

ORIGINAL ARTICLE

Relationship between Risky Food Consumption Behavior and Hypertension in Java Island, Indonesia: An Ecological Analysis of Basic Health Research Data

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ABSTRACT

Introduction: Hypertension risk is closely linked to high salt intake and low fruit and vegetable consumption. This study explores the association between hypertension prevalence and dietary risk behaviors across Java Island. **Materials and methods:** This study uses an ecological analysis approach. The study assesses the association between hypertension prevalence and dietary risk behaviors across 119 regions on Java Island using 2018 Indonesia Basic Health Survey (Riskesdas) data. Spatial analysis with Quantum Geographic Information System (QGIS) mapped prevalence, Chi-square test, and multinomial logistic regression analysis approach. **Results:** Hypertension prevalence on Java Island is concentrated in the southwest, ranging from 41.3% to 49.6% in 17 districts and cities. West Java and Banten provinces have the highest proportions of high-salt food consumption (46.1% to 79.4%), while processed food consumption is also prevalent in the western region. Lebak Regency in Banten has the highest instant noodle consumption. A significant positive correlation was observed between the proportion of Consuming Food containing Flavoring spices (CFF) ≥ 1 time day ($p = 0.035$), the proportion of Not Consuming Vegetables and Fruit (NCVF) ($p=0.018$) and hypertension. No significant relationship was identified between high-salt, processed food, instant food consumption, and hypertension. **Conclusion:** Hypertension and risky food behaviors are prevalent in West Java. A significant relationship exists between seasoning consumption, Not consuming vegetables and fruit and hypertension. These findings highlight the need for sodium reduction and public health initiatives, with further research on region-specific strategies.

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INTRODUCTION

Hypertension is a serious medical condition that can cause an increased risk of diseases such as cardiovascular, neurological, renal, and various other diseases. Globally, approximately 1.28 billion adults aged 30 to 79 years are affected, with two-thirds of these

cases found in middle- and low-income countries.(1)

The global prevalence of hypertension sufferers has increased from 32% to 33%, mainly due to population growth, increasing the overall number of adults at risk. While high-income countries have declined, prevalence rates have surged in regions like the West Pacific (24% to 28%) and Southeast Asia (29% to 32%). Among Southeast Asian countries, Indonesia ranks second in the number of hypertension cases.(2)

Hypertension is known as a "silent killer disease" as

nearly 46% of adults are unaware of their condition. Only 42% receive a diagnosis and treatment, and just 20% successfully control their blood pressure.(1) In Southeast Asia, hypertension-related deaths reached 2.4 million in 2019, making it the third-highest region globally for such fatalities.(3) Multiple factors contribute to hypertension risk, with lifestyle changes due to environmental exposure being significant. These include a diet high in sodium and low in potassium, obesity, alcohol consumption, smoking, and physical inactivity.(4)

Adopting healthy dietary behaviors can help control and prevent hypertension. Individual characteristics, cultural practices, and local food availability influence dietary habits. Effective dietary strategies focus on reducing sodium intake and increasing fiber-rich foods like fruits and vegetables.(5,6) Consuming excessive sodium increases the potential for blood pressure. It is known that 2 million deaths from cardiovascular disease in 2019 were caused by excessive sodium consumption with the result of 24-hour urinary sodium excretion above the recommended 1 to 5 grams per day.(7) In 2011, the United Nations declared a commitment by member countries to combat non-communicable diseases, focusing on reducing sodium intake by 30% by 2025. The global average sodium intake is 4310 mg/day, exceeding WHO's recommendation of less than 2000 mg/day.(7)

The number of hypertension sufferers in Indonesia (40% of the total population) is higher than the average number of hypertension sufferers globally in 2019. The highest number of hypertension sufferers in Indonesia are women (45% of the number of women aged 30-79 years). Hypertension treatment in Indonesia cannot yet cover all people aged 30-79 years, where 36% of people diagnosed with hypertension are 19%, 19% are undergoing treatment, and only 4% are undergoing routine control. The average sodium intake for people aged 30-79 years in Indonesia is 10 grams of salt daily. The behavior of consuming high salt increases the potential for death in cardiovascular patients with high blood pressure. Death of cardiovascular patients with high blood pressure was 69% in Indonesia in 2019.(7)

Studies in Jember Regency, East Java, link foods like biscuits, salted fish, dairy products, coffee, and seasonings to hypertension. Salted fish, preserved with salt, is popular in lower-income communities, contributing to high sodium intake.(8) Globalization has also impacted changes in food, such as the use of flavorings and processed foods. Research conducted on farmers in Jember Regency shows that processed milk is associated with the incidence of hypertension, where milk contains calcium, which can reduce the risk of hypertension.(9)

Indonesia's diverse cultural landscape has led to

varied dietary patterns influenced by local and external cultural practices. Given the strong link between diet and hypertension, this study examines risky dietary behaviors and the prevalence of hypertension across Java Island using an ecological study approach. This study aims to answer the following research questions: What is the spatial distribution of hypertension prevalence in districts and cities on Java Island? Additionally, how is the spatial distribution of risky dietary behaviors, such as high intake of salty foods, processed foods, instant foods, and low consumption of fruits and vegetables? Furthermore, is there a significant relationship between the prevalence of these risky dietary behaviors and hypertension prevalence in these districts and cities on Java Island? Based on the study findings, this research also intends to highlight areas for potential public health interventions, especially in regions with significant correlations between food consumption habits and hypertension prevalence, to inform future dietary guidelines and preventive health measures.

MATERIALS AND METHODS

Study Design

This study uses an ecological analysis approach. Ecological analysis focuses on comparing groups rather than individuals. This study examined aggregate data at the regencies or city level to conclude the effects or influences on these groups. The population in this study was all regencies/cities on the island of Java, namely 119 regencies/cities. The unit of analysis in this study is the regencies/city.

Variables

The dependent variable is Hypertension, a condition where blood pressure is measured according to JNC VII criteria, namely if systolic blood pressure is ≥ 140 mmHg and/or diastolic blood pressure is ≥ 90 mmHg. Independent variables included Consuming Salty foods (CSF) ≥ 1 time per day, which is the habit of consuming foods that are predominantly salty or contain a high salt content ≥ 1 time per day. Consuming Processed food (CPF) ≥ 1 time per day is consuming food derived from animals through processing and adding preservatives ≥ 1 time per day. Consuming food containing Flavoring spices (CFF) ≥ 1 time per day is the habit of consuming food containing flavoring spices such as vetsin or Mono Sodium Glutamate (MSG), instant broth, and other cooking spices ≥ 1 time per day. Consuming Instant Food (CIF) ≥ 1 time per day is the habit of consuming instant food such as instant noodles, instant porridge, and other instant foods ≥ 1 time per day. Not Consuming Vegetables and Fruit (NCVF) is the habit of not consuming vegetables and fruit. The instrument used to collect data on vegetable and fruit consumption is the WHO STEP-wise instrument, a standardized method for collecting data on non-communicable disease risk factors through surveys and physical measurements. This instrument is suitable for this study as it allows consistent

measurement of vegetable and fruit consumption across different populations, ensuring comparability of data. (10) Dividing the category of each independent variable is done by looking at the normal distribution or not. The results of the Kolmogorov-Smirnov test indicated that all independent variables were not normally distributed, with a p-value less than 0.05. Therefore, the categories for the independent variables were determined using the median cut-off of the data.

Data source

Data collection was carried out using secondary data from the 2018 Riskesdas provincial reports on Java Island, specifically the 2018 Riskesdas Report for Banten Province, DKI Jakarta Province, West Java Province, DI Yogyakarta Province, Central Java Province, and East Java Province. The Riskesdas reports, produced by the Ministry of Health, provide reliable data on health-related behaviors and disease prevalence across Indonesia. Data is collected through a comprehensive, standardized process that ensures data accuracy and consistency. These reports gathered data on the prevalence of risky food consumption behavior and hypertension in 119 districts/cities on the island of Java. (11–16).

Data analysis

The spatial descriptive analysis describes the regional map distribution of hypertension prevalence and distribution of the proportion of risky food consumption behavior using the Quantum GIS (QGIS) version 3.24 application. The color pattern on the map shows the prevalence. The lighter color pattern means the prevalence is lower, while the darker color pattern means the prevalence is higher. Statistical Package for Social Science (SPSS) version 21.0 (IBM Corp, Armonk, NY) was performed for statistical analyses. Chi-square test analysis using the contingency coefficient examines the relationship and its strength between independent and dependent variables and the multinomial logistic regression analysis approach, where the dependent variable is categorical and has more than two categories was used to investigate the relationship between each variable of risky food consumption behavior and hypertension. $P < 0.05$ was considered significant.

Ethical Clearance

This study analyzes secondary data from published government reports, so this study followed the Ethics Commission of the Health Research and Development Agency's letter number LB.02.01/2/KE.267/2017 and Ethics Amendment Approval Number LB.02.01/2/KE.024/2018 for Basic Health Research.

RESULTS

1. Geographical variations of the Indonesian population in the prevalence of hypertension, Proportion of Consuming Salty Foods (CSF) ≥ 1 time per day, Proportion

of Consuming Processed Food (CPF) ≥ 1 time per day, Proportion of Consuming Food Containing Flavoring spices (CFF) ≥ 1 time per day, proportion of consuming Instant Food (CIF) ≥ 1 -time per day and Proportion of No Consuming Vegetables and Fruit (NCVF) in 6 provinces of Java Island, Indonesia.

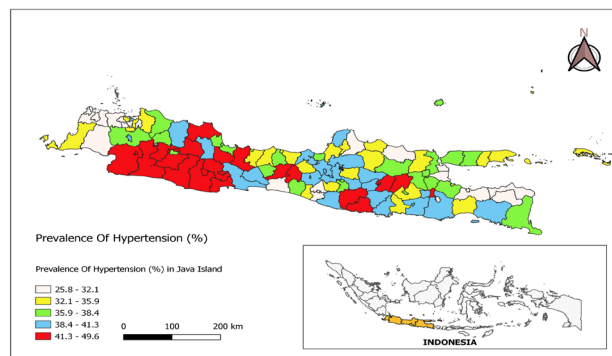


Figure 1: Geographical variations of the Indonesian population in the prevalence of hypertension in 6 provinces of Java Island, Indonesia.

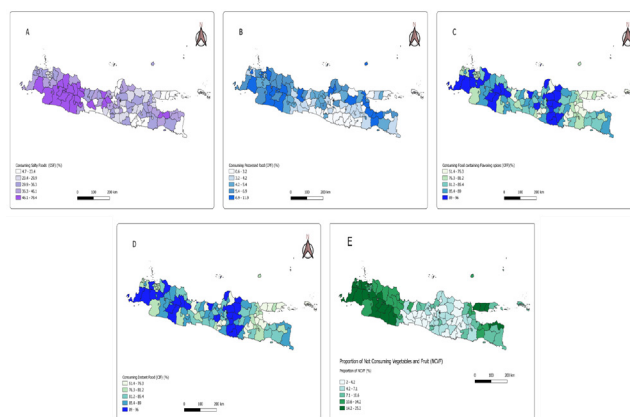


Figure 2: Proportion of independent variable. A) Proportion of Consuming Salty Foods (CSF) ≥ 1 time per day in Java Island, Indonesia, B) Proportion of Consuming Processed Food (CPF) ≥ 1 time per day in Java Island, Indonesia, C) Proportion of Consuming food containing Flavoring spices (CFF) ≥ 1 time per day in Java Island, Indonesia, D) Proportion of Consuming Instant Food (CIF) ≥ 1 time per day in Java Island, Indonesia, E) Proportion of Not Consuming Vegetables and Fruit (NCVF) in Java Island, Indonesia.

All maps were created using the Quantum GIS (QGIS) Version 3.24 application and 6 maps were produced to visualize the distribution of hypertension cases on the island of Java at the district level, where the main map is a map of the prevalence of hypertension on the island of Java and five supporting maps are presented in Maps Figure 1 to Figure 2.

The prevalence of hypertension in each province on the island of Java is taken as the absolute presentation of the number of hypertension sufferers per 100,000 population aged over 18 years, which is depicted on the main map (Figure 1) with a map of the distribution of hypertension. Prevalence of hypertension sufferers at district level and divided into five classes. with the highest class $> 41.3\%$ and the lowest class $< 32.1\%$. Looking at the region, it

can be seen on the map that the highest hypertension prevalence group (>41.3%) is mostly in the western region of the island and partly in the central and eastern regions. Ciamis Regency (49.62%) and Cianjur Regency (48.09%) are the districts with the highest prevalence in West Java Province. Meanwhile, in the central and eastern regions of the island, only a small portion has a high prevalence of hypertension, namely Wonogiri Regency (45.86%), which is in Central Java Province, and Madiun City (47.65%), which is part of East Java Province.

From a regional perspective on the island of Java, it can be seen that the distribution of hypertension (Fig. 1) is mostly in the western region of the island, namely West Java Province and Banten Province, and a small part in the central and eastern regions, namely Central Java and East Java Provinces. The distribution pattern of the prevalence of hypertension (Fig. 1) looks the same and is consistent with the Proportion of Consuming Salty Foods (CSF) variable (Fig. 2A) and the Proportion of Consuming Instant Food (CIF) variable (Fig. 2D). The distribution of CSF and CIF is clustered and not spread out, the grouping occurs in the western region of the island, namely the provinces of West Java and Banten, these two variables have the potential to be closely related to the incidence of hypertension which is visualized on the main map (Figure 1) because there is consistency in the distribution pattern.

Other variables, such as the Proportion of Consuming Processed Food (CPF) (Fig. 2B) and Consuming food containing Flavoring Spices (CFF) (Fig. 2C), show a pattern of spread and not clustered in the Java Island region, with the spread being interpreted as being found in almost all provinces, on the island of Java. In contrast to the distribution pattern of the previous map, the Not Consuming Vegetables and Fruit (NCVF) variable (Fig. 2 E) appears to be clustered in the central and eastern parts of Java Island. From a regional perspective, it can be said that the NCVF variable does not have the same pattern or is inconsistent with the main map.

As a comparison, the proportion of consumed processed food (CPF) in the Western region is more spread out and not concentrated in one area within West Java and Banten provinces. In contrast, areas with low levels of vegetable and fruit consumption are mostly in the central part of Java Island. Lebak District in Banten Province and Cianjur District in West Java Province exhibit high hypertension prevalence and high levels of processed food consumption. At the same time, Cianjur District in Central Java Province has a high hypertension prevalence alongside elevated instant noodles and processed food consumption.

2. Relationship between the proportion of risky food consumption behavior and the prevalence of hypertension

The proportion of Consuming Salty Foods (CSF) ≥ 1 time per day, Proportion of Consuming Processed Food (CPF) ≥ 1 time per day, Proportion of Consuming Food Containing Flavoring spices (CFF) ≥1 time per day, Proportion of onsuming Instant Food (CIF) ≥ 1-time per day and Proportion of No Consuming Vegetables and Fruid (NCVF) are divided into two categories: low, and high proportions. Categorization is based on statistical analysis, using the median value since the proportion data are not normally distributed. If the proportion is less than or equal to the median, it's classified as "low"; if greater, it's "high." Hypertension prevalence is divided into three categories: "high" for 66.67% and above, "medium" for 33.33% to 66.67%, and "low" for below 33.33%.

Table I: The relationship between the proportion of risky food consumption behavior and the prevalence of hypertension in six provinces of Java Island, Indonesia

Variable of risky food consumption behavior	Prevalence of Hypertension			Contingency Coefficient	p-value
	Low, n (%)	Medium, n (%)	High, n (%)		
Proportion of Consuming Salty foods (CSF) ≥ 1 time per day					
-Low (n=60)	23 (57.5)	23 (57.5)	14 (35.9)	0.199	0.087
-High (n=59)	17 (42.5)	17 (42.5)	25 (64.1)		
Proportion of Consuming Processed food (CPF) ≥ 1 time per day					
-Low (n=60)	15 (37.5)	22 (55.0)	23 (59.0)	0.184	0.126
-High (n=59)	25 (62.5)	18 (45.0)	16 (41.0)		
Proportion of Consuming Food containing Flavoring spices (CFF) ≥ 1 time day					
-Low (n=60)	26 (65.0)	20 (50.0)	14 (35.9)	0.231	0.035
-High (n=59)	14 (35.0)	20 (50.0)	25 (64.1)		
Proportion of Consuming Instant Food (CIF) ≥ 1 time per day					
-Low (n=60)	17 (42.5)	24 (60.0)	19 (48.7)	0.144	0.284
-High(n=59)	23 (57.5)	16 (40.0)	20 (51.3)		
Proportion of Not Consuming Vegetables and Fruit (NCVF)					
-Low (n=60)	13 (32.5)	25 (62.5)	22 (56.4)	0.251	0.018
-High (n=59)	27 (67.5)	15 (37.5)	17 (43.6)		

Tested using Chi-Square Test

Table I shows significant relationships between dietary habits and hypertension prevalence. The proportion of individuals consuming food with flavoring spices (CFF) at least once a day is associated with hypertension, indicated by a p-value of 0.035 and a contingency coefficient of 0.231, suggesting a weak positive relationship. Similarly, the proportion of individuals not consuming vegetables and fruit (NCVF) also relates to hypertension, with a p-value of 0.018 and a contingency coefficient of 0.251, indicating a weak positive relationship as well.

In Table II, the results of the analysis using multinomial logistic regression show the relationship between the proportion of risky food consumption behavior and the prevalence of hypertension that in model 1 (Low), it is observed that districts and cities with a low Proportion of Not Consuming Vegetables and Fruit (NCVF) have a tendency for a lower prevalence of hypertension.

Specifically, the likelihood is 0.195 times greater (95% CI = 0.04-0.952; p-value = 0.043) compared to those with a high NCVF. Additionally, districts and cities with a low Proportion of Consuming Food Containing Flavoring Spices (CFF) at least once a day are 2.808 times more likely (95% CI = 0.980-8.049; p-value = 0.055) to have a low prevalence of hypertension

than those with a high CFF. In Model 2 (Medium), it shows that districts and cities with a low Proportion of Consuming Salty Foods (CSF) at least once per day have a 2.313 times greater tendency (95% CI = 0.858-6.234; p-value = 0.097) to experience a medium prevalence of hypertension compared to those with a high CSF.

Table II: Multinomial Logistic Regression Analysis Reveals the Link Between Risky Food Consumption Behavior and Hypertension Prevalence in Six Provinces of Java Island, Indonesia

Prevalence of Hypertension		B	Std. Error	Wald	OR	95 % CI	p - value
Low	Intercept	-0.172	0.425	0.165			0.685
	Proportion of Consuming Salty foods (CSF) \geq 1 time per day = Low	0.922	0.549	2.820	2.515	0.857-7.382	0.093
	Proportion of Consuming Salty foods (CSF) \geq 1 time per day = High	Reference					
	Proportion of Consuming Processed food (CPF) \geq 1 time per day = Low	-1.339	0.641	4.367	0.262	0.075-0.920	0.037
	Proportion of Consuming Processed food (CPF) \geq 1 time per day = High	Reference					
	Proportion of Consuming Food containing Flavoring spices (CFF) \geq 1 time day = Low	1.033	0.537	3.695	2.808	0.980-8.049	0.055
	Proportion of Consuming Food containing Flavoring spices (CFF) \geq 1 time day= High	Reference					
	Proportion of Consuming Instant Food (CIF) \geq 1 time per day =Low	1.405	0.867	2.627	4.076	0.745-22.289	0.105
	Proportion of Consuming Instant Food (CIF) \geq 1 time per day = High	Reference					
	Proportion of Not Consuming Vegetables and Fruit (NCVF)= Low	-1.634	0.808	4.085	0.195	0.04-0.952	0.043
	Proportion of Not Consuming Vegetables and Fruit (NCVF)= High	Reference					
	Medium	Intercept	-0.411	0.438	0.880		
Proportion of Consuming Salty foods (CSF) \geq 1 time per day = Low		0.839	0.506	2.748	2.313	0.858-6.234	0.097
Proportion of Consuming Salty foods (CSF) \geq 1 time per day = High		Reference					
Proportion of Consuming Processed food (CPF) \geq 1 time per day = Low		-0.883	0.609	2.101	0.413	0.125-1.365	0.147
Proportion of Consuming Processed food (CPF) \geq 1 time per day = High		Reference					
Proportion of Consuming Food containing Flavoring spices (CFF) \geq 1 time day = Low		0.448	0.496	0.816	1.565	0.592-4.134	0.366
Proportion of Consuming Food containing Flavoring spices (CFF) \geq 1 time day= High		Reference					
Proportion of Consuming Instant Food (CIF) \geq 1 time per day =Low		0.903	0.789	1.310	2.468	0.525-11.589	0.252
Proportion of Consuming Instant Food (CIF) \geq 1 time per day = High		Reference					
Proportion of Not Consuming Vegetables and Fruit (NCVF)= Low		-0.225	0.746	0.091	0.799	0.185-3.444	0.763
Proportion of Not Consuming Vegetables and Fruit (NCVF)= High		Reference					

Reference category is high; Model fitting information (model final p value=0.008); Goodness of fit (pearson p value=0.015); Pseudo R-Square (Nagelkerke=0.205)

DISCUSSION

Distribution of Hypertension Prevalence and Risky Food Consumption Behavior in 119 Districts and Cities on the Island of Java, Indonesia

The 2018 Riskesdas report provides data on the prevalence of hypertension in Indonesia, categorizing it into three types based on diagnostic criteria: prevalence based on a doctor's diagnosis (8.36%), prevalence based on the intake of antihypertensive medication (8.17%),

and prevalence based on measurement results (34.11%) for individuals aged \geq 18 years. These data highlight that a substantial portion of the population remains unaware of their hypertension status. The report further indicates that Java Island has the second-highest prevalence of hypertension (36.79%) based on measurement results, following Kalimantan Island (38.78%).(10)

Java Island has six provinces, Jakarta, East Java, West Java, DI Yogyakarta, Central Java, and Banten, with

urban and rural areas. The 2018 Riskesdas Report shows hypertension prevalence rates in urban areas were 12.15% (diagnosis) and 9.64% (medication), and in rural areas, 11.94% (diagnosis) and 8.06% (medication). Based on measurement results, urban hypertension prevalence was 35.65% compared to rural prevalence at 36.69%. The highest urban prevalence based on doctor diagnosis was in East Java Province (15.01%), while Banten Province had the lowest (9.46%). Hypertension prevalence on Java Island is primarily clustered in the southwest area, with high rates (41.3% - 49.6%) in 17 regencies/cities, including 14 in West Java Province. The national hypertension prevalence, based on measurements, is 34.11%. A study conducted based on the Riskesdas results report from six provinces on the island of Java resulted in a higher prevalence rate of hypertension in Java than the prevalence of hypertension in Indonesia based on gender, namely women (38.98%) and men (33.02%).(11–16)

High levels of salt consumption are evident in the western Java regions of West Java and Banten provinces, as indicated by dark red areas on the consumption map. Processed foods and instant noodles are more commonly consumed in western Java, while spicy foods are popular across the island. Banten Province stands out for its higher proportion of individuals who do not regularly consume vegetables and fruits. As a cultural and demographic center, Java Island is home to 56.10% of Indonesia's population and displays a mix of local and migrant cultural influences. This cultural complexity, shaped by historical interactions, incorporates knowledge, beliefs, customs, and culinary preferences passed through generations.(17) Cultural influences from Javanese, Arab, Dutch, and Chinese communities are particularly prominent in the western part of Java Island, contributing to local food preferences, where salty and spicy foods are more common, while central Java residents prefer milder and sweeter flavors.

The presence of numerous processed food stalls across Java has influenced breakfast habits. Three main types of food vendors cater to various market segments and economic levels: vendors who carry food, stationary vendors, and food stalls. The convenience of processed foods, such as noodles and porridge, has increased their popularity, especially in western Java, where busy lifestyles have further promoted instant food consumption practices.(18)

Relationship between the proportion Consuming Food Containing Flavoring spices (CFF) \geq once per day with the prevalence of hypertension in 119 regencies/cities on the island of Java, Indonesia

Asian cuisine is known for food that is full of flavor. Salt or high sodium is usually found in baked and soupy foods such as soup, broth, and curry. (19) The use of sodium among people in Indonesia adapts to people's tastes. Research conducted on hypertensive patients

in hospitals found that the dosage for sodium use in hypertensive sufferers consisted of half a teaspoon, one teaspoon, the tip of a teaspoon, one tablespoon, and according to taste.(17)

Mono Sodium Glutamate (MSG) is commonly used in Indonesia to enhance umami without high salt. Research on sodium reduction through MSG substitution suggests that using MSG in moderation can reduce sodium intake without compromising taste. However, excess consumption above 3 grams per day can still contribute to elevated sodium levels, raising health risks. Acceptable Daily Intake (ADI) is set at 120 mg/kg body weight to mitigate these risks. Studies conducted in other countries, such as one from the University of Illinois, highlight that natural spices combined with minimal salt are generally accepted by consumers, suggesting potential strategies to reduce sodium while maintaining palatability.(19)

Research conducted at the University of Illinois showed that providing soup using natural spices and reducing sodium showed respondents' acceptance of soup samples. Then, the respondents were given treatment by adding salt to the soup; this treatment increased the respondents' liking.(20) This condition shows that using MSG in specified doses or natural spices can reduce sodium without reducing the delicious taste if there is no option to add salt to food. The sodium content in MSG is 12%, while the sodium in salt is 40%.(21) Many people use MSG and add table salt to add a salty taste to dishes.(22) Research conducted in India shows that people from lower to middle economic conditions still add salt to seasoned bread to give it a salty taste so it can be consumed deliciously.(23)

The type of food most frequently consumed by Indonesian people, namely meatballs, is evidence of the use of MSG and table salt. The basic meatball ingredients are meat, flour, table salt, MSG, and ice water. Salt is an important ingredient in making meatballs because it provides flavor and is a preservative. Add salt to the meatballs around 5-10% of the weight of the meat. Meatball sauce does not have many natural spices and is mostly water. To maintain the taste of the meatball sauce, traders will usually add MSG and salt in large quantities.(24)

The results of multinomial logistic regression analysis in this study found that districts and cities with a low proportion of Consuming Food Containing Flavoring Spices (CFF) at least once a day were 2,808 times more likely (95% CI = 0.980-8.049; p-value = 0.055) to have a low prevalence of hypertension than those with a high CFF. The habit of tasting food based on the suitability of the taste on the tongue that cooks the food is related to the sodium content in MSG where the dose of MSG given will be influenced by the feeling of satisfaction on the tongue that cooks the food.(25) Research conducted in Labuapi District, West Lombok Regency, shows that

health workers do not have a role. This shows that the socialization of MSG in the community is rare and can be said to have never been carried out.(26)

The relationship between the proportion of Consuming Salty Foods (CSF) \geq 1 time per day, the Proportion of Consuming Processed Food (CPF) \geq 1 time per day, the Proportion of consuming Instant Food (CIF) \geq 1-time per day, and Proportion of No Consuming Vegetables and Fruit (NCVF) with the prevalence of hypertension in 119 regencies/cities on the island of Java, Indonesia

Consuming high-salt foods that contain high levels of salt, such as salted fish, salted eggs, snacks with a salty taste, and other predominantly high-salt foods contain sodium, which can trigger hypertension. The proportion of areas that consume salty food shows no significant difference between the low, medium, and high categories on the island of Java. Areas with a high proportion of behavior in consuming high-salt foods $>$ 1 time per day have the potential to be high hypertension areas. Areas with a low proportion of behavior in consuming high-salt foods $>$ 1 time per day have the potential to be areas with low hypertension. Areas with a moderate proportion of behavior in consuming high-salt foods $>$ 1 time per day show more potential than areas with low hypertension. This condition allows for a shift in behavior in consuming high-salt foods $>$ once per day.

Behavioral shifts to reduce high-salt food intake could be a viable preventive strategy against hypertension, as suggested by a study in Semarang Regency in 2017, where individuals aware of hypertension risks reported reducing their intake of high-salt foods, such as salted fish, and minimizing table salt use. Social influences, particularly from family or friends with hypertension, play a role in these behavioral adjustments, indicating the importance of public health campaigns that utilize social networks to encourage reduced salt consumption. (24)

Consuming processed beef, chicken, fish, and other types of meat, such as corned beef, sausages, burgers, and smoked meat, is influenced by the practicality offered by processed food providers. Practicality and the growing food industry produce processed food products that meet nutritional needs and fulfill appetite desires.(27) Processed foods can reduce a person's risk of developing hypertension because food processors can change sodium levels with other ingredients, such as potassium chloride (KCl). KCl is a salt compound discussed for the last 50 years as a strategy to reduce sodium use. Processed foods can modify flavor by replacing sodium with potassium chloride. Several food processing industries in America have replaced the role of sodium using potassium chloride with a mixture of other compounds and spices in processed food products. (28–30)

Indonesia has issued regulations regarding the inclusion of salt (sodium) content in processed food product information through Minister of Health Regulation (PMK) No. 63 of 2015 concerning the Inclusion of Information on Sugar, Salt, and Fat Content and Health Messages for Processed Food and Ready-to-Eat Food is an amendment to PMK No. 30 of 2013. This shows that the behavior of consuming processed foods that comply with established food content standards can make this behavior a factor that can prevent new cases of hypertension.(31,32) The behavior of consuming instant food such as instant noodles, instant porridge, and other instant foods is influenced by the practicality of making it and the cheap selling price. People who have a high level of busyness cause the time for cooking to decrease. This condition causes many to consume instant or fast food.(22) Instant food is a type of processed food that receives regulatory monitoring from the Food and Drug Supervisory Agency Regulation No. 26 of 2021 through the inclusion of Nutritional Value Information on the Processed Food Label so that the sodium content in instant food that has a distribution permit does not exceed the specified sodium content.(33)

Research on the use of nutritional value information labels on consumer satisfaction using Kano analysis shows that consumers with special needs, such as those who want to go on a diet and have health interests, will read nutritional value information labels more often. Consumers who can read nutritional value information labels will be more satisfied if complete information on food ingredients is included, especially healthy ingredients such as protein and fiber. Nutritional value information labels do not affect consumer satisfaction but are necessary for consumers.(34) Consumer satisfaction is influenced by food likes, dislikes, and fat content.(35)

The decline in sodium consumption in Korea is due to public knowledge about the risks of sodium consumption through advertising cooking channels and educational programs on television. Consumer awareness and knowledge regarding reducing sodium is proliferating due to efforts from the food industry, academia, and government. There was a decrease in sodium consumption from 2005 to 2009 by 50.4%. Providing nutritional value information labels with complete details increases the satisfaction of people with a high knowledge of the risk of hypertension.(34) The decline in sodium consumption in the United States is due to regulations on sodium content in foods, and the food industry must reduce the sodium content of processed food products. The United States Food and Drug Administration (FDA) investigated the food industry and public health education regarding excessive sodium consumption and reduced sodium in the national food supply.(36)

Finally, consistently consuming fruits and vegetables has

shown benefits for blood pressure due to their potassium content. Potassium-rich foods counterbalance sodium levels in the body, while fiber-rich diets are associated with lower hypertension risk. However, the relationship between vegetable and fruit consumption and hypertension risk remains complex; certain vegetables, such as broccoli, carrots, and nuts, are beneficial, whereas others, like beans and cabbage, may not reduce hypertension risk as effectively. (37,38) Not consuming vegetables and fruit is related to hypertension (p value=0.018) because many factors cause hypertension; apart from that, the amount of potassium content in vegetables and fruit must be adjusted to the amount of sodium consumed through other types of food.(37,39) and in several studies, fruit and vegetable consumption is significantly related to hypertension.(40)

The analysis indicates that western areas of Java Island, particularly West Java and Banten Provinces, exhibit high salt and processed food consumption patterns alongside a relatively high prevalence of hypertension. Based on these findings, public health interventions could focus on this region with several approaches. First, nutrition education and counseling campaigns should aim to reduce the intake of high-sodium foods, including processed and salty foods, as well as instant noodles. These educational efforts could be implemented through local health centers, community health posts, and schools to raise awareness of the risks of excessive sodium related to hypertension. Additionally, enhancing public understanding of nutritional labeling on food packaging, especially sodium content, would empower consumers to make informed choices. This campaign could be conducted through social media, public service announcements, and collaborations with the food industry to create more easily understandable labels. Another key intervention is the promotion of healthier food options. Encouraging local food vendors and small businesses to offer low-sodium and low-MSG alternatives would provide the community with healthier choices.

Targeting interventions in areas with high hypertension prevalence and risky food consumption patterns can significantly reduce hypertension rates by encouraging dietary changes. This region-specific approach also allows for adjustments tailored to each area's social and cultural characteristics.

This study is limited by its ecological design, which analyzes aggregate data on the relationship between the proportion of risky food consumption behavior and hypertension prevalence across districts and cities on Java Island. Consequently, the findings do not capture individual-level associations between specific risky dietary behaviors and hypertension incidence, thus limiting the ability to generalize these results to individual behavior patterns. Another limitation is the difference in age groups used for the data sources: risky food consumption behavior was

measured by household members aged ≥ 3 years, whereas hypertension prevalence was measured only among household members aged ≥ 18 years. This age difference may reduce the comparability between risky dietary behavior and hypertension prevalence within the study sample. Despite these limitations, the findings highlight significant patterns at a regional level that provide valuable insights for targeting public health interventions in high-risk areas on Java Island.

CONCLUSION

Risky food consumption behavior with a higher proportion is more clustered in districts/cities west of Java Island, especially West Java. There is a significant relationship between the Proportion of Consuming Food containing Flavoring spices (CFF) ≥ 1 time day and Proportion of Not Consuming Vegetables and Fruit (NCVF) with the prevalence of hypertension in 119 districts/cities in Java, Indonesia. The findings underscore a pressing public health need, as high sodium intake remains a critical risk factor contributing to elevated blood pressure and hypertension.

This correlation is essential for shaping effective public health policies to curb hypertension rates in Indonesia. Addressing this issue might include promoting potassium chloride as an alternative to sodium in food products, given potassium's role in counteracting sodium and aiding blood pressure regulation. This approach would require food industry compliance with sodium-reduction standards, with government oversight and penalties for violations, ensuring public health safeguards against excessive sodium intake.

Ultimately, a region-specific intervention approach targeting high-risk areas with elevated hypertension prevalence and risky dietary patterns holds the potential for substantial health benefits. This geographically tailored strategy allows for more culturally appropriate interventions, increasing the likelihood of effective public health outcomes in Indonesia.

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REFERENCES

1. WHO. Hypertension [Internet]. 2021. p. 1–6. Available from: <https://www.who.int/health-topics/hypertension>
2. WHO. Global report on hypertension: the race against a silent killer [Internet]. Vol. 01, World Health Organization. Geneva; 2023. 291 p. Available from: <https://www.who.int/teams/noncommunicable-diseases/hypertension-report>

3. Abbafati C, Abbas KM, Abbasi-Kangevari M, Abd-Allah F, Abdelalim A, Abdollahi M, et al. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2020;396(10258):1223–49.
4. Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, Himmelfarb CD, et al. Clinical Practice Guideline: Executive Summary [Internet]. Vol. 71, Hypertension. 2018. 1269–1324 p. Available from: <http://hyper.ahajournals.org>
5. WHO. Healthy diet [Internet]. 2019 [cited 2024 Mar 20]. p. 20. Available from: <https://www.who.int/news-room/fact-sheets/detail/healthy-diet>
6. NHS UK. High blood pressure. [Internet]. Scientific American. 2024 [cited 2024 Mar 20]. Available from: <https://www.nhs.uk/conditions/high-blood-pressure/>
7. WHO. WHO global report on sodium intake reduction [Internet]. Geneva: World Health Organization; 2023. 99 p. Available from: <https://www.who.int/publications/i/item/9789240069985>
8. Aristi DLA, Rasni H, Susumaningrum LA, Susanto T, Siswoyo S. The Relationship Between High Sodium Food Consumption and The Incidence of Hypertension Among Farm Workers at Public Health Centre of Panti in Jember Regency. *Bul Penelit Sist Kesehat* [Internet]. 2020;23(1):53–60. Available from: https://repository.unej.ac.id/bitstream/handle/123456789/103077/F.KEP_JURNAL_HUBUNGAN_KONSUMSI_MAKANAN_TINGGI_NATRIUM_DENGAN_TANTUT_SUSANTO.pdf?sequence=1&isAllowed=y
9. Astuti ISW. Correlation Analysis of Food Consumption Pattern that Induced Hypertension on Farmer in Rural Areas of Jember Regency. *J Agromedicine Med Sci*. 2017;3(3):7.
10. National Institute of Health Research and Development. National Riskesdas Report [Internet]. Kementerian Kesehatan RI. Jakarta; 2019. Available from: https://repository.badankebijakan.kemkes.go.id/id/eprint/3514/1/Laporan_Riskesdas_2018_Nasional.pdf
11. National Institute of Health Research and Development. Banten Province Riskesdas Report 2018 [Internet]. Badan Penelitian dan Pengembangan Kesehatan. Jakarta; 2018. Available from: https://repository.badankebijakan.kemkes.go.id/id/eprint/3856/1/LAPORAN_RISKESDAS_BANTEN_2018.pdf
12. National Institute of Health Research and Development. DKI Jakarta Province Riskesdas Report 2018 [Internet]. Kementerian Kesehatan RI. Jakarta; 2019. Available from: https://repository.badankebijakan.kemkes.go.id/id/eprint/3881/1/CETAK_LAPORAN_RISKESDAS_DKI_2018.pdf
13. National Institute of Health Research and Development. West Java Province Riskesdas Report 2018 [Internet]. Kementerian Kesehatan RI. Jakarta; 2019. Available from: https://repository.badankebijakan.kemkes.go.id/id/eprint/3857/1/LAPORAN_RISKESDAS_JAWA_BARAT_2018.pdf
14. National Institute of Health Research and Development. Central Java Province Riskesdas 2018 Report [Internet]. Kementerian Kesehatan RI. Jakarta; 2019. Available from: https://repository.badankebijakan.kemkes.go.id/id/eprint/3882/1/CETAK_LAPORAN_RISKESDAS_JATENG_2018.pdf
15. National Institute of Health Research and Development. DI Yogyakarta Province Riskesdas 2018 Report [Internet]. Jakarta: Badan Penelitian dan Pengembangan Kesehatan; 2019. Available from: https://repository.badankebijakan.kemkes.go.id/id/eprint/3880/1/CETAK_LAPORAN_RISKESDAS_DIY_2018.pdf
16. National Institute of Health Research and Development. East Java Province Riskesdas Report 2018 [Internet]. Kementerian Kesehatan RI. Jakarta: Badan Penelitian dan Pengembangan Kesehatan; 2019. Available from: https://repository.badankebijakan.kemkes.go.id/id/eprint/3901/1/LAPORAN_RISKESDAS_JAWA_TIMUR_2018.pdf
17. Rina, Setiawan, Siregar CT. Experiences of Minang Primary Hypertension Patients Undergoing Treatment at Home. *Ners J Keperawatan* [Internet]. 2016;12(1):48–66. Available from: https://download.garuda.kemdikbud.go.id/article.php?article=904747&val=14210&title=PENGALAMAN_PASIEN_HIPERTENSI_PRIMER_SUKU_MINANG_YANG_MENJALANI_PERAWATAN_DI_RUMAH
18. Ariwibowo GA. The Culture of Eating Outside the Home in Urban Java in the Late Colonial Period. *Kapata Arkeol*. 2016;12(2):199.
19. Cox GO, Lee Y, Lee SY. Drivers of Liking in a Model Retorted Creamy Tomato Soup System with Varying Levels of Sodium, Fat, and Herbs. *J Food Sci*. 2019;84(9):2610–8.
20. Wang C, Lee Y, Lee SY. Consumer acceptance of model soup system with varying levels of herbs and salt. *J Food Sci*. 2014;79(10):S2098–106.
21. Kurtanty D, Faqih DM, Upa NP. Review Monosodium Glutamat How To Understand It Properly? [Internet]. Vol. 53, *Journal of Chemical Information and Modeling*. 2019. 1–87 p. Available from: <https://www.ajinomoto.co.id/template/ajinomoto/src/img/uploads/Buku-review-MSG-edisi-ke-4.pdf>
22. Rangkuti RPW, Sudaryati E, Nasution E. The Relationship between Knowledge and Attitudes and the Actions of Housewives in Using Instant Cooking Spices in Tanjung Sari Village, Medan Selayang District, Medan City [Internet]. Vol. 1. Universitas Sumatera Utara; 2018. Available from: <http://repositori.usu.ac.id/handle/123456789/2220>
23. Dunteman AN, McKenzie EN, Yang Y, Lee Y, Lee SY. Compendium of sodium reduction strategies in foods: A scoping review. *Compr Rev Food Sci*

- Food Saf. 2022;21(2):1300–35.
24. Mulyasari I, Septiar Pontang G. The Relationship Of Intake Of Fat, Fiber, Potassium, Sodium, And Frequency Of Fried Food Consumption With The Incidence Of Hypertension In Men Aged 40-50 Years In Gedanganak Village, Ungaran Timur District, Semarang District. *J Gizi dan Kesehatan* [Internet]. 2017;9(Vol 9 No 22 (2017): JURNAL GIZI DAN KESEHATAN):166–77. Available from: <http://jurnalgizi.unw.ac.id/index.php/JGK/article/view/204/160>
 25. Yonata A, Indah I. Toxic effects of consuming monosodium glutamate. *Majority* [Internet]. 2016;5(3):100–4. Available from: <http://repository.lppm.unila.ac.id/22691/1/1044-1594-1-PB.pdf>
 26. Adiyasa IN, Abdi LK, Fujiawati R. Mother's level of knowledge, role of health workers, and behavior in using monosodium glutamate (MSG) flavoring in cooking. *J Kesehatan Prima* [Internet]. 2016;10(2):1756–66. Available from: <http://jkp.poltekkes-mataram.ac.id/index.php/home/article/view/27>
 27. Lucas L, Riddell L, Liem G, Whitelock S, Keast R. The Influence of Sodium on Liking and Consumption of Salty Food. *J Food Sci*. 2011;76(1):72–6.
 28. Dunteman AN, Lee Y, Lee SY. A qualitative look at perception and experience of sodium reduction strategies in the food industry through focus groups and individual interviews. *J Food Sci*. 2023;88(5):2203–16.
 29. Barnett SM, Sablani SS, Tang J, Ross CF. Utilizing Herbs and Microwave-Assisted Thermal Sterilization to Enhance Saltiness Perception in a Chicken Pasta Meal. *J Food Sci*. 2019;84(8):2313–24.
 30. Lopes C de O, Barcelos M de FP, Dias NAA, Carneiro J de DS, de Abreu WC. Effect of the addition of spices on reducing the sodium content and increasing the antioxidant activity of margarine. *LWT-Food Sci Technol* [Internet]. 2014;58(1):63–70. Available from: <http://dx.doi.org/10.1016/j.lwt.2014.02.029>
 31. Permenkes RI. Peraturan Menteri Kesehatan Republik Indonesia Nomor 30 Tahun 2013 tentang Pencantuman Informasi Kandungan Gula, Garam, dan Lemak Serta Pesan Kesehatan Untuk Pangan Olahan Dan Pangan Siap Saji [Internet]. Kementerian Kesehatan RI. Jakarta; 2013. Available from: <https://peraturan.bpk.go.id/Details/172111/permenkes-no-30-tahun->
 32. Kemenkes RI. Peraturan Menteri Kesehatan Republik Indonesia Nomor 63 Tahun 2015 tentang Perubahan Atas Peraturan Menteri Kesehatan Nomor 30 tahun 2013 tentang Pencantuman Informasi Kandungan Gula, Garam, Dan Lemak Serta Pesan Kesehatan untuk Pangan Olahan dan Pangan S [Internet]. Peraturan Menteri Kesehatan Republik Indonesia Nomor 4 Tahun 2018. Jakarta; 2014. p. 4. Available from: <https://peraturan.bpk.go.id/Details/172110/permenkes-no-63-tahun-2015>
 33. Badan Pengawas Obat dan Makanan. Peraturan Badan Pengawas Obat dan Makanan Nomor 26 Tahun 2021 tentang Informasi Nilai Gizi Pada Label Pangan Olahan [Internet]. Badan Pengawas Obat dan Makanan. Jakarta; 2021. p. 94. Available from: <https://peraturan.go.id/files/bn1217-2021.pdf>
 34. Kim MK, Lee KG. Consumer Awareness and Interest Toward Sodium Reduction Trends in Korea. *J Food Sci*. 2014;79(7).
 35. WYATT CJ. Adequacy of Food Labeling for Consumers on Limited Sodium Diets. *J Food Sci* [Internet]. 1980 Mar 25;45(2):259–61. Available from: <https://ift.onlinelibrary.wiley.com/doi/10.1111/j.1365-2621.1980.tb02590.x>
 36. Henney JE, Taylor CL, Boon CS. Strategies to reduce sodium intake in the United States. *Strategies to Reduce Sodium Intake in the United States*. Washington, D.C: The National Academies Press; 2010. 1–493 p.
 37. Fadillah NA, Fakhriyah F, Pujianti N, Sari AR, Hildawati N, Fitria F. The Influence of Smoking Behavior, Fruit and Vegetable Consumption on the Incident of Hypertension (Cross Sectional Study in Communities in the Working Area of Aluh-Aluh Community Health Center, Banjar Regency) Noor. *An-Nadaa J Kesehatan Masy*. 2023;10(2):139.
 38. Indriani S, Fitri AD, Septiani D, Mardiana D, Didan R, Amalia R, et al. Knowledge, Attitudes and Behavior of Elderly People with a History of Hypertension Regarding Factors that Influence Hypertension. *J Pengabdian Kesehatan Masyarakat*. 2021;1(2):39–50.
 39. Rosadi D, Hildawati N. Analysis of risk factors for the incidence of hypertension in the community in the working area of the Sungai Raya Health Center, Hulu Sungai Selatan Regency. *J Heal Epidemiol Commun Dis*. 2022;7(2):60–7.
 40. Syamsi F. The Relationship Between Family History, Consumption of Fruits and Vegetables, and Physical Activity and Hypertension. *J Berk Epidemiol*. 2019;7(3):217.