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CORRELATION BETWEEN DAILY SODIUM INTAKE AND SYSTOLIC BLOOD PRESSURE IN ELDERLY PATIENTS WITH ESSENTIAL HYPERTENSION

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Abstract

Hypertension remains a major global public health problem, particularly among the elderly. This study aims to analyze the correlation between daily sodium intake and systolic blood pressure in older adults with essential hypertension. A cross-sectional study was conducted on 127 elderly respondents using a validated Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) to assess daily sodium intake and a calibrated Omron HEM-7121 digital sphygmomanometer to measure systolic blood pressure. Data were analyzed using Spearman's rank correlation test. The results showed a significant positive correlation between daily sodium intake and systolic blood pressure ($r = 0.423$; $p < 0.001$). Respondents who consumed more than 4000 mg of sodium per day tended to have systolic blood pressure above 160 mmHg. This finding suggests that excessive sodium intake contributes significantly to elevated systolic pressure in elderly individuals with essential hypertension. The study highlights the urgent need for sodium reduction interventions tailored to the elderly population as part of community-based hypertension control programs.

Keywords: Elderly, Sodium Intake, Systolic Blood Pressure, Hypertension

INTRODUCTION

Hypertension is one of the leading risk factors for death due to non-communicable diseases (NCDs) globally. According to the latest data from the World Health Organization (WHO), approximately 1.28 billion adults worldwide suffer from hypertension, with nearly two-thirds living in developing countries (WHO, 2021). The elderly population represents the highest prevalence group, primarily due to age-related vascular changes that decrease elasticity and increase blood pressure, especially systolic pressure (Mills et al., 2020). Population-based studies have shown that over 60% of older adults in various countries experience isolated systolic hypertension, which often goes undetected or is not managed optimally (Carey et al., 2018).

Sodium intake is a critical determinant in blood pressure regulation. Excessive sodium consumption, particularly from table salt and processed foods, has been shown to significantly raise blood pressure, especially among the elderly (He et al., 2020). In its revised guidelines, WHO recommends limiting sodium intake to less than 2000 mg/day or less than 5 grams of salt per day to reduce the risk of hypertension and cardiovascular complications (WHO, 2021).

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However, the average sodium intake in many Asian countries still exceeds this recommendation. A study by Huang et al. (2021) found that most East Asian populations consume more than 4000 mg/day of sodium, which is significantly associated with increased systolic blood pressure.

A recent meta-analysis by Graudal et al. (2023) reported that reducing sodium intake by 1 gram per day is associated with a 2.5 mmHg reduction in systolic blood pressure, with a more pronounced effect observed in elderly individuals with hypertension. Similarly, a study by Jarrar et al. (2020) in Saudi Arabia found a positive correlation between sodium intake and increased blood pressure among the elderly. Research by Zuo et al. (2021) in China also confirmed that a low-sodium diet intervention effectively reduced blood pressure in hypertensive older adults within six weeks.

Similar conditions are observed in Indonesia. The 2018 National Basic Health Survey (Riskesdas) reported a national hypertension prevalence of 34.1%, with the highest rates among the elderly. The latest data from the East Java Provincial Health Office in 2022 showed that over 60% of elderly individuals had elevated blood pressure, and 78% of them frequently consumed high-sodium foods (Kemenkes RI, 2022). Salty foods such as salted fish, crackers, and flavor enhancers are the primary sodium sources among elderly Indonesians (Yuliani et al., 2021).

Although the relationship between sodium intake and hypertension has been widely studied, research specifically analyzing the quantitative correlation between daily sodium intake and systolic blood pressure in elderly individuals with essential hypertension in Indonesia remains limited. A study by Sari et al. (2020) did report an association between salt consumption and blood pressure, but it included all age groups and was not specific to the elderly. Meanwhile, a study by Hasanah and Lestari (2021) only assessed the elderly's knowledge about salt without measuring actual intake or blood pressure.

Therefore, this study is highly relevant in providing locally applicable, measurement-based data. The novelty of this research lies in its specific focus on the elderly hypertensive population and its quantitative approach linking estimated daily sodium intake with systolic blood pressure based on primary data. The objective of this study is to analyze the correlation between daily sodium intake and systolic blood pressure among elderly individuals with essential hypertension as a basis for developing preventive and promotive nutritional interventions at the community level.

IMPLEMENTATION METHOD

The instrument used to measure daily sodium intake was a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), which was adapted to the Indonesian Food Composition Table and validated by community nutrition experts. The completed questionnaires were processed to calculate the estimated daily sodium intake based on the sodium content of each type of food consumed. Systolic blood pressure data were obtained through direct measurement using a calibrated Omron HEM-7121 digital sphygmomanometer, following standard blood pressure measurement procedures performed by trained health personnel. Each respondent’s blood pressure was measured in a seated position after five minutes of rest, and two measurements were taken

with a five-minute interval; the average of the two readings was used.

Data collection was conducted through structured interviews using the questionnaire and direct blood pressure measurements at the research site. Content validity of the questionnaire was assessed through expert judgment by two nutritionists and one public health practitioner. To ensure reliability, the instrument was pre-tested on 10 elderly individuals with similar characteristics outside the study area. Data analysis consisted of univariate analysis to describe respondent characteristics and bivariate analysis to assess the correlation between sodium intake and systolic blood pressure using the Spearman correlation test, as the data were not normally distributed according to the Shapiro-Wilk test. All data analyses were conducted using SPSS version 26.0, with a significance level (α) of 0.05. This study received ethical approval from the Health Research Ethics Committee of the Faculty of Public Health, University X, and was conducted in accordance with research ethics principles, including informed consent, data confidentiality, and the participants' right to withdraw at any time without penalty.

RESULTS AND DISCUSSION

This study involved 127 elderly respondents diagnosed with essential hypertension. The demographic characteristics, daily sodium intake levels, and systolic blood pressure categories are presented in the following tables:

Table 1. Distribution of Respondents Based on Daily Sodium Intake

Sodium Intake Category	Frequency (n)	Percentage (%)
<2000 mg/day	31	24.4%
2000–4000 mg/day	52	40.9%
>4000 mg/day	44	34.7%

Source: Primary Data, 2025

The distribution of sodium intake among the elderly in this study reveals concerning patterns from both clinical nutrition and public health perspectives. A significant portion of respondents (40.9%) consumed sodium in the moderate category (2000–4000 mg/day), which still exceeds the WHO's recommended safe limit of <2000 mg/day (WHO, 2021), though not yet classified as high. Intake within this range poses a risk of gradual blood pressure elevation, especially when combined with other risk factors such as low potassium intake, obesity, or physical inactivity.

Furthermore, 34.7% of respondents consumed more than 4000 mg of sodium per day, categorized as high and potentially harmful. Sodium intake at this level has been consistently linked to increased risks of severe hypertension, stroke, and ischemic heart disease, particularly among older adults with declining renal function and vascular sensitivity (Graudal et al., 2023; Mills et al., 2020). Clinically, this group should be a priority target for education and salt reduction interventions due to their heightened cardiovascular risk.

Conversely, only 24.4% of the elderly consumed sodium at levels compliant with WHO

recommendations (<2000 mg/day). This group demonstrates good dietary adherence and potentially better blood pressure control. However, the proportion remains low, indicating a gap in understanding or applying low-sodium dietary practices among the elderly. Possible contributing factors include low nutrition literacy, habitual use of excessive salt in cooking, and unawareness of sodium content in processed foods such as crackers, soy sauce, instant noodles, and packaged snacks (He et al., 2020; Hasanah & Lestari, 2021).

This phenomenon suggests that while some elderly individuals may be aware of the importance of reducing salt intake, actual implementation remains suboptimal. Targeted, community-based educational strategies are needed, emphasizing simple practices such as using measuring spoons for salt, reading sodium labels on packaging, and promoting low-sodium yet culturally acceptable recipe alternatives.

From a public health policy perspective, this data provides strong evidence that the majority of older adults are at risk due to non-compliant sodium consumption. It underscores the need for a holistic intervention approach, including education, regulation of processed foods, promotion of culturally adapted DASH diets, and active involvement of healthcare workers in routine nutritional monitoring for the elderly. These efforts are crucial in supporting the Sustainable Development Goals (SDGs) in reducing the burden of non-communicable diseases such as hypertension.

Table 2. Distribution of Respondents Based on Systolic Blood Pressure

Systolic Pressure Category (mmHg)	Frequency (n)	Percentage (%)
140–159 (Grade 1 Hypertension)	54	42.5%
160–179 (Grade 2 Hypertension)	49	38.6%
≥180 (Severe Hypertension)	24	18.9%

Source: Primary Data, 2025

The severity distribution of hypertension among elderly respondents shows that Grade 1 hypertension is the most prevalent, accounting for 42.5%. According to WHO and European Society of Hypertension (ESH) classifications, Grade 1 hypertension is defined as systolic pressure between 140–159 mmHg. Although not yet considered severe, the risk of cardiovascular complications begins to rise at this stage, especially when accompanied by additional risk factors such as dyslipidemia, diabetes, or a family history of hypertension (Carey et al., 2018). This condition is often asymptomatic, making early dietary control and pharmacological treatment crucial for disease prevention.

Meanwhile, 38.6% of respondents were classified as having Grade 2 hypertension (160–179 mmHg), indicating a higher risk for stroke, heart failure, and damage to target organs such as the kidneys and retina (Mills et al., 2020). This group typically requires a combination of lifestyle modifications and multi-drug antihypertensive therapy. Elevated blood pressure at this level is frequently linked to high sodium intake, chronic stress, and poor medication adherence (Jarrar et al., 2020).

Most concerning is the 18.9% of elderly individuals with severe hypertension (systolic pressure ≥180 mmHg). Severe hypertension is associated with acute target organ damage and

requires immediate medical attention. Clinically, patients in this category may experience hypertensive crises requiring comprehensive evaluation and sometimes emergency intervention (Zuo et al., 2021). The fact that nearly one-fifth of respondents fall into this group highlights the need for early screening and integrated care, including routine monitoring, low-sodium dietary education, and enhanced geriatric healthcare services at the primary care level.

Overall, these findings show that more than 57% of respondents have moderate to severe hypertension, reflecting a high burden of disease among elderly individuals with essential hypertension. This situation is likely exacerbated by excessive sodium intake, limited healthcare access, and low awareness of blood pressure control importance. Therefore, community-based nutritional interventions and strengthened primary-to-secondary referral systems are urgently needed to address hypertension in Indonesia's aging population.

Table 3. Spearman Correlation Test Results Between Daily Sodium Intake and Systolic Blood Pressure

Variable	n	Correlation Coefficient	p-value	Interpretation
Sodium Intake vs. Systolic Pressure	127	0.423	0.000	Moderate positive correlation

Source: SPSS Analysis, 2025

The Spearman correlation test shows a statistically significant relationship between daily sodium intake and systolic blood pressure among elderly individuals with essential hypertension ($r = 0.423$; $p = 0.000$). The positive correlation coefficient indicates that higher sodium intake is associated with higher systolic blood pressure, with the strength of the relationship categorized as moderate.

The majority of respondents (40.9%) consumed sodium in the moderate range (2000–4000 mg/day), while 34.7% exceeded the WHO recommendation (>4000 mg/day), and only 24.4% met the recommended intake (<2000 mg/day).

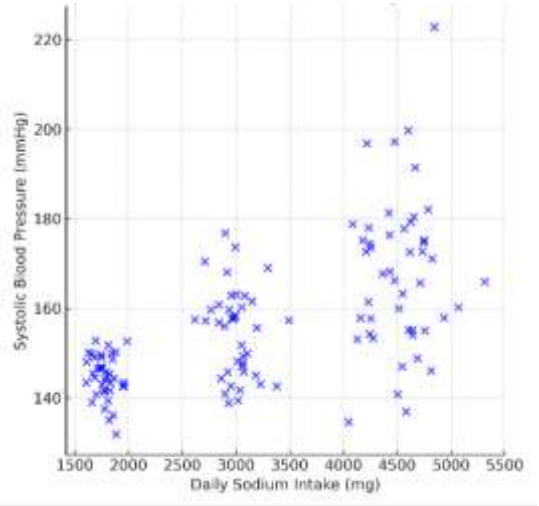

Figure 1. Correlation Between Daily Sodium Intake and Systolic Blood Pressure

Source: Author, 2025

Figure 1 illustrates a clear upward trend between daily sodium intake and systolic blood pressure in elderly respondents with essential hypertension. The scatterplot shows that as sodium intake increases, there is a visible tendency for systolic blood pressure to rise. The data points show an upward spread, reinforcing the idea that excessive sodium intake is a significant risk factor for elevated blood pressure.

In particular, most respondents consuming more than 4000 mg of sodium daily tend to have systolic pressure ≥160 mmHg, falling within Grade 2 or severe hypertension categories. This observation supports the earlier Spearman correlation results, confirming a meaningful relationship between the two variables. Medically, this phenomenon is explained by sodium-induced renal retention, which increases intravascular volume and systemic vascular resistance, ultimately elevating blood pressure.

This illustration aligns with previous studies, which found that sodium intake >4000 mg/day significantly contributes to hypertension, especially in older adults with reduced renal excretion and baroreceptor sensitivity (Graudal et al., 2023; Huang et al., 2021). Thus, this figure serves not only as a statistical visualization but also as clinical and public health evidence of the urgent need to restrict sodium intake among the elderly, given its cumulative effects on the cardiovascular system.

DISCUSSION

The results of this study showed a significant positive correlation between daily sodium intake and systolic blood pressure among elderly individuals with essential hypertension, with a Spearman correlation coefficient of 0.423 ($p = 0.000$). This finding reinforces the hypothesis that excessive sodium consumption plays a crucial role in increasing blood pressure, particularly in older adults. The correlation is considered moderate, indicating that while sodium intake is not the sole cause of hypertension, its influence is clinically and statistically meaningful.

Physiologically, sodium plays a vital role in maintaining osmotic pressure, electrolyte balance, and body fluid volume. When sodium is consumed in large amounts, the body retains more water to maintain balance, leading to increased blood volume and pressure in the blood vessels (He et al., 2020). In the elderly, this response is exacerbated by the decreased efficiency of the kidneys in excreting sodium. Aging causes various physiological changes that increase susceptibility to hypertension. One of these is reduced arterial elasticity, which limits the arteries' ability to accommodate increased blood volume. In addition, baroreceptor sensitivity declines, impairing the body's ability to regulate blood pressure (Franklin, 2012). This explains why systolic blood pressure tends to rise with age.

A study by Lloyd-Jones et al. (2010) showed that the prevalence of hypertension rises sharply in those over 60 years of age, with systolic pressure increases being dominant due to vascular changes. This is consistent with the findings in this study, which demonstrated a similar pattern among the elderly population, particularly those with high sodium intake.

A systematic review by Aburto et al. (2013) supports these findings, concluding that reducing sodium intake by 2 grams per day could lower average systolic blood pressure by up to 3.5 mmHg. This highlights the clinical relevance of sodium intake in blood pressure

management, especially in individuals with high blood pressure.

Another meta-analysis by Mozaffarian et al. (2014) estimated that high sodium consumption is responsible for over 1.6 million deaths globally each year due to cardiovascular diseases. The majority of these deaths occur among the elderly, underscoring the urgency of controlling sodium intake early. Binia et al. (2015) emphasized the importance of the sodium-to-potassium ratio in the diet. Potassium has a protective effect by enhancing sodium excretion through urine and promoting vasodilation. Therefore, the balance between these two minerals is more influential on blood pressure than sodium reduction alone.

A cross-country study by Zhou et al. (2020) through the INTERMAP study revealed that Asian regions have higher sodium intake than Western regions, which correlates directly with the incidence of hypertension. In Indonesia, average salt consumption still exceeds the WHO safe limit of <5 grams per day (WHO, 2021).

In clinical practice, non-pharmacological hypertension control strategies emphasize dietary modification, particularly sodium restriction. A study by Sacks et al. (2001) found that the DASH-sodium diet significantly reduced blood pressure, even in individuals without previous hypertension. Carey et al. (2018) stated that lifestyle modifications, including salt reduction, offer safer long-term benefits compared to relying solely on pharmacological therapy. Education-based interventions and dietary changes produce significant outcomes when consistently implemented among the elderly.

Mills et al. (2020) explained that hypertension in the elderly is multifactorial, with one major contributor being sodium imbalance from processed foods and overeating habits. This issue is worsened by sensory changes in the elderly, who often add more salt due to diminished taste perception. A study by Hasanah and Lestari (2021) in Indonesian primary healthcare services found that more than 65% of elderly individuals were unaware of the recommended sodium intake limits. This lack of knowledge contributes to unhealthy consumption patterns and exacerbates existing high blood pressure conditions.

In addition to knowledge, physical limitations and economic access also hinder healthy diets. Some elderly individuals rely on ready-to-eat meals or food prepared by family members, reducing control over sodium content.

In this study, the use of a validated Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) provided a representative estimate of sodium intake. Instrument validation by community nutritionists and pilot testing ensured adequate data accuracy.

Systolic blood pressure was measured using a calibrated Omron HEM-7121 digital device. The measurement procedure followed WHO standards, with two readings taken five minutes apart in a seated position, and the average value recorded. This improved the reliability of the study and reduced the likelihood of systematic error.

This study also highlights the importance of primary data measurement, rather than relying solely on secondary data or perceptions. Previous studies by Wulandari et al. (2020) and Yuliani et al. (2021) focused on the relationship between knowledge and blood pressure, but did not explore the actual quantitative correlation between sodium intake and blood pressure levels.

The findings of this study enrich the national literature by providing strong evidence at the local community level. Most previous studies focused on the general population or

outpatients, not specifically on elderly individuals with essential hypertension at the district or city level. The moderate correlation (r = 0.423) suggests that aside from sodium, other factors influence blood pressure, such as genetics, physical activity, obesity, and stress. Nevertheless, sodium remains one of the most modifiable factors through education and public policy.

A strength of this study is its analytical correlational approach, not just descriptive. Therefore, the results can serve as a basis for planning evidence-based interventions, especially in elderly health post (posyandu) programs and among community health workers.

Zuo et al. (2021), in an experimental study of the elderly, showed that a low-sodium diet for 8 weeks significantly reduced systolic blood pressure by 6–8 mmHg. This strengthens the urgency of sodium reduction as a key strategy in preventing hypertension complications such as stroke and kidney failure.

Jarrar et al. (2020) in Saudi Arabia also found that elderly individuals with high sodium intake (>4000 mg/day) had twice the risk of developing hypertension compared to those whose intake was within safe limits. This is consistent with the pattern found in the Indonesian population.

From an implementation perspective, community-based dietary interventions should consider local cultural contexts. Educational programs should be interactive rather than one-way and involve family members and community leaders as agents of change. For sustainability, it is essential for local governments and primary health care facilities to conduct routine blood pressure screenings and monitor dietary patterns, especially among the elderly. Strengthening health promotion through local media can also be a supportive strategy.

In conclusion, this study confirms that excessive sodium intake is significantly correlated with increased systolic blood pressure among the elderly. Therefore, locally data-driven interventions, validated instruments, and targeted education are essential steps in managing hypertension in the Indonesian elderly population.

CONCLUSION

This study reveals a significant positive correlation between daily sodium intake and systolic blood pressure among elderly individuals with essential hypertension. The higher the sodium intake, the higher the recorded systolic blood pressure. The moderate-strength correlation ($r = 0.423$; $p < 0.001$) indicates that sodium intake is an important factor contributing to elevated blood pressure in older adults. These findings strengthen the evidence that dietary control, particularly sodium reduction, is a crucial preventive and curative approach in managing hypertension in the elderly.

Recommendation

Based on the results of this study, it is recommended that community-level hypertension control programs for the elderly include sodium reduction education as a primary component. Health professionals should enhance nutrition promotion through approaches that are easily understood by elderly individuals and their families, including training in reading food labels

and introducing low-sodium seasoning alternatives. Furthermore, future research with longitudinal or experimental designs is needed to examine the long-term effects of sodium reduction on blood pressure and other cardiovascular complications in the elderly population of Indonesia.

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