Determinants of Hypertension and Stroke among Indonesians: Evidence from a National Health Survey

Abstract

Background: Hypertension and stroke remain major public health challenges in Indonesia, contributing significantly to mortality and disability. However, national-level evidence examining the determinants of both conditions simultaneously is limited. This study aimed to analyze the determinants of hypertension and stroke among Indonesian adults using data from the 2023 Indonesian Health Survey.

Methods: A cross-sectional analytical design was used, involving 638,179 respondents with complete data. Descriptive, bivariate (chi-square), and multivariable logistic regression analyses were conducted to identify factors associated with hypertension and stroke.

Results: In the analyzed sample, reported hypertension was more frequent among urban residents (9.4%) and older adults (21.9%); reported stroke was more frequent among older adults (3.2%). In the available adjusted stroke model, a history of physician-diagnosed hypertension was associated with higher odds of stroke (aOR = 14.61; 95% CI: 13.75–15.53). Daily and non-daily smoking showed higher adjusted odds of stroke. Fatty/fried-food consumption more than once daily was not significantly associated with hypertension (aOR = 0.98; 95% CI: 0.93–1.04; p = 0.456), and grilled-food consumption more than once daily was not significantly associated with stroke (aOR = 0.81; 95% CI: 0.65–1.00; p = 0.052).

Conclusion: Hypertension and stroke in Indonesia are strongly associated with demographic, behavioral, and social factors. These findings highlight the importance of integrated population-based interventions focused on promoting physical activity, strengthening urban health interventions, and addressing social determinants to reduce the burden of non-communicable diseases.

Keywords: Hypertension; stroke; risk factors; noncommunicable diseases

INTRODUCTIONS

Hypertension (HTN) is one of the most important global public health challenges, affecting approximately 1.3 billion adults worldwide [1]. As a major modifiable risk factor for cardiovascular disease, elevated blood pressure (BP), particularly systolic blood pressure (SBP), is strongly associated with the occurrence of stroke and other cardiovascular outcomes. Stroke remains one of the leading causes of death and disability worldwide, making the prevention and control of its major modifiable risk factors a critical public health priority. The relationship between BP and stroke is well established, with higher BP associated with progressively greater stroke risk. Hypertension contributes to the development of stroke through several pathophysiological mechanisms, including endothelial dysfunction, atherosclerosis, arterial remodeling, and damage to the cerebral small vessels. Consequently, effective BP control is an important component of stroke prevention.

The burden of hypertension and stroke is also substantial in Indonesia, where both conditions contribute considerably to premature mortality, disability, and socioeconomic losses [2]. Stroke has consistently been reported as a leading cause of death in Indonesia, while hypertension represents one of its most important underlying and modifiable risk factors. In 2021, cardiovascular diseases accounted for approximately 721,700 deaths in Indonesia, and an estimated 67% of these deaths were attributable to high systolic blood pressure, highlighting the substantial contribution of hypertension to the country's disease burden [3]. Despite this burden, hypertension control remains inadequate. Recent estimates indicate that approximately 43% of Indonesian adults aged 30–79 years have hypertension, compared with approximately 34% globally [3]. Among the estimated 61.5 million Indonesian adults living with hypertension, only a proportion are diagnosed and treated, while the percentage achieving adequate blood pressure control remains very low [3]. This gap between the prevalence of hypertension and effective management underscores the need for stronger population-level prevention, early detection, treatment, and control strategies.

In addition to hypertension, demographic, behavioral, and social characteristics have been associated with stroke. Age is associated with both conditions, and age-related vascular changes and cumulative exposure to established risk factors may contribute to these associations. Differences in disease prevalence may also occur between urban and rural populations because of variations in socioeconomic conditions, healthcare access, physical activity, dietary patterns, and other environmental and lifestyle characteristics. Social circumstances, including marital status, may further influence health behaviors, social support, healthcare

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utilization, and management of chronic diseases. Understanding these factors is particularly important in Indonesia because of the country's substantial demographic, geographic, and socioeconomic diversity.

Lifestyle-related behaviors are also central to the prevention of hypertension and stroke. Regular physical activity, a healthy diet, adequate sleep, and avoidance of tobacco and excessive alcohol consumption have been associated with a lower risk of cardiovascular and cerebrovascular disease. Physical inactivity, dietary patterns, and smoking have also been associated with hypertension and vascular disease, although the nature of these relationships may vary across populations and study designs. Evidence suggests that a substantial proportion of stroke events may be preventable through modification of established risk factors, emphasizing the importance of population-based interventions that promote healthier behaviors. However, associations between individual lifestyle behaviors and hypertension or stroke may be complex and influenced by differences in age, disease status, healthcare utilization, and behavioral changes following diagnosis. Therefore, these relationships need to be examined in large population-based datasets while considering relevant demographic and social characteristics.

Although previous studies have identified various risk factors for hypertension and stroke, national-level evidence examining the factors associated with both conditions simultaneously among Indonesian adults remains limited. Existing Indonesian studies have frequently focused on either hypertension or stroke separately and have often been conducted in specific regions or relatively small populations [4]. Examining both conditions within the same nationally representative population can provide a more comprehensive understanding of shared and condition-specific factors and may help identify population groups that require integrated prevention strategies. Furthermore, evidence on the relationship between hypertension and stroke is particularly important because improving population-level hypertension detection and control has the potential to reduce the occurrence and mortality associated with stroke [1].

Therefore, this study aimed to examine the demographic, residential, behavioral, and social factors associated with hypertension and stroke among Indonesian adults using data from the 2023 Indonesian Health Survey (*Survei Kesehatan Indonesia*, SKI) [5]. By analyzing these conditions within a large national population, this study seeks to provide evidence that can support integrated and population-based strategies for hypertension and stroke prevention and contribute to more effective noncommunicable disease policies in Indonesia.

METHODS

Study Design

This observational study used a cross-sectional secondary analysis of the 2023 Indonesian Health Survey (*Survei Kesehatan Indonesia*, SKI). SKI employed multistage probability sampling. Its individual data structure includes sampling weights (W_final), stratification (STRATA), and primary sampling units (PSU). The supplied statistical summaries do not establish whether these design parameters were incorporated into all reported estimates, so the present sample proportions and regression intervals should not be presented as survey-weighted national estimates.

Population and Sample

The supplied source describes 877,531 initial SKI records and 638,179 records in the analytic sample (72.72%). The difference was 239,352 records (27.28%). The available summary does not establish how many were removed due to missing values, age eligibility, or other exclusions; consequently, the exclusion breakdown and variable-specific missingness require verification. The analyzed sample included the adolescent, adult, and older-adult categories and was not restricted to persons aged 19–59 years.

Outcome Definition

The outcomes were defined as self-reported histories of physician-diagnosed hypertension (B18) and stroke (B24). The corresponding questionnaire items asked: “Has [NAME] ever been diagnosed with hypertension by a doctor?” (B18; original Indonesian: “Apakah [NAMA] pernah didiagnosis menderita hipertensi oleh dokter?”) and “Has [NAME] ever been diagnosed with stroke by a doctor?” (B24; original Indonesian: “Apakah [NAMA] pernah didiagnosis menderita stroke oleh dokter?”). The original response categories were coded as 1 (yes) and 2 (no). For binary outcome modelling, responses were recoded as 1 (yes) and 0 (no). Both items captured a history of physician-diagnosed conditions at any time before the survey, rather than current blood pressure measurements or clinically verified stroke status at the time of interview. History of hypertension was also included as an explanatory variable in the stroke model.

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Data Processing and Data Cleaning

The data were checked for completeness, consistency, and coding of categorical responses before analysis. The supplied analysis summaries identify IBM SPSS Statistics but do not provide the software version, syntax, weighting commands, or exact missing-value rules. These details must be documented to make the analyses fully reproducible.

Variables

a. Age

Age was obtained from B4K7THN (completed years). In the supplied models it was categorized as adolescents (1–18 years), adults (19–59 years), and older adults (⩾60 years), with adolescents as reference. The reported observed age range was 11–112 years. The stroke age coefficients are not reliable because zero strokes were observed in the adolescent reference group.

b. Marital status

Marital status (B4K5) used the original categories 1 = never married, 2 = married, 3 = divorced (living former spouse), and 4 = widowed (spouse deceased). The model used never married as the reference category. The full questionnaire prompt is not provided in the variable-request extract.

c. Urban or rural residence

Residential classification (B1R5) was coded 1 = urban and 2 = rural in the original dataset; urban was the regression reference category.

d. Smoking history

Smoking history (G11) asked: "Has [NAME] ever smoked?" (original Indonesian: "Apakah [NAMA] pernah merokok?"), with codes 1 = yes, every day; 2 = yes, not every day; and 3 = never smoked. Never smoked was the regression reference. The available extract does not establish a separate recent recall window or how former smokers were classified.

e. Physical activity

Vigorous physical activity was assessed using SKI variable G36: "Does [NAME] usually perform vigorous physical activity continuously for at least 10 minutes each time?" (original Indonesian: "Apakah [NAMA] biasa melakukan aktivitas fisik berat, yang dilakukan terus-menerus paling sedikit selama 10 menit setiap kali melakukannya?"). Moderate physical activity was assessed using SKI variable G39: "Does [NAME] usually perform moderate physical activity continuously for at least 10 minutes each time?" (original Indonesian: "Apakah [NAMA] biasa melakukan aktivitas fisik sedang, yang dilakukan terus-menerus paling sedikit selama 10 menit setiap kali melakukannya?"). Vigorous (G36) and moderate (G39) activity were measured separately as usual engagement in activity lasting at least 10 consecutive minutes per occasion (original codes: 1 = yes; 2 = no). Yes was the reference category for each binary model term. The models did not use days per week, activity minutes, or MET-minutes to define these binary exposures.

f. Food consumption

Salty-food consumption was obtained from SKI variable, labelled: "salty foods" (original Indonesian: "makanan asin"). Consumption of fatty foods, high-cholesterol foods, or fried foods was obtained from variable, labelled: "fatty/cholesterol-rich/fried foods" (original Indonesian: "makanan berlemak/berkolesterol/gorengan"). For salty foods and fatty/high-cholesterol/fried foods, the documented codes were: 1 = more than once per day; 2 = once per day; 3 = 3–6 times per week; 4 = 1–2 times per week; 5 = fewer than 3 times per month; and 6 = never. Never was the model reference. The introductory item wording and recall window were not provided in the supplied extract. Grilled-food intake was tabulated in the available results in the same six frequency categories, with "never" as reference. Its exact SKI question number, introductory question wording, and recall period were not available in the supplied variable request and require confirmation in the source questionnaire/codebook..

Data Analysis

Descriptive results are presented as unweighted respondent counts and within-category sample percentages. Bivariate cross-tabulations were reported separately for hypertension and stroke. The supplied summaries contain separate multivariable binary logistic regression models: both include residential area, age group, marital status, smoking, vigorous and moderate physical activity, and frequencies of salty, fatty/fried, and grilled-food intake; the stroke model also includes physician-diagnosed hypertension history. Adjusted odds ratios (aORs), 95% CIs, and p-values were transcribed from the provided analysis summary. The original modelling syntax is unavailable, so covariate prespecification, p-value-based selection, software version, and full survey-design adjustment cannot be confirmed. Survey-weighted prevalence with design-adjusted variance and confidence intervals should be computed using

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W_final, STRATA, and PSU; any singleton-PSU handling must be documented from the original analysis. Statistical significance was assessed at $p < 0.05$.

Ethical Consideration

This study used secondary data from the National Healthy Survey (Survei Kesehatan Indonesia [SKI]) 2023, which were anonymized and did not contain personally identifiable information. Therefore, individual informed consent was not required for the secondary use of the data. The use of SKI 2023 data was conducted in accordance with the applicable regulations and data-access requirements of the Ministry of Health of the Republic of Indonesia.

The data were accessed through the Ministry of Health's online Data Request Service Portal. The data request process required the submission of the relevant administrative documents and a brief terms of reference (TOR) or research proposal describing the requested data. The requested variables were specified according to the variable names and numbers corresponding to the questions in the SKI 2023 questionnaire. In addition, the requesting institution was required to sign a non-disclosure agreement (NDA) as part of the data-access process. The data were used solely for the purposes specified in the approved data request and in accordance with the applicable terms and conditions.

RESULTS

The source summary reports 877,531 original records and 638,179 analyzed respondents (72.72%). A total of 239,352 records (27.28%) were not represented in the analytic sample. Their exclusion reasons cannot be separated from the supplied documents. The analyzed sample contained 53,668 respondents reporting hypertension and 5,621 reporting stroke. See Figure 1; the exclusion breakdown must be verified using individual-level data.

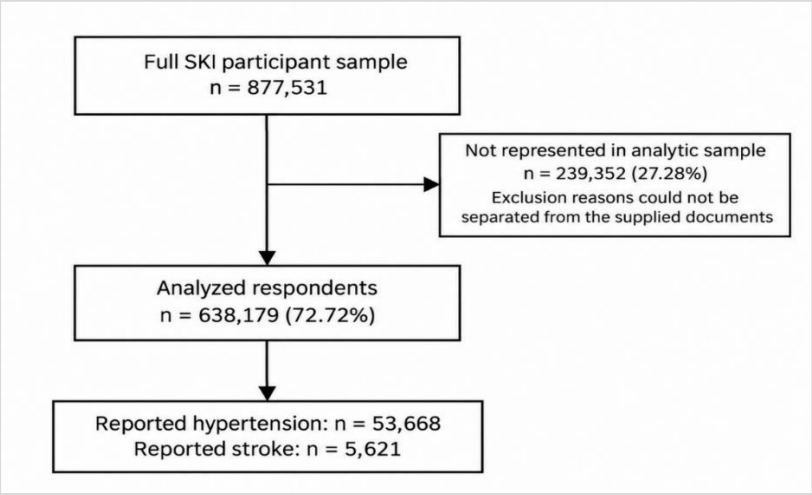


Figure 1. Participant flow diagram

Among 638,179 analyzed respondents, 53,668 (8.4%) reported physician-diagnosed hypertension and 5,621 (0.9%) reported stroke. These are unweighted sample proportions, not national weighted prevalence estimates. In unweighted cross-tabulations, hypertension was reported by 9.4% of urban respondents and 7.2% of rural respondents, while stroke was reported by approximately 1.0% and 0.7%, respectively. Older adults (⩾60 years) had higher unweighted proportions of both conditions than younger age groups. Table 1 representing separate outcome-specific counts.

The combined respondent count varies by subgroup but totals 638,179 for each fully observed variable. Percentage denominators in Table 1 are 638,179; denominators in Tables 1 and Table 2 are the respective category totals. These are unweighted percentages.

Table 1. Participant characteristics in the analytic sample (N = 638,179; unweighted n and %) representing bivariate analysis of factors associated with hypertension & stroke among indonesian adults

Variables (N = 638,179)	Hypertension				P-Value	Stroke				P-Value
	Yes		No			Yes		No		
	n	%	n	%		n	%	n	%	
Regional Classifications										
Urban	32,332	9.4	310,624	90.6	<0.001	3,534	1	339,422	99.0	<0.001

Variables (N = 638,179)	Hypertension				P-Value	Stroke				P-Value
	Yes		No			Yes		No		
	n	%	n	%		n	%	n	%	
Rural	21,336	7.2	273,887	92.8		2,087	0.7	293,136	99.3	
Age Group										
Adolescence (1-18 yo)	30	0.1	44,846	99.9		0	0.0	44,876	100.0	
Adult (19-59 yo)	32,287	6.5	463,677	93.5	<0.001	2,519	0.5	493,445	99.5	<0.001
Elderly (> 59 yo)	21,351	21.9	75,988	78.1		3,102	3.2	94,237	96.8	
Marital Status										
Single	916	0.8	111,467	99.2		102	0.1	112,281	99.9	
Married	41,558	8.9	427,710	91.1		4,333	0.9	464,935	99.1	
Divorce	1,288	10.5	10,928	89.5	<0.001	127	1.0	12,089	99.0	<0.001
Divorce-Death	9,906	22.4	34,406	77.6		1,059	2.4	43,253	97.6	
Smoking Behavior										
Never Smoking	43,119	9.4	414,717	90.6		4,125	0.9	453,711	99.1	
Smoking everyday	7,791	5.2	141,006	94.8	<0.001	1,074	0.7	147,723	99.3	<0.001
Smoking, not everyday	2,758	8.7	28,788	91.3		422	1.3	31,124	98.7	
Salty Food Eating Behavior										
Never	6,387	13.0	42,914	87.0		1,044	2.1	48,257	97.9	
> 1 time per day	4,893	7.5	60,199	92.5		398	0.6	64,694	99.4	
1 time per day	7,073	7.4	88,063	92.6	<0.001	566	0.6	94,570	99.4	<0.001
3 – 6 times per week	11,091	7.1	145,802	92.9		934	0.6	155,959	99.4	
1 – 2 times per week	15,196	8.2	170,277	91.8		1,589	0.9	183,884	99.1	
< 3 times per week	9,028	10.5	77,256	89.5		1,090	1.3	85,194	98.7	
Fatty Food Eating Behavior										
Never	2,496	13.9	15,420	86.1		631	3.5	17,285	96.5	
> 1 time per day	6,930	8.5	74,603	91.5	<0.001	583	0.7	80,950	99.3	<0.001
1 time per day	9,012	8.1	102,232	91.9		709	0.6	110,535	99.4	
3 – 6 times per week	12,626	7.3	159,277	92.7		1,076	0.6	170,827	99.4	
1 – 2 times per week	15,507	8.3	170,222	91.7		1,625	0.9	184,104	99.1	
< 3 times per week	7,097	10.2	62,757	89.8		997	1.4	68,857	98.6	
Grilled Food Behavior										
Never	9,356	11.5	72,002	88.5		1,299	1.6	80,059	98.4	
> 1 time per day	943	7.1	12,400	92.9		102	0.8	13,241	99.2	
1 time per day	1,648	7.1	21,673	92.9	<0.001	159	0.7	23,162	99.3	<0.001
3 – 6 times per week	6,501	7.4	81,435	92.6		637	0.7	87,299	99.3	
1 – 2 times per week	15,297	7.5	187,792	92.5		1,340	0.7	201,749	99.3	
< 3 times per week	19,923	8.7	209,209	91.3		2,084	0.9	227,048	99.1	
Heavy Physical Activity										
Yes	11,220	5.8	182,261	94.2	<0.001	479	0.2	193,002	99.8	<0.001
No	42,448	9.5	402,250	90.5		5,142	1.2	439,556	98.8	
Moderate Physical Activity										
Yes	36,446	7.9	424,425	92.1	<0.001	2,048	0.4	458,823	99.6	<0.001
No	17,222	9.7	160,086	90.3		3,573	2.0	173,735	98.0	
Hypertensions Diagnosis History										
Yes	-	-	-	-	-	3,826	7.1	49,842	92.9	<0.001
No	-	-	-	-	-	1,795	0.3	582,716	99.7	

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In the multivariable hypertension model (Table 2; N = 638,179), rural residence was associated with lower adjusted odds of physician-diagnosed hypertension than urban residence (aOR = 0.74; 95% CI: 0.72–0.75). Compared with adolescents, adults (aOR = 22.82; 95% CI: 15.88–32.80) and older adults (aOR = 67.99; 95% CI: 47.28–97.77) had higher adjusted odds. For fatty/fried-food consumption more than once daily, the association was not statistically significant (aOR = 0.98; 95% CI: 0.93–1.04; p = 0.456). Other category-specific estimates are presented in Table 2. These findings are associations and should not be interpreted as causal or protective effects.

Table 2. Multivariable logistic regression associations with physician-diagnosed hypertension (N = 638,179; 53,668 reported cases)

Variable / category	Adjusted OR (aOR)	95% CI	p-value
Residential area			
Urban (reference)	1.00	–	–
Rural	0.74	0.72–0.75	<0.001
Marital status			
Never married (reference)	1.00	–	–
Married	6.24	5.83–6.67	<0.001
Divorced	6.94	6.35–7.59	<0.001
Widowed	9.36	8.71–10.06	<0.001
Age group			
Adolescents (reference)	1.00	–	–
Adults	22.82	15.88–32.80	<0.001
Older adults	67.99	47.28–97.77	<0.001
Smoking behavior			
Never smoked (reference)	1.00	–	–
Daily smoking	0.57	0.55–0.58	<0.001
Non-daily smoking	0.93	0.89–0.97	<0.001
Moderate physical activity			
Yes (reference)	1.00	–	–
No	1.06	1.04–1.08	<0.001
Vigorous physical activity			
Yes (reference)	1.00	–	–
No	1.34	1.31–1.37	<0.001
Salty-food consumption			
Never (reference)	1.00	–	–
>1 time/day	0.65	0.62–0.67	<0.001
1 time/day	0.64	0.61–0.66	<0.001
3–6 times/week	0.61	0.59–0.63	<0.001
1–2 times/week	0.68	0.65–0.70	<0.001
<3 times/month	0.82	0.79–0.85	<0.001
Fatty/fried-food consumption			
Never (reference)	1.00	–	–
>1 time/day	0.98	0.93–1.04	0.456
1 time/day	0.93	0.89–0.99	0.012
3–6 times/week	0.86	0.81–0.90	<0.001

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1–2 times/week	0.90	0.85–0.94	<0.001
<3 times/month	0.92	0.88–0.97	0.004
Grilled-food consumption			
Never (reference)	1.00	–	–
>1 time/day	0.81	0.75–0.87	<0.001
1 time/day	0.82	0.77–0.86	<0.001
3–6 times/week	0.90	0.87–0.93	<0.001
1–2 times/week	0.88	0.86–0.91	<0.001
<3 times/month	0.93	0.90–0.96	<0.001

In the multivariable stroke model (Table 3; N = 638,179), a history of physician-diagnosed hypertension was associated with substantially higher adjusted odds of stroke (aOR = 14.61; 95% CI: 13.75–15.53). Daily (aOR = 1.34; 95% CI: 1.25–1.44) and non-daily smoking (aOR = 1.62; 95% CI: 1.46–1.81) were also associated with higher adjusted odds than never smoking. For grilled-food consumption more than once daily, the estimate was not statistically significant (aOR = 0.81; 95% CI: 0.65–1.00; p = 0.052). Age-related coefficients were unstable because no stroke events occurred in the adolescent reference group, and should not be interpreted until the model is re-estimated. Additional results are shown in Table 3.

Table 3. Multivariable logistic regression associations with physician-diagnosed stroke (N = 638,179; 5,621 reported cases)

Variable / category	Adjusted OR (aOR)	95% CI	p-value
Residential area			
Urban (reference)	1.00	–	–
Rural	0.80	0.75–0.85	<0.001
Marital status			
Never married (reference)	1.00	–	–
Married	2.94	2.41–3.59	<0.001
Divorced	2.65	2.02–3.47	<0.001
Widowed	2.17	1.75–2.68	<0.001
Age group: unstable estimation			
Adolescents (reference; zero stroke events)	1.00	–	–
Adults	Not reliably estimable	Not reliably estimable	0.937*
Older adults	Not reliably estimable	Not reliably estimable	0.934*
Smoking behavior			
Never smoked (reference)	1.00	–	–
Daily smoking	1.34	1.25–1.44	<0.001
Non-daily smoking	1.62	1.46–1.81	<0.001
History of hypertension diagnosis			
No (reference)	1.00	–	–
Yes	14.61	13.75–15.53	<0.001
Vigorous physical activity			
Yes (reference)	1.00	–	–
No	3.09	2.80–3.40	<0.001

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Moderate physical activity			
Yes (reference)	1.00	–	–
No	3.48	3.29–3.69	<0.001
Salty-food consumption			
Never (reference)	1.00	–	–
>1 time/day	0.60	0.53–0.68	<0.001
1 time/day	0.58	0.51–0.65	<0.001
3–6 times/week	0.57	0.51–0.63	<0.001
1–2 times/week	0.70	0.64–0.77	<0.001
<3 times/month	0.77	0.70–0.85	<0.001
Fatty/fried-food consumption			
Never (reference)	1.00	–	–
>1 time/day	0.49	0.43–0.56	<0.001
1 time/day	0.44	0.38–0.50	<0.001
3–6 times/week	0.45	0.40–0.50	<0.001
1–2 times/week	0.52	0.46–0.58	<0.001
<3 times/month	0.64	0.57–0.72	<0.001
Grilled-food consumption			
Never (reference)	1.00	–	–
>1 time/day	0.81	0.65–1.00	0.052
1 time/day	0.74	0.62–0.89	0.001
3–6 times/week	0.84	0.75–0.93	0.001
1–2 times/week	0.71	0.66–0.78	<0.001
<3 times/month	0.84	0.78–0.91	<0.001

DISCUSSIONS

The results of this study indicate that the prevalence of hypertension is higher in urban groups, the elderly, and individuals who are divorced or separated. Lack of physical activity was associated with higher odds of hypertension, whereas smoking behavior and certain dietary patterns showed inverse associations. These unexpected associations should be interpreted cautiously due to the potential influence of reverse causality, reporting bias, and residual confounding. A similar pattern is also seen in prevalence of stroke , which is more common in the elderly, urban populations, and individuals with a history of hypertension.

The finding that hypertension is higher in urban populations is in line with previous research [6]. Urbanization contributes to increased cardiometabolic risk factors through lifestyle changes, such as increased consumption of foods high in salt and fat, decreased physical activity, and higher exposure to stress [7,8] . However, several studies in developing countries show that prevalence in urban and rural areas is not significantly different, but awareness and treatment in rural areas are lower than in urban areas [9,10].

The relationship between advanced age and hypertension in this study is consistent with individual biological mechanisms in which the aging process causes decreased blood vessel elasticity and increased peripheral resistance [11]. In addition, the accumulation of exposure to risk factors such as poor lifestyle and diet throughout the life cycle also increases the likelihood of developing hypertension [12]. This finding is also reinforced by the distribution of stroke events which is more dominant in the elderly age group, considering that hypertension is the main risk factor for stroke through the mechanism of chronic vascular damage.

Marital status, particularly divorced or single, has also been found to have a higher proportion of hypertension. Losing a partner can potentially increase psychological stress (such as loneliness and depression) [12,13]. In addition, losing a partner, especially a woman, can also have an impact on life stability, including economic stability [13,14]. This combination of factors can influence a decline in health behavior which ultimately increases the risk of hypertension and its complications [15,16].

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The finding that lack of physical activity is associated with an increased risk of hypertension shows strong consistency with scientific evidence in previous studies [17]. Physical activity plays a role in maintaining blood pressure balance by improving endothelial function, regulating body weight, and controlling stress [18–20] . Low physical activity in the population, especially in urban areas, is an important determinant in the increasing burden of hypertension and cardiovascular disease [6].

Inverse associations between selected smoking or dietary categories and diagnosed hypertension should not be interpreted as evidence of protection. In particular, consumption of fatty or fried foods more than once daily was not associated with hypertension after adjustment (aOR = 0.98; 95% CI: 0.93–1.04; p = 0.456). Reverse causality, changes in diet or smoking after diagnosis, measurement error, survival bias, and residual confounding may contribute to the observed patterns [18,19,21,22].

For stroke, diagnosed hypertension showed the strongest adjusted association among the variables reported (aOR = 14.61; 95% CI: 13.75–15.53). Both daily and non-daily smoking were associated with higher, rather than lower, adjusted odds of stroke. Grilled-food consumption more than once daily was not statistically significant (p = 0.052). These cross-sectional findings do not establish temporal sequence or causation; socioeconomic and clinical confounding, diagnosis-related behavior changes, and access to healthcare should be considered when interpreting them [23,24].

The implications of this study suggest that hypertension and stroke prevention interventions need to focus on increasing physical activity, particularly in urban populations and older age groups, as well as strengthening approaches based on social determinants of health [25–29]. In addition, education about healthy living behavior remains a top priority [22].

This study has several limitations. First, its cross-sectional design prevents establishing temporal or causal relationships between the studied factors and hypertension or stroke. Second, hypertension and stroke were based on self-reported diagnoses, which may introduce recall and reporting bias and may not identify undiagnosed cases. Third, excluding respondents with missing data may have introduced selection bias. Fourth, the secondary dataset may not include all relevant confounders, resulting in potential residual confounding. Finally, the inverse associations between smoking, certain dietary patterns, and hypertension should not be interpreted as protective, as they may reflect reverse causality or other unmeasured factors. Longitudinal studies are needed to confirm these associations.

CONCLUSIONS

In this cross-sectional analysis of SKI 2023, diagnosed hypertension and stroke were associated with demographic, residential, and behavioral characteristics. A history of hypertension was strongly associated with stroke (aOR = 14.61; 95% CI: 13.75–15.53). Inactivity was associated with higher adjusted odds of both conditions, while daily and non-daily smoking were associated with higher adjusted odds of stroke. Dietary associations were heterogeneous: daily fatty/fried-food consumption exceeding one occasion and grilled-food consumption exceeding one occasion were not statistically significant in the hypertension and stroke models, respectively. These findings should be interpreted cautiously because the outcomes were self-reported, the study was cross-sectional, and residual confounding and survey-design verification remain concerns.

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Conflict of Interest

There are no potential conflicts of interest relevant to this article.

Data Availability Statement

The authors' has nothing to report.

Authorship Contribution

Conceptualization: Cholifah; Data curation: Cholifah; Formal analysis: Cholifah; Methodology: Cholifah, Djazuly Chalidyanto; Project management: Diah Indriani; Resources: Cholifah; Software: Cholifah; Supervision: Diah Indriani; Validation: Diah Indriani, Djazuly Chalidyanto; Drafting - original draft: Cholifah; Writing - proofreading and editing: Indriani, Djazuly Chalidyanto

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