

Original Research**Hypertension and Lifestyle Related Risk Factors****Dwi Kurniawati^{1*}, Afrianti Wahyu¹**¹ Department of Physiotherapy Poltekkes Kemenkes Surakarta, Indonesia**ABSTRACT**

Background: Hypertension is a leading cause of stroke, heart failure, and chronic kidney disease, contributing to substantial morbidity, mortality, and economic burden on healthcare systems globally. This study aims to identify risk factors associated with the prevalence of hypertension among a rural community in Central Java.

Methods: The study employed a cross-sectional design involving 100 respondents selected via purposive sampling. Data collection took place between July and August 2025, utilising blood pressure measurements and the completion of a questionnaire on respondent characteristics. Bivariate analysis was performed using the chi-square test, whilst multivariate analysis employed multiple logistic regression.

Results: The proportion of respondents with hypertension reached 57%. Bivariate analysis demonstrated significant associations between hypertension and age ($p = 0.012$), BMI/obesity ($p = 0.003$), physical activity ($p = 0.015$), high-salt diet ($p = 0.001$), and stress level ($p = 0.045$), whilst smoking was not significant ($p = 0.084$). Multivariate analysis identified high-salt diet as the most dominant risk factor (AOR = 4.72; 95% CI: 2.11–10.56), followed by obesity (AOR = 3.80; 95% CI: 1.74–8.26) and low physical activity (AOR = 2.65; 95% CI: 1.21–5.81).

Conclusion: Hypertension incidence is influenced by a combination of lifestyle and physiological factors. Integrated promotive and preventive strategies targeting salt reduction, weight management, physical activity, and stress management are required within primary healthcare services.

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INTRODUCTION

Hypertension is one of the major health problems that contributes significantly to the rising rates of morbidity and mortality due to cardiovascular disease (Carey et al., 2021). According to the World Health Organization (WHO), hypertension affects approximately 1.28 billion adults worldwide and is the leading attributable risk factor for premature death (Kario et al., 2024). Hypertension is defined as a condition of persistently elevated systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg (Unger et al., 2020). This condition is a major risk factor for coronary heart disease, stroke, heart failure, and chronic kidney disease (Ma & Chen, 2022). Complications of hypertension, including stroke and end-stage renal disease, impose a

substantial economic burden on healthcare systems, estimated at hundreds of billions of dollars annually in direct and indirect costs (Kario et al., 2021).

The prevalence of hypertension in Indonesia continues to be elevated. National survey findings show an increase from 27.9% in 2013 to 34.2% in 2018, and although it slightly declined to approximately 31.6% in 2023, the rate remains high, indicating an ongoing public health concern (Muharram et al., 2025). Hypertension in older adults is linked to an increased risk of adverse cardiovascular events, including coronary heart disease, heart failure, stroke, myocardial infarction, and mortality (Camara et al., 2024). In rural communities specifically, limited access to health services and lower health literacy further compound the risk of undetected and uncontrolled hypertension (Mahato et al., 2025).

Various risk factors are known to play a role in the development of hypertension, including both non-modifiable and modifiable factors. Non-modifiable factors include age, gender, and family history, whilst modifiable factors include an unhealthy diet, lack of physical activity, obesity, stress, smoking, and alcohol consumption (Carey et al., 2021). A diet high in sodium and fat, and low in fibre, is associated with increased blood pressure, particularly in populations with a sedentary lifestyle (Vignesh et al., 2025). These modifiable risk factors represent prime targets for intervention, particularly at the primary healthcare level.

A number of studies indicate that risk factors for hypertension may vary across regions and population groups. There is a significant association between age, obesity, family history, and diet with the incidence of hypertension, with diet being the most dominant factor (Minarti et al., 2024). Meanwhile, a study by Kartika et al. reported that obesity and smoking habits are associated with the incidence of hypertension in the health centre's catchment area (Kartika et al., 2021). These differing results indicate that the determinants of hypertension are strongly influenced by the social, environmental, and behavioural characteristics of the local community.

Despite the high burden of hypertension, comprehensive data on community-level risk factors in rural areas of Central Java remain limited. The novelty of this study lies in its simultaneous examination of multiple lifestyle-related and physiological risk factors including dietary sodium intake, physical activity, obesity, stress, and smoking in a rural community setting, using a multivariate approach to identify the most dominant predictor. The identification of community-specific risk factors is crucial as an evidence base for designing targeted promotive and preventive interventions at the primary healthcare level. Therefore, this study aims to analyse the factors associated with the incidence of hypertension among a rural community in Central Java and to provide actionable evidence for hypertension prevention programmes.

MATERIALS AND METHOD

This study employed a cross-sectional design as it allows for the concurrent assessment of exposures and outcomes within a defined population. Additionally, this approach offers a cost-effective way to determine prevalence and examine possible associations at a single point in time. It also enables researchers to generate baseline evidence for further analytical or longitudinal studies (Xiaofeng Wang, 2020).

The study was conducted in Bolon Colomadu between July and August 2025. The study population is comprised of adults residing in the study area. The sample consisted of 100 respondents selected using purposive sampling based on predetermined inclusion and exclusion criteria. Inclusion criteria were residents aged 30–75 years who were

willing to participate and provided written informed consent. Exclusion criteria included individuals with conditions that precluded participation in blood pressure measurement or completion of the questionnaire, such as acute illness or severe physical disability.

The dependent variable was the presence of hypertension, defined as systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg, measured using sphygmomanometer following standardised measurement protocols. The independent variables included: (1) dietary patterns (particularly high-salt food consumption); (2) physical activity level; (3) body mass index (BMI)/obesity status; (4) stress level; (5) smoking habit; and (6) age.

Blood pressure was measured directly using a calibrated sphygmomanometer by trained personnel following standard procedures. Measurements were taken in a seated position after a minimum 5-minute rest period. Hypertension was defined as systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg.

The questionnaire was adapted from the WHO STEPwise approach (WHO STEPS) and included 24 items assessing demographic characteristics, smoking, physical activity, dietary salt intake, and stress. Physical activity, diet, smoking behavior, and stress were measured using standard and validated items commonly applied in population-based studies. Prior to data collection, the instrument was tested among 30 respondents, demonstrating acceptable validity ($r > 0.361$) and good reliability (Cronbach's alpha 0.76–0.82), indicating strong internal consistency (Bull et al., 2020).

Data analysis was performed using IBM SPSS Statistics version 25. Univariate analysis was used to describe the distribution of respondents' characteristics. Bivariate analysis using the chi-square test was performed to assess the association between each independent variable and hypertension status. Variables with $p < 0.25$ in the bivariate analysis were entered into a multiple logistic regression model for multivariate analysis to identify dominant risk factors, adjusting for potential confounding factors. The statistical significance level was set at $p < 0.05$.

This study was conducted in accordance with the research permit with the number: DP.04.03/F.XXV.10/1185/2025. This study was conducted in strict adherence to the fundamental principles of research ethics, including autonomy, beneficence, non-maleficence, and justice. The principle of autonomy was upheld by providing participants with clear, comprehensive, and adequate information prior to obtaining their written informed consent. Non-maleficence was ensured by designing data collection procedures that minimized potential risks and psychological discomfort. Beneficence was reflected in the study's aim to contribute to the monitoring of hypertension risk factors. Meanwhile, the principle of justice was applied by ensuring that all eligible participants were treated equally without any form of discrimination.

RESULTS

Table 1. Sociodemographic and Health Characteristics of Respondents (n = 100)

Variable	Category	n	%
Gender	Male	45	45.0
	Female	55	55.0
Age (years)	30–40	27	27.0
	41–50	15	15.0
	51–60	21	21.0
	61–70	28	28.0

Variable	Category	n	%
BMI (Body Mass Index)	71–80	9	9.0
	Normal	32	32.0
	Overweight	13	13.0
Physical Activity Level	Obesity	55	55.0
	Low	63	63.0
	Moderate	29	29.0
Salt Intake	High	8	8.0
	Low	24	24.0
	Moderate	30	30.0
Smoking Status	High	46	46.0
	Yes	34	34.0
	No	66	66.0
Stress Status	Yes	25	25.0
	No	75	75.0
Blood Pressure	Normal	43	43.0
	Hypertension	57	57.0

The results showed that most respondents were female (55%), with the highest proportions in the 61–70 (28%) and 30–40 (27%) age groups, reflecting a concentration in middle to older adulthood. A high proportion of respondents were classified as obese (55%), while most reported light physical activity (63%). In terms of dietary habits, nearly half of the participants consumed a high-salt diet (46%). Most respondents were non-smokers (66%) and reported no stress (75%). However, despite these relatively favorable behavioral factors, more than half of the respondents were hypertensive (57%), indicating a substantial burden of hypertension within the population. The data suggest that obesity, low physical activity, and high salt intake are prominent characteristics that may contribute to the high prevalence of hypertension.

Table 2. Association Between Risk Factors and Hypertension (n = 100)

Variable	Category	Hypertension n (%)	Non-Hypertension n (%)	p-value*
Age	≥ 45 years	46 (71.9)	18 (28.1)	0.012
	< 45 years	11 (30.6)	25 (69.4)	
BMI	Obese	37 (67.3)	18 (32.7)	0.003
	Non-obese	20 (44.4)	25 (55.6)	
Physical activity	Low	36 (57.1)	27 (42.9)	0.015
	High	21 (56.8)	16 (43.2)	
High salt diet	Yes	34 (73.9)	12 (26.1)	0.001
	No	40 (60.6)	31 (57.4)	
Smoking	Yes	17 (50.0)	17 (50.0)	0.084
	No	40 (60.6)	26 (39.4)	
Stress	Low	35 (48.6)	37 (51.4)	0.045
	High	22 (78.6)	6 (21.4)	

Note: *Chi-Square

The results of the bivariate analysis using the chi-square test indicate that the bivariate analysis conducted using the chi-square test revealed that age, obesity, low physical activity, high salt intake, and stress were significantly related to hypertension ($p < 0.05$). In contrast, smoking was not found to have a statistically significant relationship (Table 2).

Table 3. Dominant Factors Associated with Hypertension (Logistic Regression Analysis)

Variable	B	S. E	Wald	p-value	AOR (Exp(B))	95 % CI
High-salt diet	1.55	0.41	14.28	0.001	4.72	21.1-10.56
BMI	1.33	0.39	11.62	0.003	3.80	1.74-8.26
Physical activity	0.97	0.36	7.24	0.015	2.65	1.21-5.81

Multivariate analysis using multiple logistic regression indicated that a high-salt diet emerged as the most dominant predictor of hypertension, with individuals consuming excessive salt having a 4.72-fold higher risk compared to those with lower salt intake (Table 3).

DISCUSSION

The results of this study indicate that a high-salt diet is the most dominant factor associated with hypertension, with an adjusted odds ratio of 4.72. This finding underscores the substantial role of excessive sodium intake in elevating blood pressure, particularly among adult and older populations. It is also consistent with previous research by Minarti et al. (2024), which identified dietary patterns as the strongest predictor of hypertension. Therefore, reducing salt consumption should be prioritized as a key preventive strategy for hypertension control.

From a physiological perspective, high salt intake increases sodium concentration in the extracellular fluid, leading to fluid retention and expansion of blood volume. This, in turn, elevates cardiac workload and intravascular pressure, thereby contributing to the development of hypertension (Ma & Chen, 2022). In line with this mechanism, clinical guidelines recommend limiting daily salt intake to less than 5 grams as a key non-pharmacological strategy for hypertension prevention and control (Carey RM et al., 2021). Adherence to this recommendation has been shown to significantly reduce both systolic and diastolic blood pressure in hypertensive patients.

Given that nearly half of the participants reported high salt consumption, these findings highlight the urgent need for targeted dietary interventions, particularly through primary healthcare-based counselling programs. Obesity was the second most dominant predictor of hypertension in this study. The pathophysiological mechanism linking obesity to hypertension involves increased peripheral vascular resistance, activation of the renin-angiotensin-aldosterone system (RAAS), and heightened sympathetic nervous system activity, all of which drive sustained elevations in blood pressure (Harrison et al., 2021). Obesity is a key contributor to hypertension, as excess body weight substantially increases blood pressure through neurohormonal activation, metabolic disturbances, and vascular dysfunction (Meouchy et al., 2022).

In addition to diet and obesity, low levels of physical activity have also been shown to be associated with the incidence of hypertension. Respondents with low levels of physical activity have a higher risk of developing hypertension compared to those who engage in moderate to vigorous physical activity. Regular physical activity can improve

blood vessel elasticity, enhance endothelial function, and reduce peripheral resistance, thereby contributing to a reduction in blood pressure (Schroeder et al., 2019). Regular physical activity plays a protective role against hypertension by improving vascular function and reducing hemodynamic load through enhanced cardiac efficiency and decreased peripheral resistance (Bull et al., 2020).

This study also found that stress is significantly associated with the incidence of hypertension. Stressful conditions can increase the activity of the sympathetic nervous system, triggering the release of the hormones adrenaline and cortisol, thereby raising heart rate and blood pressure. If this condition persists over the long term, stress can contribute to the development of chronic hypertension (Bludorn & Railey, 2024). Stress can elevate blood pressure by stimulating neuroendocrine and autonomic systems, resulting in persistent physiological changes such as increased heart rate and vascular resistance that contribute to hypertension (Park et al., 2023).

Stress is known to increase blood pressure through the activation of the sympathetic nervous system, characterised by elevated noradrenaline levels in hypertensive patients. The impact increases the likelihood of cardiovascular disease. It often shows an association with a variety of psychological disorders, including depression, anxiety, and stress. This indicates that psychosocial factors play a significant role in the pathogenesis of hypertension (Schaare et al., 2023).

Age was significantly associated with hypertension in bivariate analysis, with respondents aged ≥ 45 years having a markedly higher proportion of hypertension. This indicates that nearly half of the adult population is at risk of developing hypertension, whether already diagnosed or undiagnosed. The increasing prevalence of hypertension with age is largely attributable to age-related physiological deterioration and vascular changes, including reduced arterial elasticity and increased stiffness, which impair hemodynamic regulation and elevate blood pressure (Ahmed et al., 2024). The predominantly older adult composition of this study population (37% aged ≥ 61 years) likely amplified the contribution of age to overall hypertension prevalence (Fryar et al., 2024).

Smoking was not significantly associated with hypertension in this study. This result may reflect the relatively modest proportion of smokers (34%) and the lack of detailed assessment of smoking intensity and duration, which are important determinants of cardiovascular risk. Several studies have found no statistically significant relationship between smoking and hypertension, particularly when exposure is not comprehensively measured, such as in terms of frequency, duration, or intensity (Gao et al., 2023). These inconsistent findings may reflect the complex and dose-related nature of tobacco effects, along with the influence of other contributing factors, including metabolic status and lifestyle patterns (Zhao et al., 2026). Furthermore, cross-sectional approaches may not adequately capture the cumulative impact of long-term smoking on blood pressure, which generally develops over time (Amirzada et al., 2024).

The findings of this study have important implications for public health practice. The co-occurrence of high-salt diet, obesity, and low physical activity as dominant risk factors suggests that a multi-component, integrated intervention combining nutritional counselling, weight management support, and physical activity promotion would be most effective in reducing hypertension burden in this community. Health promotion programmes delivered through Posyandu, and primary healthcare centres should be strengthened to address these modifiable risk factors in a culturally appropriate manner.

This study offers valuable insights into modifiable determinants linked to

hypertension within a rural population. Nevertheless, some limitations need to be considered. The cross-sectional approach prevents establishing causal relationships between the identified factors and hypertension, and the use of purposive sampling may restrict the broader applicability of the results. Further research employing longitudinal methods and more representative, larger samples is recommended to enhance the robustness of the evidence.

CONCLUSION

Overall, the results of this study confirm that hypertension incidence is influenced by a combination of lifestyle and physiological factors. High-salt diet, obesity, and low physical activity were identified as the three primary independent determinants of hypertension in this rural community in Central Java. Hypertension prevention interventions should therefore focus on integrated education regarding dietary salt reduction, weight management, increased physical activity, and stress management, delivered within the framework of primary healthcare services. The strengthening of community-based promotive and preventive programmes, particularly targeting older adults with modifiable risk factors, is essential to reduce the growing burden of hypertension in rural Indonesia.

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