e-ISSN : 2597-6052

MPPKI MEDIA PUBLIKASI PROMOSI KESEHATAN INDONESIA

Research Articles Open Access

Association Between Dietary Patterns, Physical Activity, and BMI with Hypertension Among Rural Indonesian Farmers: A Cross Sectional Study Using a Nutritional Ecology Perspective

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ARTICLE INFO

Manuscript Received: 21 Mar, 2025
Revised: 14 Jun, 2025
Accepted: 23 Jun, 2025
Date of Publication: 12 Aug, 2025
Volume: 8
Issue: 8
DOI: 10.56338/mppki.v8i8.7599

KEYWORDS

Dietary Patterns;
Physical Activity;
BMI;
Hypertension;
Farmers

ABSTRACT

Introduction: Hypertension is a major non-communicable disease with a high prevalence in Indonesia, particularly in rural areas. Although farmers are generally engaged in physical labor, lifestyle factors such as unhealthy dietary patterns and poor nutritional status may contribute to elevated blood pressure. The existing literature has yet to fully integrate dietary patterns, physical activity, and BMI within a nutritional ecology framework to understand hypertension among rural farming populations; this study addresses that gap.This study aimed to analyze the association between dietary patterns, physical activity, and Body Mass Index/BMI (nutritional status) with hypertension among farmers in Kanreapia Village, Indonesia.

Methods: A cross-sectional study was conducted involving 908 farmers aged 35–59 years, selected through simple random sampling. Data were collected via structured interviews and measurements of blood pressure and anthropometry. Data analysis included univariate, bivariate (Chi-Square test), and multivariate analysis using logistic regression.

Results: The prevalence of hypertension among respondents was 51.2%. Bivariate analysis showed significant associations between age, smoking habits, risky dietary patterns (such as consumption of salty foods, grilled foods, processed meats, and instant noodles), and BMI with hypertension ($p < 0.05$). However, multivariate analysis identified only nutritional status (BMI) as significantly associated with hypertension ($p < 0.001$; OR = 0.41; CI: 0.508–0.809). Other variables were not statistically significant, including salty food consumption (OR = 0.999; CI: 0.758–1.316), grilled foods (OR = 0.963; CI: 0.613–1.514), processed meat/chicken/fish with preservatives (OR = 1.202; CI: 0.774–1.866), instant foods (OR = 0.957; CI: 0.729–1.255), and fruit consumption as a fiber source (OR = 1.124; CI: 0.847–1.491).

Conclusion: Nutritional status is the main determinant of hypertension among farmers, even though risky dietary patterns and physical activity showed significant associations in bivariate analysis. Public health interventions focusing on weight management and nutrition education are essential to reduce hypertension risk in rural farming communities.

Publisher: Fakultas Kesehatan Masyarakat Universitas Muhammadiyah Palu

INTRODUCTION

Hypertension, or high blood pressure, often goes undetected because most individuals with the condition do not show symptoms, causing many to be unaware that they are affected. Data from the World Health Organization (WHO) indicate that an estimated 1.28 billion adults aged 30–79 years worldwide suffer from hypertension, with two-thirds living in low- and middle-income countries (1). Although hypertension is both treatable and preventable, its prevalence continues to rise, particularly in developing countries.

In Indonesia, the prevalence of hypertension based on the 2018 Basic Health Research (Riskesdas) was 34.1%, an increase from 25.8% in 2013 (2). According to the 2023 Indonesian Health Survey (SKI), the prevalence of hypertension among adults aged 18 and above was 30.8%, showing a slight decrease compared to Riskesdas 2018 but still representing a significant health concern (2,3).

Hypertension is caused by both modifiable and non-modifiable risk factors. Non-modifiable factors include age, sex, and family history, while modifiable factors such as high salt and saturated fat intake, smoking, alcohol consumption, physical inactivity, and obesity play a major role in increasing blood pressure (4). Changes in these factors, such as improving dietary patterns and increasing physical activity, can help prevent or manage hypertension (5).

In rural areas, especially among farmers, these risk factors are particularly relevant. Unhealthy diets, low levels of physical activity and obesity, measured by Body Mass Index (BMI) have long been associated with an increased risk of hypertension. A study in Pingshan District confirmed that physical activity is associated with a lower of prevalence of obesity and hypertension (6). Research in Qatar reported the possible synergistic effects of diet, smoking, and physical inactivity on elevated blood pressure risk (7). Studies among middle-aged and elderly adults in both urban and rural China showed that lower hypertension prevalence in rural areas was primarily influenced by individuals' physical activity levels (8). Research on farmers in China found a high prevalence of hypertension and its associations with increasing age, sex, higher BMI, physical activity, and dietary habits (9).

The prevalence of hypertension in Indonesia, particularly in rural areas, is notably high, with approximately 46% of farmers affected (10). This highlights the need for a deeper understanding of the risk factors contributing to hypertension in this group. Although many farmers are engaged in physical labor, their lifestyles are often insufficient to maintain optimal cardiovascular health. Therefore, it is important to identify factors associated with hypertension in order to implement appropriate interventions, such as improving dietary patterns, increasing physical activity, and managing body weight. To comprehensively understand the risk factors for hypertension, an approach that considers the interaction between individuals and their environment is necessary. The ecological nutrition approach is relevant as it emphasizes the relationship between dietary patterns and physical activity within the context of daily life, particularly among rural farmers. Rural living conditions influence eating habits and physical activity levels, which may contribute to the risk of hypertension.

To fully understand the risk factors for hypertension, an individual-centered approach is insufficient. This study adopts the nutritional ecology framework developed by Sims and Smiciklas-Wright, which emphasizes the interaction between individuals and their natural, social, economic, and cultural environments in shaping diet, physical activity, nutritional status, and health outcomes (11). In rural farming communities, where food access, dietary habits, and healthcare services are shaped by the local context, these factors influence the balance of the nutritional ecology system. Accordingly, this study applies a nutritional ecology perspective to comprehensively assess the relationship between dietary patterns, physical activity, and nutritional status with hypertension among farmers.

This study aims to analyze the factors associated with hypertension among farmers in Kanreapia Village, Gowa Regency, South Sulawesi, focusing on risky dietary patterns, physical activity, and Body Mass Index (BMI). It is expected that the findings will provide useful insights for developing more effective hypertension prevention programs, particularly in rural areas, to help reduce the burden of hypertension among farmers.

METHOD

This study employed a quantitative research design using a cross-sectional approach, in which data were collected at a single point in time to examine the correlation between risk factors and the incidence of hypertension. The study was conducted in Kanreapia Village, Tombolo Pao Subdistrict, Gowa Regency, Indonesia, in July 2023.

Kanreapia Village was selected as the study site due to its unique agro-ecological conditions and high concentration of farming households. Located in the highlands of Gowa Regency, South Sulawesi, it represents a population whose daily lives are closely linked to traditional farming practices, seasonal food availability, and cultural food preferences. Local health reports have also indicated a relatively high prevalence of hypertension and nutritional problems, making it a strategic location to explore the interplay between environmental exposures, dietary patterns, physical activity, and nutritional status in relation to hypertension aligned with the nutritional ecology perspective.

The study population included all residents aged 35 to 59 years, totalling 3,642 individuals. The sample consisted of 908 farmers selected through simple random sampling. The sample size was determined using the finite population formula for proportion studies, with a 95% confidence level (Z = 1.96), a 3% margin of error (d = 0.03), and an assumed proportion of 0.5 to maximize sample size. The calculation yielded a minimum sample size of 826 respondents. To account for potential nonresponse, a 10% adjustment was added, resulting in a final sample size of approximately 908. Inclusion and exclusion criteria were applied to ensure that the selected respondents met the study objectives. Inclusion criteria included individuals aged 35 to 59 years, both male and female, residing in Kanreapia Village, and willing to provide informed consent. Exclusion criteria included individuals with a history of heart disease, kidney disorders, endocrine disorders, or other medical conditions that could affect blood pressure measurement, as well as those who refused to participate after receiving an explanation of the study.

The dependent variable in this study was hypertension, defined as systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg, based on two measurements taken five minutes apart. Independent variables included risky dietary patterns (such as consumption of salty foods, fatty foods, grilled foods, processed foods with preservatives, flavor enhancers, instant noodles, soft drinks, and intake of fruits and vegetables), physical activity (measured by the duration and intensity of light, moderate, or vigorous physical activity per week), and Body Mass Index (BMI), calculated from weight and height, and categorized as underweight, normal, or obese. All instruments used to assess dietary patterns, physical activity, and nutritional status were adapted from the standardized and validated questionnaire developed by the Indonesian Ministry of Health for the 2018 National Basic Health Survey (Riskesdas), which has been widely used in large-scale population studies across Indonesia.

Primary data were collected through face-to-face interviews using a validated questionnaire and on-site measurements of blood pressure, BMI, and waist circumference using calibrated instruments. Secondary data were also obtained from the village office regarding population figures and relevant health records. To minimize interviewer bias and measurement error, all data collectors received two days of training, which included interview techniques, blood pressure measurement using digital sphygmomanometers, and anthropometric measurements. Height was measured using a multifunctional height measuring device.

Data analysis included univariate analysis to describe the sample characteristics, bivariate analysis using the Chi-Square test to examine the relationship between two variables, and multivariate analysis using logistic regression to identify the most influential risk factors for hypertension among farmers.

RESULTS

This study involved 908 respondents (Table 1), with demographic characteristics and relevant behavioral and dietary factors presented in the table. The gender distribution was nearly equal, comprising 49.4% males and 50.6% females. Most respondents (63.1%) were aged 35–47 years, while the remaining 36.9% were in the 48–59 year age group. More than half of the respondents (51.2%) were found to have hypertension. Regarding smoking behavior, 39.5% reported being smokers. In terms of nutritional status, as measured by BMI, 5.4% of respondents were classified as thin, 56.1% had normal weight, and 38.5% were obese. A significant proportion of respondents (70.1%) engaged in light physical activity, while only 14.5% and 15.4% were engaged in moderate and heavy physical activity, respectively. With respect to dietary patterns associated with hypertension risk, a notable proportion reported risky consumption of salty food (47.1%), fatty foods (42.8%), and instant noodles or processed foods (43.6%). Risky seasoning use was highly prevalent (87.1%), while risky consumption of soft drinks (4.8%), burnt food (10.4%), and processed meats (11.2%) was less frequent. Fiber intake from fruits was categorized as risky in 67.0% of respondents, while inadequate vegetable intake was only found in 3.9% of the sample, indicating that most participants consumed vegetables adequately.

Table 1. Characteristics of Respondents and Studied Variables

Characteristics	n (908)	%
Gender		
Male	449	49.4
Female	459	50.6
Age		
35-47 years	573	63.1
48-59 years	335	36.9
Blood Pressure		
Normal	443	48.8
Hypertension	465	51.2
Smoke Behavior		
Yes	359	39.5
No	549	60.5
Body Mass Index (BMI)		
Thin	49	5.4
Normal	509	56.1
Obesity	350	38.5
Physical activity		
Light	636	70.1
Moderate	132	14.5
Heavy	140	15.4
Dietary Patterns of Risk in Hypertension		
Salty Food		
Risk	428	47.1
Not Risk	480	52.9
Fatty foods		
Risk	389	42.8
Not Risk	519	57.2
Food is burnt		
Risk	94	10.4
Not Risk	814	89.6
Processed meat, chicken, and fish with preservatives		
Risk	102	11.2
Not Risk	806	88.8
Seasoning		
Risk	791	87.1
Not Risk	117	12.9
Soft drink		
Risk	44	4.8
Not Risk	864	95.2
Instant noodles/instant food		
Risk	396	43.6
Not Risk	512	56.4
Source of fiber		
Fruits		
Risk	608	67.0
Not Risk	300	33.0
Vegetables		
Risk	35	3.9
Not Risk	873	96.1

Table 2. Risk factors associated with hypertension

Risk Factor	Status Hypertension				Total		P-value
	Normal		Hypertension		n (908)	%	
	n (443)	%	n (465)	%			
Age							
35 – 47 years	285	64.33	288	61.93	573	63.1	0.025
48 – 59 years	158	35.67	177	38.07	335	36.9	
Smoke Behavior							
Yes	192	43.34	167	35.91	359	39.5	0.022
No	251	56.66	298	64.09	549	60.5	
Dietary Patterns at Risk of Hypertension							
Salty Food							
Risk	207	46.72	221	47.52	428	47.1	0.008
Not Risk	236	53.28	244	52.48	480	52.9	
Fatty foods							
Risk	174	39.27	215	46.23	389	42.8	0.070
Not Risk	269	60.73	250	53.77	519	57.2	
Food is burnt							
Risk	45	10.16	49	10.53	94	10.4	0.006
Not Risk	398	89.84	416	89.47	814	89.6	
Processed meat, chicken, and fish with preservatives							
Risk	53	11.96	49	10.53	102	11.2	0.023
Not Risk	390	88.04	416	89.47	806	88.8	
Seasoning							
Risk	379	85.55	412	88.60	791	87.1	0.045
Not Risk	64	14.45	53	11.40	117	12.9	
Soft drink							
Risk	24	5.42	20	4.31	44	4.8	0.026
Not Risk	419	94.58	445	95.69	864	95.2	
Instant noodles/instant food							
Risk	191	43.11	205	44.08	396	43.6	0.010
Not Risk	252	56.89	260	55.92	512	56.4	
Source of fiber							
Fruits							
Risk	300	67.72	308	66.23	608	67.0	0.016
Not Risk	143	32.28	157	33.77	300	33.0	
Vegetables							
Risk	12	2.71	23	4.94	35	3.9	0.058
Not Risk	431	97.29	442	95.06	873	96.1	
Physical activity							
Linght	319	72.01	317	68.17	636	70.1	
Moderate	53	11.96	79	16.99	132	14.5	0.071
Heavy	71	16.03	69	14.84	140	15.4	
Body Mass Index (BMI)							
Thin	37	8.36	12	2.58	49	5.4	
Normal	256	57.78	253	54.41	509	56.1	0.000
Obesity	150	33.86	200	43.01	350	38.5	

Table 2 outlines the bivariate analysis between selected risk factors and hypertension status among the respondents. Several variables showed statistically significant associations with hypertension. Age was significantly associated with hypertension ($p = 0.025$), with a higher proportion of hypertension observed in the 48–59 age group. Smoking behavior also showed a significant association ($p = 0.022$), where non-smokers had a higher proportion of

hypertension. Among dietary factors, the intake of salty foods (p = 0.008), burnt foods (p = 0.006), processed meats (p = 0.023), seasoning (p = 0.045), soft drinks (p = 0.026), instant noodles (p = 0.010), and low fruit consumption (p = 0.016) were significantly associated with hypertension. Interestingly, fatty food consumption approached statistical significance (p = 0.070), while vegetable intake was not significantly associated (p = 0.058). Physical activity levels did not show a significant association (p = 0.071), although hypertension tended to be higher among those with moderate activity. In contrast, Body Mass Index (BMI) was significantly associated with hypertension (p < 0.001), with a higher prevalence of hypertension in obese individuals (43.01%) compared to those with normal or low BMI. These findings suggest that age, smoking behavior, BMI, and multiple dietary factors are important contributors to hypertension among middle-aged farmers in the study population.

Table 3. Multivariate Analysis of Risk Factors Associated with the Incidence of Hypertension

No	Sub Variable	Koef	S.E	P-value	OR	CI 95%
1	Salty Food	-0,001	0,141	0,995	0,999	0,758 - 1,316
2	Food is burnt	-0,036	0,231	0,872	0,963	0,613 - 1,514
3	Processed meat, chicken, fish with preservatives	0,180	0,224	0,412	1,202	0,774 - 1,866
4	Instant noodles/instant food	-0,043	0,139	0,750	0,957	0,729 - 1,255
5	Fruits (Source of fiber)	0,113	0,144	0,420	1,124	0,847 - 1,491
6	Body Mass Index (BMI)	- 0,436	0,119	0,00	0,41	0,508 - 0,809

Table 3 shows the results of the multivariate regression analysis of risk factors associated with the incidence of hypertension. The analysis shows that the consumption of salty foods (p-value = 0.995) and grilled foods (p-value = 0.872) does not have a significant association with hypertension. Similarly, instant noodles and other instant foods (p-value = 0.750), as well as fiber sources from fruits (p-value = 0.420), do not show a significant effect on hypertension. However, processed meat, chicken, and fish products with preservatives show an odds ratio (OR) of 1.202 (p-value = 0.412), although this is not statistically significant at the 5% level. On the other hand, nutritional status (BMI) shows a significant association with hypertension (p-value = 0.00, OR = 0.41), indicating that respondents classified as having a normal BMI were 59% less likely to experience hypertension compared to those in the obese category. This interpretation follows the standard direction of odds ratio, where an OR less than 1 implies a protective effect. In this case, lower BMI (normal range) is associated with reduced odds of developing hypertension, highlighting the importance of maintaining a healthy weight in preventing elevated blood pressure.

DISCUSSION

The results of this study indicate a significant association between risky dietary patterns, physical activity levels, and Body Mass Index (BMI) with the incidence of hypertension among farmers in Kanreapia Village, Gowa Regency. These findings highlight that although farmers are generally engaged in physically demanding work, the risk of hypertension remains high, suggesting that other lifestyle determinants play an important role.

Dietary Patterns of Risk and Hypertension

Dietary patterns of risk characterized by high consumption of salt, saturated fat, processed foods, and low intake of fruits and vegetables were found to be significantly associated with hypertension in the bivariate analysis (p < 0.05). This aligns with previous studies showing that excessive sodium intake is a well-established risk factor for hypertension. In the United States, sodium primarily comes from processed foods, whereas in China, it mainly comes from salt added during cooking (12,13). Moreover, saturated fats may contribute to the formation of atherosclerotic plaques, which narrow the blood vessels and increase blood pressure. Frequent consumption of high-fat foods, such as beef and poultry, has been linked to a higher risk of hypertension. Mendelian randomization studies have shown that increased intake of poultry and beef is associated with a heightened risk of hypertension (14,15).

In the local context, habits such as consuming instant noodles, grilled foods, and excessive use of flavor enhancers among farmers reflect a preference for convenient but unhealthy diets, which contribute to the risk of elevated blood pressure. Similarly, fiber sources from fruits also showed a statistically significant association with

hypertension in the bivariate model ($p = 0.016$). Consistent with prior evidence that diets rich in fruits, vegetables, whole grains, and low-fat dairy products have a protective effect against hypertension (16,17). Antioxidants from fruits and vegetables have been inversely associated with the risk of hypertension, suggesting that antioxidants help reduce oxidative stress, a key contributor to hypertension (18). Other studies emphasize that fiber intake from fruits, particularly whole fruits, plays a role in lowering hypertension risk. Individuals with the highest fruit fiber intake had a 14% lower likelihood of developing hypertension compared to those with the lowest intake (19). Whole fruits are preferred over fruit juices due to their stronger cardioprotective effects (20,21). The WHO recommends at least five servings of fruits and vegetables per day to prevent non-communicable diseases, including hypertension, a guideline supported by longitudinal studies demonstrating the cardiovascular benefits of fruit-rich diets (21).

However, multivariate analysis results indicate that none of the dietary pattern variables had a statistically significant effect on hypertension (all $p > 0.05$). These findings suggest that while these dietary factors correlate with hypertension in unadjusted analyses, their independent effects may be diminished in the presence of other influential variables potentially due to confounding or interaction effects among diet, lifestyle, and metabolic status.

These findings can be better understood through the nutritional ecology perspective developed by Sims and Smiciklas-Wright, which emphasizes that nutritional health outcomes are shaped by the dynamic interaction of biological, behavioral, cultural, and environmental systems (11). According to this model, dietary behavior is not merely an individual choice but the product of interconnected ecological domains including the food environment, cultural norms, economic conditions, and physiological needs.

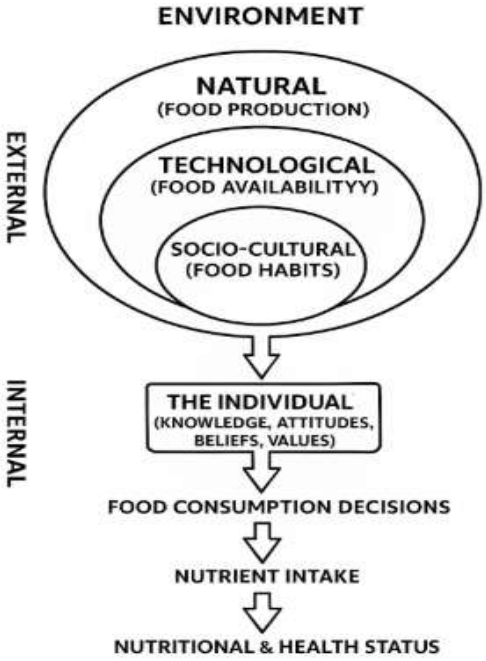

Figure 1. Model depicting the ecological nutristion perspective

In the context of this study, the observed risky dietary patterns among farmers such as high consumption of instant noodles, salty and processed foods, and low fruit intake reflect a complex interplay of factors operating across multiple ecological levels. At the individual-biological level, taste preferences for salty or fatty foods may be influenced by early life exposures or genetic predispositions. At the interpersonal and cultural levels, shared eating habits and food preparation practices within farming communities reinforce dietary behaviors high in sodium and saturated fat.

At the environmental and economic levels, the accessibility and affordability of fresh produce such as fruits and vegetables remain a challenge in rural farming areas, where diets are often shaped by convenience and availability rather than nutritional quality. Limited infrastructure, market access, and seasonal variability also contribute to reduced dietary diversity. This is consistent with the Sims and Smiciklas-Wright framework, which underscores that ecological constraints such as food systems and socioeconomic status directly influence dietary intake and, consequently, health outcomes.

The finding that dietary patterns were significantly associated with hypertension in the bivariate analysis but lost significance in the multivariate analysis further highlights the ecological complexity of nutritional risk. It suggests that dietary risk factors alone may not fully explain the incidence of hypertension without accounting for their interactions with other ecological determinants, such as BMI, physical activity, and social context. For instance, the effects of certain foods may be mediated by metabolic status (e.g., obesity), energy expenditure (e.g., occupational activity), or psychosocial stress all of which operate across ecological domains.

Physical Activity and Hypertension

Physical activity in this study did not show a statistically significant association with hypertension incidence ($p = 0.071$). However, the prevalence of hypertension was higher among respondents with light physical activity (68.17%), indicating a potential trend that may become significant with a larger sample size. Although farmers are often considered to be physically active, this study found that variations in activity intensity and duration may affect cardiovascular health. Some participants reported limited physical activity to certain seasons or short daily durations, especially among older individuals or during less labor-intensive farming periods. Reduced physical activity is known to contribute to visceral fat accumulation and lower cardiovascular fitness both well established risk factors for hypertension. However, it is important to acknowledge that the physical activity data in this study were self-reported, which may introduce recall bias or social desirability bias. Participants may have overestimated their activity levels or inaccurately reported duration and intensity. These potential biases may have influenced the observed statistical associations.

Despite these methodological limitations, the physiological impact of inadequate physical activity remains well-documented in the literature. Reduced physical activity promotes the accumulation of visceral fat and lowers cardiovascular fitness, two conditions strongly associated with elevated blood pressure. This is supported by studies in rural China, including in the Pingshan District, which found that low physical activity is associated with a higher prevalence of hypertension and obesity (6). Physical activity plays a crucial role in lowering both systolic and diastolic blood pressure. Aerobic exercise, resistance training, and a combination of both are effective, especially in individuals with hypertension and resistant hypertension (22). A cohort study in China showed that moderate to vigorous physical activity significantly reduced the risk of hypertension, with an optimal level of 112 METs-hours/week (23). In specific groups such as postmenopausal women and the elderly, higher physical activity levels have also been associated with lower blood pressure (24, 25).

From a nutritional ecology perspective, physical inactivity among farmers can be understood as a behavior shaped by the surrounding environment rather than individual factors alone. Seasonal changes in labor intensity, availability of farming tools, and cultural perceptions about aging and rest influence how individuals engage in daily physical activity. In some cases, reduced physical exertion may be normalized within the community, especially during certain agricultural cycles or among older adults. These socio-cultural and environmental influences interact with individual beliefs, attitudes, and knowledge about health, ultimately affecting physical activity behavior. When such behaviors persist, they contribute to lower energy expenditure, increased body fat, and heightened risk of hypertension. This underscores the need for interventions that not only promote individual awareness but also target environmental and cultural conditions that enable or constrain healthy activity patterns.

Body Mass Index (BMI) and Hypertension

In this study, Body Mass Index (BMI) was the only variable that remained significantly associated with hypertension in the multivariate analysis, serving as a strong and independent predictor of risk. Higher body mass index (BMI) is also closely associated with the risk of hypertension in this population. Farmers with a BMI ≥ 25 kg/m^2 had a higher risk of developing hypertension compared to those with a normal BMI. Nutritional status (BMI) was the

only variable in the multivariate model that showed a statistically significant association, indicating that BMI is a strong predictor of hypertension (OR = 0.41; p-value = 0.000, 95% CI: 0.508–0.809). Farmers with normal BMI had a 59% lower likelihood of developing hypertension compared to those who were obese. This reinforces findings from previous studies that obesity is a major determinant of hypertension, even in populations with high levels of physical activity such as farmers.

BMI is a strong predictor of hypertension, as supported by various observational and longitudinal studies. Studies conducted in Medan, Indonesia, and rural India have shown that being overweight or obese is significantly associated with hypertension, where individuals with higher BMI tend to have elevated systolic and diastolic blood pressure levels (26,27). In South Asia, being overweight or obese significantly increases the likelihood of hypertension compared to individuals with normal BMI [28]. Physiologically, obesity triggers hemodynamic changes such as increased heart rate and systemic vascular resistance, which contribute to high blood pressure (29).

Obesity is a major health concern that affects cardiac workload and insulin resistance. It is characterized by increased blood volume and cardiac output. If systemic vascular resistance does not decrease in response to these changes, hypertension may occur. Weight loss can reverse these effects by reducing blood volume and cardiac output, thereby lowering blood pressure (29). Obesity not only increases the risk of hypertension but also exacerbates other cardiovascular risk factors such as dyslipidemia, insulin resistance, and inflammation. Collectively, these factors increase the risk of cardiovascular diseases including heart failure and stroke (30, 31).

From a nutritional ecology perspective, the significant association between BMI and hypertension in this study reflects the influence of individual behaviors and broader environmental changes in rural communities. The relatively high obesity rate among farmers (38.5%) suggests a nutritional transition driven by increased consumption of energy-dense, low-fiber foods and decreased physical activity due to mechanization of farming. This behavioral shift is shaped by external ecological factors such as food availability, market access, and sociocultural norms interacting with internal factors such as health knowledge, attitudes, and beliefs. Although farmers operate in a physically oriented environment, these findings highlight how ecological determinants at multiple levels contribute to the risk of overweight and hypertension, reinforcing the need for context-specific, community-based prevention strategies.

These findings highlight that, although farmers live in environments that support regular physical activity, the risk of hypertension remains high if not balanced with a healthy diet and optimal weight management. This underscores the importance of designing public health interventions in rural areas, where awareness of nutrition and the prevention of non-communicable diseases is still low. Health promotion programs in rural communities should include nutrition education, access to affordable healthy foods, and regular monitoring of Body Mass Index (BMI) and blood pressure. A community-based approach involving health cadres or agricultural extension workers can also be employed to more effectively reach this population.

Limitations and Cautions

This study has several limitations that need to be considered. First, the dietary patterns analyzed did not quantitatively measure nutrient intake such as daily sodium or calorie levels, resulting in a less detailed understanding of the relationship between food consumption and hypertension. Second, the physical activity measurements used were not sensitive enough to distinguish intensity and frequency, so physical activity did not show a significant association with hypertension in the multivariate analysis. In addition, both dietary and physical activity data were self-reported, which may have introduced recall bias and social desirability bias, potentially affecting the accuracy of the findings. Additionally, other important factors such as stress, family history, alcohol consumption, and sleep quality were not examined, which could potentially be confounding variables. Finally, the results of this study are only applicable to farmers in Gowa Regency, particularly in Kanreapia, limiting the generalizability to other regions.

Recommendations for Future Research

Future research is recommended to use more detailed and quantitative methods for measuring nutrient intake, such as daily food records or analyses of sodium and calorie levels, to provide a more accurate picture of the relationship between dietary patterns and hypertension. Studies should also include additional factors such as stress,

family history, and alcohol consumption. Furthermore, research with more diverse samples from various regions will help broaden the understanding of hypertension among farmers.

CONCLUSION

This study found a high prevalence of hypertension (51.2%) among farmers in Kanreapia Village. While risky diet and physical activity were significantly associated with hypertension in bivariate analysis, both were not significant in the multivariate model. BMI was the only independent predictor, with obese individuals having a 59% higher risk of hypertension compared to those with normal BMI (OR = 0.41; $p < 0.001$). These findings highlight the important role of excess weight in driving hypertension, even in a physically active rural population, and emphasize the need for targeted weight management strategies. From a nutritional ecology perspective, these findings reflect the complex interactions between individual behaviors, cultural norms, and environmental conditions in shaping hypertension risk. Food choices among farmers such as frequent consumption of salty foods, processed foods, and low consumption of fruits are influenced by food availability, affordability, and communal cooking practices. Similarly, physical activity is shaped not only by labor demands but also by seasonal cycles and aging. These interrelated ecological factors contribute to the increasing rates of obesity and hypertension in rural areas. Therefore, integrating ecological understanding into community-based health programs may support more sustainable and environmentally and culturally appropriate solutions for hypertension prevention in rural areas.

AUTHOR'S CONTRIBUTION STATEMENT

Syamsul Alam conceptualized the study, developed the research framework, data analysis and led the manuscript writing. Habibi contributed to data analysis, statistical interpretation, and critically reviewed the manuscript. Nildawati coordinated field data collection and managed research logistics. Syarfaini assisted in designing the dietary pattern assessment tools and supervised data entry. Nurfaidah and Isymiarni Syarif contributed to literature review and assisted in manuscript formatting and references. All authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors confirm that there are no conflicts of interest or personal relationships that could have influenced the work presented in this paper.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

Generative AI (ChatGPT, OpenAI) was used minimally in this article to refine sentence structure and support literature searches. However, all core ideas, analyses, interpretations, and final content were developed, verified, and approved solely by the authors.

SOURCE OF FUNDING STATEMENTS

This research did not receive any grants.

ACKNOWLEDGMENTS

The author would like to express his deepest gratitude to the Public Health Study Program, Universitas Islama Negeri Alauddin Makassar, for the invaluable support and assistance provided during the data collection process at the Student Field Learning Practice Activity (PBL 1) location.

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