

# Sodium Intake and Socio-Demographic Determinants of the Non-Compliance with Daily Sodium Intake Recommendations: Thai NHES IV

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**Objective:** To estimate daily intake of sodium and examine the relation of socio-demographic factors with sodium intake exceeding the recommendations.

**Material and Method:** Data from the Thai National Health Examination Survey IV (NHES IV) conducted during 2008-2009 were used. The 24-hour-dietary-recall data were available for a subsample of 10% of the total participants. All food and beverage data were analyzed for amount of total daily sodium intake for each person. In statistical analyses, descriptive statistics were employed to describe participants' characteristics, quantities of dietary sodium and percentages of participants non-compliant with daily sodium intake recommendations. Logistic regression was used to examine socio-demographic determinants of sodium intake exceeding the recommendations.

**Results:** 2,969 participants participated in this study. Sodium intake varied by socio-demographics. Percentages of participants non-compliant with sodium intake recommendations ranged from 75.3 ( $\geq 1,500$  mg) to 52.0 ( $\geq 2,400$  mg) for those aged <16 years and from 86.3 ( $\geq 1,500$  mg) to 67.6 ( $\geq 2,400$  mg) for those aged  $\geq 16$  years. In the younger group, age and region were key determinants of consuming sodium exceeding all recommendations. Having family income between 5,000 and <10,000 baht/month was significantly associated with sodium intake exceeding recommendation targets. In the older group, being female and increasing age reduced a risk of non-compliance with some recommendations; oppositely, region and residential area participants lived significantly, increased non-compliant risk.

**Conclusion:** Most participants consumed dietary sodium exceeding current recommendations. Effective programs to reduce sodium intake in Thais are critical.

**Keywords:** Sodium, Socio-demographic determinants, Recommendations, Thai NHES

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Sodium is one of major minerals that the human body requires for maintaining several essential functions. By co-working with other electrolytes, sodium helps the body to regulate fluid and blood

pressure<sup>(1,2)</sup>, maintain electrolyte balance and also assists in nerve impulse transmission, muscle contractions and nutrient transport processes<sup>(1)</sup>. Recommendations of daily requirement of sodium intake vary across countries. For example, in the United States, the adequate intake (AI) of sodium for Americans aged 1 year old and older ranges from 1,000 to 1,500 mg/day depending on age and gender groups<sup>(3)</sup>. In Thailand, for Thai people with the age of 1 year old and older, the

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Dietary Reference Intake of Thais (Thai DRI) for sodium ranges from 225 to 1,600 mg/day<sup>(4)</sup>.

Due to the relation of sodium with hypertension and cardiovascular disease (CVD)<sup>(5-8)</sup>, several health organizations have established daily, recommended amounts of sodium depending on age that the general people should consume with no harm to health. For instance, to protect against chronic diseases, the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) of the United Nations suggest that the population worldwide should consume salt less than 5 g/day or 2,000 mg/day of sodium<sup>(9)</sup>. The American Society of Hypertension (ASH) suggests the general Americans to eat no more than 2,300 mg/day of sodium<sup>(10)</sup>, while the Committee on Development of Dietary Reference Intake for Thais hints the daily sodium consumption should be less than 2,400 mg<sup>(4)</sup>. Furthermore, due to physiological differences, the age-specific nutrition guidelines for healthy eating and chronic disease prevention are proposed. This includes the sodium intake recommendation for children and adolescents. For instance, the American Heart Association (AHA) suggests children aged 1-3, 4-8, 9-13, 14-18 years should consume sodium <1,500, <1,900, <2,200, and <2,300 mg/day<sup>(11)</sup>, respectively.

Unfortunately, most people have consumed sodium over its recommended levels. Brown and colleagues<sup>(12)</sup> evaluated the quantities of sodium consumed by the population in various countries, except Thailand, by using the data from national surveys and observational studies, gathering the sodium intake data during 1985 to 2005. On the whole, a majority of adult people consumed sodium on an average intake of >2,300 mg/day; interestingly, many countries, e.g. Brazil, Panama, Japan, and People's Republic of China, have the average sodium intake at >4,600 mg/day. Compared with adult population, children aged 1-5 years old consumed less amounts of sodium, ranging from 1,343 to 2,300 mg/day. As for children over 5 years old and adolescents, the mean sodium intake varied from 1,796 to 4,400 mg/day. Notably, these consumed amounts seem to be larger than sodium levels recommended by the AHA<sup>(11)</sup>. However, population-based data on sodium consumption among Thais were sparse. Thus, the current situation of sodium intake in Thai population should be determined. It is not clear whether sodium intake is associated with socio-demographic status. The objectives of this study were to determine the amount of sodium intake among Thai population and examine

the socio-demographic factors associated with sodium intake exceeding recommended levels.

## **Material and Method**

### ***Study design and participants***

The Thai National Health Examination Survey IV (NHES IV) was a cross-sectional survey. A stratified four-stage probability sampling method was used for recruiting participants. Twenty-one provinces were selected as representative. More details are explained elsewhere<sup>(13)</sup>. Additionally, 10% of 31,700 calculated participants aged 1 year old and older were selected at random with replacement as subsamples to gather food consumption data. By this means, 3,170 subsamples would be interviewed about their food intakes by using a single 24-hour-dietary recall. Ethical approvals from the Ethics Review Committee for Research in Human Subjects, Ministry of Public Health and Ethical Clearance Committee on Human Rights, Faculty of Medicine, Ramathibodi Hospital, Mahidol University were obtained. All participants or/and mothers/caregivers of participants, provided written informed consent for a voluntary participation into the NHESIV.

### ***Instrument***

Research instruments utilized in the present study were described as below. First, a questionnaire covered following information: sex, age, marital status, highest educational attainment, family monthly income, region, and residential area. The 24-hour-dietary recall form was designed for recording dietary data. Those data included the name of the meal (e.g. breakfast, lunch, dinner, morning snack, afternoon snack, or evening snack), sources of foods, and details of food and beverage types and amounts consumed. Moreover, a photographic food atlas handbook of illustrations of two-dimensional, portion-size and 45 food pictures with actual size found in Thai households, and portion sizes, was provided. Measuring, cooking and eating utensils were used along with the photographic food atlas handbook. They consisted of a standard plastic liquid measuring cup (250 cc), a set of standard measuring cups, a set of standard measuring spoons, a rice ladle, an Asian soup spoon, and a tea spoon. These last two instruments were used to help participants estimate the amounts of foods they consumed more closely and accurately.

### ***Data collection***

Data collection was performed during July

2008 to March 2009. Interviewers were trained about the NHES IV objectives and survey processes, meaning of each question, process of interview, and practice related to collecting data by interview. On the survey appointment day, the eligible participants or/and their mothers/caregivers were interviewed by trained interviewers about socio-demographic data. To gather food intake data, the trained interviewers asked participants and/or their mothers/caregivers to recall types and amounts of foods eaten more or less one day before the interview. The food atlas handbook and measuring, cooking and eating utensils were exploited as the aids to assist participants to estimate a portion size of foods eaten by them. All food items were recorded in details by the trained interviewers and then the filled questionnaires were checked for completeness by the field supervisors.

#### *Assessment of sodium contents*

Foods, beverages, and ingredients were analyzed for sodium content using the INMUCAL-N version 2.0 WD.5.0 software program (Institute of Nutrition, Mahidol University, Thailand). The reference database of sodium is only available for 65.9% of the total of 2,026 items. To estimate the dietary sodium intake more accurately, all food items commonly consumed by participants were reexamined. If the selected foods were composed of salt or sodium chloride or had a salty taste, but their reference sodium databases from the software program were not available, salt would be added in participants' food intake data before starting the food analysis for dietary sodium content by this software program. In the present study, a quantity of salt in the selected foods was taken from a number of Thai food recipes. The median amount of salt was computed and employed.

#### *Statistical analysis*

Only data of participants with complete and reliable 24-hour-dietary recall and selected socio-demographic data were analyzed in the present study. Thus, a final number of participants was 2,969. Data analyses were conducted by using Stata/SE 10.0 for Windows (StataCorp, College Station, TX). The normality of data distribution was tested by using Skewness-Kurtosis test. In statistical analysis, participants were separated into 2 age groups, 1-15 years old vs. 16 years old and older. Descriptive statistics including the number, percentage, median and/or interquartile range (IQR) were used to describe participants' characteristics, quantities of dietary

sodium and the percentages of participants non-compliant with its recommendations. In the present study, the national and health organizational recommendations<sup>(4,9-11)</sup> of daily sodium intake were applied. Those include <1,500<sup>(11)</sup>, <1,900<sup>(11)</sup>, <2,000<sup>(9)</sup>, <2,200<sup>(11)</sup>, <2,300<sup>(11)</sup> and <2,400 mg/day<sup>(4)</sup> for participants with the age of 1 to 15 years old and older and <1,500<sup>(11)</sup>, <2,000<sup>(9)</sup>, <2,300<sup>(10,11)</sup> and <2,400 mg/day<sup>(4)</sup> for those aged 16 years old and older.

Subsequently, the univariate logistic regression was used to compute crude odd ratios (ORs crude) for socio-demographic factor associated with failure to follow the sodium intake recommendations. In addition, the multivariate logistic regressions, including all selected socio-demographic factors in the model, were performed with the backward elimination. Adjusted odd ratios (ORs adjusted) were reported. The binary outcome variables in the logistic models were "follow the recommendations" as "0" and "exceeding the recommendations" as "1". Depending on the age groups, the selected socio-demographic factors, as independent variables consist of gender, age, family monthly income, region, residential area and/or marital status and highest educational attainment. Statistically significant level was considered at  $p < 0.05$ .

## **Results**

### *Socio-demographic characteristics*

Among 2,969 Thai participants, 32.8% were those aged between 1-15 years old. As illustrated in Table 1, a slightly higher female to male ratio was found in both younger and older groups (1-15 years old vs. 16 years old and older). The 37.2% of the younger group lived in the families with the monthly earnings of 5,000- <10,000 baht, while 41.2% of the older group had the family income equal to <5,000 baht/month. About 60% of both groups lived in an urban area. Among the older group, 2/3 were married and 3/5 only had an elementary school education.

### *Situation of sodium intake*

Table 2 reveals the quantities of sodium intake distributed by the age groups and socio-demographics. Among the older group, the amount of sodium (median = 3,264.5 mg/day) consumed was 1.3 times higher than that of the younger group (median = 2,472.7 mg/day). A variety of sodium quantities were observed across different socio-demographics. For example, participants living in northern Thailand consumed sodium in the largest amount, compared to those living in other regions. With the advanced age, the median sodium

**Table 1.** Characteristics of 2,969 Thai participants

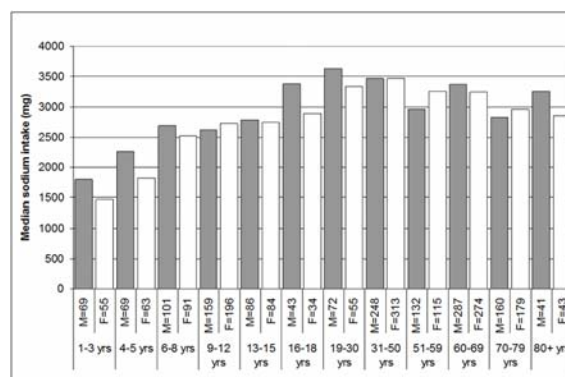
Sociodemographics	1-15 years old (n = 973)	16 years old and older (n = 1,996)
Male (%)	49.7	49.2
Age (years)		
Mean(SD); median	8.6 (3.8); 9.0	54.8 (17.2); 58.0
Family monthly income (%)	n = 814	n = 1,820
<5,000 baht/month	21.3	41.2
5,000-<10,000 baht/month	37.2	21.9
10,000-<15,000 baht/month	16.3	11.5
≥15,000 baht/month	25.2	25.4
Marital status (%)		n = 1,978
Single	-	12.8
Married	-	67.7
Widowed/divorced/separated	-	19.5
Highest educational attainment (%)		n = 1,994
No formal education	-	5.3
Elementary school	-	62.6
Secondary/vocation school	-	25.3
University	-	5.7
Others	-	1.1
Region (%)		
Central including Bangkok	38.2	39.6
North	19.6	19.3
Northeast	21.3	22.0
South	20.9	19.1
Residential area (%)		
Urban	59.5	60.4
Rural	40.5	39.6

intake increased from approximately 1,806 and 1,469 mg/day in 1-3-year-old boys and girls, respectively, to 3,634 mg/day in 19-30-year-old males and 3,471 mg/day in 31-50-year-old females. After that, this trend had gradually decreased (Fig. 1).

Based on the recommended levels of daily sodium intake, the percentages of participants who were non-compliant with recommended ranges were from 75.3 (≥1,500 mg of sodium) to 52.0 (≥2,400 mg) for the younger group and from 86.3 (≥1,500 mg) to 67.6 (≥2,400 mg) for the older group (Table 2).

**Socio-demographic determinants of non-compliance with recommendations**

For the younger group by using univariate and multivariate logistic regressions, age and region were the key socio-demographic determinants of the excessive sodium intake over all recommended levels, namely <1,500, <1,900, <2,200, <2,300 and <2,400 mg/day. Compared to reference (family income <5,000 baht/month), having family, monthly income between 5,000 and <10,000 baht significantly increased the



**Fig. 1** Quantities of sodium intake in different age groups. M = male; F = female

non-compliant risk to almost all sodium intake recommendations (OR<sub>adjusted</sub> = 1.71 for ≥1,900 mg/day of sodium; OR<sub>adjusted</sub> = 1.64 for ≥2,000 mg/day; OR<sub>adjusted</sub> = 1.74 for ≥2,200 mg/day, OR<sub>adjusted</sub> = 1.61 for ≥2,300 mg/day and OR<sub>adjusted</sub> = 1.63 for ≥2,400 mg/day).

Some disparities in determinants of non-compliance with sodium intake recommendations

**Table 2.** Quantities of sodium intake (grams) and percentages of noncompliant participants with daily sodium intake recommendations

Sociodemographics	1-15 years old (n = 973)					16 years old and older (n = 1,996)						
	Median		% of participants non-compliant with recommendations			Median		% of participants non-compliant with recommendations				
	≥1,500 mg	≥1,900 mg	≥2,000 mg	≥2,200 mg	≥2,300 mg	≥2,400 mg	≥1,500 mg	≥2,000 mg	≥2,300 mg	≥2,400 mg		
Total	2472.7	75.3	63.5	61.7	57.1	54.4	52.0	3264.5	86.3	76.3	69.5	67.6
Gender												
Male	2485.5	75.4	62.8	60.9	58.1	55.4	52.7	3309.0	86.5	78.4	70.6	68.3
Female	2463.3	75.3	64.2	62.4	56.2	53.4	51.3	3214.9	86.2	74.3	68.5	66.9
Family monthly income												
<5000 Baht/month	2422.1	77.1	65.1	63.4	56.0	53.7	50.9	3359.3	87.5	77.9	71.6	69.5
5000-<10000 Baht/month	2576.4	76.0	66.8	64.5	59.9	56.2	54.6	3375.4	85.2	76.1	70.3	69.1
10000-<15000 Baht/month	2417.4	72.1	60.3	58.8	56.6	52.2	50.7	3309.0	84.7	74.6	67.0	65.1
≥15000 Baht/month	2454.4	75.6	62.2	60.8	56.5	54.1	50.7	3171.7	87.9	77.5	69.5	66.9
Marital status												
Single	-	-	-	-	-	-	-	3280.0	85.8	77.9	71.6	70.1
Married	-	-	-	-	-	-	-	3336.2	86.8	77.3	70.2	68.3
Widowed/divorced/separated	-	-	-	-	-	-	-	3072.5	85.4	72.7	66.5	63.9
Highest educational attainment												
No formal education	-	-	-	-	-	-	-	2659.6	84.0	69.8	60.4	58.5
Elementary school	-	-	-	-	-	-	-	3345.3	86.0	76.2	70.2	68.1
Secondary/vocation school	-	-	-	-	-	-	-	3246.0	86.9	77.6	69.0	67.3
University	-	-	-	-	-	-	-	3243.3	89.4	79.6	72.6	70.8
Others	-	-	-	-	-	-	-	3138.0	87.0	73.9	73.9	73.9
Region												
Central including Bangkok	1835.3	64.0	47.6	46.2	43.0	39.8	39.0	2769.6	84.3	71.0	62.1	59.3
North	3044.1	78.5	74.9	71.7	67.5	64.4	62.3	4410.4	88.8	84.2	79.5	77.7
Northeast	2855.2	90.8	80.7	78.7	71.5	68.6	64.2	3739.4	90.4	84.1	78.6	77.5
South	2585.6	77.3	64.5	63.0	58.6	57.1	53.7	3039.1	83.2	70.5	64.5	63.2
Residential area												
Urban	2362.2	73.1	59.6	57.5	53.9	50.9	49.0	3133.1	84.8	74.1	66.8	64.6
Rural	2647.2	78.7	69.3	67.8	61.9	59.4	56.3	3476.1	88.7	79.8	73.7	72.1

**Table 3.** Crude and adjusted odd ratios of sociodemographic determinants of noncompliance with daily sodium intake recommendations among Thai participants with the age of 1 to 15 years old and older

	Sodium intake											
	≥1,500 mg		≥1,900 mg		≥2,000 mg		≥2,200 mg		≥2,300 mg		≥2,400 mg	
	OR <sub>crude</sub>	OR <sub>adjusted</sub>	OR <sub>crude</sub>	OR <sub>adjusted</sub>	OR <sub>crude</sub>	OR <sub>adjusted</sub>	OR <sub>crude</sub>	OR <sub>adjusted</sub>	OR <sub>crude</sub>	OR <sub>adjusted</sub>	OR <sub>crude</sub>	OR <sub>adjusted</sub>
<b>Gender</b>												
Male	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Female	0.89	0.87	0.94	0.92	0.95	0.93	0.84	0.80	0.84	0.81	0.86	0.83
Age (years)	1.13***	1.18***	1.11***	1.16***	1.12***	1.17***	1.12***	1.16***	1.11***	1.15***	1.11***	1.15***
<b>Family monthly income</b>												
<5,000 baht/month	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5,000-<10,000 baht/month	0.94	1.42	1.07	1.71*	1.05	1.64*	1.17	1.74**	1.11	1.61*	1.16	1.63*
10,000-<15,000 baht/month	0.76	1.27	0.81	1.38	0.82	1.38	1.02	1.64	0.94	1.46	0.99	1.48
≥15,000 baht/month	0.92	1.50	0.88	1.48	0.89	1.50	1.02	1.58	1.01	1.54	0.99	1.44
<b>Region</b>												
Central including Bangkok	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
North	2.18**	3.39***	3.05***	4.75***	2.84***	4.43***	2.67***	4.20***	2.65***	4.01***	2.52***	3.75***
Northeast	6.51***	8.33***	4.55***	5.78***	4.24***	5.36***	3.32***	4.26***	3.35***	4.18***	2.81***	3.42***
South	2.32***	2.76***	2.06***	2.37***	2.02***	2.32***	1.91**	2.20***	2.08***	2.38***	1.91**	2.16***
<b>Residential area</b>												
Urban	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Rural	1.31	1.22	1.35*	1.26	1.41*	1.34	1.27	1.21	1.28	1.22	1.26	1.20
	n = 824	n = 824	n = 824	n = 824	n = 824	n = 824	n = 824	n = 824	n = 824	n = 824	n = 824	n = 824

Initial model for multivariate logistic regression consists of gender, age, family monthly income, region, and residential area

\* refers to p&lt;0.05, \*\* refers to p&lt;0.01, \*\*\* refers to p&lt;0.001

between age groups were found. In the older group, female gender was more likely to comply with sodium intake <2,000 mg/day recommended by WHO. As well, increasing age predicts a very small lower non-compliant risk to recommendations of <2,300 and <2,400 mg/day of sodium (ORs<sub>adjusted</sub> = 0.99). Marital status, educational attainment, and family monthly income were not significant factors determining whether this participant group would follow all recommendations of sodium intake in multivariate logistic regression analysis. Interestingly, compared with those living in the central region including Bangkok, participants living in the northern and northeastern regions had significantly higher chances to be non-compliant with sodium intake recommendations of <2,000, <2,300, and <2,400 mg/day. Living in rural area had 47% and 31% higher non-compliant risks to sodium intake recommendations of <1,500 (OR<sub>adjusted</sub> = 1.47) and <2,000 mg (OR<sub>adjusted</sub> = 1.31).

## Discussion

Previous studies provide the strong evidence of positive relation between sodium consumption in large amount and the occurrences of chronic diseases<sup>(5-8)</sup>. Besides the practical, reducing intake strategies, a periodic monitor of sodium consumption situation is indispensable. This study reveals that a majority of Thais consumed a large amount of sodium. The median sodium intakes were 2,472.7 mg/day for those aged 1-15 years and 3,264.5 mg/day for those aged 16 years and older. The amount of sodium intake estimated from the present study was slightly lower than that of a survey by the Department of Health, Ministry of Public Health, which reported an average sodium chloride individual Thai consumed was 10.9 g/day or 4,320 mg of sodium<sup>(14)</sup>. The difference in the estimation may be due to the dissimilar methods and number of provinces used to collect data; however, both surveys demonstrated the same direction of over consumption of sodium in the Thai population.

Compared with other countries, the consumption of sodium in Thais from the present study was slightly lower. For example, the NHANES 2005-2008 reported an average intake of sodium in Americans aged  $\geq 2$  years was 3,513 mg/day<sup>(15)</sup>. In prospective study conducted by Takachi et al, Japanese adults ate the median of 4,709 mg of sodium<sup>(16)</sup>. Based on the KNHNES III data, Korean adults in both hypertensive and normotensive had the average daily sodium intake of >5,500 mg<sup>(17)</sup>. Even though Thai population consumed a smaller amount of sodium when compared with others,

sodium quantity was still above its recommended level at 2,400 mg/day of sodium.

The sodium recommendation for Thais at “<2,400 mg/day<sup>(4)</sup>”, is higher than others, for example WHO recommendation, <2,000 mg/day<sup>(9)</sup> or ASH recommendation, <2,300 mg/day<sup>(10)</sup>. Using WHO guidelines, up to 3/5 of the younger and 3/4 of the older could not follow the WHO’s recommendation.

Interestingly, differences in socio-demographic background appear to affect the quantities of sodium intake and also non-compliance with its recommendations. The authors found that in the younger group, age and region were the vital determinants of non-compliance with all sodium intake recommendations. Normally, with growing up, the younger eat more in quantity and variety of foods. Hence, they could get more energy and nutrients including sodium. Thus, the risk to non-compliance rose with increasing age. Moreover, from scrutinizing 24-hour-dietary data in details, the authors observed that on the day of survey, the median quantities of all seasonings consumed by the participants aged 1 to 15 years were likely to increase with age. Notably, 1/3 to 1/2 of all seasonings used for adding food taste were high in sodium. In addition to data from the 24-hour-dietary-recall method, data collected from a simple food frequency questionnaire used in the NHES IV were looked into. It was found that the “old younger” ate instant noodle, French fries, cookie/cake/pie and pizza/spaghetti/hamburger more frequently than the “young younger”. As for region, those living in the northeast of Thailand had substantially the highest chance of non-compliance with almost all recommended targets (ORs<sub>adjusted</sub>: 4.18 to 8.33). Regional distinction in eating cultures and food availability and accessibility may shape sodium consumption pattern. As well, family monthly income merely between 5,000 and <10,000 baht/month significantly increased 61% to 74% higher risks to non-compliance with some recommendations, compared with reference category (<5,000 baht/month). Risk of non-compliance between those with monthly family income <5,000 baht and  $\geq 10,000$  baht did not differ. Further studies must be performed to clarify this point.

With regard to the older age group, demographic determinants related to non-compliance with sodium recommendations are somewhat different from those of the younger age group. Increasing age was more likely to comply with sodium intake <2,300 mg and <2,400 mg. Explanation for this outcome may be linked mainly to overall decrease in food intake in the

later life<sup>(18)</sup>, although age-related-change in taste buds may drive, some elderly to consume more seasonings. Thereby, the seasoning consumption pattern of participants aged 16 years old and older was examined. The trend of seasoning intake quantities in males decreases with age; until the age of 80 years when this trend to begin rising. For females, this trend increases until the age of 30 years, after that it turns down. Similar to those of the younger group, 1/3 to 1/2 of all seasonings used for adding food taste are rich in sodium. Like the younger group, the older participants living in the northeast of Thailand had about 1.56 to 2.12 times more chance to non-compliance with all recommended levels of daily sodium intake. Regional influence on sodium intake also occurs in other countries. For instance, in the Hajjar and Kotchen study<sup>(19)</sup> indicated that people living in the southern region of the United States consumed significantly larger amounts of sodium compared with those living in other regions. Conversely, Newby and research team could not find a regional effect on sodium intake among adult Americans<sup>(20)</sup>. They explained that identifying no regional effect on sodium intake might be because the FFQ they used for collecting dietary data might have underestimated the amount of sodium intake. In contrast to the younger group, older people living in rural areas consumed sodium more than those in urban areas, and the result is consistent with those from the KNHNES III study<sup>(17)</sup>.

Whereas Radhika et al found higher income levels associated with higher salt or sodium intake among south Indian adults<sup>(21)</sup>. In the present study, levels of income as well as education attainment were not determinants of non-compliance with recommendations. In the other words, Thai participants with any income and education levels had an equal opportunity to non-compliance with any sodium intake recommendations.

Potential limitations of the present study are the followings. First, sodium database in the dietary analysis software is limited by approximately 2/3 of total food items. This can cause the underestimation<sup>(22)</sup> of dietary sodium intake. However, the authors have added more food items with average sodium content to improve the coverage of estimation. Second, the quantities of sodium intake here came only from foods, but did not include sodium available in some medicine, supplement etc. Third, estimated sodium intake by using a single 24-hour-dietary recall method might not be representative of an individual's typical habit. However, it is still adequate for referring to the intake

situation of population or sample group. For a future study, to get the accurate amount of sodium intake, the use of 24-hour urinary sodium excretion along with multiple 24-hour-dietary recalls is suggested. Fourth, like the other developing countries, the recommendation of sodium intake for particular Thai younger age group is not available. More research studies leading to determine the recommended sodium intake levels in Thailand are required. Markedly, given the limitations, it is more likely that the actual amount of sodium intake might be greater than that the authors have estimated.

Most importantly, an implementation of reducing sodium intake programs with appropriate regional approaches should be made, especially for those living in the north and northeast. The first step might be that the goal of daily consuming <2,400 mg should be met; and further step would be the international level of <2,000 mg/day. The government or public health authority has to provide political and financial support to modify Thais' eating behavior, build the healthy environment, and/or produce the sodium reduction related ad or media for efficiently communicating to general people. Finally, measure for salt or sodium reduction in processed foods has to be operated continuously.

In conclusion, most participants consumed dietary sodium greater than current sodium intake recommendations. Individuals living in the north and northeastern region were more likely to consume excessive sodium. Reducing sodium intake programs with appropriate regional approaches should be implemented.

#### **Acknowledgement**

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#### **Potential conflicts of interest**

None.

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**การบริโภคโซเดียมและตัวกำหนดทางสังคมประชากรของการไม่ปฏิบัติตามคำแนะนำการบริโภคโซเดียมประจำวัน: การสำรวจสุขภาพประชาชนไทยโดยการตรวจร่างกายครั้งที่ 4**

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**วัตถุประสงค์:** เพื่อประมาณค่าการบริโภคโซเดียมประจำวันและตรวจสอบความสัมพันธ์ของปัจจัยทางสังคมประชากรกับการบริโภคโซเดียมมากกว่าคำแนะนำ

**วัสดุและวิธีการ:** ข้อมูลจากการสำรวจสุขภาพประชาชนไทยโดยการตรวจร่างกายครั้งที่ 4 ดำเนินการในปี พ.ศ. 2551-2552 ถูกใช้ ร้อยละ 10 ของผู้เข้าร่วมการศึกษามีข้อมูลอาหารบริโภคย้อนหลัง 24 ชั่วโมง ข้อมูลอาหารและเครื่องดื่มทั้งหมดนำไปวิเคราะห์หาปริมาณโซเดียมที่บริโภคตลอดวันของแต่ละบุคคล การวิเคราะห์ทางสถิติใช้สถิติเชิงพรรณนาอธิบายลักษณะของผู้เข้าร่วมการศึกษามีปริมาณโซเดียมจากอาหาร และร้อยละของผู้เข้าร่วมการศึกษาที่ไม่สามารถปฏิบัติตามคำแนะนำการบริโภคโซเดียมประจำวัน การถดถอยโลจิสติกใช้เพื่อตรวจสอบตัวกำหนดทางสังคมประชากรของการบริโภคโซเดียมมากกว่าคำแนะนำ

**ผลการศึกษา:** ผู้เข้าร่วมการศึกษานี้มีจำนวนรวม 2,969 ราย การบริโภคโซเดียมผันแปรตามลักษณะทางสังคม ประชากร ร้อยละของผู้เข้าร่วมการศึกษาที่ไม่ปฏิบัติตามคำแนะนำการบริโภคโซเดียมมีช่วงจากร้อยละ 75.3 ( $\geq 1,500$  มก.) ถึง 52.0 ( $\geq 2,400$  มก.) สำหรับผู้เข้าร่วมการศึกษาที่มีอายุ  $< 16$  ปี และร้อยละ 86.3 ( $\geq 1,500$  มก.) ถึง 67.6 ( $\geq 2,400$  มก.) สำหรับผู้เข้าร่วมการศึกษาที่มีอายุ  $\geq 16$  ปี ในกลุ่มที่มีอายุน้อย อายุและภูมิภาคที่อยู่อาศัย เป็นลักษณะชี้เฉพาะที่สำคัญของการบริโภคโซเดียมมากกว่าคำแนะนำทุกข้อแนะนำ การมีรายได้ครอบครัวระหว่าง 5,000 และ  $< 10,000$  บาทต่อเดือนสัมพันธ์กับการบริโภคโซเดียมมากกว่าคำแนะนำอย่างมีนัยสำคัญทางสถิติในกลุ่มที่มีอายุมากกว่า เพศหญิงและอายุที่เพิ่มขึ้น ลดความเสี่ยงต่อการปฏิบัติตามข้อแนะนำบางข้อแนะนำ ตรงกันข้าม ภูมิภาคและเขตที่ผู้เข้าร่วมการศึกษายู่อาศัยเพิ่มความเสี่ยงต่อการปฏิบัติตามข้อแนะนำอย่างมีนัยสำคัญทางสถิติ

**สรุป:** ผู้เข้าร่วมการศึกษาส่วนใหญ่บริโภคโซเดียมจากอาหารมากกว่าข้อแนะนำปัจจุบัน โปรแกรมที่มีประสิทธิภาพเพื่อลดการบริโภคโซเดียมของประชาชนไทยเป็นสิ่งจำเป็น

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