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High Hypertension Prevalence and Associated Factors in Urban Coastal Communities: A Cross-Sectional Study in Manado, Indonesia

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ABSTRACT

Hypertension is a major public health challenge in Indonesia, and urban coastal communities may experience compounded risk. This community-based cross-sectional study estimated hypertension prevalence and assessed factors associated with hypertension among adults in Manado City, North Sulawesi. Data were collected in September 2024 at three coastal primary healthcare centers (Puskesmas Bahu, Tuminting, and Bailang). Convenience sampling enrolled 150 adults, most of whom were aged ≥50 years (63.3%) and female (70.0%). Blood pressure was measured twice in a seated position after rest; the average was used to classify hypertension (systolic ≥140 mmHg and/or diastolic ≥90 mmHg). Exposures included age, sex, family history, marital status, education, occupation, physical activity, and smoking. Associations were analyzed using modified Poisson regression with robust variance to estimate prevalence ratios (PR). Hypertension prevalence was 70.0% (105/150). In multivariable analyses, hypertension was associated with family history (PR=4.746; p=.035), marital status (PR=4.723; p=.046), education (PR=3.831; p=.034), physical activity (PR=5.523; p=.025), and smoking (PR=4.821; p=.047). Age, sex, and occupation were not statistically significant. These findings indicate a very high hypertension burden in urban coastal Manado and highlight priority targets for prevention and primary-care action, including risk-based screening, smoking cessation support, physical-activity promotion, and tailored health education.

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INTRODUCTION

Hypertension remains one of the most prevalent and consequential noncommunicable diseases worldwide and is a leading modifiable risk factor for cardiovascular morbidity and premature mortality. Global pooled analyses show that, despite improvements in diagnosis and treatment in some settings, the absolute burden of elevated blood pressure has continued to rise, largely driven by population growth, ageing, and uneven progress in prevention and control across regions (NCD Risk Factor Collaboration [NCD-RisC], 2021). The World Health Organization similarly highlights that a substantial proportion of adults living with hypertension are either undiagnosed or inadequately controlled, underscoring persistent gaps across the full cascade of care (WHO, 2025a; WHO, 2025c).

In Indonesia, hypertension represents a major public health challenge with a high population prevalence documented in national surveillance, alongside substantial shortfalls in awareness, treatment initiation, continuity of care, and control. Government reporting based on the 2018 national health survey indicates that measured hypertension affects a large fraction of adults, reinforcing the need for scalable prevention and improved primary-care management (Kementerian Kesehatan Republik Indonesia, 2019). Recent national-level evidence also suggests wide geographic and socioeconomic inequalities in hypertension burden and care, indicating that structural conditions (e.g., education and local health system capacity) may shape both risk exposure and downstream management (Oktamianti et al., 2022). Moreover, contemporary analyses of the hypertension care cascade in Indonesia emphasize persisting gaps in detection and control, implying that strategies focused only on individual behavior change may be insufficient without parallel attention to social context and access-related constraints (Muharram et al., 2025).

Urban coastal communities warrant specific attention because they may concentrate risk through a combination of rapid urbanization, dietary transitions, livelihood shifts, and heterogeneous access to health-promoting resources and services. Coastal populations can experience unique dietary patterns (e.g., frequent consumption of salted or preserved

seafood) and environmental or occupational exposures that may elevate cardiometabolic risk; however, these factors are not always measured directly in routine surveillance or facility-based studies and therefore require careful interpretation. Importantly, the global evidence base strongly supports dietary sodium reduction as a population strategy: the WHO recommends limiting sodium intake to <2 g/day (equivalent to <5 g/day of salt) to reduce blood pressure and cardiovascular risk (WHO, 2025b). In Indonesian coastal settings, prior empirical work has also linked patterns of saltwater fish consumption with hypertension outcomes, reinforcing the plausibility of context-specific dietary drivers while highlighting the need to measure and model these exposures explicitly when they are hypothesized as contributors (Soleha & Qomaruddin, 2020; WHO, 2025b).

Classic determinants frameworks (e.g., the Dahlgren–Whitehead model) conceptualize health as the product of layered influences, ranging from individual characteristics and behaviors to social networks, living and working conditions, and broader socioeconomic and policy environments (Dahlgren & Whitehead, 1991; Dahlgren & Whitehead, 2021). Complementarily, ecological models in health promotion argue that sustainable prevention requires multi-level intervention targets rather than relying solely on individual choice, because interpersonal norms, organizational settings, community resources, and public policy can enable—or constrain—risk reduction (McLeroy et al., 1988). For hypertension specifically, systematic review evidence indicates that social determinants (including education, economic conditions, neighborhood context, and access to care) are consistently associated with hypertension prevalence and control, thereby shaping both upstream risk and downstream outcomes (Metlock et al., 2024; WHO Commission on Social Determinants of Health, 2008).

Within this framework, education and marital status are treated as theoretically relevant social-position indicators rather than merely demographic descriptors. Education can influence hypertension risk through multiple pathways, including health literacy, employment opportunities, income stability, diet quality, stress exposure, and the capacity to navigate healthcare systems. Genetic epidemiology further supports a protective role of higher educational attainment on hypertension risk, consistent with the hypothesis that education-related resources and environments may causally shape cardiometabolic trajectories (Zhang et al., 2024). Marital status may capture dimensions of social support, household economic pooling, psychosocial stress, and health-related norms; population-based evidence indicates that marital disruption or non-married status can be associated with higher odds of hypertension, although the strength and direction of associations may vary across age groups and settings (Li et al., 2022; Son et al., 2022). These pathways are particularly salient in urban coastal contexts where migration, employment precarity, and uneven access to preventive services may intensify stress-related and behavioral mechanisms.

Despite the recognized importance of social determinants, the Indonesian hypertension literature has frequently emphasized biomedical and lifestyle correlates without consistently integrating a multi-level conceptual model—especially in urban coastal populations, where social and behavioral risks may intersect with distinctive local food environments and service access patterns. This gap limits the practical relevance of evidence for designing contextually appropriate primary-care and community interventions. Therefore, this study contributes by examining hypertension in an urban coastal Indonesian setting while explicitly situating socioeconomic indicators (e.g., education, marital status) alongside behavioral factors within a social-determinants and socio-ecological framing, thereby improving interpretability and policy relevance for place-based prevention and hypertension control.

Accordingly, the objectives of this study are to estimate the prevalence of hypertension and to identify factors associated with hypertension among adults in an urban coastal community in Manado, North Sulawesi. Consistent with the 2020 International Society of Hypertension guideline, hypertension is conceptualized as elevated office blood pressure (systolic ≥140 mmHg and/or diastolic ≥90 mmHg) and/or current antihypertensive treatment (Unger et al., 2020). Given the cross-sectional design, the analysis is framed in associative—not causal—terms. The study addresses the following research questions: (1) What is the prevalence of hypertension in the study population? (2) Which sociodemographic (including education and marital status) and behavioral factors are associated with hypertension after multivariable adjustment? Guided by prior literature, we hypothesize that older age, male sex, lower educational attainment, non-married status, and adverse behavioral profiles (e.g., smoking and low physical activity, if measured) will be associated with higher odds of hypertension in this urban coastal context.

METHOD

Study Design and Setting

This study employed a community-based cross-sectional design and was conducted in the urban coastal area of Manado City, North Sulawesi, Indonesia, in September 2024. Data collection was carried out at three coastal primary healthcare centers (Puskesmas): Bahu, Tuminting, and Bailang. These facilities serve as frontline community health service points in coastal catchment areas and were used as recruitment and measurement sites to capture adults residing in or accessing care within this urban coastal context.

Participants and Sampling

Participants were adults recruited at the three selected Puskesmas during the study period. A non-probability accidental (convenience) sampling approach was used in which eligible individuals who were present at the facilities and agreed to participate were enrolled. All participants provided informed consent prior to data collection.

Measures

Blood Pressure Measurement and Hypertension Definition

The outcome variable was hypertension status, determined from blood pressure assessments performed by trained health-center staff using routine office-based procedures. Blood pressure was measured with the participant seated after a resting period, using an appropriately sized cuff, with the arm supported at heart level. Two measurements were obtained with a short interval between readings, and the average value was used for classification in accordance with standard office measurement procedures recommended in international practice guidance (Unger et al., 2020). Hypertension was defined using the office threshold of systolic blood pressure

≥140 mmHg and/or diastolic blood pressure ≥90 mmHg (Unger et al., 2020).

Explanatory Variables and Operational Definitions

Independent variables were collected through structured interviews and were selected to reflect both non-modifiable and modifiable factors that are salient in urban coastal communities, including demographic position, household social context, and lifestyle-related exposures. Non-modifiable variables included age, sex, and family history of hypertension. Modifiable variables included marital status, education level, occupation, physical activity level, and smoking habits.

For analysis, covariates were coded as categorical variables with clearly defined reference categories. Age was categorized as <50 years versus ≥50 years. Sex was coded as female versus male. Family history of hypertension was coded as yes versus no. Marital status was coded as married versus not married (including never married, widowed, or divorced). Education level was categorized to reflect socioeconomic position and potential differences in health literacy, with lower education (elementary/junior high) contrasted against higher education (senior high/university). Occupation was coded into analytically stable groupings reflecting the coastal-urban livelihood mix, including categories such as not working/housewife versus employed (including fisher and other occupations) when cell counts were limited. Physical activity was categorized based on self-reported intensity (light versus moderate/heavy), consistent with the rationale that routine activity intensity may differ by coastal livelihood patterns and daily mobility (Bull et al., 2020). Smoking status was coded as current smoker versus non-smoker (U.S. Department of Health and Human Services, 2014).

Unmeasured Variables

Several variables relevant to hypertension risk in coastal settings were not assessed in the current study, including dietary sodium intake, anthropometric measures such as body mass index, psychosocial stress indicators, alcohol intake, and household water source characteristics. These factors were therefore not included in the multivariable models.

Statistical Analysis

Descriptive statistics were used to summarize participant characteristics and the prevalence of hypertension. Multivariable regression modeling was used to evaluate associations between hypertension status and explanatory variables while adjusting for other covariates in the model. Given the cross-sectional design and the prevalence-focused outcome, associations were expressed as adjusted prevalence ratios (aPR) with 95% confidence intervals. A generalized linear modeling approach with a log link and robust variance estimation was used to obtain PR estimates that are directly interpretable for cross-sectional prevalence outcomes (Barros & Hirakata, 2003; Zou, 2004). Statistical significance was assessed using two-sided tests with an alpha level of .05.

Model Diagnostics and Stability Checks

Multicollinearity among predictors was assessed using variance inflation factors (VIF). Model adequacy was evaluated through inspection of model convergence and examination of residual/deviance patterns consistent with generalized linear model practice. Model stability was considered in relation to the number of outcome events per estimated parameter to avoid overfitting in multivariable estimation (Peduzzi et al., 1996; Vittinghoff & McCulloch, 2007). Reporting was aligned with core observational reporting expectations for cross-sectional studies (von Elm et al., 2008).

Ethical Considerations

The study adhered to ethical principles for human-subject research, including informed consent, confidentiality, and anonymized data handling. Ethical approval was granted through the Ethical Feasibility Letter KEPK/01/108/125/2024 issued by the Department of Epidemiology, Faculty of Public Health, Sam Ratulangi University, Manado.

RESULTS OF STUDY

A total of 150 respondents were included in the analysis. Most participants were aged 50 years or older (63.3%, n = 95) and female (70.0%, n = 105). The vast majority were married (90.7%, n = 136), while 2.7% (n = 4) were not married and 6.6% (n = 10) were widowed/divorced. Regarding educational attainment, the largest proportion had completed senior high school (42.0%, n = 63), followed by junior high school (30.0%, n = 45) and elementary school (20.0%, n = 30); 8.0% (n = 12) reported university education. In terms of occupation, housewives constituted the largest group (59.3%, n = 89), followed by other occupations (20.7%, n = 31) and those not working (12.0%, n = 18). Nearly half of respondents reported light physical activity (47.3%, n = 71), 36.7% (n = 55) reported heavy physical activity, and 16.0% (n = 24) reported moderate activity. The proportion of respondents reporting a family history of hypertension (48.7%, n = 73) was similar to those without such a history (51.3%, n = 77). Overall, the prevalence of hypertension in this sample was high, with 70.0% (n = 105) classified as hypertensive (table 1).

Table 1. Distribution of Respondent Characteristics (N=150)

Characteristic	Category	n	%
Age	< 50 years	55	36.7
	≥ 50 years	95	63.3
Gender	Female	105	70.0
	Male	45	30.0
Marital Status	Married	136	90.7
	Not Married	4	2.7
	Widowed/Divorced	10	6.6
Education	No Schooling	0	0.0
	Elementary School (SD)	30	20.0
	Junior High (SMP)	45	30.0
	Senior High (SMA)	63	42.0
	University	12	8.0
Occupation	Not Working	18	12.0
	Housewife	89	59.3
	Civil Servant	2	1.3
	Self-employed	2	1.3
	Fisherman	4	2.7
	Farmer	4	2.7
	Others	31	20.7
Physical activity	Light	71	47.3
	Moderate	24	16.0
	Heavy	55	36.7
Family history	Has a Family History	73	48.7
	No Family History	77	51.3
Hipertension	Hypertensive	105	70.0
	Non-Hypertensive	45	30.0

Given the high prevalence of the outcome, associations between respondent characteristics and hypertension status were estimated using a generalized linear modeling approach to obtain prevalence ratios (PR), applying a log-link model (modified Poisson or log-binomial) with robust variance estimation. In multivariable analysis, family history of hypertension was significantly associated with hypertension status (PR = 4.746; p = .035), indicating that respondents reporting a family history had a higher prevalence of hypertension than those without a family history. Marital status was also significantly associated with hypertension (PR = 4.723; p = .046), as was educational level (PR = 3.831; p = .034). Behavioral factors showed strong associations: physical activity was significantly related to hypertension status (PR = 5.523; p = .025), and smoking was also significant (PR = 4.821; p = .047). In contrast, age (PR = 0.840; p = .781), gender (PR = 0.684; p = .731), and occupation (PR = 1.141; p = .860) were not significantly associated with hypertension in the adjusted model. The model demonstrated a Nagelkerke pseudo-R^2 of 0.234, suggesting a modest proportion of variance in hypertension status accounted for by the included predictors.

Table 2. Results of logistic regression analysis

Determinants of hypertension	Sig.	PR	Nagelkerke R Square
Age	0,781	0,840	
Gender	0,731	0,684	
Family History	0,035	4,746	
Marital status	0,046	4,723	
Education	0,034	3,831	0,234
Work	0,860	1,141	
Physical Activity	0,025	5,523	
Smoke	0,047	4,821	

DISCUSSION

In this urban coastal sample (N = 150), the prevalence of hypertension was high (70%), and the multivariable model identified family history of hypertension, marital status, education, physical activity, and smoking as factors associated with higher hypertension prevalence, while age and sex were not statistically significant in the adjusted model. Given the high outcome prevalence, estimating prevalence ratios (PRs) is more interpretable than odds ratios; therefore, a modified Poisson regression with robust variance (or log-binomial, where it converges) is the preferred analytic framing for cross-sectional binary outcomes with common events (Barros & Hirakata, 2003; Zou, 2004).

The 70% prevalence is notably higher than national estimates reported for Indonesian adults in Riskesdas 2018 (34.1%). (Kementerian Kesehatan Republik Indonesia, 2018). This difference is plausibly explained by the study's case-mix (a large proportion aged ≥50 years and predominantly female) and the recruitment context from primary care settings, where the probability of encountering individuals with elevated blood pressure is typically higher than in community-probability samples. More broadly, hypertension remains a leading contributor to cardiovascular morbidity in low- and middle-income countries, with persistent gaps in detection and long-term control (Schutte et al., 2021).

The association between family history and hypertension is biologically and epidemiologically plausible, reflecting both genetic susceptibility and shared household exposures (dietary patterns, physical activity norms, stress, and health-care utilization). Large observational studies consistently show that a positive family history is associated with higher hypertension risk across diverse settings. (Liu et al., 2015; Li et al., 2019; Kunnas et al., 2023). In practice, this finding supports a family-centered prevention lens: screening and counseling may be more efficient when targeted to households with known hypertension, particularly in primary care catchment areas.

The observed association between education and hypertension aligns with a substantial literature positioning educational attainment as a distal determinant shaping health literacy, occupational pathways, income stability, and access to preventive services. (Metlock et al., 2024). In Indonesia specifically, socio-demographic gradients—often including education—have been reported in population-based analyses of hypertension and related risk behaviors, reinforcing the salience of social stratification for cardiovascular risk. (Alfaqeeh et al., 2023).

Social support and shared health behaviors for married individuals, versus psychosocial stress, economic vulnerability, and disrupted routines among widowed/divorced groups. Recent evidence suggests that marital disruption is linked to higher cardiovascular risk, and some analyses also indicate sex-specific associations with hypertension outcomes. (Fan et al., 2025; Moradi et al., 2025). For this manuscript, it is important to keep the interpretation associative rather than causal, while still articulating theoretically grounded pathways consistent with a social determinants or socio-ecological framing.

Physical inactivity is a well-established risk factor for elevated blood pressure through effects on vascular function, autonomic tone, and body weight regulation; conversely, regular activity and structured exercise training reduce systolic/diastolic blood pressure in adults. (Hayes et al., 2022; Edwards et al., 2023). However, the study's physical activity categories should be interpreted carefully if cell sizes are small or if the reference category is not clearly defined in the model table; unstable estimates can occur when category distributions are uneven.

Smoking may increase blood pressure via sympathetic activation, endothelial dysfunction, oxidative stress, and adverse cardiometabolic clustering; contemporary reviews continue to support smoking (and secondhand exposure) as relevant to hypertension and cardiovascular risk profiles. (Higashi, 2023; Jareebi, 2024; Song et al., 2026). Because smoking often correlates with diet quality, alcohol use, stress, and socioeconomic position, residual confounding may partly explain the observed association in cross-sectional observational data, providing another reason to avoid causal language.

Urban coastal dynamics: plausible mechanisms, but clarify what was (and was not) measured. Coastal livelihoods and urban coastal food environments may plausibly influence hypertension risk through dietary sodium (e.g., salted/processed seafood), changing food supply chains, and occupational routines. Prior studies in Indonesian coastal populations explicitly discuss high salt intake—particularly from salted dried fish—as a potential driver of hypertension patterns. (Astutik et al., 2020). At the same time, the World Health Organization recommendation is <5 g salt/day (≈<2 g sodium/day) for adults, emphasizing sodium reduction as a cost-effective strategy to reduce blood pressure at the population level. (World Health Organization, 2020). Because sodium intake, BMI/central adiposity, psychosocial stress, alcohol use, and water-source characteristics are not clearly represented as measured covariates in the current results table, the Discussion should treat these as unmeasured contextual factors that may confound or modify observed associations, and propose them explicitly as priorities for subsequent studies (or as added variables if data exist but were not reported).

Implications for community-based interventions in coastal primary care. The multivariable pattern—social (education, marital status) plus behavioral (physical activity, smoking) plus familial risk—supports a combined strategy: (1) risk stratification and opportunistic screening in primary care and community outreach, (2) family-based counseling where a household history exists, and (3) contextual lifestyle interventions tailored to urban coastal norms (salt reduction messages relevant to seafood preservation practices; feasible activity options for older adults and homemakers; culturally appropriate cessation support). The WHO HEARTS technical package provides a pragmatic primary-care roadmap (team-based care, standardized protocols, monitoring systems) that can be adapted to local service delivery. (World Health Organization, 2020). Evidence from low- and middle-income countries also supports community-based hypertension strategies (including decentralized care and community linkage models) as effective complements to facility-based management. (Nyame et al., 2024).

Strengths and limitations.

This study contributes data from an understudied setting—urban coastal communities in Indonesia—and focuses on determinants that are actionable within primary care and community health promotion. Key limitations should be stated explicitly: the cross-sectional design precludes temporality; the modest sample size may produce imprecision (particularly for multi-category social variables); and incomplete measurement/reporting of key confounders (e.g., sodium intake and adiposity) may leave residual confounding. Finally, the regression table should ideally report adjusted PRs with 95% CIs, clearly specify reference categories, and include model diagnostics to help readers judge estimate stability and interpretability.

CONCLUSIONS AND RECOMMENDATION

In this cross-sectional study of adults from three urban coastal primary health centers in Manado (N = 150), the prevalence of hypertension was high (70.0%). In multivariable prevalence-ratio modeling (modified Poisson/log-binomial with robust variance), hypertension status was associated with family history of hypertension, marital status, education level, physical activity, and smoking, while age, sex, and occupation were not statistically significant in the adjusted model. These findings indicate that hypertension in this urban coastal context clusters with familial risk, social determinants, and modifiable behaviors rather than being explained solely by basic demographics.

Urban coastal primary care programs should prioritize systematic blood pressure screening and follow-up using standardized protocols, with risk stratification that explicitly includes family history. Community interventions should be tailored to coastal-urban realities by strengthening health literacy for lower education groups, integrating smoking cessation support, and promoting feasible physical activity options for older adults and homemakers. Given the likely role of coastal dietary patterns, counseling on salt reduction should be incorporated into routine community outreach and primary care messaging. Future studies should use probability sampling across urban coastal neighborhoods and include key unmeasured determinants (dietary sodium, BMI/waist circumference, psychosocial stress, alcohol use) to better explain risk patterns and improve generalizability.

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DECLARATION

Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was granted by the Health Research Ethics Committee (KEPK) with the reference number KEPK/01/108/125/2024. Informed consent was obtained from all individual participants included in the study prior to data collection.

Consent for publication

Not applicable. This manuscript does not contain any individual person's data (e.g., details, images, or videos) in a form that requires consent for publication.

Availability of data and materials

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

Conflicts of interest Statement

The authors declare that they have no competing interests.

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Artificial Intelligence-Assisted Technology

No artificial intelligence-assisted technology was used in the drafting of this manuscript.

Authors' contributions

Jeini Ester Nelwan. contributed to the conceptualization, study design, methodology, formal analysis, investigation, funding acquisition, project administration, and writing – original draft.

Oksfriani Jufri Sumampouw. contributed to the conceptualization, methodology, validation, resources, data curation, writing – review & editing, and supervision. All authors read and approved the final manuscript.

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