

RESEARCH ARTICLE

Dietary sodium intake and its association with hypertension: A cross-sectional study in Selangor, Malaysia

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Abstract

Objective: To identify the prevalence of hypertension and its relationship with dietary sodium intake among the Malay population in Selangor, Malaysia.

Methods: Respondents were recruited from the year 2013 to 2015 from households in Klang Valley (urban area) and several settlements of the Federal Land Development Authority (FELDA) in Selangor (rural area). Data were collected using two questionnaires, a sociodemographic questionnaire and a food frequency questionnaire.

Results: A total of 3,453 adults participated in this study. The mean age of the respondents was 50.9 (± 10.23) years. The prevalence of hypertension was 23.3%. Mean dietary sodium consumption was 3.6 (± 6.63) grams/day, 1.6 grams higher than the current WHO recommendation. The prevalence of hypertension was higher among males aged 60 years and older; among rural population with low education level; among housewives and those with high dietary sodium intake. After adjusting for age, gender and marital status in a multiple logistic regression analysis, rural location (OR = 5.81) and high sodium intake (OR = 2.33) have been shown to affect the incidence of hypertension.

Conclusion: A substantial proportion of Malay population in Selangor was hypertensive with a higher sodium intake than the WHO recommendation. Hypertension was associated with rural location and high sodium intake. Sustainable and cost-effective population-based health promotion and prevention interventions using a multi-sectoral approach are needed to ensure sufficient community sodium intake.

Keywords: Hypertension, High blood pressure, Dietary sodium, Malay population. (JPMA 71: S-68 [Suppl. 2]; 2021)

Introduction

Hypertension is defined as systolic blood pressure (SBP) of 140 mmHg or greater or diastolic blood pressure (DBP) of 90 mmHg or more.¹ It is the leading cause of cardiovascular disease and stroke, killing around 7.5 million people worldwide each year. Over the last 40 years, the number of people living with hypertension has doubled, with the problem shifting from rich Western countries to developing countries.² Globally, more than one billion adults have hypertension, and this number is expected to increase to 1.5 billion by 2025.³ In Malaysia, according to the latest National Health and Morbidity Survey,⁴ the prevalence of hypertension among adults was 30.3% (6.1 million), including 17.2% of previously undiagnosed adults. This indicates that more than half of them were unaware of hypertension.

Various factors can influence or accelerate the development of hypertension, such as genetic, lifestyle and environmental. Undoubtedly, excess salt intake consumption is a major contributor to hypertension, the

leading individual risk factor for death and disease burden worldwide.⁵ Previous epidemiological studies have shown that populations with higher sodium intakes have a higher incidence of hypertension relative to lower sodium-intake populations. In the PURE research,⁶ a direct relationship between 24-hour urinary sodium excretion and blood pressure was revealed. DASH trials indicated that blood pressure can be substantially lowered by reducing sodium intake from 150 mmol/day to 100 mmol/day and further to 50 mmol/day.⁷

There is a clear evidence of the effectiveness of lowering salt intake to lower blood pressure, which has a subsequent effect on cardiovascular disease.⁸ Population salt reduction has been listed as one of the top five priority strategies for the prevention of non-communicable diseases (NCDs) based on criteria such as health benefits, cost-effectiveness, low costs of implementation and political and financial feasibility.⁹ Reducing salt intake by 30% was one of the nine global targets endorsed by all the WHO Member States to minimise NCDs.¹⁰

Malaysia initiated its Salt Reduction Programme in 2011 with an emphasis on health promotion and education to raise awareness of salt and its health impacts on the general population. However, the 2012 study¹¹ found that the mean salt consumption was 8.7 grams/day, or equal

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to 3.4 grams of sodium/day, which was higher than the WHO recommendation. The current WHO guideline for dietary sodium intake is <2 grams/day (equivalent to <5 grams/day of salt).¹² Current US dietary guidelines suggest restricting sodium consumption to 2.3 grams/day for healthy individuals below the age of 50.¹³ At the same time, adults over 50 years of age, all African-Americans and those with hypertension, diabetes or chronic kidney disease are recommended to limit sodium intake to 1.5 grams/day. However, average consumption levels in many countries are much higher, with most Americans eating about 3.5 grams/day¹⁴ and Canadians about 3.5 to 4.0 grams/day. A similar finding was also made in the current report, where the mean sodium intake for respondents was 3.6 grams/day.

Interestingly, recent studies have called the existing recommendations into question and established the need to recommend higher levels of sodium restriction and to consider intakes of other minerals, such as potassium, magnesium and calcium, in addition to sodium in relation to blood pressure control. Mente found that, contrary to common opinion, low-salt diets (<3 grams/day) may not be beneficial and may increase the risk of cardiovascular disease and death relative to normal salt intake. He has also shown that reducing sodium intake is better aimed at those with hypertension who also consume high sodium diets and has shown that dietary potassium plays a greater role in evaluating improvements in blood pressure than sodium. Another research in the United States also endorsed the concept of modifying the existing salt restriction policy.¹⁴ This research found that after following more than 2,600 normotensive men and women over 16 years of age, participants who ate less than 2,500 mg of sodium/day had a higher blood pressure than those who consumed higher levels of sodium. The study also backed the possibility that minerals other than sodium, such as magnesium and calcium, had a major dietary effect on blood pressure control.

These findings have led to new understanding of the relationship between salt intake and health and challenge the appropriateness of existing guidelines that prescribe low sodium intake for the whole population. Consequently, an approach that suggests salt in moderation, focusing primarily on those with hypertension, is more in-line with existing evidence by Mente et al.⁶

As the prevalence of hypertension in Malaysia rises, there is a need for additional consideration to the severity of hypertension in Malaysia. Since there is a lack of studies investigating the association between dietary intake and

hypertension in Malaysia, the current study aimed at identifying the prevalence of hypertension and its relationship with dietary sodium intake among urban and rural Malay populations in Malaysia.

Subjects and Methods

This cross-sectional study was carried out between 2013 to 2015 among the adult population in the state of Selangor. A simple random sampling approach was used to select respondents in the Klang Valley; namely the settlements of Ampang, Cheras and Hulu Langat (urban areas) and the Federal Land Development Authority (FELDA) in Kuala Kubu Bharu, Kuala Selangor, Tanjung Karang and Sabak Bernam (rural areas). Home visits have been made, and respondents were briefed about the study. Trained interviewers administered face-to-face interviews using a standardised pre-tested questionnaire with the consent of the respondents.

The inclusion criteria for the study were Malaysians of Malay origin between 35 and 75 years of age who had at least one blood pressure measurement taken during the interview. Of the 7,839 adults who responded, 3,453 (44.0%) met the study requirements. The questionnaires were made available in the Malay language and consisted of two parts. The first section consisted of questions about the respondents' sociodemographic background. The second section was a Food Frequency Questionnaire (FFQ), which asked respondents to show the frequency of their consumption of 137 selected food types. The amount of food intake ranged from 'never' to 'more than 6 servings per day'. The sodium content was determined on the basis of the value of each type and frequency of daily intake of food. For data analysis, the amount of dietary sodium intake was divided into two categories: high sodium intake (≥ 2.0 grams/day) and low sodium intake (<2.0 grams/day).

Hypertension being the dependent variable, blood pressure readings equal to 140 mmHg SBP and/or 90 mmHg DBP is considered to be hypertension.¹ Any readings below these levels were considered normal. Blood pressure was assessed by a qualified research assistant at all centres following a standardized protocol using a digital blood pressure measuring device (Omron HEM-757). The mean of the two measurements was used for all the analyses. Independent variables included demographic factors, such as age, gender and locality; rural or urban; education; occupation and marital status. The ages of respondents were either < 60 or ≥ 60 years of age. Education was classified as either a low education level, i.e. none, primary school or secondary school, or a high education level, i.e. college, university or higher

level. For marital status, married respondents were categorised as married, and those who were single, divorced, widowed or separated were categorised as not married. Dietary sodium intake was classified into two groups, i) low sodium intake (<2.0 grams/day) and ii) high sodium intake (\geq 2.0 grams/day), as recommended by the WHO for adult dietary sodium intake.¹²

Data were analysed using the IBM Statistical Package for Social Sciences (SPSS), Version 22. Categorical data were presented as frequencies and percentages, while numerical data were presented as means and standard deviations. The Pearson chi-squared test was used to analyse categorical independent variables. Multivariate analysis was used to determine the predictors for hypertension while adjusting for confounding factors. The 95% confidence interval and a p-value of <0.05 were used to determine the level of significance. The study was approved by the research and ethics committee of the National University of Malaysia Medical Centre (approval code: UKM3.2.24/244/2).

Results

Sociodemographic characteristics of the respondents:

The total number of respondents in this study was 3,453, with a higher proportion of women, 1999 (57.9%) than men, 1454 (42.1%) (Table-1). The ages of the respondents ranged from 35 to 75, with a mean age of 50.9 (\pm 10.23). The majority of the respondents, 2663 (77.1%) were under 60 years of age. The distribution of respondents by locality was comparable; however, a slightly higher proportion of respondents came from rural areas. The majority of respondents had received formal education; 1663 (48.2%) had received a secondary school education, and 207 (6%) did not have any formal education. The majority of respondents were housewives, 1465 (42.4%) who were already married, 3110 (90.0%).

Prevalence of hypertension: The prevalence of hypertension was 805 (23.3%) (Table-1), with a higher prevalence in the rural population, 529 (28.6%) (Table 2). Interestingly, the majority of the respondents 2200 (63.7%) were found to have a lower sodium intake (<2.0 grams/day) in their diet (Table-1). There was a higher prevalence of hypertension in males, 356 (24.5%) compared to females, 449 (22.5%) (Table-2). The mean dietary sodium intake was 3.64 g/day, which was higher than the current WHO guideline (<2 grams/day) (Table-1).

Predictors of hypertension: The risk factors examined in this study were age, gender, locality, marital status, educational level, occupation and dietary sodium intake. Bivariate and multivariate analyses, based on the

Table-1: Sociodemographic characteristics of the respondents (N = 3,453).

Variables	Mean (min, max)	SD	N	(%)
Age (in years)	50.91 (35, 75)	10.23		
<60			2663	77.1
\geq 60			790	22.9
Gender				
Male			1454	42.1
Female			1999	57.9
Locality				
Rural			1850	53.6
Urban			1603	46.4
Marital Status				
Never Married			95	2.8
Currently Married			3110	90.0
Widowed/Divorced			235	6.8
Separated			13	0.4
Educational level				
No education			207	6.0
Primary School			1061	30.7
Secondary School			1663	48.2
College/University			522	15.1
Occupation				
Professional			530	15.3
Semi-Professional			1140	33
Labourer			318	9.2
Housewife			1465	42.4
Hypertension				
Yes			805	23.3
No			2468	76.7
Sodium (in grams)	3.64 (0, 69.97)	6.63		
Low (<2.0 grams/day)			2200	63.7
High (\geq 2.0 grams/day)			1253	36.3

predictors, were performed to determine the adjusted odds ratio against the hypertension outcome. As a result, locality, educational level, occupation and dietary sodium intake were significantly associated with hypertension among respondents (Table-2). Age, gender and marital status have not been found to be significant.

While there were no significant associations between some of the independent variables and hypertension, certain trends were noted (Table-2). Hypertension was somewhat higher among the older age group (\geq 60 years of age) 200 (25.3%), males 356 (24.5%) and those who were not married (separated, never married, or widowed/divorced), 25 (26.3%).

The results of multiple logistic regression analysis with hypertension status as a dependent variable are shown in Table-3. Even after adjusting for the confounding factors, it was noticed that hypertension was affected by rural locality and high sodium intake. Rural locality and high sodium intake were suggested as strong predictors of hypertension in which rural locality and high sodium

Table-2: Factors associated with hypertension among the respondents (N = 3,453).

		Hypertension				χ^2	p
		No		Yes			
		n	%	n	%		
Age (years)	<60	2058	77.3	605	22.7	2.3	0.129
	\geq 60	590	74.7	200	25.3		
Locality	Rural	1321	71.4	529	28.6	62.18	< 0.001*
	Urban	1327	82.8	276	17.2		
Education Level	None	149	71.9	58	28.1	21.26	< 0.001*
	Primary School	778	73.3	283	26.7		
	Secondary School	1288	77.5	375	22.5		
	College/University	433	83.0	89	17.0		
Occupation	Professional	431	81.3	99	18.7	11.88	0.008*
	Semi-professional	880	77.2	260	22.8		
	Labourer	228	71.7	90	28.3		
	Housewife	1109	75.7	356	24.3		
Marital Status	Never married	70	73.7	25	26.3	1.18	0.759
	Currently married	2392	76.9	718	23.1		
	Widowed/Divorced	177	75.3	58	24.7		
	Separated	9	69.2	4	30.8		
Gender	Female	1550	77.5	449	22.5	1.93	0.165
	Male	1098	75.5	356	24.5		
Sodium	Low (<2.0 grams)	1706	77.5	494	22.5	2.5	< 0.001*
	High (\geq 2.0 grams)	942	75.2	311	24.8		

* Statistical significance $p < 0.05$.**Table-3:** Factors predicting hypertension among the respondents.

Factor	Wald test	Multiple Logistic Regression		
		p-value	Adj. OR	95% CI
Rural locality	373.43	0.001*	5.81	4.86 - 6.95
Education				
Primary	1.91	0.168	1.26	0.91 - 0.76
Secondary	19.83	0.110	1.31	0.94 - 1.82
Occupation				
Housewife	1.77	0.183	1.23	0.91 - 1.66
High sodium intake	2.50	0.014*	2.33	0.97 - 1.34

*Statistical significance $p < 0.05$.

intake had adjusted odds ratios of 5.81 and 2.33, respectively. For the other risk factors, i.e. educational level and occupation, after adjusting for the confounding risk factors, these factors were found to be no longer significant.

Discussion

The rising prevalence of hypertension has reached a worrying level in developing countries. Most substantial increases have been seen in South Asia and parts of Africa. This rising prevalence is consistent with evolving people's lifestyles, such as unhealthy diet, lack of physical activity and commuter families. In Western countries, such as the

United Kingdom and other parts of Europe, rates have fallen significantly. This is possibly due to healthy diets, primarily as a result of government policies aimed at lowering salt intake.²

In the current study, the overall prevalence of hypertension was found to be 23.3%, significantly lower than the national prevalence of 30.3%.⁴ This lower prevalence, relative to national data may have contributed to the age and gender of the respondents and the time of sampling. However, this prevalence is comparable to that reported in studies of other developing countries, such as Vietnam (25.1%)¹⁵ and India (29.8%).¹⁶

Comparing localities, the current research found that the rural population (28.6%) had almost twice the prevalence of hypertension compared to the urban population (17.2%). This is consistent with the results of 2015 National Health and Morbidity Survey (NHMS),⁴ which also found that the prevalence of hypertension in rural Malaysia (33.5%) was higher than in urban areas (29.3%). Higher education, healthier dietary patterns and lifestyle can lead to a lower prevalence of hypertension in urban areas.

Unhealthy diets, lack of physical activity and a sedentary occupation are among the predictors of the higher prevalence of hypertension in rural areas. Rural Malay

cuisine is considered to contain high levels of salt in a variety of food forms, such as salted egg, salted fish and pickled fruits, and Malay condiments, such as pickled fish (pekasam), shrimp paste (belacan), pickled anchovies (budu), fermented shrimps (cencalok) and fermented durian (tempoyak). More than 25% (27% to 35%) of the respondents at least once a week consume tempoyak, soy sauce, chilli sauce and oyster sauce as part of their diet. In addition, salt per se is not only used for cooking food, but is often applied directly to food as a condiment. In comparison to these findings, according to an INTERSALT study,¹⁷ urban rather than rural populations were reported as having higher salt intake and tend to have the highest percentage of hypertension.

Dietary sodium and its association with hypertension have been explored extensively in the past.¹⁸ The relationship between sodium intake and blood pressure has been recorded in numerous cross-sectional studies^{6,17,19} and experimental studies have studied the effects of changes in sodium intake.²⁰⁻²² These findings suggest that people who consume higher levels of sodium are more vulnerable to hypertension than those who consume low sodium.

The strengths of the current study are that, the results can be derived from the Selangor population as the respondents were representative of both its urban and rural areas. Secondly, the analysis consisted a broad sample size. Third, the amount of salt in a person's diet can be accurately quantified using a validated semi-quantitative food frequency questionnaire.

One of the study's limitation was its cross-sectional study design, which was unable to establish a causal relationship between sodium intake and hypertension. For rigorous study designs, such as longitudinal or cohort studies, are required for future research to determine the effect of different concentrations of sodium intake on the development of hypertension and other circulatory diseases. The role of high potassium intake with lower dietary sodium and potassium ratios (Na⁺ : K⁺) in reducing hypertension prevalence is an important factor not included in this study. Population studies²³ have shown that those who take part in potassium rich diets, vegetables, fruit and low-fat dairy products (including whole grains, poultry, fish and nuts) have lower mean arterial blood pressure.

Conclusion

A substantial proportion of Malay population in Selangor was hypertensive with a higher sodium intake than the WHO recommendation. Hypertension was associated

with rural location and high sodium intake. Sustainable and cost-effective population-based health promotion and prevention interventions using a multi-sectoral approach are needed to ensure sufficient community sodium intake.

Further studies should be conducted locally to determine the best practise guideline or approach to the recommendation of salt in moderation, with a particular focus on those with hypertension, to be consistent with current evidence.

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