



Associations Among Dietary Patterns, Perceived Stress, and Hypertension: A Community-Based Path Analysis Study

Supriadin Supriadin¹, Imam Fajlurrahman², Linda Putri Jumiati³

¹Program Studi Ilmu Keperawatan STIKes Yahya Bima, Nusa Tenggara Barat, Indonesia

²Program Studi Ilmu Keperawatan STIKes Yahya Bima, Nusa Tenggara Barat, Indonesia

³Program Studi Ilmu Keperawatan STIKes Yahya Bima, Nusa Tenggara Barat, Indonesia

*Corresponding E-mail: supriadinmyusuf@stikesyahyabima.ac.id

ABSTRACT

Introduction: Hypertension is a leading modifiable contributor to cardiovascular morbidity and mortality. Dietary patterns and psychosocial stress are interrelated determinants of hypertension, yet they are rarely examined simultaneously within community settings. **Objective:** To examine direct and indirect pathways linking dietary patterns and perceived stress with hypertension among community-dwelling adults using path analysis. **Methods:** A cross-sectional study was conducted among adults aged 30–65 years selected through multistage cluster sampling from community health center areas. Dietary intake was assessed using a validated 95-item Food Frequency Questionnaire to identify Prudent, Western, and Traditional dietary patterns. Perceived stress was measured with the PSS-10. Blood pressure was measured using standardized procedures; hypertension was defined as SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg or antihypertensive use. Associations were examined using bivariate analysis and structural equation modeling. **Results:** Among 250 participants (mean age 49.6 ± 8.7 years; 57.2% female), hypertension prevalence was 38.8%. The Prudent pattern was inversely associated with blood pressure and stress, whereas the Western pattern showed positive associations (all $p \leq 0.01$). Path analysis showed that the Western pattern was positively associated with perceived stress ($\beta = 0.24$, $p = 0.002$) and hypertension status ($\beta = 0.29$, $p < 0.001$), while the Prudent pattern was inversely associated with hypertension status ($\beta = -0.18$, $p = 0.004$). **Conclusion:** Western dietary patterns were associated with higher hypertension risk both directly and indirectly through perceived stress, while Prudent patterns showed protective associations.

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1. INTRODUCTION

Hypertension remains a leading modifiable driver of cardiovascular morbidity and mortality worldwide. Recent pooled analyses estimate that ~1.28 billion adults were living with hypertension in 2019, with a substantial proportion undiagnosed or inadequately controlled, underscoring the need for scalable, community-level prevention strategies (NCD Risk Factor Collaboration [NCD-RisC], 2021). Dietary patterns and psychosocial stress are two highly prevalent, interrelated exposures that plausibly shape hypertension risk but are often examined in isolation. Understanding their joint and pathway-specific contributions in real-world community settings could refine primordial and primary prevention efforts.

Dietary patterns capture how foods and nutrients co-occur in habitual intake and may better represent lived diets than single-nutrient approaches. Two patterns are especially relevant for blood pressure (BP) control: the Dietary Approaches to Stop Hypertension (DASH) and the Mediterranean diet. Meta-analyses of randomized trials show that DASH lowers systolic and diastolic BP in adults with and without hypertension, with effect sizes amplified when background sodium intake is higher (Filippou et al., 2020). Parallel syntheses conclude that Mediterranean-style eating produces modest but significant BP reductions, particularly with longer follow-up (Filippou et al., 2021). Longitudinal cohort evidence further links “modern” patterns rich in fruits and dairy to lower BP trajectories, while meat-heavy patterns associate with higher diastolic BP and incident hypertension (Zhang et al., 2023). Mechanistically, sodium–potassium balance remains a cornerstone: contemporary dose–response work and tightly controlled feeding studies demonstrate that modest sodium reduction yields clinically meaningful BP declines across diverse subgroups within days to weeks (Filippini et al., 2021; Gupta et al., 2023).

Psychosocial stress is also implicated in the development and progression of hypertension through neuroendocrine, autonomic, and inflammatory pathways. Acute and chronic stress activate the sympathetic–adrenomedullary system and the hypothalamic–pituitary–adrenal (HPA) axis, promoting vasoconstriction, sodium retention, and endothelial dysfunction (Chu, 2024). Prospective studies associate higher perceived stress and occupational job strain with elevated incident hypertension risk, suggesting that stress is not merely comorbid with, but may precede, BP elevation (Spruill et al., 2019; Liu et al., 2022). Experimental and mechanistic reviews also indicate heightened cardiovascular reactivity to acute mental stress among individuals with essential hypertension, consistent with a stress-reactivity phenotype (Walther et al., 2023).

Emerging work hints that stress and diet are intertwined. Stress can degrade diet quality by reducing adherence to Mediterranean or DASH-like dietary patterns and increasing the consumption of energy-dense, nutrient-poor foods. This may contribute to hypertension risk through unhealthy dietary behaviors and stress-related physiological responses. Together, these findings suggest that stress may influence blood pressure both directly through neuroendocrine mechanisms and indirectly by shaping unhealthy dietary behaviors. However, studies simultaneously examining these interrelationships within a single analytical framework remain limited, particularly in community-based populations.

Despite robust literatures on diet–BP and stress–BP relationships, three gaps persist. First, most studies model diet and stress separately, limiting insight into their joint and potentially synergistic effects on hypertension risk. Second, when pathways are examined, analyses often

focus on either diet and hypertension or stress and blood pressure reactivity, rather than a single integrative framework that simultaneously tests direct and indirect pathways among dietary patterns, perceived stress, and hypertension in community-dwelling adults (Harris & Gleason, 2022; Louca et al., 2022; Yuan et al., 2023). Third, community-based evidence using rigorous structural approaches remains sparse; recent structural equation/path analyses have been applied to specific populations (e.g., women of childbearing age) or outcomes other than hypertension, leaving general adult community settings underexplored (Khaled et al., 2024; Zhang et al., 2023).

To address these gaps, the present study applied path analysis in a community-based sample to examine the direct and indirect relationships between dietary patterns, perceived stress, and hypertension. Specifically, we hypothesized that dietary patterns influence hypertension both directly and indirectly through perceived stress as a mediating factor. This framework enables simultaneous evaluation of the interrelationships among dietary behaviors, psychological stress, and hypertension, thereby providing evidence to inform integrated community-based prevention strategies.

2. METHODS

Study design and setting

This study employed a community-based cross-sectional design with an embedded path analysis approach to investigate the direct and indirect relationships between dietary patterns, perceived stress, and hypertension. The design was selected to allow simultaneous examination of multiple interrelated variables within a naturalistic population setting.

Sample

The study population consisted of adults aged 30–65 years residing in the catchment area of selected community health centers (Puskesmas). A multistage cluster sampling technique was applied, beginning with random selection of villages, followed by proportional sampling of households, and finally recruitment of eligible participants within each household.

Inclusion criteria were: (1) adults aged 30–65 years, (2) residing in the study area for at least one year, and (3) willing to provide written informed consent. Exclusion criteria included: (1) pregnancy, (2) history of severe psychiatric illness or cognitive impairment that could interfere with questionnaire completion, (3) use of medications affecting blood pressure variability other than standard antihypertensives, and (4) presence of severe comorbidities such as cancer or advanced heart failure.

The sample size was estimated using G*Power version 3.1 for structural equation modeling (SEM) with path analysis. Assuming a medium effect size ($f^2 = 0.15$), $\alpha = 0.05$, power = 0.80, and a maximum of 10 predictors, the minimum required sample was 208 participants. To account for potential nonresponse and incomplete data, the final target was 250 participants, which ensured adequate power for the hypothesized model.

Instruments

Dietary intake was assessed using a Food Frequency Questionnaire (FFQ) adapted from Willett et al. (1985), which has been validated and widely applied in community nutrition studies.

The FFQ consists of 95 items covering major food groups consumed in the Indonesian context. Respondents indicated their frequency of consumption on a 7-point Likert scale, ranging from “never or less than once per month” to “six or more times per day.” Exploratory factor analysis using principal component analysis was used to derive dietary patterns from the FFQ data.

Stress was measured using the Perceived Stress Scale (PSS-10) developed by Cohen et al. (1983). This instrument contains 10 items scored on a 5-point Likert scale (0 = never to 4 = very often), with total scores ranging from 0 to 40. Higher scores indicate greater perceived stress. Interpretation follows cutoffs: low (0–13), moderate (14–26), and high stress (27–40). The original version reported Cronbach’s α of 0.78, while the validated Bahasa Indonesia version yielded $\alpha = 0.76$.

Blood pressure was measured using a calibrated digital sphygmomanometer (Omron HEM-7120, Japan) following WHO guidelines. Two readings were obtained after 5 minutes of rest, with a third reading if differences exceeded 10 mmHg; the average of the two closest readings was recorded. Hypertension was defined as systolic BP ≥ 140 mmHg and/or diastolic BP ≥ 90 mmHg, or current use of antihypertensive medication.

Procedure

Ethical approval was obtained from the Institutional Review Board (IRB) of STIKes Yahya Bima (approval number: 042/IRB/2025). Permission was also secured from local health authorities and community leaders. Eligible participants were identified through household enumeration and were informed about the study objectives and procedures. Written informed consent was obtained prior to data collection. Trained research assistants conducted face-to-face interviews for questionnaire administration and measured blood pressure using standardized protocols. Data collection was conducted over a three-month period. At the end of each session, participants received personalized feedback regarding their blood pressure readings and dietary patterns, and were encouraged to consult community health workers for follow-up if needed.

Data Analysis

Data were analyzed using SPSS version 29.0 and AMOS version 26.0. Descriptive statistics (mean, standard deviation, frequency, and percentage) were used to summarize sample characteristics. Bivariate analyses (chi-square tests, t-tests, and Pearson’s correlations) were performed to explore associations between key variables. For the main analysis, observed-variable path analysis was conducted using AMOS version 26.0 to examine the direct and indirect associations among dietary patterns, perceived stress, and hypertension status. Hypertension was modeled as a binary observed variable coded as 0 = non-hypertensive and 1 = hypertensive. The path coefficients were interpreted as standardized statistical associations rather than causal effects due to the cross-sectional design.

Dietary patterns were derived using exploratory factor analysis with principal component analysis and varimax rotation. The suitability of the data for factor analysis was assessed using the Kaiser–Meyer–Olkin measure of sampling adequacy and Bartlett’s test of sphericity. Factors were retained based on eigenvalues greater than 1.0, scree plot inspection, and interpretability of the extracted patterns. Food groups with factor loadings ≥ 0.30 were considered meaningful

contributors to each dietary pattern. Dietary pattern scores were calculated for each participant by summing the standardized intake frequencies of food groups weighted by their factor loadings.

3. RESULT

A total of 250 participants were enrolled, with a response rate of 94.7%. The mean age was 49.6 years (SD = 8.7), and 57.2% were female. The majority had completed secondary education (61.6%), and 32.4% were overweight or obese. Hypertension prevalence in the sample was 38.8% (n = 97) (Table 1).

Table 1. Demographic and Clinical Characteristics of Participants (N = 250)

Variable	n = 250 (%)
Age, mean ± SD (years)	49.6 ± 8.7
Sex, n (%)	
Male	107 (42.8)
Female	143 (57.2)
Education, n (%)	
Primary	42 (16.8)
Secondary	154 (61.6)
Higher	54 (21.6)
BMI status, n (%)	
Normal	169 (67.6)
Overweight/Obese	81 (32.4)
Hypertension, n (%)	97 (38.8)

Table 2 demonstrates significant associations between dietary patterns, stress, and blood pressure. The Prudent dietary pattern showed a negative correlation with both systolic ($r = -0.21$, $p < 0.01$) and diastolic blood pressure ($r = -0.18$, $p < 0.05$), as well as with stress ($r = -0.15$, $p < 0.05$), suggesting a protective effect against hypertension and psychological strain. In contrast, the Western dietary pattern was positively correlated with systolic ($r = 0.32$, $p < 0.001$) and diastolic blood pressure ($r = 0.28$, $p < 0.001$), as well as stress levels ($r = 0.22$, $p < 0.01$), indicating a detrimental influence. The Traditional dietary pattern exhibited no significant relationships with either blood pressure or stress. Additionally, stress scores were positively associated with both systolic ($r = 0.28$, $p < 0.001$) and diastolic blood pressure ($r = 0.25$, $p < 0.001$), reinforcing the role of psychological stress as a risk factor for hypertension.

Table 2. Correlations Between Dietary Patterns, Stress, and Blood Pressure

Variable	Systolic BP (mmHg)	Diastolic BP (mmHg)	Stress (PSS-10)
Prudent pattern	-0.21**	-0.18*	-0.15*
Western pattern	0.32***	0.28***	0.22**
Traditional pattern	0.05	0.02	0.04
Stress (PSS-10 score)	0.28***	0.25***	—

Note: Pearson correlation coefficients reported. $p < 0.05$ (), $p < 0.01$ (*), $p < 0.001$ (**).

Table 3 presents the results of the structural equation model examining the pathways between dietary patterns, stress, and hypertension. The Western dietary pattern was significantly associated with higher stress levels ($\beta = 0.24$, $p = 0.002$) and directly predicted an increased risk of hypertension ($\beta = 0.29$, $p < 0.001$). The Prudent dietary pattern demonstrated a protective effect, showing a negative association with hypertension ($\beta = -0.18$, $p = 0.004$). Stress itself was also a significant positive predictor of hypertension ($\beta = 0.22$, $p = 0.001$), indicating that higher perceived stress contributes to elevated blood pressure. Importantly, the indirect pathway revealed that the Western dietary pattern increased the likelihood of hypertension through its effect on stress ($\beta = 0.05$, 95% CI: 0.02–0.09, $p = 0.008$), confirming stress as a partial mediator in the relationship between diet and hypertension.

Table 3. Path Coefficients of the Structural Equation Model

Pathway	Standardized β	95% CI	p-value
Western pattern → Stress	0.24	0.11–0.37	0.002
Western pattern → Hypertension	0.29	0.15–0.43	<0.001
Prudent pattern → Hypertension	-0.18	-0.30 to -0.06	0.004
Stress → Hypertension	0.22	0.09–0.35	0.001
Western pattern → Hypertension (indirect via Stress)	0.05	0.02–0.09	0.008

Model fit indices: $\chi^2 = 38.4$, $df = 22$, $p = 0.019$; CFI = 0.96; TLI = 0.94; RMSEA = 0.051; SRMR = 0.041.

4. DISCUSSION

The present study delineates how a Western dietary pattern is both directly associated with higher hypertension risk and indirectly via elevated stress levels, whereas a Prudent dietary pattern manifests a protective effect. A large cross-sectional analysis of the Indonesian Family Life Survey (IFLS-5) corroborates these findings: a “modern” diet—characterized by fast foods, sugary snacks, and high-fat items—was significantly linked to greater odds of hypertension and obesity, while a traditional pattern did not show such associations (Anyanwu et al., 2022). This convergence underscores that dietary habits aligning with Western trends may elevate hypertension risk in Indonesian communities. Local evidence further supports this. A study among elderly populations in Sukabumi found that both moderate stress and poor diet were each significantly associated with hypertension (Tresnawan, 2025), reinforcing the mediating role of psychological stress identified in our analysis.

Interestingly, the Traditional dietary pattern was not significantly associated with either perceived stress or hypertension in the present study. This finding may reflect the heterogeneous composition of traditional Indonesian diets, which include both cardioprotective foods, such as vegetables, legumes, and fish, and foods prepared with high amounts of sodium, coconut milk, and fried ingredients. Consequently, the overall health effect of this dietary pattern may be neutral rather than consistently beneficial or harmful. Furthermore, traditional dietary practices vary considerably across Indonesian regions, making it difficult to characterize them as uniformly healthy or unhealthy. Similar findings have been reported in several Asian populations, where traditional dietary patterns demonstrated inconsistent associations with blood pressure outcomes,

suggesting that food preparation methods and regional dietary variations may substantially influence cardiovascular risk.

Globally, the efficacy of dietary patterns similar to our Prudent model, such as the DASH diet, is well established. A meta-analysis of 30 randomized controlled trials ($n = 5,545$) reported significant reductions in systolic (-3.2 mm Hg; 95% CI: -4.2 to -2.3) and diastolic (-2.5 mm Hg; 95% CI: -3.5 to -1.5) blood pressure among DASH adherents compared to controls (Filippou et al., 2020). Additionally, high adherence to DASH was associated with a lower risk of incident hypertension in cohort studies (HR: 0.81; 95% CI: 0.73–0.90) and cross-sectional designs (OR: 0.80; 95% CI: 0.70–0.91) (Theodoridis et al., 2023). These results parallel our findings that a Prudent dietary pattern significantly reduces hypertension risk ($\beta = -0.18$, $p = 0.004$), reinforcing the value of diet quality in cardiovascular risk mitigation.

An umbrella review of meta-analyses further emphasizes that dietary patterns such as DASH and Mediterranean, particularly when combined with sodium reduction, contribute substantially to blood pressure control (Aljuraiban, 2023). Indeed, sodium reduction alone has a potent blood pressure-lowering effect (Huang et al., 2020). Collectively, these findings suggest that dietary interventions integrating healthy eating with sodium restriction can yield enhanced benefits. Moreover, fiber intake plays a distinct role in hypertension management. A dedicated meta-analysis revealed that higher dietary fiber intake significantly improves blood pressure control in individuals with pre-existing hypertension or cardiovascular disease (Reynolds et al., 2022). Plant-based and Mediterranean patterns, which are inherently rich in fiber and micronutrients, therefore align strongly with our Prudent dietary model and its protective associations.

Although our study did not directly assess physical activity, existing evidence indicates that the combination of healthy dietary patterns and recommended physical activity significantly reduces hypertension risk beyond either intervention alone (Zhu & Wang, 2024). This suggests that lifestyle-based strategies for hypertension prevention are most effective when multidimensional. The mediation effect of stress in our model is particularly noteworthy. While dietary interventions often focus on metabolic or physiological pathways, our findings highlight psychological stress as a meaningful intermediary—suggesting that comprehensive strategies integrating stress management may enhance the effectiveness of diet-based hypertension interventions. From a community health perspective, these findings have important implications for hypertension prevention in primary healthcare settings. In Indonesia, Puskesmas and community-based integrated health posts (Posbindu PTM) provide strategic platforms for implementing comprehensive hypertension prevention programs. Integrating nutrition education, routine blood pressure screening, stress management counseling, and community empowerment through trained health volunteers (kader kesehatan) may improve early detection and promote sustained healthy lifestyle behaviors. Such integrated interventions could strengthen existing community-based non-communicable disease control programs and contribute to reducing the growing burden of hypertension at the population level. Clinically, these findings recommend integrative approaches, promoting Prudent dietary habits alongside stress reduction strategies such as mindfulness or therapy. Public health initiatives can further strengthen impact by advocating policy measures that subsidize nutrient-rich foods, regulate sodium content in processed food, and support mental health services within primary care.

Nonetheless, limitations include the cross-sectional design, which precludes causal inference, and reliance on self-reported dietary and stress data that may be biased. Unmeasured confounders, including physical activity and socioeconomic status, could also impact relationships. Additionally, the regional nature of the sample limits generalizability and underscores the need for replication in diverse settings. Future research should include longitudinal and intervention studies to confirm causality and explore whether integrated lifestyle modifications, including diet, stress management, physical activity yield synergistic benefits. Investigating biomarkers such as inflammatory or metabolic indices may elucidate underlying mechanisms. Additionally, understanding how social determinants like income and education intersect with diet and stress could further guide tailored interventions.

5. CONCLUSION

This study found that Western dietary patterns were associated with higher hypertension risk both directly and indirectly through perceived stress, while Prudent dietary patterns showed protective associations. These findings emphasize the importance of integrated community-based strategies that combine healthy dietary promotion with stress management within primary healthcare settings. However, because of the cross-sectional design, the proposed pathways should be interpreted as statistical associations rather than causal mechanisms. Longitudinal and intervention studies are needed to confirm the temporal relationships and mediation pathways observed in this study.

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This research received no external funding.

8. AUTHOR CONTRIBUTIONS

SS conceived and designed the study, collected and analyzed the data, and drafted the manuscript. **IF** contributed to data validation, methodology, and manuscript revision. **LPJ** supervised the study, reviewed and edited the manuscript, and approved the final version. All authors read and approved the final manuscript.

9. DATA AVAILABILITY STATEMENT

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

10. CONFLICT OF INTEREST

None declared.

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