	6.2E-01	0.32674	0.00611	4.17407
Positive	76	74				

Age

Age was identified as the most influential predictor of hypertension, with individuals older than 45 years exhibiting a markedly greater risk compared with those aged 18–45 years. This observation is consistent with a substantial body of literature that highlights age as a predominant determinant of hypertension (Guo et al., 2020; Hay et al., 2020; Onuh & Qiu, 2020; Suvila et al., 2020; Tirtasari & Kodim, 2019). Physiologically, increasing age is accompanied by reduced vascular elasticity, a process that contributes to elevated blood pressure levels (Rizzoni et al., 2019). The strength of the association in this study is reinforced by the highly significant p-value (2.2E-16) and the notably high odds ratio (71.19170), indicating a strong association between advancing age and hypertension risk. These results affirm that

individuals over the age of 45 exhibit a substantially heightened likelihood of developing hypertension relative to that of younger adults. Collectively, the findings underscore the necessity for early preventive measures and routine blood pressure surveillance tailored specifically for older populations.

Physical Activity

Physical activity was also found to play a significant role in hypertension risk, with individuals exhibiting low levels of activity showing a substantially greater likelihood of developing the condition. The statistical results, indicated by a p-value of 3.8E-03 and an odds ratio of 15.73508, show that inadequate physical activity is strongly associated with increased hypertension risk. In this study, respondents who engaged in minimal daily movement characterized by limited walking and an the absence of moderate-intensity tasks such as household chores, cycling, or regular exercise were considerably more prone to hypertension. These findings suggest that insufficient routine movement and the constitutes of sedentary behaviors constitute the specific activity patterns contributing to elevated risk. This outcome is consistent with the broader literature, which indicates that a sedentary lifestyle promotes hypertension through mechanisms including weight gain and insulin resistance (Battista et al., 2021; Guo et al., 2020; Park et al., 2020). Conversely, adequate levels of physical activity support blood pressure regulation by enhancing cardiovascular function and improving circulatory efficiency (Gibbs et al., 2021; Pinckard et al., 2019; Tian & Meng, 2019). Accordingly, the findings reinforce the importance of health promotion initiatives that encourage regular physical activity. Based on global guidelines and prior research, engaging in at least 150 minutes of moderate-intensity physical activity per week, which is equivalent to approximately 30 minutes daily for five days is recommended to reduce hypertension risk (WHO, 2020).

Diet Patterns

An unhealthy dietary pattern was also shown to be associated with hypertension, although its influence was less substantial compared to the effects of age and physical activity. The relationship remained statistically significant, as indicated by a p-value of 1.8E-02, however, the relatively small odds ratio (0.10057) suggests that, within this population, dietary habits contribute less prominently to hypertension risk than the other variables examined. The findings indicate that both hypertensive and non-hypertensive respondents reported similar eating behaviors such as frequent consumption of salty foods, processed foods, and limited intake of fruits and vegetables consumption. This minimal variation in dietary practices between groups likely attenuated the effect size, thereby making diet appear to exert a weaker influence in the statistical analysis. Nevertheless, evidence from previous studies consistently identifies high salt intake, excessive consumption of saturated fats, and inadequate fiber intake as key dietary contributors to hypertension risk (Hassana et al., 2019; Jabbari et al., 2023; Nepali et al., 2022). Reducing sodium intake has been shown to lower blood pressure through mechanisms involving decreased fluid retention and reduced vascular resistance, as demonstrated in systematic reviews showing substantial blood pressure reductions following lower sodium consumption (Filippini et al., 2021). Furthermore, increasing the intake of fruits and vegetables enhances potassium levels and provides dietary fiber, vitamins, and antioxidants that improve endothelial function and promote vasodilation, thereby supporting hypertension prevention (Lu et al., 2023; Madsen et al., 2023). These findings underscore the need for targeted dietary interventions and public health education, particularly efforts to reduce salt consumption and encourage higher fruit and vegetable intake to help mitigate the burden of hypertension.

Smoking Habits

This study did not identify a statistically significant association between smoking behavior and hypertension, a finding thatis in contrast to numerous prior studies linking smoking to a range of cardiovascular conditions (Duncan et al., 2019; Gallucci et al., 2020; Osei et al., 2019). Although the odds ratio (0.32674) indicated a direction of association, the p-value of 6.2E-01 indicated that the relationship was not statistically meaningful. Within the context of this research, smoking, therefore, does not emerge as a prominent risk factor for hypertension. The data revealed that most respondents who reported smoking were classified as light smokers, with a relatively low frequency and duration of use. Furthermore, the distribution of smokers and non-smokers was similar across both hypertensive and non-hypertensive groups, resulting in limited variation between groups. Such characteristics likely reduced the detectable effect size, contributing to the absence of a significant association in the statistical analysis. Despite these findings, it is important to note that smoking remains a well-established risk factor for cardiovascular morbidity more broadly. Consequently, public health interventions aimed at reducing smoking prevalence continue to be essential for promoting and safeguarding population health.

Implications for Health Policy

The results of this study indicate that hypertension prevention efforts should prioritize two key components: promoting higher levels of physical activity and improving dietary behaviors,

particularly among older adults. These strategies must be complemented by continuous health education that emphasizes the importance of adopting healthy lifestyle habits, including routine blood pressure monitoring. Although smoking did not demonstrate a significant association with hypertension in this population, public health measures aimed at reducing tobacco use remain crucial, given its well-documented role in cardiovascular morbidity. A notable strength of this study lies in its use of a case-control design, which enables strong analytical interpretation even with a relatively modest sample size. Nevertheless, the implementation of a 1:1 ratio between the case and control groups presents a methodological limitation. Future studies are encouraged to increase the number of controls to reduce potential biases and enhance analytical precision. Moreover, due to the observational nature of the study, causal inferences cannot be established between the examined variables.

One notable strength of this research is the application of a case-control design supported by primary data obtained through direct interviews, which enables a more accurate depiction of actual behavioral patterns and hypertension-related risk factors within the Plosojenar community. Furthermore, the measurement tools for physical activity and dietary patterns underwent prior validity and reliability assessments, thereby reinforcing the precision of the data collected. Despite these advantages, several methodological constraints remain. Limited variability in dietary intake and smoking behavior between the case and control groups may have attenuated the observed associations for these variables. Additionally, the observational nature of the study restricts the ability to infer causal relationships. The sample, which is confined to a single village setting, also presents challenges for the broader generalization of the findings to wider populations.

CONCLUSION

The findings of this study demonstrate that age and insufficient physical activity constitute the most influential risk factors for hypertension in Plosojenar Village, with older adults and individuals exhibiting low activity levels showing a markedly elevated likelihood of developing the condition. Dietary behaviors were also associated with hypertension risk, although their impact appeared less substantial than that of age and physical inactivity. Conversely, smoking habits did not exhibit a significant relationship with hypertension in this study population.

In light of these outcomes, hypertension prevention initiatives should place primary emphasis on promoting regular physical activity and encouraging healthier dietary practices, especially among older individuals. Although smoking did not emerge as a significant predictor in this context, its well-established effects on cardiovascular health underscore the continued importance of tobacco control efforts. Future studies with larger sample sizes and broader population coverage are recommended to generate more comprehensive insights into hypertension risk determinants and to support the development of more targeted preventive interventions.

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Conflict of Interest and Funding Disclosure

None.

Author Contributions

RN: conceptualization, investigation, methodology, supervision, writing–review and editing; EQ: methodology, writing–original draft; VAA: methodology; formal analysis, writing–original draft; NRS: methodology; formal analysis, writing–original draft.

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