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Multidimensional Lifestyle Determinants of Hypertension in Indonesia: A Systematic Review with Implications for Population Level Prevention

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ABSTRACT

Introduction: Hypertension prevalence in Indonesia continues to increase, and unhealthy lifestyle factors such as high-salt diets, physical inactivity, and smoking are widely recognized as important modifiable risk factors. This study aims to examine the association between unhealthy lifestyle behaviors and hypertension in Indonesia.

Methods: A systematic review was carried out based on the PRISMA framework, aiming to identify, screen, and evaluate relevant studies published from 2015 to 2025. Articles were searched through the Scopus, PubMed, and ScienceDirect databases, focusing on studies examining the relationship between unhealthy lifestyles and hypertension in Indonesia

Results: Of the 19 studies analysed, most employed cross-sectional designs. High salt intake, smoking habits, and low physical activity were consistently associated with higher odds of hypertension. Several studies also indicated stronger associations among individuals with sedentary lifestyles. However, given the predominance of cross-sectional evidence, the findings primarily reflect associations rather than causal relationships.

Conclusion: Unhealthy lifestyle factors including high salt intake, low physical activity, smoking, alcohol consumption, stress, and poor sleep patterns are consistently associated with hypertension in Indonesia. These findings underscore the importance of population-level strategies promoting healthy dietary practices, increased physical activity, and behavioral risk reduction. However, given the predominance of cross-sectional evidence, further longitudinal and methodologically robust studies are needed to strengthen causal inference.

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INTRODUCTION

Hypertension remains a key risk factor for cardiovascular disease and is closely linked to premature mortality as well as preventable disability worldwide. Its impact continues to expand globally, with a more pronounced increase observed in low- and middle-income countries, largely influenced by population aging, urban growth, and changing lifestyle behaviors (1). The reported prevalence of hypertension varies widely, ranging from 13% to 41%, reflecting differences in underlying risk factors across populations (2). In the Indonesian context, prehypertension affects approximately 22.5% of young adults aged 20–30 years and rises to about 32.5% among individuals older than 40 years (3). National data further indicate a substantial increase in hypertension prevalence among individuals aged ≥18 years, from 25.8% in 2013 to 34.11% in 2018, with a higher proportion observed in women compared to men (4). At the global level, a systematic review involving 90 countries reported an overall prevalence of 31.1%, with slightly higher rates in low- and middle-income countries (31.5%) than in high-income countries (28.5%) (5).

Hypertension is widely recognized as a complex, multifactorial condition resulting from the interplay between genetic predisposition and environmental influences involved in its development. A range of factors have been consistently associated with its occurrence, including increasing age, overweight and obesity (BMI ≥ 25), diabetes mellitus (DM), physical inactivity, smoking habits, alcohol consumption, psychological stress, a positive family history, high intake of saturated fats and salt, as well as low consumption of fruits and vegetables (6–10). In the Southeast Asian region, hypertension affects approximately 33.82% of urban populations, with its prevalence influenced by factors such as sex, obesity, smoking behavior, and dyslipidemia (11). Evidence from India indicates a substantial rise in hypertension prevalence, largely associated with risk factors such as obesity, diabetes, and high salt intake. Despite this increase, levels of awareness and effective control remain relatively low (12). In the African context, although data on hypertension among children and adolescents are still limited, existing studies suggest a growing trend, potentially linked to sedentary behavior and excessive dietary salt consumption (13). These patterns highlight the need for early preventive efforts focusing on modifiable lifestyle factors, including healthier dietary practices, regular physical activity, and improved awareness of risk factors, particularly in the context of ongoing urbanization and its impact on daily living habits (14).

In addition to descriptive epidemiological findings, recent perspectives increasingly interpret cardiovascular risk using a socioecological approach. This perspective views hypertension as the result of interactions across multiple levels, ranging from individual behaviors to broader community and societal influences (15). Studies applying this approach have shown that factors at the individual, interpersonal, and community levels contribute to differences in hypertension awareness, control, and prevalence. These findings suggest that lifestyle behaviors are not formed in isolation, but are shaped by surrounding social and environmental conditions that may either support or hinder healthy choices (16).

Although previous studies have consistently identified risk factors such as obesity, unhealthy dietary patterns, and physical inactivity, evidence specific to Indonesia remains limited. Research examining these associations has been widely conducted in other settings; however, a comprehensive synthesis focusing on lifestyle-related determinants of hypertension in Indonesia is still lacking, particularly in the context of ongoing urban–rural transitions and rapid lifestyle changes. Therefore, this study aims to assess the relationship between unhealthy lifestyle factors—such as high salt intake, smoking behavior, and low levels of physical activity—and hypertension in Indonesia. This review is expected to provide a more context-specific understanding of existing evidence and to support the development of more targeted prevention strategies for the Indonesian population.

METHODS

This study adopted a systematic review design guided by the PRISMA framework. Although the review was not registered in a public database such as PROSPERO, key components of the protocol including eligibility criteria, search strategy, and analytical procedures were defined in advance of the data extraction process to reduce the risk of selective reporting.

Research Question Formulation

The research question in this study was developed using the PICO framework, which includes Population, Intervention, Comparison, and Outcome components. In this review, the population of interest was the Indonesian

population, with unhealthy lifestyle behaviors as the exposure and healthier lifestyle groups as the comparison. Hypertension was defined as the main outcome. Accordingly, this study addressed the following question: What is the relationship between unhealthy lifestyle behaviors such as poor diet, physical inactivity, smoking, and alcohol consumption and hypertension in Indonesia?

Search strategy

The search strategy focused on key concepts related to lifestyle risk factors, including dietary patterns, physical activity, smoking, and alcohol use. These terms were combined with keywords such as "hypertension" or "high blood pressure," along with the geographic identifier "Indonesia." Boolean operators (AND, OR), truncation symbols (*), and database-specific field restrictions (e.g., TITLE-ABS-KEY in Scopus) were applied where appropriate. The final database search was conducted on 17 August 2025. Eligible studies were limited to those published between January 2015 and August 2025. No study design filters were applied during the search phase. Language restrictions (English only) were applied at the screening stage due to feasibility constraints. We acknowledge that this may introduce potential language bias. The detailed database-specific search strategies are presented in **Supplementary Table 1**.

Study Inclusion and Exclusion Criteria

Inclusion Criteria: All observational studies, including those using correlational, cross-sectional, case-control, and cohort designs, published between 2015 and 2025. These studies must be published in indexed journals and have undergone peer review, both in Indonesia and abroad, in English, and be accessible in full text. These studies must be original published research that reports on hypertension outcomes (e.g., diagnosed hypertension status or prevalence) and demonstrates a quantitative association between hypertension and lifestyle risk factors using epidemiological effect measures.

Exclusion Criteria: This review excluded systematic reviews, books, conference proceedings, and non–peer-reviewed publications, including editorials, commentaries, opinion papers, and brief reports. These studies are ineligible because they do not report hypertension data and do not report lifestyle data.

Study Selection

Three authors will independently review articles retrieved from the search based on the eligibility criteria. Study selection was conducted in three stages: screening of titles, abstracts, and full texts. Any discrepancies between reviewers were resolved through discussion or by involving a third reviewer. Reasons for excluding studies were documented and reported.

Quality Assesment

The methodological quality of the included studies was evaluated using an adapted version of the Newcastle–Ottawa Scale. As the original tool is primarily designed for cohort and case–control studies, several adjustments were made to allow its application to cross-sectional designs, ensuring a more appropriate assessment of observational studies examining hypertension-related outcomes. For case–control studies, quality assessment covered three domains: selection, comparability, and exposure. A similar framework was applied to cross-sectional studies, with modifications to reflect study design characteristics. In this context, selection referred to sample representativeness and clarity of inclusion criteria, comparability addressed the control of confounding variables or use of multivariable analysis, and exposure focused on how consistently lifestyle-related variables were measured.

The total score ranged from 0 to 9 points. Studies were categorized as "Good" (≥7), "Fair" (4–6), or "Poor" (≤3). Only studies rated as "Fair" or "Good" were retained for the final synthesis in line with the predefined criteria. A detailed risk-of-bias summary, including domain-specific scores and overall ratings, is provided in Supplementary **Table 2**. Based on this evaluation, 12 studies were classified as "Good" and 7 as "Fair," while no studies fell into the "Poor" category, indicating that all included studies met the required methodological standards.

Data Extraction and Synthesis

Data extraction was carried out independently by the author using a standardized form, and the extracted information was organized in Microsoft Excel. The data collected included study characteristics such as author and year of publication, study location, design, variables examined, and key findings. The study selection process is illustrated in the PRISMA flow diagram (**Figure 1**).

Reported effect measures were standardized by presenting odds ratios (OR/AOR) with 95% confidence intervals whenever available. Adjusted estimates were clearly distinguished from crude estimates. Studies that reported correlation coefficients (e.g., Spearman's r) were presented separately and interpreted based on their direction and statistical significance. Given the variability in study designs, exposure definitions, and reported outcomes, a quantitative meta-analysis was not undertaken.

RESULTS

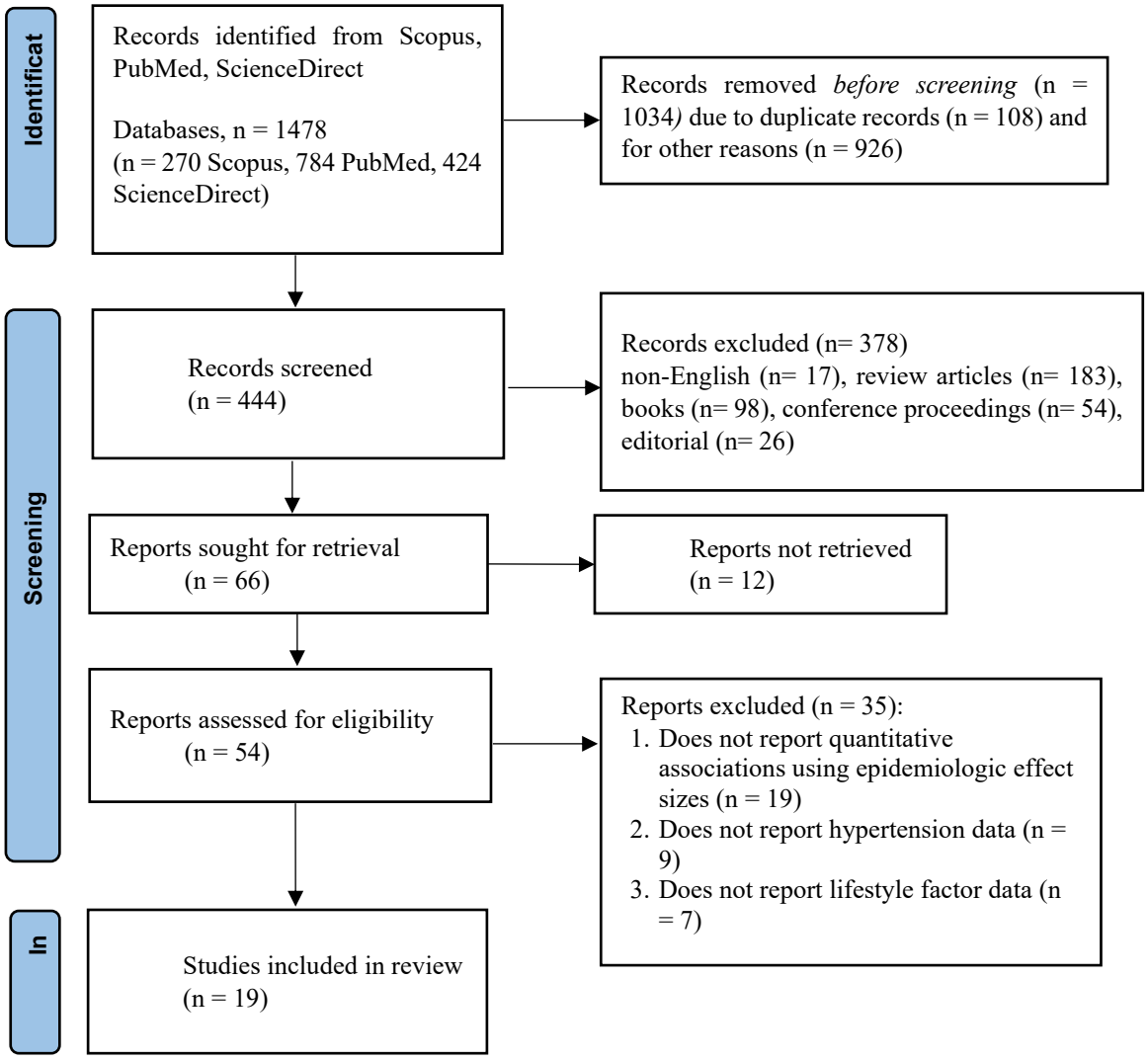

Figure 1: Systematic Review Flow

Table 1. Summary of reviewed articles

No	Author (Year)	Research Location	Desain Study	Sampel Size	Variables	Major Findings
1	Nurbaiti et al. (2024) (17)	Central Buton, Indonesia	Case control	152	Physical activity; Smoking; Stress State; Coffee Consumption; Alcohol Consumption; Sleep Pattern	Physical activity (OR 1.75; p=0.114, crude); Smoking (OR 3.39; p<0.001, crude); Stress (OR 1.79; p=0.074, crude); Coffee consumption (OR 1.26; p=0.497, crude); Alcohol consumption (OR 4.28; p=0.001, crude); Sleep pattern (OR 2.63; p=0.003, crude)
2	Rachmawati et al. (2024) (18)	Batu, Indonesia	Cross-sectional	265	Sex; Age; Physical Activity Level; Sleep Quality; Stress Level	Sex (OR 2.30; p=0.030, crude); Age (OR 0.58; p=0.018, crude); Physical activity level (OR 1.60; p=0.011, crude); Sleep quality (OR 2.55; p=0.032, crude); Stress level (OR 0.45; p=0.030, crude)
3	Martiningsih et al. (2021) (19)	Bima, Indonesia	Cross-sectional	108	Smoking Age Smoking Habit After Waking Up Daily Smoking	Smoking age (OR 2.12; p=0.028, crude); Smoking after waking up (OR 1.50; p<0.001, crude); Daily smoking (OR 0.70; p<0.001, crude)
4	Garwahusada & Wirjatmadi (2020) (20)	Provinsi Jawa Tengah, Indonesia	Case control	46	Sex; Smoking Habit; Physical Activity	Sex (OR 8.23; p=0.003, crude); Smoking habit (OR 8.08; p=0.019, crude); Physical activity (p=0.122, crude; not significant)

5	Karlen et al. (2023) (21)	West Java, Indonesia	Cross-sectional	46,186		Age; sex; salty food intake; sweetened beverage intake; smoking status; physical activity; BMI	Age (OR 1.06; p<0.001, crude); Gender (OR 0.93; p=0.082, crude); Salty food consumption (OR 1.16; p=0.045, crude); Sweetened beverage consumption (OR 0.79; p=0.003, crude); Smoking habits (OR 0.92; p=0.070, crude); Physical activity (OR 1.00; p<0.001, crude); BMI/obesity (OR 2.59; p<0.001, crude)
6	Bawazir & Sianipar (2018) (22)	West Jakarta, Indonesia	Case control		152	Physical activity; smoking; BMI	Physical activity (p=1.000, crude; not significant); Smoking status (p=0.285, crude; not significant); Body mass index/BMI (p=0.003, crude; significant)
7	Arwan Setyo Nugroho & Erniastutik (2020) (23)	Indonesia	Cross-sectional	5401		Age; Gender, Smoking Habit; Physical Activity; Obesity	Age (AOR 1.62; p<0.001, adjusted); Gender (AOR 1.75; p<0.001, adjusted); Smoking habit (AOR 1.98; p<0.001, adjusted); Physical activity (AOR 0.86; p<0.001, adjusted); Obesity (AOR 1.96; p<0.001, adjusted)
8	Ida Leida Maria et al. (2022) (24)	Sulawesi Selatan Indonesia	Cross-sectional	356		Age; education; family history; smoking; stress	Age (OR 6.50; p<0.001, crude); Education level (OR 3.10; p<0.001, crude);

						Family history of hypertension (OR 4.20; p<0.001, crude); Smoking behavior (OR 1.90; p<0.001, crude); Stress level (OR 6.50; p=0.004, crude)
9	Trini Sudiarti et al. (2019) (25)	West Java, Indonesia	Cross-sectional	152	Sex; Genetic; BMI; Physical Activity; Smoking; Stress	Sex (OR 6.50; p=0.036, crude); Genetic factors (OR 1.26; p=0.873, crude); Body mass index/BMI (OR 5.38; p=0.002, crude); Physical activity (OR 1.79; p=0.365, crude); Smoking (OR 8.73; p=0.022, crude); Stress (OR 0.63; p=0.450, crude)
10	Widia Rahmi Pratiwi et al. (2023) (26)	Garut, Indonesia	Case control	132	Smoking Habit; Physical Activity; Stress	Smoking habit (OR 5.15; p=0.014, crude); Physical activity (OR 0.45; p=0.046, crude); Stress (OR 3.10; p=0.005, crude)
11	Jasrida Yunita & Ratu Ayu Dewi Sartika (2021) (27)	Indonesia	Cross-sectional	1255	Obesity; Current Smoking; Physical Activity	Obesity (OR 2.64; p=0.001, crude); Current smoking (OR 0.57; p=0.001, crude); Physical activity (OR 1.29; p=0.038, crude)
12	Cindy Debora et al. (2023) (28)	North Minahasa, Indonesia	Cross-sectional	384	Family history; obesity; smoking; physical activity; alcohol consumption	Family history (OR 7.68; p=0.010, crude); Obesity (OR 4.08; p=0.030, crude); Smoking (OR 2.98; p=0.010, crude); Physical activity (OR 3.11; p=0.010, crude); Alcohol

						consumption (OR 2.82; p=0.010, crude)
13	Rafiah Maharani Pulungan, Helda Helda, M. Ikhsan Amar (2022) (29)	Indonesia	Cross-sectional	20,320,600	Age; Contraception; Residential Area; Education; Physical Activity; Smoking; Alcohol Consumption; Consumption of Risky Foods	Age (OR 1.88; p<0.001, crude); Contraception use (OR 1.00; p<0.001, crude); Residential area (OR 1.01; p=0.090, crude); Education (OR 1.47; p<0.001, crude); Physical activity (OR 0.98; p<0.001, crude); Smoking (OR 0.86; p<0.001, crude); Alcohol consumption (OR 0.87; p<0.001, crude); Risky food consumption (OR 1.12; p<0.001, crude)
14	Oliva Suyen Ningsih et al. (2022) (30)	East Nusa Tenggara, Indonesia	Cross-sectional	44	Sex; smoking; alcohol consumption; family history of hypertension; physical activity; high-salt diet	Gender (OR 0.34; p=0.118, crude); Smoking (OR 0.17; p=0.016, crude); Alcohol consumption (OR 4.00; p=0.042, crude); Family history of hypertension (OR 0.70; p=0.704, crude); Physical activity (OR 0.37; p=0.347, crude); High-salt diet (OR 0.63; p=0.543, crude)
15	Sutriyawan et al. (2022) (31)	Bandung, Indonesia	Cross-sectional	245	Age; sex; family history; smoking; obesity; physical activity; stress; salt intake; alcohol consumption	Age (OR 4.28; p<0.001, crude); Gender (OR 1.03; p<0.001, crude); Family history (OR 1.98; p=0.015, crude); Smoking (OR 1.40;

						p=0.264, crude); Obesity (OR 7.74; p<0.001, crude); Physical activity (OR 2.31; p=0.003, crude); Stress (OR 6.63; p<0.001, crude); Salt consumption (OR 2.12; p=0.007, crude); Alcohol consumption (OR 6.39; p<0.001, crude)
16	Hodimatum Mahiroh, Erni Astutik, Rochmad Ardiansyah Pratama (2019) (32)	Indonesia	Cross-sectional	26,472	BMI; physical activity; age; sex; education; marital status; smoking status	Body mass index/BMI (AOR 4.08; p<0.001, adjusted); Physical activity (AOR 1.05; p=0.349, adjusted); Age (AOR 6.15; p<0.001, adjusted); Sex (AOR 1.48; p<0.001, adjusted); Education (AOR 2.35; p<0.001, adjusted); Marital status (AOR 0.98; p<0.001, adjusted); Smoking status (AOR 0.87; p=0.070, adjusted)
17	Maharani et al. (2024) (33)	Bali, Indonesia	Cross-sectional	80	Physical Activity	Physical activity — Spearman r −0.48; p<0.001 (correlation)
18	Anwar et al. (2020) (34)	Aceh, Indonesia	Cross-sectional	483	Spirituality; Physical Activity; Sleep Duration	Spirituality (OR 0.94; p=0.007, crude); Physical activity (OR 0.55; p<0.001, crude); Sleep duration (OR

						0.59; p=0.006, crude)
19	Yolanda et al. (2024) (35)	Sumatera Barat, Indonesia	Case control	66	Sodium Intake; Potassium Intake; Physical Activity	Sodium intake (OR 5.46; p=0.003, crude); Potassium intake (OR 2.40; p=0.106, crude); Physical activity (OR 5.95; p=0.004, crude)

Table 1 summarizes key characteristics of the included studies, including study design, study location, and year of publication. In total, 19 studies involving 20,402,711 participants were included in the qualitative synthesis. Most studies were conducted in Java (36.84%), followed by Sulawesi (15.79%), Sumatra (10.53%), and nationwide analyses (21.05%). In terms of study design, cross-sectional approaches were more commonly used (73.68%), while the remaining studies applied a case–control design (26.32%). More than half of the included studies were published in 2022 or later (63.16%), with the rest published before 2022 (36.84%).

Although several studies were based on large national survey data, each article represented a distinct analytical sample, characterized by differences in exposure definitions and analytical approaches. No duplicate publications using identical datasets and analytical samples were identified, indicating that there was no overlap in study populations. As this review applied a narrative synthesis approach rather than a meta-analysis, the total sample size was reported for descriptive purposes only and was not used for pooled statistical estimation.

Table 2. Associations between lifestyle factors and hypertension

Lifestyle Domain	No. of Studies Examining Factor	Positive Association (↑ Hypertension)	Inverse Association (↓ Hypertension)	No Significant Association	Overall Interpretation
High salt / sodium intake	4	3	0	1	Strong positive association
Physical inactivity	13	6	4	3	Moderate association with heterogeneous direction
Smoking	12	6	2	4	Moderate positive association with inconsistencies
Alcohol consumption	7	5	1	1	Strong positive association
Obesity / BMI	8	8	0	0	Very strong and consistent association
Psychosocial stress	6	4	1	1	Moderate association
Sleep patterns / duration	4	3	1	0	Suggestive association
Family history	4	3	0	1	Strong association

Table 2 provides a domain-based overview of the associations identified across the included studies. Obesity emerged as the factor most consistently linked to hypertension, with relatively strong associations reported in nearly all studies. High salt intake and alcohol use also showed a consistent tendency toward increased hypertension risk. In contrast, the evidence for physical activity and smoking was less uniform. Some studies reported inverse or non-significant relationships, indicating variation in findings across different settings. Socio-demographic factors, including education, sex, and place of residence, also varied considerably between studies, suggesting the influence of contextual conditions and potential confounding. Overall, lifestyle-related factors were generally associated with

hypertension; however, both the strength and direction of these associations differed depending on study design, measurement approaches, and population characteristics.

Sample Size

The sample sizes of the included studies varied considerably. Several large-scale studies were identified, including one involving 20,320,600 participants in Indonesia examining hypertension prevalence (29), another with 26,472 participants focusing on lifestyle factors (32), and a study conducted in West Java with 46,186 participants addressing physical activity and lifestyle changes (21). In contrast, smaller studies were also represented, such as those conducted in Batu City (265 participants) (18), and Garut (132 participants) (26), with the smallest study involving 46 participants in Central Java (20). Overall, the included studies ranged from small, localized investigations to large population-based analyses.

Study Design

Of the 19 studies included, the majority applied a cross-sectional design (84%), primarily to describe the prevalence of hypertension in community settings, including studies conducted in Batu City and West Java (18,21). A smaller proportion of studies (16%) used a case–control approach, comparing individuals with hypertension to normotensive controls, as reported in studies from Buton and Central Java (17,20). Together, these study designs offer complementary perspectives, combining population level descriptions with analytical comparisons to better understand the role of lifestyle-related factors in hypertension across Indonesia.

The Influence of Lifestyle on Hypertension

The findings consistently indicate that lifestyle-related factors play a substantial role in the development of hypertension. Dietary patterns, particularly high salt and sodium intake, were frequently associated with increased hypertension risk across multiple studies (21,29,31,35). Although some variations were observed, the overall pattern suggests that excessive consumption of salty and processed foods contributes significantly to elevated blood pressure. In contrast, evidence regarding other dietary components, such as sweetened beverages, remains less consistent studies (21).

Physical activity also emerged as an important determinant of hypertension. Higher levels of physical activity were generally associated with a reduced risk, while insufficient activity tended to increase the likelihood of hypertension (18,20,22,35). However, some studies reported non-significant associations, indicating variability across populations and study designs.

Smoking behavior showed a generally positive association with hypertension risk. Most studies indicated that tobacco use contributes to increased blood pressure and a higher probability of developing hypertension, although some inconsistencies were observed (20–23).

Alcohol consumption was also identified as a contributing factor, with several studies reporting an increased risk of hypertension among individuals with higher alcohol intake (17,28,30,31). Nevertheless, the strength of this association was not uniform across all studies.

Psychological stress demonstrated a strong association with hypertension in several studies, suggesting its role as an important non-physical risk factor (24). However, some findings reported no significant relationship (17,25).

Sleep patterns were also found to influence hypertension risk. Poor sleep quality and inadequate duration were generally associated with increased risk, while longer or adequate sleep duration appeared protective (17,18,34).

DISCUSSION

Dietary patterns show a significant association with hypertension. Several studies show that consumption of foods high in salt is directly linked to an increased risk of hypertension. For example, excessive salt consumption has been found to increase blood pressure (21), on the other hand, consumption of sweetened beverages is associated with a reduced risk of hypertension, with results showing a positive association (29). Research conducted in Bandung also confirmed that excessive salt consumption increases the risk of hypertension (31), while potassium intake, despite playing a role in controlling blood pressure, does not have a significant effect on the hypertension (35). In

terms of healthy eating patterns, the Mediterranean diet or DASH diet, which is rich in vegetables, fruit, whole grains, nuts, olive oil, and moderate alcohol consumption, has been proven effective in lowering blood pressure (36). Conversely, diets high in processed foods, red meat, and sugary drinks, which are generally associated with unhealthy lifestyles, have a strong correlation with hypertension (37). Differences in dietary findings across studies may be related to variations in how exposure was measured, such as the use of 24-hour dietary recall compared with categorical frequency-based approaches. Regional differences in eating patterns and variations in age distribution across study populations may also have contributed to these inconsistencies. For instance, studies conducted in urban areas of Java may reflect higher consumption of processed foods than those carried out in rural settings, which could influence the magnitude of the reported associations. In addition, some studies did not fully account for factors such as total caloric intake, obesity, or socioeconomic status. This limitation suggests the presence of residual confounding, which may help explain the inconsistent findings observed.

Several studies reported a significant association between physical activity and hypertension. For example, findings from Batu City indicated a statistically meaningful relationship, although the direction of the association depended on how physical activity was categorized in the original study (18). Similar patterns were observed in studies from West Java, where the strength and direction of the association varied according to the measurement approach and classification of activity intensity (21). Other evidence suggests that individuals with low or irregular levels of physical activity tend to have higher odds of hypertension (23,35,36). However, the direction and magnitude of these associations were not always consistent across studies. This variation may reflect differences in how physical activity was measured, including the use of self-reported data and varying definitions of activity intensity. In addition, some studies relied on crude estimates without adjusting for potential confounders such as age, body mass index, or comorbid conditions, which may have influenced the observed results. Residual confounding and possible misclassification of physical activity levels could therefore contribute to the inconsistencies reported (38). Overall, these findings highlight the need for careful interpretation of physical activity measures when examining their relationship with hypertension.

Smoking is considered a modifiable risk factor for cardiovascular disease and has often been linked to hypertension. Evidence from Central Java indicates that smoking significantly increases the risk of hypertension (20). Similar findings have been reported in Indonesia, where smoking was associated with higher systolic and diastolic blood pressure among adult men (23,39). In addition, exposure to second-hand smoke has been shown to increase the risk of heart disease among workers with a history of hypertension (40). However, not all studies reported a significant association between smoking and hypertension (21,22). suggesting that the relationship may vary across different study populations. One possible explanation relates to differences in sex distribution, as smoking prevalence and intensity in Indonesia are substantially higher among men than women. Studies dominated by female participants may therefore underestimate the true effect due to lower exposure levels. Moreover, underreporting of smoking behavior particularly among women may lead to differential misclassification. In some cases, the lack of adjustment for factors such as obesity or alcohol consumption may also introduce residual confounding, which could contribute to the inconsistent findings observed.

Alcohol consumption has been consistently associated with hypertension in several studies. Evidence suggests that alcohol intake may increase the risk of developing hypertension, supporting its role as an important behavioral factor in its development (17,28). Similar findings have been reported in Indonesia, including studies conducted in West Nusa Tenggara and West Java, where alcohol consumption was linked to a higher risk of hypertension (30,31). However, research conducted on women in Indonesia reported a negative relationship between alcohol consumption and hypertension, albeit with a smaller effect (29). Nevertheless, the overall results of the study emphasise that alcohol consumption is a significant risk factor for hypertension, although variations in the strength of the association reported by various studies indicate differences based on gender and the population studied. This heterogeneity may be attributable to gender-specific drinking patterns, differences in frequency versus quantity measurement, and sociocultural underreporting. Furthermore, variation in analytic adjustment sets, particularly the inclusion or exclusion of BMI and smoking, may influence effect estimates. Such methodological differences should be considered when interpreting the direction and magnitude of alcohol-related associations.

Stress is also recognized as an important psychosocial factor associated with hypertension. Various studies show that high levels of stress are closely related to an increased risk of hypertension (24,26). These findings are

consistent with research in Nigeria, which shows that stress has a significant relationship with an increased risk of hypertension (41). This is also consistent with findings in Mexico, where psychosocial stress has been shown to worsen blood pressure and play a role in the development of hypertension (42). However, not all studies support these findings, with some studies reporting no significant association between stress and hypertension (17,25), indicating that other factors may also play a role in the occurrence of hypertension. Nevertheless, stress levels are still considered a factor that needs to be taken into account in efforts to prevent hypertension. Variations in stress measurement approaches, such as the use of validated psychological scales compared with single-item questions, may contribute to the inconsistent findings observed across studies. In addition, the cross-sectional nature of many studies limits the ability to determine causal relationships. Reverse causality may also be involved, as individuals with hypertension could report higher levels of perceived stress, making it difficult to clearly establish the direction of the association.

Sleep patterns are also associated with blood pressure regulation. Several studies have reported that poor sleep quality increases the risk of hypertension (17,18), with similar findings observed across different populations (18). In contrast, longer sleep duration has been linked to a lower risk of hypertension, although the strength of this association appears weaker than that observed for sleep quality. These findings suggest that both adequate sleep duration and good sleep quality are important in the prevention of hypertension, while insufficient or disturbed sleep may worsen the condition. However, the evidence is not entirely consistent. Differences in how sleep variables were measured such as self-reported duration versus standardized sleep quality indices may contribute to this variability. Age-related factors may also influence the observed associations, as sleep disturbances are more common among older adults and may modify the relationship between sleep and hypertension (34).

The findings of this review are generally in line with global evidence identifying modifiable lifestyle factors, particularly obesity and high sodium intake, as key contributors to hypertension. However, the inconsistent results observed for smoking and physical activity suggest that these relationships may be influenced by context-specific factors within Indonesia. This indicates that global patterns of cardiovascular risk may not always translate uniformly across rapidly developing settings. The variability across studies likely reflects differences in regional characteristics, population demographics, exposure measurement, and analytical approaches, as well as the potential for residual confounding. These factors should be carefully considered when interpreting findings derived from narrative synthesis.

This study has several limitations. First, only articles published in English and those with full-text access were included, which may introduce selection bias. Second, differences in study design, particularly between cross-sectional and case control studies, may affect the comparability of results. In addition, the overall quality of included studies, as assessed using the Newcastle Ottawa Scale, may influence the robustness of the conclusions. Therefore, the findings should be interpreted with caution. Further research using more rigorous study designs is needed to strengthen the evidence on lifestyle-related determinants of hypertension.

CONCLUSIONS

This review highlights the role of lifestyle-related factors—such as high salt intake, low levels of physical activity, smoking, alcohol consumption, stress, and poor sleep—in relation to hypertension in Indonesia. Although the strength of these associations varies across studies, the overall evidence points to the importance of modifiable behavioral factors in the prevention of hypertension. These findings underscore the need for population-level interventions that promote healthier dietary habits, increased physical activity, and the reduction of behavioral risk factors. However, given the predominance of cross-sectional evidence, further longitudinal and methodologically robust studies are required to strengthen causal inference.

AUTHOR CONTRIBUTION STATEMENT

Henny Kaseger: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing.

Gita Sandy Patonengan: Investigation, Data curation, Resources, Software, Writing – original draft.

Juritno Harmi Gaib: Project administration, Supervision, Validation, Writing – review & editing.

Siska Sibua: Visualization, Formal analysis, Writing – review & editing.

Widya Astuti: Funding acquisition, Supervision, Writing – review & editing.

Helkim Sarino Laode Manika: Conceptualization, Methodology, Resources, Writing – original draft.
Suci Rahayu Ningsih: Data curation, Investigation, Project administration.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest. They affirm that there are no financial or personal relationships with any organizations or entities that could influence the impartiality or objectivity of this research.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that no generative artificial intelligence (AI) tools or AI-assisted technologies, such as ChatGPT, Grammarly, or DeepL, were used in the writing or preparation of this manuscript. All work was completed manually by the authors to ensure academic integrity and originality.

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