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Urban–Rural Disparities in Metabolic Risk Factors for Hypertension Among the Elderly in Indonesia

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Abstract

Hypertension remains a major public health challenge among the elderly in low- and middle-income countries. This cross-sectional study examined demographic and metabolic factors associated with hypertension among the elderly living in urban and rural areas of West and Central Java Provinces, Indonesia. This study included 1,920 adults aged ≥60 years who had resided in the study areas for at least six months, were able to communicate effectively, and provided informed consent. Data were collected between March and August 2023 using stratified multistage random sampling, structured questionnaires, and biochemical measurements. Multivariable logistic regression revealed distinct patterns of association across settings. In urban areas, hypertension was associated with older age (AOR =1.366; 95% CI: 1.043–1.789), female sex (AOR=1.681;95% CI: 1.198–2.359), central obesity based on waist circumference (AOR=2.031; 95% CI:1.477–2.793), and abnormal blood glucose levels (AOR=2.821; 95% CI: 1.754–4.536). In rural areas, hypertension was associated with older age (AOR=1.613; 95% CI: 1.228–2.119), lower education level (AOR=0.686; 95%CI:0.507–0.928), central obesity (AOR = 1.613; 95% CI: 1.204–2.161), and blood glucose levels (AOR=1.503; 95% CI: 0.978–2.310). These findings highlighted that while metabolic markers, such as waist circumference and blood glucose, were universal predictors, demographic factors, such as sex and education level, varied by environment. Consequently, public health interventions must adopt tailored, context-specific approaches to manage hypertension in urban and rural Indonesian communities effectively.

Keywords: elderly, hypertension, metabolic risk factor, urban-rural

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Introduction

Hypertension is one of the most prevalent public health issues affecting the elderly worldwide. It is estimated that >60% of individuals aged ≥60 years live with hypertension, and its prevalence increases steadily with age, posing a remarkable health burden in aging populations.[1,2] Hypertension is a leading risk factor for cardiovascular disease, stroke, and kidney failure. Despite being a largely preventable condition, it remains a primary cause of global morbidity and mortality. According to the World Health Organization (WHO), an estimated 1.4 billion adults worldwide are living with hypertension, with a substantial proportion remaining undiagnosed and untreated.[1]

The absolute number of adults with hypertension has nearly doubled over the past three decades, from approximately 650 million in 1990 to more than 1.2 billion in 2019.[2] More recent WHO estimates indicate that this number has continued to rise, reaching approximately 1.4 billion adults in 2024.[1] Although the global age-standardized prevalence has remained relatively stable at approximately 32%, the burden has shifted disproportionately toward low- and middle-income countries (LMICs), largely driven by population aging and lifestyle-related metabolic risk factors.[1,2]

Further evidence from the Non Communicable Diseases Risk Factor Collaboration pooled analysis in 2021, which included over 100 million adults from 1,201 population-based studies, showed that more than one billion people aged 30–79 years had hypertension in 2019.[2] Advancing age is one of the strongest and most consistent risk factors across settings, which is closely associated with vascular stiffening, reduced arterial compliance, and impaired baroreceptor sensitivity, all of which contribute to elevated systolic blood pressure in the elderly.[2]

A 2020 meta-analysis reported only a 2.45% difference in hypertension prevalence between urban (30.5%) and rural (27.9%) areas in LMICs, with the gap narrowing as rural prevalence increased.[3] According to the 2023 Indonesian Health Survey, the prevalence of hypertension among the elderly is 56.8%. This is remarkably higher than that in the general adult population (which stands at 30.8%).[4] The elderly individuals not only face an increased risk of elevated blood pressure due to physiological aging processes such as arterial stiffness,[5,6] but are also influenced by various metabolic factors, including serum levels of uric acid, blood glucose, and total cholesterol.[7–9]

For instance, hyperuricemia has been identified as an independent predictor of hypertension in middle-aged and elderly.[7,10] Metabolic dysfunctions, such as diabetes and dyslipidemia, exacerbate vascular risk and complicate blood pressure control. Metabolic and behavioral risk factors, such as diabetes, dyslipidemia, and physical inactivity, are more prevalent in urban areas. In contrast, advanced age and higher body mass index (BMI) are stronger predictors of hypertension in rural areas.[11,12]

In addition to metabolic factors, demographic characteristics, such as age and sex, contribute to variations in hypertension risk. Studies have shown that hypertension risk increases considerably with advancing age due to structural changes in blood vessels and reduced arterial elasticity.[13,14] Differences in hypertension prevalence and associated risk factors between men and women have also been reported, with hormonal influences, lifestyle behaviors, and the burden of chronic diseases identified as major contributing factors.[15–17] Abdominal adiposity, often measured by waist circumference, is a key metabolic risk factor for hypertension in the elderly. Individuals with central obesity are at higher risk of hypertension due to the association of visceral fat with insulin resistance, inflammation, and vascular dysfunction.[18,19] Education level also plays a critical role, as lower education level is linked to reduced health literacy, poorer access to health care, and unhealthy lifestyle behaviors, which may increase hypertension risk.[3,20,21]

Occupation further influences hypertension by affecting physical activity and stress levels. The elderly who remain employed tend to have a lower hypertension risk, likely reflecting the protective effects of occupational physical activity and social engagement, whereas jobs with high stress and low physical activity can exacerbate hypertension risk.[22] Urban versus rural residence plays a critical role in the distribution of hypertension among the elderly. Global and national studies have revealed remarkable disparities in hypertension prevalence, underlying risk factors, and access to management strategies between these populations.[3,11,21,23] The elderly living in urban areas generally have better access to healthcare services but are more exposed to unhealthy lifestyle risks, such as high-salt and high-fat diets and physical inactivity.[24,25] In contrast, the elderly living in rural areas may engage in more physical activity but often have limited access to diagnosis and treatment services.[26,27]

Although advancing age is a well-established risk factor for hypertension, growing evidence indicates that its development reflects a complex interaction of metabolic, functional, and socioenvironmental determinants across the life course. Studies conducted in Indonesian adult populations have demonstrated that even among younger and more educated groups, environmental exposures, occupational characteristics, and lifestyle patterns substantially shape hypertension risk. These findings indicate that hypertension in later life is not only a consequence of biological aging but also the cumulative result of long-term contextual and behavioral influences that may persist or intensify in older age, particularly across different urban and rural settings.[28]

Despite growing evidence on hypertension, context-specific data from Indonesia remain limited, particularly studies using primary, community-based data that simultaneously examine both demographic (age and sex) and metabolic (BMI, blood glucose, uric acid, and total cholesterol) risk factors across urban and rural settings. This gap highlights the need to understand how hypertension risk among Indonesia's aging population varies across residential contexts. This study was designed to assess the effects of demographic factors (age and sex) and metabolic indicators (BMI, blood glucose, uric acid, and total cholesterol) on hypertension in individuals aged ≥60 years, categorized by urban and rural living environments. The authors anticipated uncovering unique risk patterns for hypertension among the elderly in urban and rural settings, which would provide valuable insights for developing targeted prevention and management strategies for hypertension in Indonesia.

Method

This study employed a comparative cross-sectional design to examine differences in the determinants of hypertension-related factors among the elderly living in urban and rural settings. This study was conducted in selected locations in West and Central Java to allow meaningful urban–rural comparisons based on population density, socioeconomic characteristics, lifestyle patterns, and access to healthcare services. Urban study sites included Bandung City, Cimahi City, and Semarang City, which represent densely populated urban centers with relatively well-developed healthcare infrastructure. Rural study sites comprised West Bandung District, Bogor District, and Kebumen District, characterized by lower population density, predominantly agricultural or semirural livelihoods, and limited access to healthcare services.[29] Although the study sites were not nationally representative, they were considered appropriate for examining contextual differences between urban and rural environments.

This study used primary data collected specifically for research purposes. Data were obtained through direct interviews, physical measurements, and biochemical assessments conducted during the study period. Data were cleaned and screened for completeness before analysis. Ethical approval was obtained as the data were anonymized. The study population consisted of elderly individuals aged ≥60 years who had resided in the study area for at least 6 months, were able to communicate effectively, and provided informed consent. A total of 1,920 respondents were included. Participants were selected using stratified multistage random sampling, involving the selection of urban and rural districts, the random selection of villages or neighborhoods within each district, and the random recruitment of eligible elderly individuals within selected clusters. The sample selection process is explained in Figure 1.

Trained enumerators collected data between March and August 2023 using structured questionnaires. Sociodemographic information included age, sex, education level, and occupation status. Anthropometric measurements, including body weight, height, and waist circumference, were obtained using standardized procedures. Blood pressure was measured using a calibrated digital sphygmomanometer, and biochemical measurements (blood glucose, cholesterol, and uric acid) were assessed using validated point-of-care devices. Blood pressure was measured twice during the same visit, with an interval of at least 5 minutes between measurements, while the respondent was seated and at rest. The mean of the two readings was used as the final blood pressure value for analysis.

Random blood glucose levels were measured using glucometers. Total cholesterol was measured using a peripheral blood cholesterol test with a portable testing device. Serum uric acid levels were assessed using capillary blood samples. Anthropometric measurements were conducted following standard protocols. Body weight was measured with a calibrated digital scale, and height was measured with a stadiometer, with participants standing barefoot and wearing light clothing. BMI was calculated as weight (kg) divided by height (m^2).

Waist circumference was measured as an indicator of nutritional status and abdominal fat distribution in the elderly. Measurements were performed using a nonelastic measuring tape with a precision of 0.1 cm. Participants were instructed to stand upright without thick clothing or jackets, and the measurement was taken at the midpoint between the lower margin of the last rib and the top of the iliac crest, following a normal exhalation without holding their breath. Sociodemographic data, including age, sex, education level, and occupation status, were collected via face-to-face interviews using structured questionnaires.

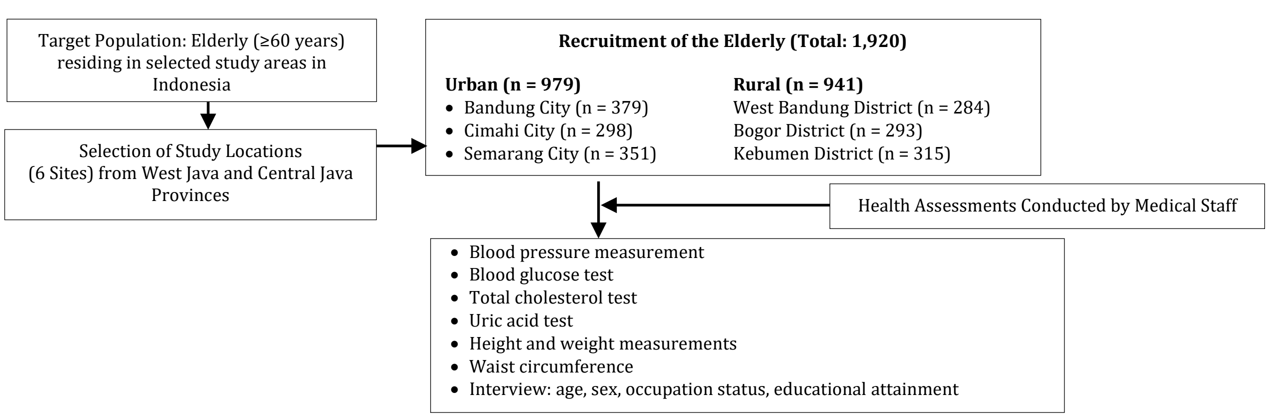

Figure 1. Sample Selection

The dependent variable was hypertension status, defined as a binary outcome (yes/no), with respondents classified as hypertensive if they had a systolic blood pressure ≥140 mmHg or a diastolic blood pressure ≥90 mmHg, or both, or reported current use of antihypertensive medication.[30] Age was categorized into <67 and ≥67 years based on a cutoff derived from the study sample distribution to facilitate interpretation and comparison between age groups in the logistic regression models. Occupation status was assessed using a structured questionnaire. Respondents were classified as either working (currently engaged in any form of income-generating or productive activity) or not working (retired, homemakers, or unable to work). This variable was analyzed as a dichotomous variable (1 = working; 0 = unemployed).

Education level was assessed based on respondents' highest completed formal education and categorized into two groups for analytical purposes to reflect potential differences in cognitive and socioeconomic status that may influence health behaviors and disease risk. Participants who had never attended school, did not complete primary school, and completed primary and junior high school (≤9 years of schooling) were classified as having low education. Those who completed senior high school or attained higher education (≥12 years of schooling) were classified as having higher education. The variable was coded as 0 = low education and 1 = high education.

The elderly BMI was calculated as weight (kg) divided by height squared (m^2) and categorized according to the Indonesian Ministry of Health guidelines for the elderly. Participants with BMI <18.5 or ≥25 were classified as overweight, whereas those with BMI between 18.5 and 24.9 were classified as non-overweight.[34] Waist circumference was used as an indicator of abdominal adiposity. Participants with a waist circumference <90 cm for males and <80 cm for females were classified as having no central obesity, whereas those with a waist circumference ≥90 cm for males and ≥80 cm for females were classified as having central obesity.[35] A random blood glucose level of ≥200 mg/dL is classified as high.[31] A total cholesterol level of ≥200 mg/dL is considered high.[32] Serum uric acid levels ≥7 mg/dL for men and ≥6 mg/dL for women are classified as high.[33]

Descriptive analyses were conducted separately for urban and rural samples. Multivariate logistic regression analyses were performed to examine factors associated with hypertension. Separate regression models were estimated for urban and rural populations to allow clearer interpretation of context-specific associations and to account for structural differences between urban and rural settings. Given the study objectives, this approach was preferred over a combined model with interaction terms to enhance interpretability and avoid model complexity. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported, and statistical significance was set at a p-value of <0.05.

Results

Table 1 describes the characteristics of the elderly in urban (51.0%) and rural (49.0%) areas. The prevalence of hypertension was almost identical in both settings, affecting 39.2% of urban and 39.3% of rural respondents. The average age in both areas was 67 years, and the age distributions were comparable, with slightly more than half of the respondents aged <67 years and a similar age range (60–93 years). Females predominated in both groups, particularly in rural areas. Education level differed markedly: low education was more common in rural areas, whereas higher education was more common in urban areas. Most participants in both settings were still working, with a higher proportion in rural areas. Urban respondents showed a higher prevalence of abnormal BMI and central obesity than rural respondents. Metabolic profiles also varied: high cholesterol levels were more common in rural areas, whereas elevated uric acid levels were more common in urban areas. Elevated blood glucose levels were relatively low in both groups, although slightly higher in rural respondents.

In the bivariate analysis (Table 2), several factors were associated with hypertension among the elderly in both urban and rural areas. In urban settings, sex, occupation, waist circumference, and uric acid and blood glucose levels were statistically significantly associated with hypertension (p-value <0.05). BMI and age were also retained for further modeling due to their theoretical and biological relevance (p-value <0.25). In rural areas, age, education level, BMI, and waist circumference were significantly associated with hypertension (p-value < 0.05), whereas uric acid and blood glucose showed marginal associations (p-value ≤ 0.25). Therefore, these variables were included in the multivariate analysis. Total cholesterol was excluded from both models because it was not statistically significant. Separate multivariate models were constructed for urban and rural populations to capture contextual variations in metabolic and sociodemographic predictors of hypertension (Table 3).

Table 1. Characteristics of Elderly Respondents in Urban and Rural Areas

Variable	Urban (n = 979, 51.0%)	Rural (n = 941, 49.0%)
Hypertension		
Yes	384 (39.2)	370 (39.3)
No	595 (60.8)	571 (60.7)
Age, mean±Standard Deviation (range)	**67 ± 6.1 (60–93)**	**67 ± 6.2 (60–93)**
≥67 years	445 (45.5)	422 (44.8)
<67 years	534 (54.5)	519 (55.2)
Sex		
Male	258 (26.4)	178 (18.9)
Female	721 (73.6)	763 (81.1)
Education Level		
Low	440 (44.9)	665 (70.7)
High	539 (55.1)	276 (29.3)
Occupation Status		
Unemployed	261 (26.7)	197 (20.9)
Working	718 (73.3)	744 (79.1)
Body Mass Index		
Overweight	536 (54.7)	481 (51.1)
Non-overweight	443 (45.3)	460 (48.9)
Waist Circumference		
Central obesity	683 (69.8)	607 (64.5)
Normal	296 (30.2)	334 (35.5)
Cholesterol		
High	520 (53.1)	568 (60.4)
Normal	459 (46.9)	373 (39.6)
Uric Acid		
High	432 (44.1)	315 (33.5)
Normal	547 (55.9)	626 (66.5)
Blood Glucose		
High	84 (8.6)	98 (10.4)
Normal	895 (91.4)	843 (89.6)

Table 2. Associations between Respondent Characteristics and the Incidence of Hypertension in the Elderly in Urban and Rural Areas

Variable	Urban				Rural			
	Hypertension yes [n = 384 (50.9%)]	p-value	Crude OR	95% CI	Hypertension yes [n = 370 (49.1%)]	p-value	Crude OR	95% CI
Age								
≥67 years	183 (47.7)	0.266	1.157	0.894–1.497	189 (51.1)	0.002	1.515	1.164–1.971
<67 years	201 (52.3)		Ref		181 (48.9)			
Sex								
Male (1)	73 (19.0)	0.001	0.520	0.382–0.708	63 (17.0)	0.269	0.814	0.579–1.143
Female	311 (81.0)		Ref		307 (83.0)			
Education level								
Low (1)	170 (44.3)	0.784	1.046	0.808–1.354	278 (75.1)	0.015	0.696	0.519–0.934
High	214 (55.7)		Ref		92 (24.9)			
Occupation Status								
Unemployed (1)	83 (21.6)	0.005	1.548	1.147–2.089	72 (19.5)	0.416	1.160	0.838–1.605
Working	301 (78.4)		Ref		298 (80.5)			
Body Mass Index								
Overweight (1)	222 (57.8)	0.139	1.226	0.947–1.588	211 (57.0)	0.004	1.479	1.137–1.925
Non-overweight	162 (42.2)		Ref		159 (43.0)			
Waist Circumference								
Central obesity (1)	307 (79.9)	0.001	2.322	1.720–3.136	265 (71.6)	0.001	1.690	1.276–2.239
Normal	77 (20.1)		Ref		105 (28.4)			
Cholesterol								
High (1)	210 (54.7)	0.468	1.110	0.858–1.435	213 (57.6)	0.180	0.825	0.632–1.078
Normal	174 (45.3)		Ref		157 (42.4)			
Uric Acid								
High (1)	185 (48.2)	0.047	1.310	1.012–1.696	137 (37.0)	0.074	1.298	0.986–1.710
Normal	199 (51.8)		Ref		233 (63.0)			
Blood Glucose								
High (1)	49 (12.8)	0.001	2.340	1.486–3.687	46 (12.4)	0.128	1.417	0.931–2.157
Normal	335 (87.2)		Ref		324 (87.6)			

Notes: OR = odds ratio, CI = confidence interval.

Crude ORs were calculated using binary logistic regression. Reference categories (coded as 0) were <67 years; female; higher education; working status; and normal BMI, waist circumference, cholesterol, uric acid, and blood glucose.

Table 3. Final Multivariate Logistic Regression Model for Hypertension Among the Elderly in Urban and Rural Areas

Variable	p-value	Adjusted OR	95% CI
Urban			
Age	0.024	1.366	1.043–1.789
Sex	0.001	0.569	0.407–0.794
Waist circumference	0.001	2.031	1.477–2.793
Blood glucose	0.001	2.821	1.754–4.536
Rural			
Age	0.001	1.613	1.228–2.119
Education level	0.015	0.686	0.507–0.928
Waist circumference	0.001	1.613	1.204–2.161
Blood glucose	0.063	1.503	0.978–2.310

Notes: OR = odds ratio, CI = confidence interval.
The multivariable logistic regression analysis was conducted separately for the elderly residing in urban and rural areas.
Variables were included in the final model using the backward likelihood ratio method.

The multivariable logistic regression analysis demonstrated distinct patterns of factors associated with hypertension among the elderly in urban and rural settings (Table 3). In urban areas, age, sex, waist circumference, and blood glucose level were independently associated with hypertension. The elderly aged ≥67 years had higher odds of hypertension than those aged <67 years (AOR = 1.366; 95% CI: 1.043–1.789), indicating an increased likelihood of hypertension with advancing age. Sex was also associated with hypertension, with females showing lower AOR compared with males (AOR = 0.569; 95% CI: 0.407–0.794). Among metabolic indicators, waist circumference showed a strong association. The elderly with central obesity had approximately twice the odds of hypertension compared with those without central obesity (AOR = 2.031; 95% CI: 1.477–2.793). Blood glucose level emerged as the strongest metabolic correlate, with individuals with elevated blood glucose having nearly 3 times the odds of hypertension as those with normal levels (AOR = 2.821; 95% CI: 1.754–4.536).

In rural areas, age, education level, and waist circumference remained associated with hypertension. The elderly aged ≥67 years were more likely to have hypertension than their younger counterparts (AOR = 1.613; 95% CI: 1.228–2.119), indicating a stronger age-related pattern in rural settings. Higher education was associated with lower odds of hypertension (AOR = 0.686; 95% CI: 0.507–0.928), suggesting a potential role for socioeconomic and health literacy factors. Central obesity was consistently associated with hypertension, with rural elderly with elevated waist circumference showing higher odds compared with those with normal waist circumference (AOR = 1.613; 95% CI: 1.204–2.161). Blood glucose level showed a positive but weaker association with hypertension (AOR = 1.503; 95% CI: 0.978–2.310), suggesting a potential contribution of glycemic status to hypertension in rural populations.

Discussion

This study examined factors associated with hypertension among the elderly living in urban and rural settings with an emphasis on both metabolic and sociodemographic factors. By analyzing these two contexts separately, this study aimed to illustrate how the relative influence of these factors may differ according to environmental and social conditions. Overall, the observed patterns were broadly consistent with those of previous studies, which have shown that a combination of aging-related biological changes and modifiable metabolic and socioeconomic factors influences hypertension in later life. However, the strength and relevance of these determinants often vary across settings.[3,11,21,23]

In this study, age, education, BMI, and waist circumference appeared to play a more prominent role in rural areas. In contrast, central obesity, blood glucose, and sex were more strongly associated with hypertension in urban populations. These findings indicated that the pathways contributing to hypertension among the elderly were not uniform but were shaped by context-specific interactions among biological vulnerability, lifestyle behaviors, and environmental exposures. This framework provided a basis for a more detailed discussion of each predictor within its respective urban or rural context and underscored the importance of tailored strategies for the prevention and management of hypertension among the elderly.

This study's findings indicated that waist circumference, blood glucose level, sex, and age were associated with hypertension among the elderly living in urban areas. Waist circumference emerged as the strongest metabolic factor, with elderly individuals with normal waist circumference having lower odds of hypertension than those with central obesity (AOR = 2.031; 95% CI: 1.477–2.793). This observation aligned with previous evidence suggesting that central obesity is a more sensitive indicator of cardiometabolic risk than BMI in the elderly, particularly in urban environments characterized by sedentary lifestyles and dietary transitions.[36–38]

Blood glucose level was also associated with hypertension, with the elderly presenting abnormal blood glucose levels having higher odds of hypertension than those with normal glucose levels (AOR = 2.821; 95% CI: 1.754–4.536). This association reflected the close interrelationship between glucose dysregulation and elevated blood pressure in urban populations, likely driven by shared pathophysiological mechanisms, including insulin resistance, endothelial dysfunction, and chronic inflammation. However, this relationship should be interpreted cautiously, as treatment effects and reverse causality may partially account for the observed pattern, in which individuals with diagnosed hyperglycemia are more likely to receive clinical management that may also influence blood pressure levels.[8]

Sex differences remained evident in the urban model. Female elderly had higher odds of hypertension than males (AOR = 1.681; 95% CI: 1.198–2.359), consistent with previous studies linking postmenopausal hormonal changes and differential lifestyle behaviors to elevated cardiovascular risk.[15,16,24] Age was also associated with hypertension, with the elderly aged ≥67 years showing higher odds than those aged <67 years (AOR = 1.366; 95% CI: 1.043–1.789). Although the magnitude of the association was modest, this finding aligned with evidence that cumulative exposure to urban environmental stressors, lifestyle factors, and metabolic risks over the life course contributes to hypertension risk. Evidence from adult populations in Indonesia further indicates that environmental factors, occupational exposures, and lifestyle behaviors substantially shape hypertension risk profiles in urban settings, where metabolic factors such as central obesity and hyperglycemia appear to play a more dominant role alongside chronological aging.[39]

In rural areas, age, educational background, waist circumference, and blood glucose were associated with hypertension. Advancing age was associated with higher odds of hypertension, suggesting that cumulative vascular aging remains an important contributor to blood pressure elevation in rural settings. This pattern is consistent with evidence from rural populations in China and Ethiopia, where increasing age has been linked to hypertension through mechanisms such as arterial stiffness, endothelial dysfunction, and reduced baroreflex sensitivity.[11,26] In rural contexts, age-related declines in renal function, including reduced glomerular filtration and impaired sodium handling, may further contribute to elevated blood pressure, particularly in settings with limited access to preventive and continuous healthcare services.[5]

Education level was also associated with hypertension in rural areas. The elderly with a higher education level had lower odds of hypertension than those with a lower education level (AOR = 0.686; 95% CI: 0.507–0.928). This pattern suggested that education may confer protective effects by improving health literacy, enhancing health-seeking behavior, and increasing awareness of lifestyle-related risk factors. Similar patterns have been reported in rural LMIC settings, where education level is linked to dietary practices, physical activity, and access to preventive healthcare services.[3,24] These findings highlighted the role of social determinants in determining hypertension risk even within resource-limited rural communities.

Waist circumference was an important metabolic predictor of hypertension in rural areas. Female elderly with increased waist circumference had higher odds of hypertension than those with normal waist circumference (AOR = 1.613; 95% CI: 1.204–2.161). This finding reinforced the role of central adiposity as an important cardiovascular risk factor, even in rural populations with relatively low overall obesity prevalence. Visceral fat accumulation contributes to hypertension through inflammatory pathways, insulin resistance, and dysregulation of the renin–angiotensin system, highlighting that central obesity remains clinically relevant beyond urban environments.[36,37] Blood glucose level showed a borderline association with hypertension in rural areas (AOR = 1.503; 95% CI: 0.978–2.310; p-value = 0.063). Although not statistically significant at the conventional threshold, this association indicated a potential metabolic contribution to hypertension risk. The weaker association observed in rural settings may reflect lower diagnosis rates, limited access to routine metabolic screening, and delayed detection of hyperglycemia, leading to an underestimation of its true effect on blood pressure regulation.[12,40]

Several limitations should be acknowledged. First, the cross-sectional design precluded causal inference and limits the ability to determine temporal relationships, particularly in the presence of potential reverse causality and treatment effects. Second, measurements were conducted at a single time point, which may not reflect long-term exposure or disease trajectories. Third, unmeasured factors, such as dietary intake, physical activity intensity, renal function, and medication adherence, may have confounded the observed associations.

Importantly, this study was conducted in selected urban and rural areas of West Java and Central Java. Therefore, the findings were most appropriately generalized to the city and provincial levels, and cautiously to Java Island, rather than to the national level. The exclusion of Eastern Indonesia limits representativeness because sociocultural practices, dietary patterns, healthcare access, and epidemiological profiles differ substantially across regions. These contextual differences should be considered when interpreting the results and designing public health interventions.

Despite these limitations, the findings underscore meaningful urban–rural heterogeneity in determinants of hypertension among the elderly. The observed inverse associations highlight the complexity of hypertension epidemiology in aging populations and reinforce the need for context-specific, longitudinal research to disentangle biological aging, treatment effects, and survivorship dynamics. Future prospective studies across diverse Indonesian regions are warranted to validate these findings and inform equitable, regionally tailored hypertension prevention strategies.

Conclusions

This study demonstrates that the predictors of hypertension among the elderly differ between urban and rural settings. In urban populations, age, sex, waist circumference, and blood glucose are important predictors, highlighting the prominent role of central adiposity, metabolic dysregulation, and demographic factors. In rural populations, age, education level, BMI, waist circumference, and blood glucose are important predictors, indicating the combined influence of aging, nutritional status, and metabolic factors. These findings underscore that hypertension risk is context-dependent, shaped by both environmental and lifestyle factors, and emphasize the need for tailored, setting-specific strategies in hypertension prevention and management among the elderly.

Abbreviations

WHO: World Health Organization; LMICs: low- and middle-income countries; BMI: Body Mass Index; AOR: adjusted odds ratio; CI: confidence interval.

Ethics Approval and Consent to Participate

This study received ethical approval from the Research Ethics Committee of Universitas Respati Indonesia, with approval letter No. 568/SK.KEPK/UNR/VIII/2023. All research subjects provided written informed consent prior to participation, in accordance with ethical standards and institutional guidelines.

Competing Interest

The authors declare no competing interests.

Availability of data and materials

The datasets during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' Contribution

SN was responsible for the conception and design of the study, data collection, statistical analysis, manuscript writing, and final approval of the version to be published. PW contributed to statistical analysis, data interpretation, literature review, manuscript writing, and critical revision of the manuscript. All authors have read and approved the final manuscript.

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Declaration on the Use of Artificial Intelligence

The authors declare that artificial intelligence (AI) tools were utilized solely for language editing and grammatical refinement to improve the clarity and readability of the manuscript. The specific AI tool used is ChatGPT 4 (chat.openai.com). AI was not involved in content generation, data analysis, interpretation, or any decision-making processes. All scientific content, interpretations, conclusions, and responsibilities related to the manuscript rest solely with the authors.

References

1. World Health Organization. Hypertension. Geneva: World Health Organization; 2025.
2. Zhou B, Carrillo-Larco RM, Danaei G, et al. Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: A pooled analysis of 1201 population-representative studies with 104 million participants. Lancet. 2021; 398 (10304): 957–980. DOI: 10.1016/S0140-6736(21)01330-1.
3. Ranzani OT, Kalra A, Di Girolamo C, et al. Urban-rural differences in hypertension prevalence in low-income and middle-income countries, 1990-2020: A systematic review and meta-analysis. PLoS Med. 2022; 19 (8): 1–19. DOI: 10.1371/journal.pmed.1004079.
4. Badan Kebijakan Pembangunan Kesehatan. Survei Kesehatan Indonesia (SKI): 2023 Dalam Angka. Jakarta: Kementerian Kesehatan Republik Indonesia; 2024.
5. Laurent S, Boutouyrie P. Arterial Stiffness and Hypertension in the Elderly. Front Cardiovasc Med. 2020; 7: 544302. DOI: 10.3389/fcvm.2020.544302.
6. Alanis GA, Boutouyrie P, Abouqateb M, et al. Vascular ageing manifestations and hypertension in the community. Am J Prev Cardiol. 2025; 21: 100918. DOI: 10.1016/j.ajpc.2024.100918.
7. Sasaki N, Ueno Y, Ozono R, et al. Association of serum uric acid levels with blood pressure and the incidence of hypertension in the middle-aged and elderly populations. J Hypertens. 2024; 42 (2): 292–300. DOI: 10.1097/HJH.0000000000003597.
8. Jia G, Sowers JR. Hypertension in Diabetes: An Update of Basic Mechanisms and Clinical Disease. Hypertension. 2021; 78 (5): 1197–205. DOI: 10.1161/HYPERTENSIONAHA.121.17981.

9. Bertolotti M, Lancellotti G, Mussi C. Changes in cholesterol homeostasis associated with aging and with age-related conditions: Pathophysiological and clinical implications. J Gerontol Geriatr. 2024; 72 (Sp 1): 32-42. DOI: 10.36150/2499-6564-N637.
10. Zhu J, Shen L, Jia S, et al. The role of uric acid in the risk of hypertension developed from prehypertension: A five-year Chinese urban cohort study. Arch Public Health. 2024; 82 (1): 185. DOI: 10.1186/s13690-024-01421-2.
11. Song H, Feng D, Wang R, et al. The urban-rural disparity in the prevalence and risk factors of hypertension among the elderly in China-a cross-sectional study. PeerJ. 2019; 7: e8015. DOI: 10.7717/peerj.8015.
12. Zhou Q, Liu X, Zhao Y, et al. BMI and risk of all-cause mortality in normotensive and hypertensive adults: The rural Chinese cohort study. Public Health Nutr. 2021; 24 (17): 5805–5814. DOI: 10.1017/S1368980021001592.
13. Jensen LJ. Functional, Structural and Proteomic Effects of Ageing in Resistance Arteries. Int J Mol Sci. 2024; 25 (5): 2601. DOI: 10.3390/ijms25052601.
14. Wu J, Han X, Sun D, et al. Age-specific association of stage of hypertension at diagnosis with cardiovascular and all-cause mortality among elderly patients with hypertension: A cohort study. BMC Cardiovasc Disord. 2023; 23 (1): 270. DOI: 10.1186/s12872-023-03250-7.
15. Defianna SR, Santosa A, Probandari A, et al. Gender differences in prevalence and risk factors for hypertension among adult populations: A cross-sectional study in indonesia. Int J Environ Res Public Health. 2021; 18 (12): 6259. DOI: 10.3390/ijerph18126259.
16. Ghazi L, Annabathula RV, Bello NA, et al. Hypertension Across a Woman's Life Cycle. Curr Hypertens Rep. 2022; 24 (12): 723–733. DOI: 10.1007/s11906-022-01230-4.
17. Al-Shoaibi AAA, Chiang C, Khalequzzaman M, et al. Age and sex differences in factors associated with hypertension among an urban poor population in Bangladesh. Nagoya J Med Sci. 2022; 84 (1): 69–79. DOI: 10.18999/nagjms.84.1.69.
18. Sun JY, Ma YX, Liu HL, et al. High waist circumference is a risk factor of new-onset hypertension: Evidence from the China Health and Retirement Longitudinal Study. J Clin Hypertens. 2022; 24 (3): 320–328. DOI: 10.1111/jch.14446.
19. Wu Y, Tong Y, Wang H, et al. Waist-to-height ratio and new-onset hypertension in middle-aged and older adult females from 2011 to 2015: A 4-year follow-up retrospective cohort study from the China Health and Retirement Longitudinal Study. Front Public Health. 2023; 1122995. DOI: 10.3389/fpubh.2023.1122995.
20. Liu W, Zheng R, Zhang Y, et al. Differences in the influence of daily behavior on health among older adults in urban and rural areas: evidence from China. Front Public Health. 2023; 11: 1259204. DOI: 10.3389/fpubh.2023.1259204.
21. Astutik E, Farapti F, Tama TD, et al. Differences risk factors for hypertension among elderly woman in rural and urban Indonesia. Yale J Biol Med. 2021; 94 (3): 407–415.
22. Maurya P, Chattopadhyay A, Sharma P. Unravelling the occupational factor and hypertension puzzle among Indian older adults. Arch Gerontol Geriatr Plus. 2025; 2 (3): 100172. DOI: 10.1016/j.aggp.2025.100172.
23. Cheng H, Gu Y, Ma X, et al. Urban–rural disparities in hypertension prevalence, awareness, treatment, and control among Chinese middle-aged and older adults from 2011 to 2015: A repeated cross-sectional study. BMC Cardiovasc Disord. 2022; 22: 319. DOI: 10.1186/s12872-022-02769-5.
24. Cohen SA, Greaney ML, Sabik NJ. Assessment of dietary patterns, physical activity and obesity from a national survey: Rural-urban health disparities in older adults. PLoS One. 2018; 13 (12): e0208268. DOI: 10.1371/journal.pone.0208268.
25. Cacciatore S, Mao S, Nuñez MV, et al. Urban health inequities and healthy longevity: Traditional and emerging risk factors across the cities and policy implications. Aging Clin Exp Res. 2025; 37 (1): 143. DOI: 10.1007/s40520-025-03052-1.
26. Shukuri A, Tewelde T, Shaweno T. Prevalence of old age hypertension and associated factors among older adults in rural Ethiopia. Integr Blood Press Control. 2019; 12: 23–31. DOI: 10.2147/IBPC.S212821.
27. Venkatesh U, Grover A, Vignitha B, et al. Urban–rural disparities in blood pressure and lifestyle risk factors of hypertension among Indian individuals. J Family Med Prim Care. 2022; 11 (9): 5746–5756. DOI: 10.4103/jfmpc.jfmpc_573_22.
28. Justine M, Latir A, Noor N, et al. Association between Self-Reported Fatigue and Sarcopenia Measures among Elderly in Selangor, Malaysia. Kesmas. 2021; 16 (3): 145-150. DOI: 10.21109/kesmas.v16i3.4384.
29. Badan Pusat Statistik. Peraturan Kepala Badan Pusat Statistik Nomor 120 Tahun 2020 Tentang Klasifikasi Desa Pekotaan dan Perdesaan di Indonesia 2020. Jakarta: Badan Pusat Statistik; 2021.
30. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Hypertension. 2017; 71 (6). DOI: 10.1161/HYP.0000000000000065
31. American Diabetes Association Professional Practice Committee. 2. Diagnosis and Classification of Diabetes: Standards of Care in Diabetes-2024. Diabetes Care. 2024; 47 (Suppl 1): S20-S42. DOI: 10.2337/dc24-S002.
32. United States Centers for Disease Control and Prevention. Cholesterol. Atlanta, GA: United States Centers for Disease Control and Prevention; 2024.
33. George C, Leslie SW, Minter DA. Hyperuricemia. In: Urology at a Glance. StatPearls Publishing; 2023.
34. Menteri Kesehatan Republik Indonesia. Keputusan Menteri Kesehatan Republik Indonesia Nomor HK.01.07 Tahun 2021 Tentang Pedoman Nasional Pelayanan Kedokteran Tata Laksana Hipertensi Dewasa. Jakarta: Kementerian Kesehatan Republik Indonesia; 2021.
35. Kementerian Kesehatan Republik Indonesia. Pedoman Pelayanan Gizi Lanjut Usia. Jakarta: Kementerian Kesehatan Republik Indonesia; 2023.
36. Zhang W, He K, Zhao H, et al. Association of body mass index and waist circumference with high blood pressure in older adults. BMC Geriatr. 2021; 21: 260. DOI: 10.1186/s12877-021-02154-5.
37. Wang Q, Song X, Du S, et al. Waist Circumference Trajectories in Relation to Blood Pressure and the Risk of Hypertension in Chinese Adults. Nutrients. 2022; 14 (24): 1–13. DOI: 10.3390/nu14245260.
38. Mfuru GH, Allan JN, Njau A, et al. Using waist circumference as a predictor of hypertension in Manzese, Dar es Salaam: A community-based cross-sectional study, 2023. BMC Public Health. 2024; 24: 3618 . DOI: 10.1186/s12889-024-20556-z.

39. Kalsum U, Andini MP, Sitanggang HD, et al. Noncommunicable Diseases (Hypertension or Diabetes Mellitus) Among Private University Lecturers and Related Factors. Kesmas. 2025; 20 (5): 107-115. DOI: 10.7454/kesmas.v20isp1.2135.
40. Ferede YM, Derso T, Sisay M. Prevalence of malnutrition and associated factors among older adults from urban and rural residences of Metu district, Southwest Ethiopia. BMC Nutr. 2022; 8: 52. DOI: 10.1186/s40795-022-00532-9.