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Original Article

Lifestyle behaviors associated with hypertension among older adults: A cross-sectional study

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Abstract

Background: Hypertension is common in later life, while locally specific evidence on modifiable dietary and smoking behaviors among older adults in primary-care settings remains limited. Identifying lifestyle factors associated with hypertension can support targeted assessment and counseling in community and gerontological nursing.

Objective: To examine the associations of fatty-diet adherence, high-sodium-diet adherence, and smoking habits with hypertension status among older adults in the working area of Puskesmas Sungai Durian, Sawahlunto.

Methods: An analytic cross-sectional study was conducted at Puskesmas Sungai Durian, Sawahlunto, from August to September 2025. A total of 308 older adults were purposively selected from a source population of 1,345. Dietary behaviors were assessed using a 24-item hypertension diet-adherence questionnaire based on DASH principles, smoking was assessed using a five-item questionnaire, and blood pressure was measured twice at a five-minute interval. Associations were examined using chi-square tests and binary logistic regression with the three lifestyle variables entered simultaneously.

Results: Hypertension was recorded in 162 of 308 participants (52.6%). Fatty-diet nonadherence ($p < 0.001$), high-sodium-diet nonadherence ($p = 0.011$), and smoking habits ($p = 0.031$) were associated with hypertension in bivariate analyses. In the multivariable model, fatty-diet nonadherence was associated with higher odds of hypertension (OR = 2.675; 95% CI 1.614–4.432; $p < 0.001$), and the smoking term remained statistically significant (OR = 1.665; 95% CI 1.120–2.475; $p = 0.012$). High-sodium-diet nonadherence was not statistically significant after mutual adjustment (OR = 1.279; 95% CI 0.786–2.082; $p = 0.322$).

Conclusion: Among older adults in this primary-care population, fatty-diet nonadherence and smoking were associated with hypertension after mutual adjustment of the three lifestyle variables, whereas high-sodium-diet nonadherence was associated only in bivariate analysis. Because of the cross-sectional design, these findings indicate associations rather than causal effects and can inform risk assessment and lifestyle counseling in community-based care.

Background

Population ageing has increased the need for effective prevention and management of cardiovascular diseases, particularly hypertension. Globally, hypertension remains a major contributor to cardiovascular morbidity and mortality, with substantial disparities in detection, treatment, and control across countries (World Health Organization, 2023; NCD Risk Factor Collaboration [NCD-RisC], 2021; Mills et al., 2016). International guidelines also emphasize that hypertension management in older adults should account for clinical characteristics, frailty, the accuracy of blood pressure measurement, and safe, individualized lifestyle interventions (Unger et al., 2020; Mancia et al., 2023; McEvoy et al., 2024; Stergiou et al., 2021; Egan et al., 2024; Hu et al., 2023).

In Indonesia, the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia [SKI]) reported a measured hypertension prevalence of 30.8% among adults aged ≥18 years. The corresponding prevalence in West Sumatra was 24.1%, while the national prevalence among adults aged ≥60 years reached 56.8% (Kementerian Kesehatan Republik Indonesia, 2024a, 2024b). These findings highlight hypertension among older adults as an important concern for primary healthcare and community nursing. Sungai Durian Community Health Center in Sawahlunto serves a growing older population; health center records indicated that 1,345 older adults lived within its service area as of April 2025 (Medical record, 2025).

Dietary behaviors are central to blood pressure management. Experimental evidence and systematic reviews indicate that dietary patterns emphasizing food quality, sodium restriction, and the DASH eating plan are associated with reductions in blood pressure (Appel et al., 1997; Sacks et al., 2001; Gay et al., 2016; Ndanuko et al., 2016; Filippou et al., 2020; Theodoridis et al.,

2023a, 2023b). Conversely, diets high in saturated fat and ultra-processed foods, together with other unhealthy dietary factors, are associated with increased cardiometabolic risk (GBD 2017 Diet Collaborators, 2019; Lichtenstein et al., 2021; Schwingshackl et al., 2017; Wang et al., 2022). Biologically, dietary fat composition may influence endothelial function, lipid metabolism, vascular tone, and atherosclerotic processes; however, these mechanisms do not establish causality in a cross-sectional study (Harrison et al., 2021; Nestel, 2019; Jovanovski et al., 2019; Zang et al., 2025).

Sodium intake is another relevant dietary factor. Meta-analyses of controlled trials have demonstrated a dose–response relationship between sodium reduction and lower blood pressure, although the magnitude of the response may vary according to population characteristics and baseline potassium intake (He et al., 2013; Aburto et al., 2013; Filippini et al., 2021; Huang et al., 2021; Lai et al., 2022; Aliasgharzadeh et al., 2022; Xun et al., 2023). Nevertheless, associations observed at the individual level may be influenced by dietary assessment methods, correlated dietary patterns, and unmeasured clinical factors.

Smoking is also relevant to blood pressure and cardiovascular risk. Nicotine exposure can affect sympathetic activity and vascular responses, while observational evidence has identified differences in blood pressure by smoking status and associations between changes in smoking status and blood pressure (Andriani et al., 2020; Yamato et al., 2025; Arakawa et al., 2026; Song et al., 2026). In Indonesia, smoking behaviors and adherence to healthy lifestyles remain important targets for health promotion among older adults (Linda, 2018; Suprapto et al., 2021).

Although evidence on diet, sodium, and smoking continues to grow, limited data simultaneously describe these three behaviors and hypertension status among older adults in the Sungai Durian Community Health Center service area. Previous local studies have generally examined these factors separately or in different populations and settings (Imelda et al., 2020; Miranda, 2019; Purwono et al., 2020; Wirawan et al., 2023). Indonesian nursing literature has also highlighted the importance of knowledge, attitudes, physical activity, and education in blood pressure management among older adults (Efrianty & Sartika, 2024; Sarwoko, 2022). Therefore, this study aimed to examine the associations of low-fat dietary adherence, low-sodium dietary adherence, and smoking habits with hypertension status among older adults in the service area of Sungai Durian Community Health Center, Sawahlunto. It provides context-specific evidence for lifestyle assessment and education in primary care, while interpreting the findings as cross-sectional associations.

Methods

Study Design

An analytical cross-sectional design was used to assess lifestyle-related exposures and hypertension status during a single assessment period. Reporting of this manuscript was revised with reference to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies (von Elm et al., 2007).

Study Setting and Period

The study was conducted in the service area of Sungai Durian Community Health Center, Sawahlunto, Indonesia. Data were collected over two months, from August to September 2025.

Study Population, Sampling, and Eligibility Criteria

The source population comprised all 1,345 older adults registered in the Sungai Durian Community Health Center service area as of April 2025 (Medical record, 2025). Participants were selected through nonprobability purposive sampling according to predefined criteria. Inclusion criteria consistent with the study population and analyses were being an older adult, being willing to participate, residing in the service area, and being able to communicate effectively. Exclusion criteria included conditions that prevented participation, such as dementia or schizophrenia, and coexisting chronic illnesses specified in the source protocol, such as stroke. The original manuscript stated that only older adults previously diagnosed with hypertension were eligible; this restriction was removed during revision because it conflicted with the reported results, which included both normotensive and hypertensive participants.

The source documents did not report the numbers of potential participants identified, invited, declining participation, or excluded at each recruitment stage. Therefore, a more detailed participant flow was not reconstructed because the necessary data were unavailable.

Sample Size

The source manuscript specified a minimum sample of 308 participants using Slovin's formula, a 5% margin of error, and a source population of 1,345 older adults (Sugiyono, 2022; Mulyani, 2021). As this original calculation was not based on an anticipated effect size, outcome prevalence, significance level, statistical power, or number of predictors, no retrospective sample-size calculation was performed without documented assumptions. This limitation was considered when interpreting the findings.

Variables and Instruments

Low-fat and low-sodium dietary adherence were assessed using a 24-item hypertension dietary adherence questionnaire based on the Dietary Approaches to Stop Hypertension (DASH) principles. Responses were rated on a five-point Likert scale: always, often, sometimes, rarely, and never. The source documents reported item validity coefficients of $r > 0.635$ and a Cronbach's alpha of 0.947 from previous use. Total scores were classified as adherent (72–120) or nonadherent (24–71). The source documents did not identify the instrument validation publication, specify which items represented the fat and sodium subscales, or report reliability for the present sample. Consequently, these details were not added without verification.

Smoking habits were assessed using a five-item questionnaire. The scoring categories specified in the source methods were never smoked (score 0), light smoking (scores 1–3), moderate smoking (scores 4–6), and heavy smoking (scores 7–8). The distribution across these four categories was retained in the descriptive analysis. However, the source materials were inconsistent: the descriptive table used four smoking categories, whereas the bivariate cross-tabulation used three. Because individual-level data were unavailable, the inconsistent smoking cross-tabulation was not reproduced in the revised manuscript.

Blood pressure was measured twice using a sphygmomanometer, with a five-minute interval between measurements. The study outcome was reported as hypertension status (normal or hypertension), rather than incident hypertension. The source documents did not specify the numerical diagnostic thresholds; whether a prior diagnosis or antihypertensive medication use informed classification; device type and validation; cuff size; body position; rest period; timing of measurement; assessor training; or how the two measurements were combined. These details were not reconstructed in the absence of supporting information.

Efforts to Reduce Bias

Using the same procedure for both blood pressure measurements and the same questionnaire instruments for all participants was intended to improve data collection consistency. Nevertheless, purposive sampling may introduce selection bias, while self-reported dietary and smoking behaviors are susceptible to recall and social desirability biases.

Statistical Analysis

Data were analyzed using SPSS version 25. Descriptive statistics were reported as frequencies and percentages. Bivariate associations were examined using chi-square tests with a significance threshold of $\alpha = 0.05$. For the 2×2 tables of low-fat and low-sodium dietary adherence, crude odds ratios (ORs) and 95% confidence intervals (CIs) were calculated from the reported frequencies. Multivariable analysis used binary logistic regression with the Enter method, in which all three lifestyle variables were included simultaneously. Accordingly, the resulting ORs represent estimates mutually adjusted for the three lifestyle variables rather than estimates adjusted for demographic or clinical covariates not included in the model. Values shown as $p = 0.000$ in statistical output were reported as $p < 0.001$. Available tables indicated $n = 308$ for the reported analyses, and the source documents did not describe any missing-data imputation. Model diagnostics, multicollinearity assessments, interaction tests, and details of the coding of the smoking variable were unavailable and were not reconstructed.

Ethical Considerations

All participants were reported to have received information about the study and to have signed informed consent forms. The name of the approving ethics committee and the ethics approval number were not included in the source documents available for revision; therefore, these details were not added without verifiable documentation.

Results

A total of 308 participants were included in the analysis. Hypertension was recorded in 162 participants (52.6%). Nonadherence to a low-fat diet was reported by 168 participants (54.5%), while 173 (56.2%) were classified as nonadherent to a low-sodium diet. Table 1 presents the distribution of smoking habits according to the four categories reported in the descriptive data.

Table 1. Distribution of study variables among older adults in the Sungai Durian Community Health Center service area, Sawahlunto (n = 308)

Variable/category	n	%
Hypertension status		
Normal	146	47.4
Hypertension	162	52.6
Low-fat dietary adherence		
Adherent	140	45.5
Nonadherent	168	54.5
Low-sodium dietary adherence		
Adherent	135	43.8
Nonadherent	173	56.2
Smoking habits		
Never smoked	149	48.4
Light smoking	144	46.8
Moderate smoking	10	3.2
Heavy smoking	5	1.6

In bivariate analyses, low-fat dietary adherence, low-sodium dietary adherence, and smoking habits were each associated with hypertension status. Tables 2 and 3 present the cross-tabulations and crude ORs calculated directly from the reported frequencies for the two dietary variables.

Table 2. Low-fat dietary adherence and hypertension status (n = 308)

Low-fat dietary adherence	Normal, n (%)	Hypertension, n (%)	Total	Crude OR (95% CI)	p
Adherent	88 (62.9)	52 (37.1)	140	1.00	< 0.001
Nonadherent	58 (34.5)	110 (65.5)	168	3.21 (2.01–5.12)	
Total	146	162	308		

Smoking habits were associated with hypertension status in the bivariate analysis (p = 0.031). Because the source tables contained incompatible smoking-category distributions in the descriptive and bivariate cross-tabulations, category-specific bivariate frequencies are not presented to avoid reproducing contradictory values.

Table 3. Low-sodium dietary adherence and hypertension status (n = 308)

Low-sodium dietary adherence	Normal, n (%)	Hypertension, n (%)	Total	Crude OR (95% CI)	p
Adherent	75 (55.6)	60 (44.4)	135	1.00	0.011
Nonadherent	71 (41.0)	102 (59.0)	173	1.80 (1.14–2.83)	
Total	146	162	308		

In the multivariable model, nonadherence to a low-fat diet remained associated with hypertension status (OR = 2.675; 95% CI: 1.614–4.432; p < 0.001), as did the smoking variable (OR = 1.665; 95% CI: 1.120–2.475; p = 0.012). Nonadherence to a low-sodium diet was not statistically significantly associated with hypertension after the three lifestyle variables

were entered simultaneously (OR = 1.279; 95% CI: 0.786–2.082; p = 0.322).

Table 4. Binary logistic regression of lifestyle variables and hypertension status (n = 308)

Variable	B	SE	Wald	p	OR	95% CI
Low-fat dietary adherence	0.984	0.258	14.580	< 0.001	2.675	1.614–4.432
Low-sodium dietary adherence	0.246	0.249	0.981	0.322	1.279	0.786–2.082
Smoking habits	0.510	0.202	6.362	0.012	1.665	1.120–2.475
Constant	−3.571	0.634	31.712	< 0.001	0.028	–

Discussion

This study yielded three principal findings. First, more than half of the participants were classified as having hypertension. Second, nonadherence to low-fat and low-sodium diets and smoking habits were associated with hypertension status in bivariate analyses. Third, after the three lifestyle variables were entered simultaneously, low-fat dietary nonadherence and the smoking variable remained statistically significant, whereas low-sodium dietary nonadherence did not. Given the cross-sectional design, these results establish neither temporal sequence nor causality.

Nonadherence to a low-fat diet showed the numerically largest association among the available model estimates; however, the OR magnitude alone is insufficient to characterize it as the "most dominant" factor. The crude OR calculated from the cross-tabulation was 3.21 (95% CI: 2.01–5.12), compared with 2.675 (95% CI: 1.614–4.432) in the simultaneous regression model. These results are broadly consistent with literature linking dietary fat quality and overall dietary patterns to blood pressure and cardiovascular risk, although findings may vary across specific types of dietary fat (Nestel, 2019; Jovanovski et al., 2019; Zang et al., 2025; Lichtenstein et al., 2021).

Biologically, a diet high in saturated fat may be associated with endothelial dysfunction, altered lipid profiles, atherosclerosis, and changes in vascular resistance. These mechanisms provide biological plausibility but do not demonstrate that fatty food consumption caused hypertension in this study. Intervention evidence indicates that healthy overall dietary patterns, particularly DASH, can reduce blood pressure (Appel et al., 1997; Sacks et al., 2001; Filippou et al., 2020; Theodoridis et al., 2023b). Thus, the present findings are more appropriately applied to dietary screening and education than to causal inference.

Nonadherence to a low-sodium diet was associated with hypertension in the bivariate analysis (crude OR = 1.80; 95% CI: 1.14–2.83; p = 0.011), but this association was no longer statistically significant in the simultaneous regression model (OR = 1.279; 95% CI: 0.786–2.082; p = 0.322). Thus, the present data do not support an independently statistically significant association for the sodium-related measure after mutual adjustment for the other two lifestyle behaviors.

The absence of statistical significance in the multivariable model does not mean that sodium is clinically irrelevant. Randomized trials and meta-analyses have shown that reducing sodium intake can lower blood pressure (He et al., 2013; Aburto et al., 2013; Filippini et al., 2021; Lai et al., 2022; Aliasgharzadeh et al., 2022; Xun et al., 2023), with effects that may differ according to potassium intake and individual characteristics (Huang et al., 2021). Differences between experimental evidence and the present model may reflect questionnaire-based dietary assessment, correlations among dietary behaviors, and the exclusion of other clinical or sociodemographic covariates.

Smoking habits were associated with hypertension status in the bivariate analysis (p = 0.031), and the smoking variable remained statistically significant in the regression model (OR = 1.665; 95% CI: 1.120–2.475; p = 0.012). Because the source documents did not provide detailed coding for the smoking variable in the model and the bivariate smoking-category cross-tabulations were inconsistent, this OR should be interpreted cautiously and should not be presented as a comparison between specific smoking categories.

Physiologically, nicotine can increase sympathetic nervous system activity and cause acute changes in vascular tone and heart rate. Observational

studies from Indonesia and elsewhere have also reported associations between smoking status and blood pressure, while passive smoke exposure may be related to hypertension risk (Andriani et al., 2020; Yamato et al., 2025; Arakawa et al., 2026; Song et al., 2026). These mechanisms offer possible explanations, not causal evidence from this study.

Implications for Community and Gerontological Nursing

The findings support structured assessment of lifestyle behaviors among older adults in primary care. Nurses can incorporate assessment of dietary patterns, sodium consumption, and smoking status into blood pressure management education while considering functional capacity, comorbidities, patient preferences, and family support. Evidence syntheses suggest that nonpharmacological interventions can improve blood pressure outcomes in older adults, although implementation should be adapted to individual needs (Li et al., 2022; Egan et al., 2024). Local nursing studies similarly emphasize the roles of knowledge, attitudes, physical activity, and ongoing support in blood pressure management (Efrianty & Sartika, 2024; Sarwoko, 2022).

Strengths and Limitations

Strengths of this study include a relatively large sample for a single primary-care service area and the concurrent assessment of three clinically relevant lifestyle behaviors. However, several limitations warrant consideration. The cross-sectional design precludes conclusions about temporal sequence or causality. Purposive sampling and the absence of information on nonrespondents limit generalizability and the assessment of selection bias. The initial sample size was calculated using Slovin's formula rather than an effect-size- and power-based approach appropriate for an analytical study. Self-reported dietary and smoking behaviors may be affected by recall and social desirability biases.

In addition, the source documents did not provide the diagnostic thresholds for hypertension; complete details of the blood pressure measurement device and protocol; the source of dietary instrument validation; reliability estimates for the current sample; or item-level mapping of dietary measures to fat and sodium exposure. Smoking-category distributions were inconsistent between the descriptive and bivariate tables; these categories could not be reconciled without raw data. The regression model included only the three lifestyle variables, so its adjusted ORs should not be interpreted as controlling for potential confounders such as age, sex, body mass index, physical activity, diabetes, kidney disease, family history, antihypertensive medication use, socioeconomic status, or duration of hypertension. Model diagnostics and interaction assessments were also unavailable.

Directions for Future Research

Future research should consider prospective cohort or other analytical designs, probability sampling, sample size calculations based on effect size and statistical power, standardized blood pressure measurement protocols, and dietary instruments with documented subscale definitions and reliability. Multivariable analyses should incorporate key confounders selected using a prespecified causal framework, including age, sex, body mass index, physical activity, diabetes, kidney disease, family history, antihypertensive medication use, socioeconomic status, and hypertension duration. Smoking data should be coded consistently and reported with clearly defined categories and reference groups.

Conclusion and Recommendation

Among older adults in the service area of Sungai Durian Community Health Center, nonadherence to low-fat and low-sodium diets and smoking habits were associated with hypertension status in bivariate analyses. When all three lifestyle variables were entered simultaneously, nonadherence to a low-fat diet and the smoking variable remained statistically significant, whereas nonadherence to a low-sodium diet did not. These findings reflect cross-sectional associations and should not be interpreted as causal relationships. The results may strengthen lifestyle assessment and counseling in community and gerontological nursing, provided that limitations related to sampling, measurement, and confounder control are considered.

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The authors declare no competing interests.

Declaration on the Use of AI
No AI tools were used in the preparation of this manuscript.

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Data sharing is not applicable to this article.

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