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**RESEARCH**

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## Hypertension and Salt Consumption: A Story from A Coastal Area

Titik Respati<sup>1a\*</sup>, Zulfi Noor Fadia<sup>2b</sup>, Wida Purbaningsih<sup>3c</sup>, Fajar A Yulianto<sup>1d</sup>, Tri Wahyuni<sup>4e</sup>

<sup>1</sup> Department of Public Health, Faculty of Medicine, Universitas Islam Bandung, Bandung, West Java, Indonesia

<sup>2</sup> Faculty of Medicine, Universitas Islam Bandung, Bandung, West Java, Indonesia

<sup>3</sup> Department of Histology, Faculty of Medicine, Universitas Islam Bandung, Bandung, West Java, Indonesia

<sup>4</sup> Institute for Research and Community Services, Universitas Islam Bandung, Bandung, West Java, Indonesia

<sup>a</sup> Email address: [titik.respati@unisba.ac.id](mailto:titik.respati@unisba.ac.id)

<sup>b</sup> Email address: [zulfifadia16@gmail.com](mailto:zulfifadia16@gmail.com)

<sup>c</sup> Email address: [wida7089@gmail.com](mailto:wida7089@gmail.com)

<sup>d</sup> Email address: [fajar@unisba.ac.id](mailto:fajar@unisba.ac.id)

<sup>e</sup> Email address: [trwyni@gmail.com](mailto:trwyni@gmail.com)

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### Abstract

Indonesia has a high prevalence of hypertension accompanied by relatively high salt consumption, posing a significant public health concern, particularly in coastal areas where salty foods and saline water are commonly available. This study aimed to analyze the relationship between salt consumption and hypertension grade among residents in a coastal area. A cross-sectional study was conducted involving 174 hypertensive patients in Pangandaran District who had recorded blood pressure measurements at the local health center. Data on respondents' characteristics, including age, sex, education level, occupation, and income, were collected. Salt intake was assessed using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Multiple logistic regression analysis was performed to examine the association between salt consumption and hypertension grade while controlling for potential confounding variables. The mean sodium intake among respondents was  $1312.11 \pm 596.27$  mg/day. Salt consumption was significantly associated with hypertension grade ( $\beta = 0.001$ ;  $p = 0.004$ ) after adjustment for education level and type of occupation. In conclusion, higher salt consumption is significantly associated with increased severity of hypertension in coastal populations, highlighting the need for targeted dietary interventions to reduce salt intake in these areas.

**Keywords:** Coastal Area, Hypertension, Salt Consumption.

### Corresponding Author:

Titik Respati

Department of Public Health, Faculty of Medicine, Universitas Islam Bandung, Bandung, West Java, Indonesia

Email: [titik.respati@unisba.ac.id](mailto:titik.respati@unisba.ac.id)



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## 1. INTRODUCTION

Geographical areas, such as coastal regions, can become risk factors for hypertension due to high exposure to salty foods, including processed seafood. In addition, coastal areas were also prone to water salinity, partly due to global climate change (Vineis, Chan, & Khan, 2011; Rasheed et al., 2016; Scheelbeek et al., 2016; Talukder et al., 2016; Rakib et al., 2019; Khan et al., 2020; Mueller et al., 2024). High blood pressure, or hypertension, is a multifactorial disease involving genetic, environmental, and behavioral factors (Joshi et al., 2021; Rossier et al., 2017; Siregar et al., 2020). It is a serious medical condition that significantly increases the risk of heart, kidney, brain, and other diseases (Adrian, 2019; Nuraili et al., 2020; World Health Organization, 2021). According to the World Health Organization (WHO), the prevalence of hypertension in the world in 2015 reached 1.13 billion, with an overall majority of around 30-45% in adults (Williams B et al, 2018). In 2025, the number of people with hypertension is expected to increase by 15-20%, reaching 1.5 billion (Kario et al., 2024).

Based on NCD, the evolution of hypertension in Indonesia from 2009-2019 showed an alarming fact, with female rank increasing from 154th to 26th, while males from 182nd to 119th. Indonesia was ranked fourth as a country with steadily increasing hypertension rates in women, with a percentage of 12% (Badan Penelitian dan Pengembangan Kesehatan, 2019). The 2018 Indonesia Basic Health Research study revealed a prevalence of hypertension at 34.1%, representing an 8.3% increase from the 2013 data (Badan Penelitian dan Pengembangan Kesehatan, 2013). This data showed that Hypertension, as one of the Chronic noncommunicable diseases (NCD), had become an enormous health burden.

Research has consistently shown a strong relationship between salt consumption and hypertension. Salt is a significant risk factor for high blood pressure (Aristi et al., 2020; Farapti, 2020; Kassie et al., 2020; Shaikh et al., 2022). Studies have shown that the average sodium intake exceeds the recommended daily limit (Zhou et al., 2021; Thow et al., 2020). Although the positive effects of a reduced sodium intake on blood pressure levels are widely recognized, dietary policy regarding sodium intake in the population still needs to be effective (Yulianto et al., 2020). The Indonesian Ministry of Health already has regulations governing the consumption of sugar, salt, and fat (Kementerian Kesehatan Republik Indonesia, 2023). A study showed that the reduction of dietary sodium in the population tends to decrease over time, usually due to poor dietary compliance (Nurmayanti et al., 2022; Shaikh et al., 2022). The results of epidemiological studies demonstrate a strong relationship between high salt intake and high blood pressure (Farapti, 2020; Nurmayanti et al., 2022).

The awareness of excessive salt consumption regarding hypertension is not yet fully understood among Indonesian Community. This study aims to investigate the relationship between sodium consumption and the degree of hypertension in coastal area in Pangandaran, Indonesia.

## 2. RESEARCH METHOD

The study employed a cross-sectional method and was conducted in Pangandaran district, a coastal area in West Java. The participants were recruited from the health centers in the study area. The health centers chosen were those with the highest and lowest numbers of patients with high blood pressure. Eligible participants included hypertensive patients aged 18 years and above, with a medical diagnosis and recorded blood pressure values available in their medical records. Informed consent was obtained from all participants prior to their inclusion in this study.

The sample size was calculated using the formula for cross-sectional samples. The parameters used for the calculation are as follows: a level of confidence (Z) of 1.96, a population size (N) of 900, and an absolute precision (d) of 0.1. Based on the parameters, the required sample size was determined to be 87 for each health center, totaling 174 samples. Data was collected from June to October 2022 during office hours at the selected health centers.

Participants who met the inclusion criteria and visited the health center during the data collection period were invited to participate in the study. Trained research personnel administered the structured questionnaires to collect information on participants' characteristics, including age, sex, level of education, employment status, and income (measured categorically).

The Semi-Quantitative Food Frequency Questionnaires (SQ-FFQ) were used to assess participants' daily dietary practices and salt consumption. The food list is grouped to assess consumption scores according to six categories: staple foods, animal side dishes, vegetable side dishes, fruits, and beverages. To develop the SQ-FFQ, data on Indonesian food consumption were used as a reference for identifying common sodium food sources. The initial food list was then refined based on the market survey for food that is widely consumed and available at the study location.

A scoring system was employed to assess the consumption frequency and quantity of each food item listed in the SQ-FFQ questionnaires. The scoring system consist of six categories based on the frequency of food consumption that were: > 3 times/day (score of 50), once/a day (score of 25), 3-6 times/week (score of 25), 1-2 times/week (score of 10), 2 times a month (score of 5), and never (score of 0). The scores for all food items consumed were added up based on the total column score, providing an overall food consumption score for each participant. The collected data were analyzed using the distribution of proportions, the Chi-Square test, and logistic regression. All statistical analyses were performed using Stata MP 16 Software. The study obtained ethical approval from Universitas Islam Bandung Health Committee Ethics with approval no. 128/KEPK-Unisba/V/2022.

### 3. RESULTS AND DISCUSSION

The characteristics of the respondents are shown in Table 1, providing valuable insight into the study sample and its distribution across variables. Regarding blood pressure status, we found that most of the respondents had grade 2 hypertension (47%), grade 1 hypertension was found in 45% of respondents, and individuals with pre-hypertension were the lowest at 8%.

**Table 1.** Respondent Characteristics

Variables		%	95%	CI
Blood pressure status	Pre-hypertension	8.09	4.83	13.24
	Hypertension grade 1	45.09	37.78	52.61
	Hypertension grade 2	46.82	39.46	54.32
Income (IDR)	≤ Rp 1.850.000	67.05	59.66	73.69
	> Rp 1.850.000	32.95	26.31	40.34
Work	No	57.22	49.69	64.43
	Yes	42.77	35.56	50.31
Education	Junior High School	84.97	78.79	89.59
	Senior High School	15.03	10.41	21.21
Area	M	50.29	42.34	57.73
	Non-M	49.71	42.27	57.16
Sex	Female	76.3	69.34	82.08
	Male	23.69	17.91	30.65
Age Category	< 60	43.93	36.67	51.46
	≥ 60	56.07	48.54	63.33

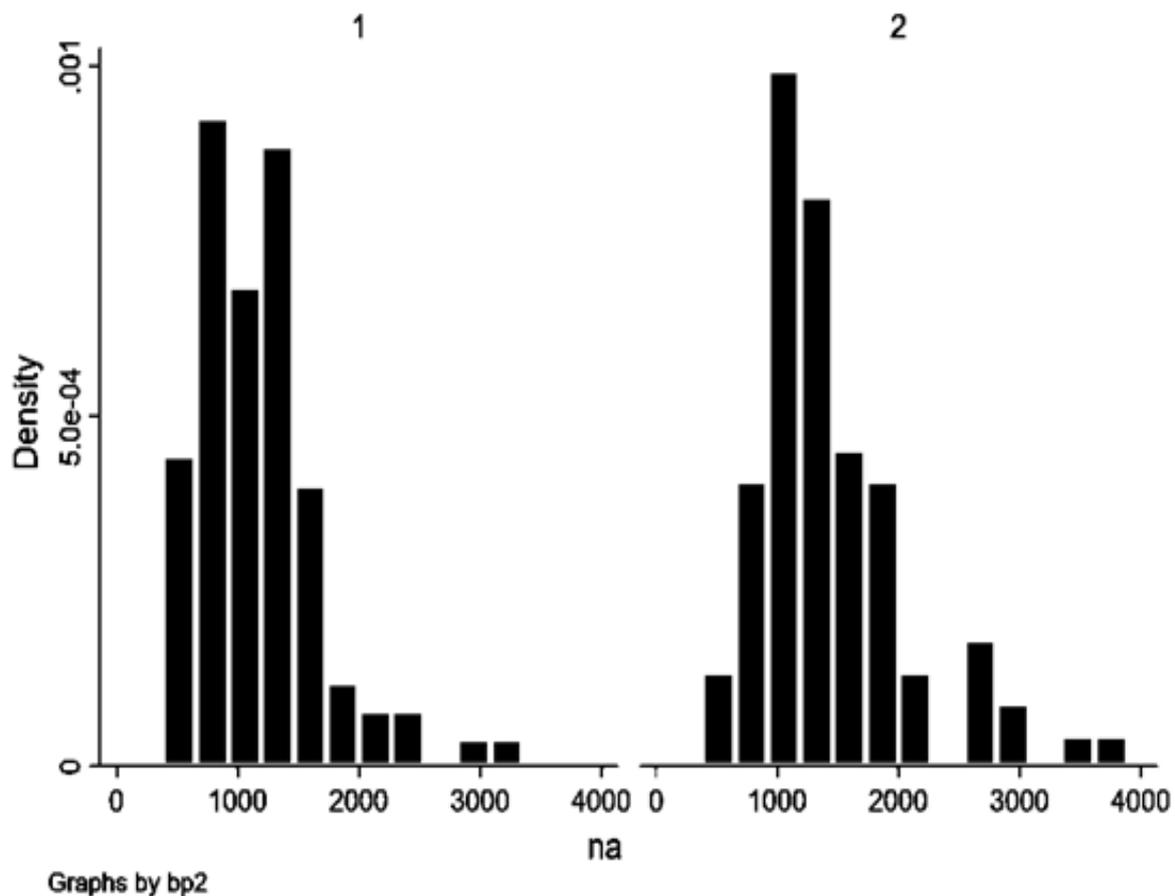
Table 1 presents that the maximum income is less than IDR 1,850,000, which is the regional minimum wage for the area in 2022. Mostly have an unemployed status with a junior

high school education or below. Female is the most common gender compared to males (76.3 versus 23.69%), with respondents above 60 years being 56.07% (95% CI 48.54: 63.33%).

**Table 2.** Sodium Consumption.

	Na intake		
	Total	Pre-ht & ht gr 1	ht gr 2
Minimum	380.5	380.5	433.2
Median	1238.65	1111.7	1335.15
Maximum	3886.8	3199.4	3886.8
Mean	1312.106	1175.76	1465.07
SD	596.27	510.55	649.39
	Difference		289.31
	P (T)		0.001

The mean sodium consumption of the study was 1312.106 (*SD* 596.27) mg/day, as shown in Table 2. The distribution of sodium consumption among the different hypertension groups was further analyzed based on the categories presented in Table 1. Due the significantly smaller number of pre-hypertensive patients compared to the other group, the pre-hypertension and grade I hypertension groups were combined for analysis purposes. The analysis showed that the combined pre-hypertension and grade I hypertension group had a significantly lower sodium consumption compared to grade 2 hypertension group ( $p = 0,001$ ).



**Figure 1.** Na Consumption in Pre-Hypertension and Hypertension in group 1 (1) and group 2 (2)

To visually represent the distribution of sodium consumption, Figure 1. Illustrate the distribution of sodium consumption approaching the normal distribution curve, confirming the differences in the mean-median sodium consumption in each group and their standard deviations. These findings highlight the differences in sodium consumption among the different hypertension groups, emphasizing the potential impact of sodium intake on hypertension severity. The normal distribution pattern observed in the distribution of sodium consumption adds further credibility to the statistical differences observed. Additional analysis and exploration of these relationships can contribute to a deeper understanding of the association between sodium consumption, age group, and hypertension in the coastal area.

Multivariate analysis was conducted to examine the relationship between sodium consumption and the degree of hypertension while considering other variables. The results showed that sodium consumption had a significant influence on variation in the degree of hypertension after controlling for other factors. The coefficient for sodium consumption was 0,001 with a corresponding p-value of 0,004, indicating a statistically significant relationship.

**Table 3.** Relationship between Na Consumption and Hypertension Grade.

Hypertension Grade	Coefficient	P (z)	P (chi sq)	Pseudo R sq
Na Consumption	0.001	0.004		
Education	-0.63	0.18	0.002	0.06
Work	-0.37	0.24		
Constant	-1.03	0.02		

Table 3 presents that when adjusting for recent education and employment status, the relationship between sodium consumption and hypertension grade remained significant. However, the coefficients for education (-0.63) and work (-0.37) did not reach statistical significance, with p-values of 0.18 and 0.24, respectively.

The multivariate analysis revealed that sodium consumption plays a significant role in explaining variation in hypertension grade, accounting for approximately 6% of the variance (pseudo R-squared). However, it is essential to note that other unmeasured variables may also contribute to the grade of hypertension.

The findings of this study indicate that most respondents in both health centers were aged 60 and over, which aligns with a previous study that reported a higher prevalence of hypertension among older individuals (Kario et al., 2024; Siregar et al., 2020). This can be attributed to physiological changes that occur with aging, such as increased stiffness and reduced elasticity of blood vessels (Adrian, 2019). These age-related changes in the cardiovascular system contribute to higher blood pressure levels and an increased risk of hypertension.

This study also supports the research that those aged over 45 years had a risk of 2.22 times greater than those aged 25-35 years having hypertension (Sugiharto, 2007). Meanwhile, according to a study, hypertension can increase three times higher in the age group of 50-60 years because age is a risk factor that cannot be changed due to natural changes in the heart and blood vessel system, accompanied by other risk factors (Defianna et al., 2021).

The results of this study found that 75.9 of the incidences of hypertension and those who carry out the examination are women compared to men. Several studies stated that women have a higher risk when they are older because it is caused by a decrease in the hormone estrogen after menopause (Aristi et al., 2020; Ramdhani, Respati, & Irasanti, 2013). In contrast, a study found that it is higher in men compared to women, with an opportunity of 1.77 times higher because men have the most significant risk factor, that is smoking (Defianna et al., 2021). Hayon et al. found that the prevalence of hypertension was higher in men (34.6%) compared to women (30.8%), but after 60 years, more cases occur in women, which is in line with this study, where more subjects are in the age group  $\geq 60$  years and are female (Choi et al., 2017).

In this gender distribution, the gender imbalance may reflect the differences in health-seeking behavior, as women tend to have higher healthcare utilization and may be more proactive in managing their health.

Education is a critical determinant in health outcomes, including the risk of hypertension. Higher levels of education are generally associated with better health knowledge, increased awareness, and healthier behaviors. In our study, most respondents had an education level below the junior high school level. This low educational attainment may be associated with limited health literacy, reduce awareness of hypertension risk factors, and inadequate knowledge of preventive measures. In contrast to a study that stated a low level of education is an important protective factor for the development of hypertension because there is an interaction between a low level of education and the type of work. Most likely, many people with low education have jobs as laborers and farmers, which require high physical activity (Defianna et al., 2021; Nurmayanti et al., 2022).

The employment status of individuals can have a significant impact on their lifestyle and overall health including the risk of developing hypertension. In our study, a substantial proportion of the respondents were unemployed, which may suggest limited access to resources and a potential barrier to adopting a healthy lifestyle. The lack of employment stability and financial strain can lead to unhealthy coping mechanisms such as poor dietary choices, sedentary behavior, and increased stress levels (Laraia et al., 2017; Panahi, & Tremblay, 2018; Kurnianto et al., 2020).

In our study, we observed that education and employment status may have important implications for salt consumption and hypertension. For example, individuals with higher levels of education may be more informed about the detrimental effects of high salt intake on blood pressure and overall health. Conversely, individuals who are unemployed and have low incomes may rely more on processed and affordable foods, which are often high in salt content. This can contribute to higher salt consumption levels and increase the risk of hypertension (Unger et al., 2020). However, it is important to note that the relationship between education, employment, salt consumption, and hypertension is complex. Cultural norms can influence them: socio-economic disparities and individual behaviors.

The analysis of sodium intake in the two health centers did not reveal a significant difference in sodium intake between the health centers and the incidence of hypertension. This could be attributed to the effective non-communicable disease health service program, such as Prolanis. The education and information provided to the subjects regarding sodium intake appear to have had a positive impact, as individuals began reducing their consumption of high-sodium foods. These findings aligned with a study on salt consumption, which reported a significant difference in sodium intake before and after education, showing an impact on blood pressure.

These studies suggest that education and information on sodium intake can effectively influence individuals' dietary choices and contribute to better blood pressure control. The incorporation of educational intervention as part of comprehensive hypertension management programs is crucial in promoting healthier dietary practices and reducing the risk of hypertension. The high prevalence of hypertension and salt consumption in Indonesia may be related to several factors, including the increasing adoption of Westernized diets and lifestyles, low levels of physical activity, and increasing rates of obesity (Kurnianto et al., 2020). Additionally, cultural factors, such as the use of high-sodium condiments in cooking, may contribute to higher levels of sodium consumption (Hussain et al., 2016).

Efforts to address hypertension and salt consumption in Indonesia include public health campaigns to raise awareness about the risks of excessive salt intake, food labeling regulations, and working with the food industry to reduce the amount of salt in processed foods (Farapti et al., 2020). However, there is still much work to be done to address this significant public health issue in the region.

The research we conducted aligns with the study conducted by Qayra and Farapti, which found a significant relationship between the threshold of salty taste and the occurrence of hypertension in adolescent boys in Surabaya. According to Qayra and Farapti, the threshold of salty taste can be a risk factor for an increase in blood pressure (Syifadhiya & Farapti, 2023). In this study, a less detectable salty taste is likely to increase the consumption of high-salt foods in women aged over 60, possibly because most of them are housewives.

While our study provides valuable insights into the relationship between salt consumption and hypertension in the coastal areas of West Java, it is important to acknowledge specific limitations. One limitation of the study design is its cross-sectional nature, which limits the ability to establish a causal relationship between salt consumption and hypertension. We cannot determine the temporal sequence or assess the long-term effects.

The sampling method chosen from the community health center in the two subdistricts may not be representative of the entire population; consequently, the findings may not be generalizable to other regions or populations. The data collection tool SQ-FFQ has limitations, as it is self-reported, subject to recall bias, and may not provide entirely accurate estimates of actual salt consumption. These findings highlight the importance of sodium consumption as a factor influencing the severity of hypertension, even after considering other variables such as education and employment status. Further research and intervention targeting sodium intake can contribute to the management and prevention of hypertension in coastal areas. A longitudinal study design with larger samples and objective measures of sodium intake should be considered.

#### 4. CONCLUSION

In conclusion, our study highlights the importance of addressing sodium consumption as a significant risk factor for hypertension, particularly in coastal areas. The findings add to the existing body of evidence that supports the need for population-wide intervention aimed at reducing salt intake. Public health strategies that promote awareness, education, and behavioral changes related to sodium consumption can play a crucial role in preventing and managing hypertension.

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