

Review

# Hypertension, Sodium and Their Relationship among Adults or Middle-Aged Adults: A Scoping Review

Aisyah Desfiani Putri, Andi Putri Niswatu Syakirah, Almira Sitasari and Tri Siswati\*

Department of Nutrition, Politeknik Kesehatan Kementerian Kesehatan Yogyakarta 55293, Indonesia

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## \*Correspondence:

Tri Siswati  
Address: Poltekkes Kemenkes Yogyakarta, Jl  
Tata Bumi no 3, Banyuraden, Gamping,  
Sleman, Yogyakarta, 55293. Indonesia.  
Email: [tri.siswati@poltekkesjogja.ac.id](mailto:tri.siswati@poltekkesjogja.ac.id)

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## ABSTRACT

**Background:** Hypertension is expected to reach 60% by 2025, largely in low- and middle-income countries, with 46% unaware and 42% undiagnosed and untreated. Knowing the intricate association between salt and adult hypertension is vital for public health efforts. This scoping review explains how sodium affects blood pressure to prevent hypertension in adults and middle-aged people. **Methods:** Tricco and colleagues' approach was used to examine hypertension and salt in adults and middle-aged people. Assessment techniques, hypertension prevalence, and sodium-hypertension relationships were reviewed. A comprehensive PubMed and Google Scholar search of full-text academic journals spanning 2013-2023 found relevant studies. Two researchers extracted data separately and reached consensus for eligible trials. The search phrases were hypertension, salt, adult, middle-aged, and young adult. **Results:** There were 13 articles, found that nutritional intake evaluations, 24-hour urine collections, clinical and laboratory tests, physical measurements, blood pressure monitoring, and specific trials or interventions are assessment methods. Salt consumption and hypertension show different prevalence rates. **Conclusion:** These studies also describe the complex relationship between salt intake and hypertension in adults and middle-aged people. These studies effectively elucidate a complex correlation between salt consumption and hypertension among middle-aged and adult individuals, notwithstanding variations in measurement approaches and prevalence.

**Keywords:** Scoping; hypertension; sodium; mid-aged adult

## 1. INTRODUCTION

Hypertension, commonly known as high blood pressure, is a significant public health concern affecting a large proportion of the adult population worldwide.<sup>(1,2)</sup> Hypertension, also known as high or raised blood pressure occurs when the blood vessels have persistently raised pressure, with the force of blood pushing against the walls of blood vessels as it is pumped by the heart. The prevalence of hypertension in the general population was approximately 25% (or 1.28 billion people), and this number is expected to increase to 60% (or 1.56 billion people) by 2025, primarily in low- and middle-income countries.<sup>(2)</sup> Forty six percent are unaware of the condition, 42% lack diagnosis and treatment and only 21% have hypertension under control.<sup>(1)</sup> Based on Basic Health research in 2013 and 2018, there is a trend of increasing prevalence of hypertension in Indonesia. In 2013, the prevalence of hypertension was 25,8%,<sup>(3)</sup> while in 2018 it increased to 34,1%.<sup>(4)</sup> This increase occurred evenly across all age groups, various living settings, educational level and occupational backgrounds.<sup>(4)</sup> The reduction of the prevalence of hypertension by 33% between the years 2010 and 2030 is one of the global targets for noncommunicable diseases.

Hypertension is often asymptomatic, and many people may not be aware they have a problem. Symptoms can include early morning headaches, nosebleeds, irregular heart rhythms, vision changes, and buzzing in the ears. More severe forms may exhibit fatigue, nausea, vomiting, confusion, anxiety, chest pain, and muscle tremors. If left untreated, hypertension can cause persistent chest pain (also called angina), heart attacks, heart failure, and an irregular heartbeat, which can lead to a sudden death. Hypertension is a leading cause of early death and prevalent medical condition with far-reaching implications for global health.<sup>(1,2,5)</sup> In many cases, this illness is linked to an elevated risk of cardiovascular diseases, and other serious health complications.<sup>(6)</sup> Hypertension can also cause strokes by blocking or bursting arteries that supply blood and oxygen to the brain, as well as kidney damage, which can lead to kidney failure. High blood pressure causes damage to the heart by hardening arteries and decreasing the flood of blood and oxygen to the heart. However, there is a correlation between hypertension and a poor human development index.<sup>(5)</sup>

Reducing modifiable risk factors is the best way to prevent hypertension and associated diseases of the heart, brain, kidney, and other organs. These factors include unhealthy diets (excessive salt consumption, a diet high in saturated fat and trans fats, low intake of fruits and vegetables), physical inactivity, consumption of tobacco and alcohol, and being overweight or obese. Specifically, sodium is a key dietary factor that has been closely linked to the development and management of hypertension. World Health Organization recommends that adults should consume less than 5 grams of salt per day. Reduced salt intake 50 mmol per day also will decrease systolic blood pressure 4 mmHg and diastolic blood pressure 2.5 mmHg.

The complicated relationship that occurs between sodium, hypertension, and the health of adults has major consequences for the policies and interventions in public health sectors. It is important to have a full understanding of the relationship between hypertension and salt, as well as the influence that these factors have on adults or middle-aged adults, in order to establish public health policies and clinical practices. It is vital to conduct this scoping review in order to provide an explanation of the impact that sodium consumption has on blood pressure levels, which will contribute to the prevention of hypertension in adult and middle-aged adult populations

## 2. METHODS

This study was a scoping review to assess hypertension and sodium's relationship, applying Tricco and colleagues<sup>(7)</sup> methodological framework. The flow diagram depicts the process of articles from search to final selection, following the preferred reporting items for systematic reviews and meta-analyses extension for scoping review (PRISMA-ScR).

### 2.1. Identifying the Questions

The review questions were: (1) What are the assessment tools used to measure hypertension and sodium in adults and middle-aged adults? (2) What is the prevalence of hypertension in adults and middle-aged adults? (3) What is the relation between hypertension and sodium among adults and middle-aged adults?

### 2.2. Identifying Relevant Studies

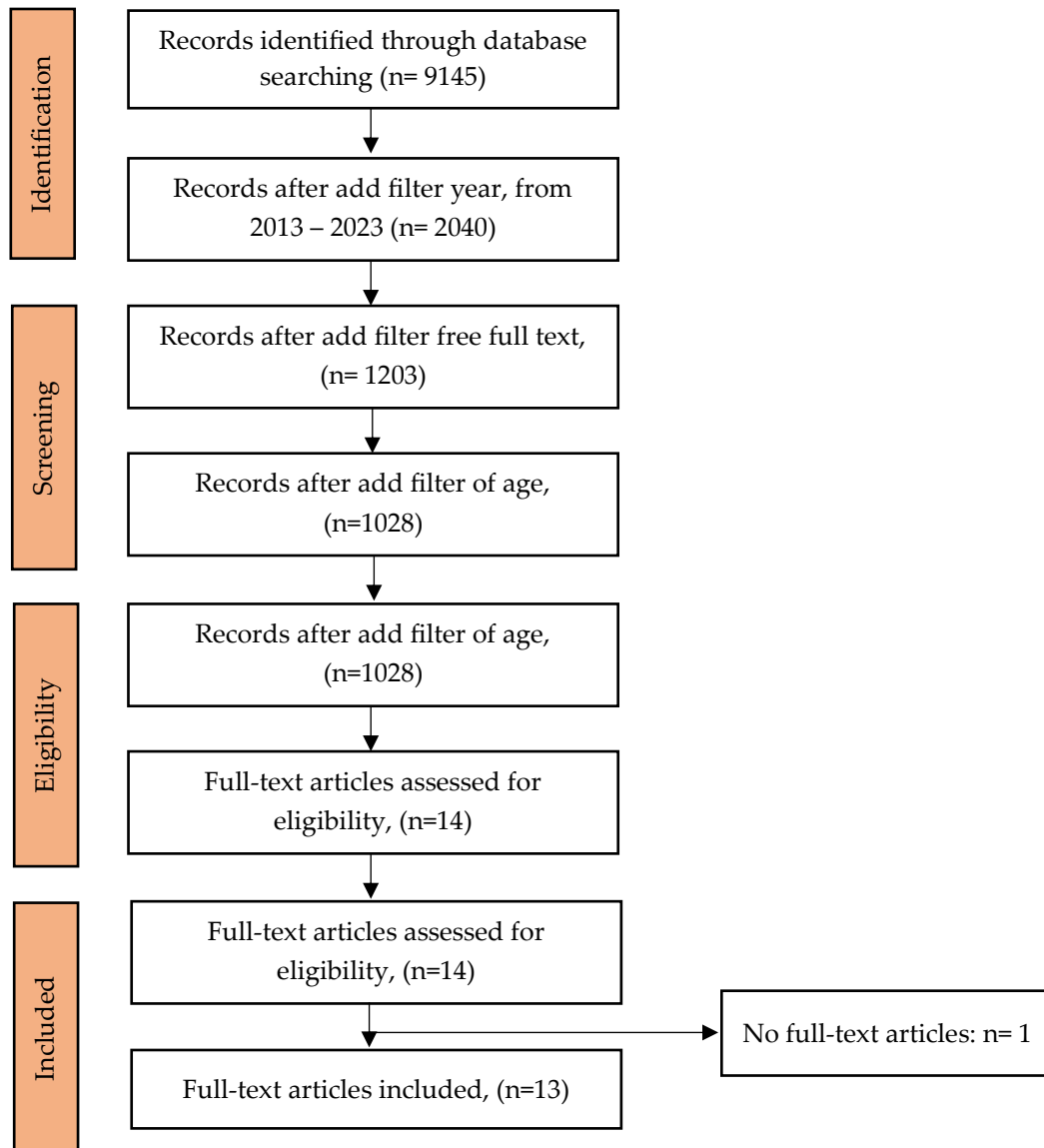
We used PubMed and Google Scholar as an electronic database. A comprehensive search was conducted on the full-text accessibility academic journals using English language which published from 2013 to 2023. All types of study designs were included in the search, either an observational study and randomized study among adults and middle-aged adults.

During the selection of studies, two researchers independently performed the data extraction process, and consensus was obtained for all eligible studies. All retrieved articles' reference lists were hand-searched for further eligible studies. The titles of the studies were screened first, followed by the abstracts. The key terms used for searching articles are listed in Table 1.

**Table 1.** Key search terms in scoping review

Key Search Terms
hypertension AND sodium
hypertension AND sodium AND adult
hypertension AND sodium AND adult OR middle-aged OR young adult

Disagreements that emerged throughout the process of selecting studies were deliberated and assessed by the researchers. The Flow chart of scoping review depicted in Figure 1.



**Figure 1.** Flowchart of scoping review

### 2.3. Study Selection

Two reviewers conducted the review in two stages. In the first stage, the literature was screened by title and abstract according to the inclusion and exclusion criteria (Table 2). In the second phase, articles that passed phase one will be reviewed.

The reviewed studies were selected with the information about:

(1) What assessment tools are used to measure hypertension and sodium in adults and middle-aged adults?

(2) What is the prevalence of hypertension in adults and middle-aged adults?

(3) What is the relation between hypertension and sodium among adults and middle-aged adults?

**Table 2.** Inclusion and exclusion criteria form

Criteria	Review Result
<b>Inclusion</b>	
Observational or randomized study	<input type="checkbox"/> Yes <input type="checkbox"/> No
Using the assessment tool to measure hypertension	<input type="checkbox"/> Yes <input type="checkbox"/> No
Using the assessment tool to measure sodium intake	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>Exclusion</b>	
Subject only in < 13 years old or >60 years old-population	<input type="checkbox"/> Yes <input type="checkbox"/> No

## 2.4. Charting the Data

An electronic search utilizing PubMed and Google Scholar was conducted by accessing electronic databases. The articles were subsequently filtered to remove duplicates. The remaining full articles were evaluated for eligibility, using inclusion criteria: (1) observational and randomized study; (2) published between 2013 - 2023; (3) included the term "hypertension" or a similar term (for example sodium) when describing the index in the abstract, introduction, or methods section of the manuscript; (4) adults and middle-aged adults aged 13 - 60 years; (5) free full-text; and (6) using English language. Studies were excluded if they (1) were not peer-reviewed, had review, commentary, editorial, or conference proceedings. After removing the full-text article that did not meet the criteria, the remaining data were included in this scoping review. The studies were qualitatively summarized. Title, country, citation (author, year), study design, participants characteristics, and results are summarized.

## 3. RESULTS

### 3.1. Assessment Tools Used to Measure Hypertension and Sodium in Adults and Middle-Aged Adults

These assessment tools include various methods such as dietary intake assessments, 24-hour urine collections, clinical and laboratory examinations. In addition, several studies also included physical measurements, blood pressure monitoring, and specific trials or interventions. Each study employs different tools based on its design and objectives.

Dietary intake assessment particularly sodium intake was assessed at both individual levels (24 hours recall in three days) and all available food such as condiments at the household was assessed using food weighing. Twenty-four-hour urine collections were also used to measure serum Na<sup>+</sup> and urinary excretion that is associated to hypertension.

### 3.2. Prevalence of Hypertension in Adults and Middle-Aged Adults

In a series of studies examining hypertension and sodium intake, notable variations exist in the reporting of hypertension prevalence rates. The first investigation in China by Carolina B. and colleagues in 2013<sup>(8)</sup> did not explicitly state the prevalence of hypertension but underscored a noteworthy correlation: the group with

the highest sodium intake exhibited the lowest probability of hypertension-free survival. In summary, although these studies contribute valuable insights into hypertension, explicit prevalence rates were not consistently reported across the diverse research endeavors.

### 3.3. Relation Between Hypertension and Sodium Among Adults and Middle-Aged Adults

The collective findings from the reviewed studies unveil a nuanced understanding of the intricate relationship between hypertension and sodium levels in adults and middle-aged individuals. These studies collectively contribute to a comprehensive understanding of the complex relationship between hypertension and sodium intake among adults and middle-aged individuals, emphasizing the multifaceted nature of this association (Table 2).

## 4. DISCUSSION

This study showed that sodium intake is closely related to hypertension and excessive sodium consumption can increase the risk of developing high blood pressure. This is because high sodium intake can lead to water retention, an increase in systemic peripheral resistance, endothelial dysfunction changes in the structure and function of large elastic arteries, and alterations in the automatic neuronal modulation of the cardiovascular system. The mechanism behind this relationship include the pressure-natriuresis mechanism, where an increase in blood pressure in the renal vessels leads to an increase sodium excretion and the non-osmotic storage of sodium, where sodium may be stored in the body without water retention.<sup>(21)</sup> High sodium intake also cause endothelial dysfunction, which reduces the endothelial nitric oxide and leading to elevated blood pressure and various cardiovascular complication.<sup>(22)</sup>

Moreover, urine excretion is also closely related to sodium intake and hypertension, identical to the results of this study. Excessive sodium intake can lead to an increase blood pressure, as a result increased urine sodium excretion. The mechanism of pressure natriuresis suggests that an increase in blood pressure in the renal arteries causes an increase in sodium excretion.<sup>(20)</sup> Additionally, high sodium intake may result to water retention, which can increase blood pressure and alter vascular resistances.<sup>(20,23)</sup> Studies have

**Table 2.** Selected articles demonstrating hypertension, sodium and their relationship among adults or middle-aged adults

Country; authors	Study design	Sample size	Participants characteristics	Assessment tool	Results
China; Carolina <i>et al.</i> , 2013 <sup>(8)</sup>	Randomized trials	6578	18-65 years old	Dietary intake	The highest sodium intake group had the lowest hypertension-free survival probability and a positive dose-response association with incident hypertension throughout the follow-up.
US; Nancy <i>et al.</i> , 2013 <sup>(9)</sup>	Randomized trials	3011	30-54 years old	24-hour urine collections	A direct linear relationship between average sodium intake and mean of death, with a 15% lower risk in intervention group
Switzerland; Nicolas <i>et al.</i> , 2017 <sup>(10)</sup>	Cross sectional	277	Men and women aged 15–29, 30–44, 45–59 and ≥60 years	Dietary salt intake, Body mass index (BMI)	A positive association between urinary Na <sup>+</sup> excretion, systolic blood pressure and hypertension, with hypertensive individuals having a higher 24-hour urinary Na <sup>+</sup> /K <sup>+</sup> ratio.
China; Xiaofu <i>et al.</i> , 2020 <sup>(11)</sup>	Observational study	7512	40 - 75 years old	Clinical and laboratory	An essential hypertension due to various factors, including arteritis, cancer, bone metabolism diseases, previous glucocorticoids or calcitonin use, or drugs affecting calcium or vitamin D status.
China; Zhang <i>et al.</i> , 2014 <sup>(12)</sup>	Randomized trial	9600	Adults aged from 18 to 69 years old	Physical measurement and laboratory tests	Jiangsu residents have a 33.0% hypertension prevalence, with 31.4% aware of their condition. 88.4% take anti-hypertension medications, with 23.7% controlling their blood pressure. The mean sodium excretion is 188.2 mmol.
China; Xi Nan <i>et al.</i> , 2021 <sup>(13)</sup>	Cross sectional	820	55–65 years old	Weighing method and 24-h recall	63.80% of subject suffer from hypertension, with excessive sodium and alcohol consumption being linked to higher risk.
US; Zefeng <i>et al.</i> , 2013 <sup>(14)</sup>	Randomized controlled trials	10563	Age groups: 20–29, 30–39, 40–49, 50–59, 60– 69 and 70 years	Blood pressure	Sodium, potassium, and sodium-to-potassium ratio intake significantly affects systolic blood pressure, with increased intake leading to a 1.04 mmHg increase and decreased intake leading to a 1.24 mmHg decrease.
Colorado; Shailendra <i>et al.</i> , 2014 <sup>(15)</sup>	Cross-sectional	6985	18 years and older with no prior history of hypertension	SBP and DBP	After adjustment for age, sex, race, body mass index, diabetes, and estimated glomerular filtration rate, there was association between higher quartiles of sodium or potassium intake with the risk of a BP >140/90 mm Hg or >130/80 mm Hg.
China; Zhang <i>et al.</i> , 2015 <sup>(16)</sup>	Cross-sectional	2122	18-69 years old	24-h urine sodium excretion level	70% of subjects reported high 24-hour sodium excretion, despite low or moderate sodium intake, suggesting that many low-intensity individuals actually had high urine sodium excretion.

Table 2 (continued)

Country; authors	Study design	Sample size	Participants characteristics	Assessment tool	Results
China; Shufa et al., 2014 <sup>(17)</sup>	Cohort study	16,869	Adults aged 20–60	24-h dietary recalls and condiment and food weights	High sodium intake, low potassium intake, and high Na/K ratio have strong dose-response associations with incident hypertension, according to recent measurements.
Beijing; Jianwei et al., 2017 <sup>(18)</sup>	Cross-sectional	2281	Aged 18-69 years old	24-h urinary sample	The average usual intakes of sodium and potassium, and the mean sodium-potassium ratio, were 166.9 mmol/day, 25.3 mmol/day, and 6.8, respectively.
Boston; Stephen et al., 2019 <sup>(19)</sup>	Crossover design (cohort study)	412	Aged 22 years and older	DASH-Sodium trial	Higher sodium levels slightly increased mean of body weight in control group, but not DASH group. Energy intake remained constant, but increased thirst and urine volume suggested higher fluid intake.
Shanghai; Jong et al., 2020 <sup>(20)</sup>	cross-sectional design	16936	Aged 20 years or older	Kawasaki method for determining 24-hour urine sodium excretion.	The study found that individuals with elevated triglycerides serum (TGs) had a higher risk of hypertension due to increased sodium intake.

shown that approximately 93% of dietary sodium is excreted in urine, with males excreting more than female but not significantly different, that are 97.4% and 93.2% of ingested sodium in urine respectively.<sup>(21)</sup>

In addition, the research discovered that a greater reduction in the amount of salt consumed was linked to a greater decrease in the systolic blood pressure,<sup>(24)</sup> so that reducing cardiovascular morbidity and mortality.<sup>(25)</sup> This is because excessive sodium consumption can increase blood pressure, which is a risk factor for cardiovascular diseases such as heart attack and stroke. High blood pressure is a major contributor to cardiovascular morbidity and mortality, accounting for approximately 32% of all global deaths.<sup>(26)</sup> A reduction in dietary sodium intake can decrease blood pressure and the incidence of hypertension in both hypertensive and normotensive individuals, regardless of sex and ethnic group. This reduction in blood pressure is associated with a decrease in cardiovascular morbidity and mortality. The mechanism behind this is that high sodium intake can lead to water retention, increased systemic peripheral resistance, and alterations in endothelial function, which can contribute to arterial stiffness and changes in large elastic arteries.<sup>(21)</sup> A meta-analysis showed that a

modest reduction in salt intake for four or more weeks causes a significant fall in blood pressure irrespective of sex and ethnic group, with larger reductions in salt intake linked to larger falls in systolic blood pressure.<sup>(21)</sup> However, current health policies have not been successful in effectively reducing dietary sodium intake due to poor dietary compliance.<sup>(24)</sup> In summary, reducing sodium intake can lead to a decrease in blood pressure, which is a risk factor for cardiovascular diseases. This reduction in blood pressure is associated with a decrease in cardiovascular morbidity and mortality.<sup>(1,21,27)</sup>

In addition, the Dietary Approaches to Stop Hypertension (DASH) diet, which focuses on reducing sodium intake. Dietary pattern DASH diet also concentrate in boosting potassium, magnesium, and calcium intake, and increasing intake of fruits, vegetables, and whole grains. Due of this reason, the Dash diet has been linked with avoiding hypertension, fewer cardiac events, reduced risk of stroke, type 2 diabetes mellitus, and obesity.<sup>(28)</sup> Hypertension itself, is a risk factor for a variety of other diseases such as damage blood vessels, leading to atherosclerosis, heart attacks, strokes, and peripheral artery disease.<sup>(29)</sup> Hypertension is also caused kidney disease including

chronic kidney disease, kidney failure, and the need for dialysis or kidney transplant.<sup>(30)</sup> Hypertension also causes eye disease such as retinopathy,<sup>(31)</sup> brain diseases such as dementia, cognitive decline, and stroke,<sup>(32)</sup> and respiratory diseases including pulmonary oedema, shortness of breath and difficulty breathing<sup>(33)</sup> In addition, hypertension resulted sexual dysfunction, including erectile dysfunction in men and decreased sexual desire in women.<sup>(34)</sup> Among pregnancy, hypertension during pregnancy can lead to complications such as preeclampsia, which can be life-threatening for both the mother and the baby.<sup>(35,36)</sup>

This research also revealed that pharmaceuticals exhibit a favourable response in the treatment of hypertension. These medications as an antihypertensive medications function in multiple methods, for instance by blocking the effects of hormones and chemicals that cause blood vessels to constrict, increasing blood volume, or reducing the effects of hormones that cause blood vessels to relax. So that it helps to reduce blood pressure and improve overall cardiovascular health. By lowering blood pressure in a variety of different methods, these drugs are effective namely; 1)ACE inhibitors for blocking this conversion, blood vessels can relax, reducing blood pressure, 2)Beta-blockers which blocking adrenaline, blood vessels can relax, reducing blood pressure, 3) Calcium channel blockers which block the entry of calcium ions into the smooth muscle cells of blood vessels, causing them to relax and widen, 4) Diuretics which increase the excretion of sodium and water by the kidneys, reducing blood volume and lowering blood pressure, 5) Alpha-blockers which blocking norepinephrine, blood vessels can relax, reducing blood pressure, 6) Angiotensin II receptor blockers (ARBs) that blocking angiotensin II, blood vessels can relax, reducing blood pressure, 7) Mineralocorticoid receptor antagonists (MRAs) which blocking aldosterone, blood vessels can relax, reducing blood pressure.

## 5. CONCLUSION

The scoping review of studies investigating the relationship between hypertension and sodium levels among adults and middle-aged individuals revealed a diverse array of assessment tools employed across the studies. These studies collectively contribute to a comprehensive understanding of the complex and multifaceted relationship between hypertension and

sodium intake in adults and middle-aged individuals, with variations in assessment tools and prevalence reporting across the studies. Further study regarded low-sodium diet for improving hypertension among adults and middle-aged adults should be provided to tested levels of sodium needed for achieving goals.

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This research received no fund.

## Conflict of Interest

The authors declare no conflict of interest.

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