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The Effect of Genetic Factors and Physical Activity on the Incidence of Hypertension among the Productive-Age Population in Kedungwuni Timur Village, Kedungwuni District, Pekalongan Regency

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A R T I C L E I N F O

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A B S T R A C T

Hypertension remains a major public health problem, particularly among the productive-age population. In the working area of Kedungwuni I Public Health Center, hypertension ranks as the most prevalent non-communicable disease, with Kedungwuni Timur Village reporting the highest number of cases. This study aimed to analyze the effect of physical activity and genetic factors on the incidence of hypertension among the productive-age population (15–59 years) in Kedungwuni Timur Village, Kedungwuni District, Pekalongan Regency. This research employed an analytic observational design with a quantitative approach. Data were collected from productive-age respondents using structured questionnaires and analyzed using bivariate statistical tests. The results showed that most respondents were aged 44–48 years and had a junior high school educational background. Based on genetic factors, 55 respondents had a family history of hypertension, while 45 respondents did not. Bivariate analysis indicated that physical activity had no significant effect on the incidence of hypertension among the productive-age population (p=0.109). Similarly, genetic factors were not significantly associated with the incidence of hypertension (p=0.230). In conclusion, although physical activity and genetic factors are considered determinants of hypertension, this study found no statistically significant effect of these factors on hypertension incidence among the productive-age population in Kedungwuni Timur Village in 2025.

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INTRODUCTION

The Indonesian Health Survey (Survei Kesehatan Indonesia/SKI) 2023 clearly describes the occurrence of hypertension among the productive-age population. In the productive age group of 15–20 years, the prevalence of hypertension was reported at 0.4%, while in the 25–34 years age group it reached 1.8%. Hypertension or high blood pressure is often perceived as a health problem affecting older adults. However, current data indicate that individuals of productive age in Indonesia are also vulnerable to this condition. The Indonesian Health Survey (SKI) 2023 recorded a hypertension prevalence based on sphygmomanometer measurements of 10.7% in the 15–20 years age group and 17.4% in the 25–34 years age group (Survei Kesehatan Indonesia SKI, 2023).

The World Health Organization (WHO) estimated that the prevalence of hypertension reached 33% in 2023, with two-thirds of cases occurring in low- and middle-income countries (WHO, 2023). The number of people with hypertension is expected to continue increasing over time and is projected to reach 1.5 billion by 2025 (WHO, 2021). In Central Java Province, the prevalence of hypertension reached 37.57%, with a higher prevalence among women (40.17%) compared to men (34.83%). The prevalence of hypertension in urban areas was reported at 38.11%, slightly higher than in rural areas at 37.01% (WHO, 2023).

From June to December 2022, data based on the Ministry of Health Strategic Plan (Renstra Kemenkes 2020–2024) showed that the percentage of hypertension patients with controlled blood pressure at public health centers or primary healthcare facilities reached 20 patients in June and increased to 43 patients in December. In 2023, from June to December, a total of 93 patients were reported based on prevalence data. Furthermore, in 2024, from June to December, the number of patients increased to 130 cases (Renstra Kemenkes, 2024).

Puskesmas Kedungwuni I is one of the public health centers with the highest number of hypertension patients in Pekalongan Regency. Hypertension is also included among the top ten diseases at Puskesmas Kedungwuni I. According to registry data over the last three years for the entire working area of Puskesmas Kedungwuni I, the number of hypertension patients from 2022 to 2024 was recorded using the indicator of hypertension patients receiving services according to established standards. In 2022, the number of targeted hypertension patients was recorded at 19,563 individuals. In 2023, this number slightly decreased to 19,230 individuals. A more significant change occurred in 2024, when the number of targeted hypertension patients decreased to 15,560 individuals.

Kedungwuni Timur Village was selected as a priority area for hypertension intervention based on the analysis of productive-age population data and the estimated number of hypertension cases in 2024. Among 11 villages listed, Kedungwuni Timur had the highest productive-age population, totaling 10,632 individuals. The estimated number of hypertension patients was also the highest, reaching 1,384 individuals, consisting of 698 males and 687 females.

These data indicate that the proportion of hypertension cases in Kedungwuni Timur Village is significantly higher compared to other villages. The high number of productive-age individuals with hypertension has the potential to affect work productivity and the community's economic conditions, as well as increase the future burden on health services. Therefore, interventions in Kedungwuni Timur Village have high urgency and significant potential impact if intensive prevention and hypertension control efforts are implemented through health education, regular screening, and the promotion of healthy lifestyles.

Hypertension or high blood pressure is a serious health condition that can lead to mortality worldwide. The urgency of hypertension lies in conditions where blood pressure increases suddenly without organ damage, which may result in complications such as stroke, heart failure, and kidney failure. Most of the population in Kedungwuni is within the productive-age group, a stage of life characterized by high levels of activity related to work and other daily responsibilities. High activity levels and daily pressures may trigger stress, fatigue, and unhealthy lifestyle patterns, which are significant risk factors for hypertension among the productive-age population. Therefore, it is important for the community to maintain a balance between activity and health and to adopt healthy lifestyles to prevent hypertension.

Risk factors associated with hypertension among the productive-age population (15–59 years) include family history of hypertension, stress levels, and lifestyle factors. Other factors related to hypertension in this age group include obesity and inadequate fluid intake. This study examines hypertension risk factors such as genetic or hereditary factors, environmental factors, age, ethnicity, salt intake, physical activity, stress, obesity, dietary patterns, smoking, and alcohol consumption (Febriyanti, 2023).

Preliminary research findings in Kedungwuni Timur Village indicate that the productive-age population is at risk of non-communicable diseases (NCDs), such as hypertension and diabetes mellitus, due to insufficient physical activity. The research gap identified in this study is the absence of previous research that specifically analyzes the effect of genetic factors and physical activity on the incidence of hypertension among the productive-age population in Kedungwuni Timur Village, Kedungwuni District, Pekalongan Regency, using a consecutive sampling approach and integrating physical activity and genetic variables.

Based on the above description, this study aims to analyze the effect of genetic factors and physical activity on the incidence of hypertension among the productive-age population in Kedungwuni Timur Village, Kedungwuni District, Pekalongan Regency. Specifically, the objectives of this study are to describe the characteristics of respondents in Kedungwuni Timur Village, to describe physical activity and genetic factors as determinants of hypertension among the productive-age population, and to analyze the effect of physical activity and genetic factors on the incidence of hypertension among the productive-age population in Kedungwuni Timur Village.

LITERATURE REVIEW

Epidemiology of Hypertension

Hypertension is derived from the English term *hypertension*, which originates from the Latin words *hyper*, meaning excessive, and *tension*, meaning pressure. In English, hypertension is also referred to as *high blood pressure*. Blood pressure represents the force exerted by circulating blood against the walls of blood vessels as it is pumped by the heart to overcome vascular resistance. In other words, it is the amount of force required to circulate blood throughout the body (World Health Organization, 2024). An individual is classified as having hypertension when blood pressure exceeds 140/90 mmHg. Hypertension is often associated with emotional conditions, such as excessive anger, which commonly leads to the perception that individuals who frequently experience anger are more likely to have high blood pressure (Kementrian Kesehatan, 2024). According to the World Health Organization (WHO), normal blood pressure in adults is 120/80 mmHg, while systolic pressure above 140 mmHg and diastolic pressure above 90 mmHg are considered hypertensive. In 2022, the global prevalence of hypertension reached 22% of the world's population, and epidemiologically, primary hypertension has also been detected among adolescents, with prevalence increasing alongside the obesity epidemic (WHO, 2023).

The pathophysiology of hypertension involves a sustained increase in blood pressure which, if chronic, can result in damage to target organs. Elevated blood pressure may occur due to abnormalities in peripheral resistance or cardiac output. Hypertension is also closely related to the renin–angiotensin–aldosterone system (RAAS) (Halomoan, 2024). Renin is synthesized and stored as prorenin in the juxtaglomerular cells of the kidneys and is released when arterial pressure decreases. This process leads to the conversion of angiotensinogen, produced by the liver, into angiotensin I, which is then converted by angiotensin-converting enzyme (ACE). Aldosterone, secreted by the zona glomerulosa of the adrenal cortex, plays an important role in regulating sodium reabsorption and potassium secretion in the renal tubules by stimulating sodium–potassium ATPase activity and increasing sodium permeability in the tubular membrane (Yoshimichi Takeda et al., 2024).

Clinically, hypertension is often asymptomatic, making it difficult to detect without proper screening. Medical history assessment should include cardiovascular risk factors such as smoking, obesity, insufficient physical activity, diabetes mellitus, and family history of hypertension. Blood pressure measurement should be conducted using appropriate equipment, correct cuff size, and proper positioning, with at least two measurements taken on separate occasions to confirm diagnosis (Kemenkes RI, 2020). Although many patients do not present symptoms, certain clinical manifestations may indicate secondary hypertension or complications, including chest pain, shortness of breath, palpitations, headaches, and dizziness. Comprehensive physical examination is necessary to identify hypertension-mediated organ damage (HMOD) or secondary causes of hypertension (Moningka et al., 2021; Pramana, 2020; Kementrian Kesehatan, 2024).

Uncontrolled hypertension, particularly among the productive-age population, can lead to serious complications such as stroke, myocardial infarction, kidney failure, visual impairment, and neurological disorders (Dika Lukitaningtyas & Eko Agus Cahyono, 2023). Hypertension is classified etiologically into essential (primary) hypertension, which accounts for approximately 90–95% of cases with no clearly identified cause, and secondary hypertension, which has identifiable causes such as kidney disease or hormonal disorders (Kemenkes P2PTM, 2023). Classification based on blood pressure levels follows the Joint National Committee 8 (JNC 8) and WHO/International Society of Hypertension guidelines, categorizing hypertension into normal, prehypertension, stage 1, and stage 2. Lifestyle modification is the primary management approach for mild hypertension, while moderate and severe hypertension requires pharmacological treatment due to the higher risk of cardiovascular events and organ damage (Kementrian Kesehatan Republik Indonesia, 2024).

Hypertension Prevention Programs

Efforts to prevent the occurrence of hypertension include several levels of prevention. Primordial prevention focuses on modifying and developing healthy public policies aimed at reducing population-level risk factors. Health promotion is conducted to increase public awareness and knowledge regarding healthy lifestyles. Protective measures include reducing salt consumption as one of the major risk factors for hypertension. Early diagnosis is carried out through screening and routine medical check-ups to detect hypertension at an early stage. Appropriate treatment is provided by administering causal or early treatment to address initial complaints promptly. In addition, rehabilitation is implemented as a long-term effort for individuals with hypertension that cannot be fully cured, aiming to improve health status and prevent further complications (PZPTM Kemenkes, 2023; 2024).

Determinants of Hypertension Incidence

Genetic or Hereditary Factors

Genetic or hereditary factors are one of the risk factors for hypertension among the productive-age population. The genetic influence of hypertension includes the transmission of hypertension from parents to children and grandchildren. Individuals who have family members suffering from hypertension are at a higher risk of developing the condition themselves. This increased risk may occur as a result of gene mutations or genetic abnormalities that affect blood pressure regulation (R. Setiani, 2023).

Physical Activity

Physical activity refers to any bodily movement produced by skeletal muscles that requires energy expenditure. Physical activity includes daily activities that help burn calories obtained from food consumption. Examples of physical activity include washing clothes, mopping floors, walking, cleaning windows, gardening, ironing, and playing with children. Insufficient physical activity is an independent risk factor for chronic diseases.

Several studies have shown that regular physical activity can reduce blood pressure, as consistent physical activity may cause blood vessels to dilate, thereby contributing to the normalization of blood pressure levels (D. Lukitaningtyas, 2023).

Theoretical Framework

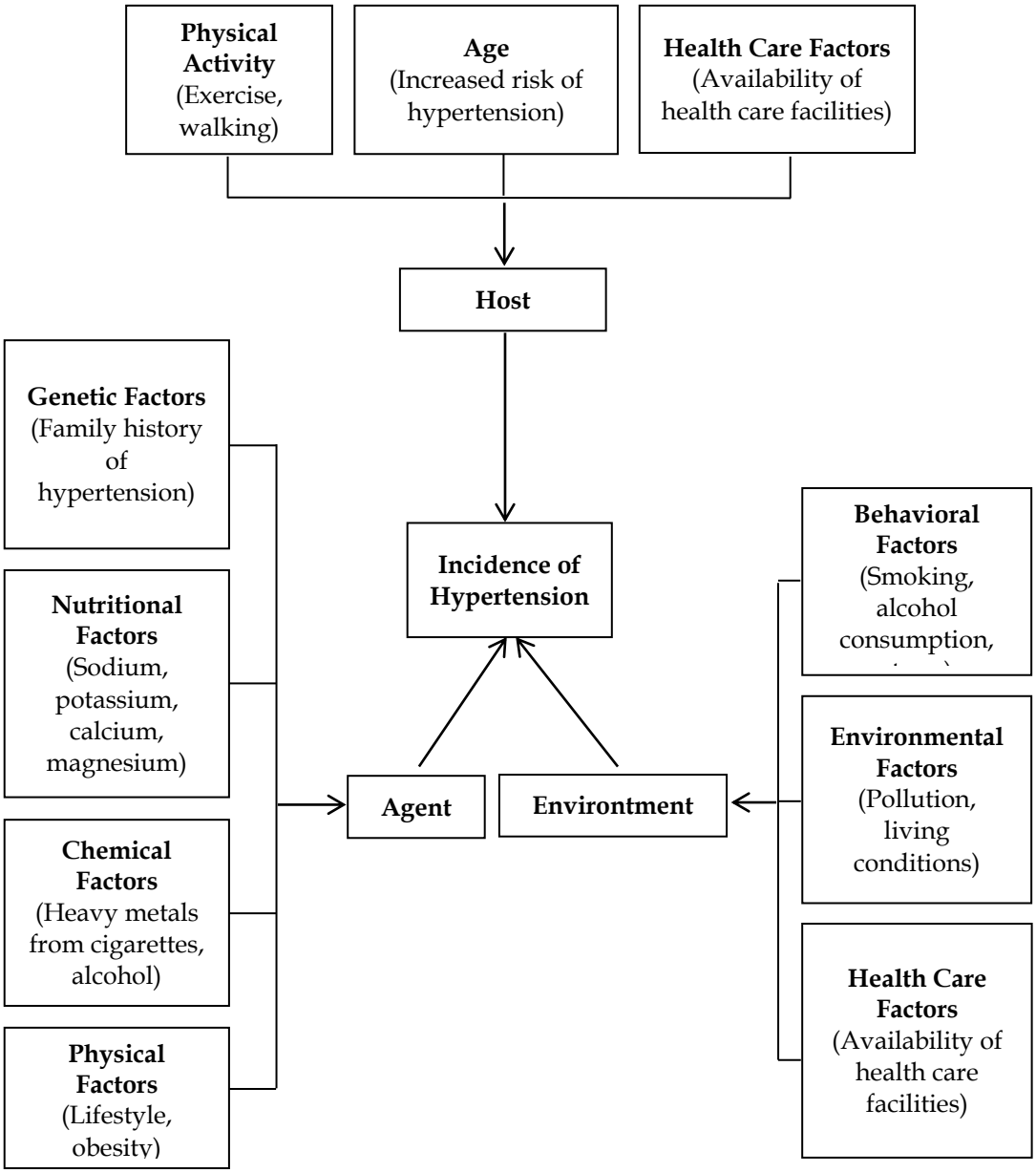


Figure 1. Research Framework

METHODOLOGY

This study employed a quantitative research method, in which data were obtained in numerical form and analyzed systematically. An observational analytic design with a case–control approach was used to determine the magnitude of risk between the dependent variable (hypertension incidence) and independent variables (physical activity and genetic factors) using a retrospective approach.

The study population consisted of individuals aged 15–59 years registered in the Prolanis program at Kedungwuni Timur Village, Kedungwuni 1 Public Health Center, with a total of 1,384 hypertension cases recorded in 2024. The minimum sample size was calculated using the Lemeshow formula and rounded to 50 respondents for each group. Sampling was conducted using consecutive sampling for newly diagnosed cases. The case group included 50 hypertension patients with blood pressure ≥140/90 mmHg who were receiving treatment at Kedungwuni 1 Public Health Center and met the inclusion criteria, while the control group consisted of 50 non-hypertensive individuals from the same service area who met the specified criteria. Data were collected through structured interviews using a closed-ended questionnaire as the main research instrument. Data processing involved editing, coding, data entry, and tabulation, followed by univariate analysis to describe variable characteristics and bivariate analysis using the Chi-square test to examine the association between physical activity, genetic factors, and hypertension incidence.

RESEARCH RESULT

Characteristics of Study Subjects

Characteristics Based on Age

The results of the study indicate that the age distribution of respondents in Kedungwuni Timur Village can be seen in Table 5 below.

Table 1. Distribution of Respondents Based on Age in Kedungwuni Timur Village, 2025

No	Age Group (Years)	N	%
1	19–23	2	2
2	24–28	5	5
3	29–33	5	5
4	34–38	6	6
5	39–43	16	16
6	44–48	27	27
7	49–53	17	17
8	54–58	17	17
9	59–63	5	5
	Total	**100**	**100**

Based on Table 1, the largest proportion of respondents was in the age group 44–48 years, totaling 27 respondents (27%), while the smallest proportion was in the 19–23 years age group, with 2 respondents (2%).

Characteristics Based on Educational Level

The distribution of respondents according to educational level in Kedungwuni Timur Village is presented in Table 2.

Table 2. Distribution of Respondents Based on Educational Level in Kedungwuni Timur Village, 2025

No	Educational Level	N	%
1	Elementary School	13	13
2	Junior High School	57	57
3	Senior High School	28	28
4	Bachelor's Degree	2	2
	Total	**100**	**100**

Based on Table 2, most respondents had an educational background at the junior high school level, totaling 57 respondents (57%), while the smallest proportion of respondents had a bachelor's degree, with 2 respondents (2%).

Results of Univariate Analysis

Physical Activity

The results of the study among respondents in Kedungwuni Timur Village can be seen in Table 3, which shows that out of a total of 100 respondents, 57 respondents (57%) engaged in light physical activity, 27 respondents (27%) engaged in moderate physical activity, and 16 respondents (16%) engaged in vigorous physical activity.

Table 3. Frequency Distribution of Respondents Based on Physical Activity in Kedungwuni Timur Village, 2025

Physical Activity	N	%
Light	57	57
Moderate	27	27
Vigorous	16	16
Total	**100**	**100**

Genetic Factors

The results of the study among respondents in Kedungwuni Timur Village can be seen in Table 4, which shows that out of a total of 100 respondents, 55 respondents (55%) had a family history of hypertension, while 45 respondents (45%) did not have a family history of hypertension.

Table 4. Frequency Distribution of Respondents Based on Genetic Factors in Kedungwuni Timur Village, 2025

Genetic Factors	N	%
Yes	55	55
No	45	45
Total	**100**	**100**

Results of Bivariate Analysis

Effect of Physical Activity on the Incidence of Hypertension

The results of the bivariate analysis between physical activity and the incidence of hypertension are presented in Table 5 below.

Table 5. Results of the Analysis of the Relationship Between Physical Activity and the Incidence of Hypertension in Kedungwuni Timur Village, 2025

Physical Activity	Hypertension		Total	P value	OR	95% CI
	Yes	No				
	N	%	N	%	N	
Light	31	62	26	52	57	
Moderate	9	18	18	36	27	0.101
Vigorous	10	20	6	12	16	0.776
Total	50	100	50	100	100	

The results of the analysis of the relationship between physical activity and the incidence of hypertension showed that out of 100 respondents, 57 respondents had light physical activity, of whom 31 respondents experienced hypertension and 26 respondents did not experience hypertension. Furthermore, 27 respondents had moderate physical activity, with 9 respondents experiencing hypertension and 18 respondents not experiencing hypertension, and 16 respondents had vigorous physical activity, with 10 respondents experiencing hypertension and 6 respondents not experiencing hypertension.

The analysis results in the light–moderate physical activity category showed a Chi-Square value with a p value of 0.101 > 0.05, and in the light–vigorous physical activity category, the Chi-Square value showed a p value of 0.776 > 0.05, which means that there is no significant relationship between physical activity and the incidence of hypertension among the productive-age population (15–59 years) in Kedungwuni Timur Village in 2025.

The analysis results in the light–moderate physical activity category obtained an Odds Ratio (OR) = 2.385 with a 95% confidence interval (CI) of 0.918–6.196, while in the light–vigorous physical activity category, an Odds Ratio (OR) = 0.715 with a 95% confidence interval (CI) of 0.229–2.233 was obtained, indicating that physical activity is not a risk factor for the incidence of hypertension.

Effect of Genetic Factors on the Incidence of Hypertension

The results of the bivariate analysis between genetic factors and the incidence of hypertension are presented in Table 6 below.

Table 6. Results of the Analysis of the Relationship Between Genetic Factors and the Incidence of Hypertension in Kedungwuni Timur Village, 2025

Genetic Factors	Hypertension		Total	P value	OR	95% CI
	Yes	No				
	N	%	N	%	N	
Yes	28	56	21	42	49	0.230
No	22	44	29	58	51	
Total	50	100	50	100	100	

The results of the analysis of the relationship between genetic factors and the incidence of hypertension showed that out of 100 respondents, 49 respondents had a family history of hypertension, of whom 28 respondents experienced hypertension and 21 respondents did not experience hypertension, while 51 respondents did not have a family history of hypertension,

with 22 respondents experiencing hypertension and 58 respondents not experiencing hypertension.

The analysis results showed a Chi-Square value with a p value of 0.230 > 0.05, which indicates that genetic factors are not a risk factor for the incidence of hypertension among the productive-age population (15–59 years) in Kedungwuni Timur Village in 2025. The analysis of genetic factors obtained an Odds Ratio (OR) = 1.758 with a 95% confidence interval (CI) of 0.796–3.880.

Supporting and Inhibiting Factors

Several factors supported the smooth implementation of this study. One of the supporting factors was the support from the village administration and the local public health center, which provided research permission and assisted in coordinating with the community, thereby facilitating the researchers in accessing respondents who met the inclusion criteria. In addition, respondents generally showed a positive response and were willing to allocate time to participate in interviews and blood pressure measurements, allowing the required data to be collected comprehensively. The availability of adequate facilities and measurement tools also supported the research process, such as calibrated digital sphygmomanometers, structured questionnaire sheets, as well as stationery and supporting documents, which ensured that data collection was conducted systematically. Furthermore, weather conditions and the surrounding environment were relatively conducive during the data collection period, enabling the researchers to schedule visits according to the planned timeline.

However, several obstacles were encountered during the research process. One of the main constraints was the limited time for data collection, as some respondents were busy working, requiring the researchers to adjust visit schedules outside working hours or during weekends. Communication barriers were also experienced with some respondents, particularly younger elderly respondents or those with lower educational levels, who required additional explanations to fully understand the questionnaire content. In addition, there was a potential for recall bias when respondents were asked to remember their family history of hypertension, which could result in inaccuracies in the data. Fluctuating health conditions of respondents also became a challenge, for example, blood pressure levels influenced by fatigue or stress during interviews, which could affect measurement results. Moreover, the relatively wide coverage area of Kedungwuni Timur Village required extra time and effort to reach the respondents' residences.

DISCUSSION

Physical activity, including regular exercise, plays an important role in maintaining overall health by supporting organ function and improving metabolic processes, which can reduce excessive fat accumulation and lactic acid buildup that contribute to obesity and increased blood pressure. Regular physical activity has been shown to provide various health benefits, such as weight control, weight maintenance, and a reduced risk of falls, particularly among older adults. Frequent engagement in exercise has been associated with significant weight reduction, which may indirectly lower the risk of hypertension (Gusriani et al., 2021).

However, the results of this study indicate that there was no statistically significant relationship between physical activity and the incidence of hypertension among the productive-age population (15–59 years) in Kedungwuni Timur Village in 2025, as shown by a chi-square p value of 0.109 (>0.05). These findings are consistent with previous studies by Gusriani et al. (2021), Afnam et al. (2024), and Wirakhmi and Purnawan (2023), which also reported no significant association between physical activity and hypertension. The absence of a significant relationship in these studies may be attributed to the generally adequate level of physical activity among respondents, including routine and prolonged exercise duration, which results in relatively homogeneous activity patterns and minimizes observable differences in hypertension risk.

The results of the analysis showed a chi-square p value of 0.230 (>0.05), indicating that there was no significant association between genetic factors and the incidence of hypertension among the productive-age population (15–59 years) in Kedungwuni Timur Village in 2025. Among the 50 hypertension cases, 28 respondents had a family history of hypertension, while 22 did not. A similar pattern was observed in the control group, where 21 respondents had a genetic history of hypertension and 29 did not. These findings suggest that genetic factors were not a significant risk factor for hypertension in this population. This result is consistent with studies by Sabanari et al. (2023) and Pangaribuan (2020), which also reported no significant relationship between genetic factors and hypertension, indicating that lifestyle-related factors may play a more dominant role than heredity.

Although genetic predisposition can increase susceptibility to hypertension through hereditary mechanisms related to intracellular sodium levels and potassium–sodium imbalance, not all individuals with a family history of hypertension develop the condition. Conversely, some respondents without a genetic history still experienced hypertension due to other contributing factors such as older age, female sex, and high salt consumption. Individuals with hypertensive parents are reported to have a twofold higher risk of developing hypertension compared to those without a family history (Khairunnisa et al., 2022); however, this study demonstrates that genetic factors alone are insufficient to explain the occurrence of hypertension without the influence of other risk factors.

CONCLUSIONS AND RECOMMENDATIONS

The results of this study indicate that there was no significant effect of physical activity on the incidence of hypertension among the productive-age population (15–59 years) in Kedungwuni Timur Village in 2025, as evidenced by a p value of 0.109 (>0.05), and no significant effect of genetic factors on the incidence of hypertension, with a p value of 0.230 (>0.05). Based on these findings, it is recommended that the government enhance health education and socialization programs related to hypertension among the productive-age population, while primary healthcare facilities such as community health centers strengthen preventive efforts by reducing hypertension risk factors.

In addition, the community is encouraged to improve their knowledge of hypertension by seeking information from healthcare providers or reliable online sources and to consistently adopt healthy lifestyle practices as a preventive measure against hypertension.

ADVANCED RESEARCH

One limitation related to the respondents was that most of them were within the productive age range (15–59 years) and worked outside the home throughout the day, which often resulted in their absence when the researchers visited, making face-to-face interviews difficult to conduct. Another limitation was encountered during respondent interviews, as some respondents, particularly those aged 50–59 years or those with lower educational backgrounds (junior high school or elementary school), had difficulty understanding several questions in the questionnaire. As a result, the researchers needed to provide more detailed explanations to ensure that respondents' answers were aligned with the research instrument.

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