

Dietary Sodium Intake by Semi-Quantitative Food Frequency Questionnaire among Undergraduate Students of Mahidol University

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Objective: To assess sodium intake and identify its sources among undergraduate students aged 17 to 20 years who lived in the dormitory of Mahidol University, Salaya Campus.

Material and Method: A cross sectional study was conducted among 170 students in July 2007. Data were collected using a semi-quantitative food frequency questionnaire.

Results: The mean total daily sodium intake was $5,225.0 \pm 2,228.9$ mg for males and $4,497.9 \pm 2,091.2$ mg for females. Male students consumed significantly higher sodium than females ($p = 0.030$). Daily sodium intake mainly came from one plate meals in the campus cafeteria which the average was $2,852.3 \pm 1,421.8$ mg/day in males and $2,042.3 \pm 1,214.2$ mg/day in females. Males consumed significantly higher sodium from one plate meals than females ($p < 0.001$). In addition, the average sodium intake from seasoning added during consumption was 539.8 ± 498.8 mg/day in males and 473.3 ± 514.5 mg/day in females. Dietary sodium intake among students was 2-fold higher than recommended amount (2,400 mg per day).

Conclusion: The findings revealed that the undergraduate students who mainly consumed one plate meals are at risk of high sodium intake. Nutrition promotion for reducing sodium consumption in students and food vendors is needed for early prevention of chronic diseases in later life.

Keywords: Sodium intake, Semi-quantitative food frequency questionnaire, Undergraduate students

J Med Assoc Thai 2009; 92 (Suppl 7): S75-82

Full text. e-Journal: <http://www.mat.or.th/journal>

High dietary sodium intake is associated with the development of hypertension which is one of the most important risk factors for cardiovascular disease (CVD), including stroke⁽¹⁾. Decreasing sodium intake will contribute to reduce risk in developing CVD⁽²⁾. Moreover, high sodium consumption is associated with renal disease and osteoporosis⁽³⁻⁵⁾.

The 2003 National Food and Nutrition Survey of Thailand found that the age-adjusted prevalence of hypertension was 20.2%. Furthermore, hypertension in children and adolescents is rapidly increasing⁽⁶⁾. Sodium intake in children in developed countries is as high as 2,400 mg/day in early childhood and has been increasing into the early adult period. Daily sodium

intake by urinary excretion and dietary records among adolescents in western countries were higher than recommended level. They ranged from 3 to 10 g/day⁽⁷⁻⁹⁾. In Thailand, Kwanmaung reported the mean sodium intake was 3,047.27 mg/day for young adult and 3,303.72 mg/day for elderly by 24 urine sodium excretion⁽¹⁰⁾. The 2003 survey on the eating patterns and behaviors of the Thai population⁽⁶⁾ showed that adolescents aged 15-19 years consumed snacks, ready-to-eat food, mixed food dishes and fast food 92.4%, 88.3%, 75.5% and 49.5% of the time respectively. Most of the population (90.4%) added salt or sauces to their food. The practice of adding salt or sauces to food was highest among the age group 20-29 years (98.2%). It is possible that sodium intake in early childhood may indirectly affect sodium intake in adulthood. The reduction of sodium intake is the primary prevention of hypertension⁽¹¹⁾. Adolescents commonly consume excessive calories

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and sugars and higher than recommended intakes of sodium, total fat, and saturated fat. There has been a rapid increase in the prevalence of obese adolescents who are at increased risk of developing obesity and related chronic diseases in adulthood⁽¹²⁾.

The semi-quantitative food frequency (SFFQ) method was used to identify the usual amount of sodium consumption; when this is combined with frequency and sodium content information, estimates of habitual consumption of sodium, can be derived⁽¹³⁾.

There have been few studies on the sodium intake of adolescents. Thus, this study aimed to estimate the amount and sources of sodium intake among undergraduate students, living in a dormitory of Mahidol University.

Material and Method

This cross sectional study was conducted in 170 undergraduate students (83 males, 87 females) who lived in the dormitory at Mahidol University, Salaya campus (spent at least seven nights at the dormitory during data collection). Subjects were aged 17 to 20 years, healthy, and willing to participate in the study. Students with poorly controlled diabetes mellitus, hyperlipidemia, cardiovascular disease, liver disease or kidney disease were excluded. Participants were students who lived in the selected dormitories. One females' dormitory and one males' dormitory were selected by simple random sampling from 11 dormitories. The data were collected in July 2007. This study was approved by the Committee on Human Rights Related to Human Experimentation, Mahidol University (No. MU 2007-112).

The instruments for collecting data consisted of self administered questionnaires designed to collect socio-demographic data and SFFQ. Self reported height and weight were used to calculate body mass index (BMI). The classification of nutritional status by using BMI for Asia adult by WHO, 2000⁽¹⁴⁾ are as follow: BMI < 18.5, 18.5-22.9, 23-24.9, ≥ 25 kg/m² indicate underweight, normal, overweight and obesity, respectively. Blood pressure (BP) was measured by a trained nurse using a sphygmomanometer; subjects were seated and had been at rest for at least 5 minutes. Blood pressure levels are classified according to The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VII)⁽¹⁵⁾.

The SFFQ was modified and based on the literature review⁽¹⁶⁾. The food items in the SFFQ were based on a 3-day food record of students from the

preliminary study, local foods in the Thai Food Composition Table and observed at the cafeteria and food shops surrounding the university. Frequency of consumption and portion size were grouped into 3 categories based on results of a pilot study and modified from Munkkorpist⁽¹⁶⁾. Three nutrition experts verified the food items chosen for the questionnaire. The validity of the SFFQ was tested by comparing sodium values from the SFFQ with a 3 day food record maintained by the same undergraduate students. Generally, correlations of more than 0.40 showed that the SFFQ had good validity⁽¹⁷⁾. The analysis showed a strong correlation ($r=0.71$, $p<0.001$) between these two methods. In addition, the difference in the mean sodium of the two methods was not significant ($p = 0.298$). Sodium intake was classified according to the recommended allowance from Thai RDI (less than 2,400 mg/day)⁽¹⁸⁾.

The SFFQ was designed to measure an individual's eating habits and sodium intake during the preceeding week. The instrument included 109 food items, grouped into seven categories: seasoning added during consumption; flour and nut products; meat products; one plate meals; fast food; snacks and dessert; beverages. For each food item, participants were asked to indicate their usual consumption frequency. Categories ranged from never or < 1 time per week to ≥ 4 times per day. Portion sizes were grouped into 3 categories less than, equal to, and more than an average portion size, respectively.

Data analysis

The sodium values were derived primarily from Food Composition Tables for standard reference. Sodium intake based on the SFFQ was computed by multiplying the consumption frequency of each food by the sodium content of the food.

General characteristics of the participants are presented using descriptive statistics including mean, standard deviation, frequency and percentage. Mean and standard deviation were calculated for sodium intake. The comparison between sodium intake in males and females was assessed by Independent Samples t- test. Significance level was established at p -value < 0.05.

Results

About half of the students (55.6%) were classified as having normal nutritional status. Overweight and obese students were 11.1% and 6.1%, respectively. Males were overweight and obese more

than females. About one-third of students (37.8%) had family history of hypertension. The males had higher blood pressure level than females. Two students (1.1%) had stage 1 hypertension, and 15 students (8.3%) were prehypertensive.

The results shown in Table 1 indicate that the largest amount of daily sodium intake came from one plate meals bought at cafeterias near the dormitory. The mean sodium intake from one plate meals was $2,852.3 \pm 1,421.8$ mg/day for males and $2,042.3 \pm 1,214.2$ mg/day for females. Males consumed significantly higher sodium from one plate meals than females ($p < 0.001$). The mean sodium intake from seasoning added during consumption was 539.8 ± 498.8 mg/day for males and 473.3 ± 514.5 mg/day for females. The mean daily sodium intake from all food groups was $5,225.0 \pm 2,228.9$ mg for males and $4,497.9 \pm 2,091.2$ mg for females. Males consumed significantly higher sodium than females ($p = 0.03$). The findings also showed that sodium intake of the majority of students (88.8%) was more than recommended (2,400 mg per day or less). Ninety three percent of males and 85% of females had higher intakes of sodium than recommended level (Table 2).

The amount of seasoning added is shown in Table 3. Fifty percent and over of participants add 1 teaspoon of seasoning into their foods except for

fast food. More than half (65%) of students added > 1 teaspoon in their fast food. The frequency of sodium intake is shown in Table 4. The top added seasonings were fish sauce, tomato ketchup, chili ketchup, and soy sauce. In the category of flour products, the subjects consumed instant wheat noodles 2-3 times per week. In the category of meat products, males often consumed omelets 3 times per week, while females consumed fried meat balls, omelets and sausages twice a week. The popular one plate meals for both males and females were rice noodles with meat balls and soup, and rice with fried meat and holy basil leaves. They consumed them twice a week. Females ate fast food, snacks and dessert more frequently than males. For beverages, most students always consumed UHT milk 4-5 times per week.

Discussion

Thai Recommended Daily Intakes (Thai RDI)⁽¹⁸⁾ for those over 6 years of age are based on a 2,000 kcal diet that limits total daily intake of salt to 6 grams (equivalent to 2,400 mg of sodium). Sodium intake in students living in a dormitory at Mahidol University was about 2 times higher than recommended level. This result was slightly higher than those found in studies by Sasaki⁽¹⁹⁾, and Micheli and Rosa⁽⁷⁾. Sasaki

Table 1. The mean daily sodium intake from food groups of the undergraduate students (n = 170)

Food groups	Mean daily sodium intake (mg/day)			p-value ¹
	Males (n = 83)	Females (n = 87)	Total (n = 170)	
One plate meals	$2,852.3 \pm 1,421.8$	$2,042.3 \pm 1,214.2$	$2,437.8 \pm 1,376.9$	<0.001
Meat products	635.1 ± 44.5	591.0 ± 522.6	612.5 ± 487.4	0.557
Flour, nut, seed products	470.1 ± 410.3	566.7 ± 546.0	519.6 ± 485.5	0.196
Seasoning added during consumption	539.8 ± 498.8	473.3 ± 514.5	505.8 ± 506.5	0.394
Snacks and desserts	357.1 ± 316.8	429.3 ± 320.8	394.1 ± 320.0	0.142
Beverages	168.5 ± 165.0	162.9 ± 167.0	165.6 ± 165.6	0.826
Fast food	250.7 ± 332.8	232.1 ± 362.3	241.2 ± 347.2	0.728
Overall	$5,225.0 \pm 2,228.9$	$4,497.9 \pm 2,091.2$	$4,852.9 \pm 2,183.7$	0.030

¹ Independent samples t-test

Table 2. Level of sodium intake in the undergraduate students

Classification of sodium intake level	Males (n = 83)	Females (n = 87)	Total (n = 170)
	No. (%)	No. (%)	No. (%)
< 2,400 mg/ day	6 (7.2)	13 (14.9)	19 (11.2)
≥ 2,400 mg/ day	77 (92.8)	74 (85.1)	151 (88.8)

Table 3. Amount of seasoning added

Amount of seasoning added	Males No. (%)	Females No. (%)	Total No. (%)
Mixed food dish ¹	n = 44	n = 23	n = 67
< 1 teaspoon	7 (15.9)	4 (17.4)	11 (16.4)
1 teaspoon	25 (56.8)	17 (73.9)	42 (62.7)
> 1 teaspoon	12 (27.3)	2 (8.7)	14 (20.9)
Range = 0.25-3 teaspoons			
One plate meals ²	n = 57	n = 53	n = 110
< 1 teaspoon	5 (8.8)	7 (13.2)	12 (10.9)
1 teaspoon	24 (42.1)	31 (58.5)	55 (50.0)
> 1 teaspoon	28 (49.1)	15 (28.3)	43 (39.1)
Range = 0.25-3 teaspoons			
Ready to eat food ³	n = 7	n = 4	n = 11
<1 teaspoon	1 (14.3)	1 (25.0)	2 (18.2)
1 teaspoon	4 (57.1)	3 (75.0)	7 (63.6)
> 1 teaspoon	2 (28.6)	0 (0.0)	2 (18.2)
Range = 0.5-2 teaspoons			
Fast food	n = 21	n = 25	n = 46
< 1 teaspoon	1 (4.8)	0 (0.0)	1 (2.2)
1 teaspoon	8 (38.1)	7 (28.0)	15 (32.6)
> 1 teaspoon	12 (57.1)	18 (72.0)	30 (65.2)
Range = 0.5-10 teaspoons			
Snacks	n = 3	n = 1	n = 4
1 teaspoon	1 (33.3)	1 (100)	2 (50.0)
> 1 teaspoon	2 (66.7)	0 (0.0)	2 (50.0)
Range = 1-2 teaspoons			

¹ Mixed dish food is defined as foods consumed with rice such as curry, fried vegetables and soup

² One plate meals are defined as foods cooked by the seller when the customer orders it, such as noodles and fried rice

³ Ready to eat food is defined as foods requiring the addition of hot water or microwave cooking before consumption. Most products contain packets of seasoning such as those found in instant wheat noodles, and frozen foods

et al.⁽¹⁹⁾ reported that mean sodium intake measured by sodium urinary excretion were 3,795 mg/day for men and 3,128 mg/day for women. Michelin and Rosa's investigation of 188 children and adolescents in Brazil, aged 6 to 17 years, found mean sodium intake from dietary records was 4,068.7 mg/day; 24-hour urinary excretion was 3,355.7 mg/day⁽⁷⁾. The 24-hour urinary excretion was 17% less than from food records. Liu et al.⁽²⁰⁾ showed 24-hour urine sodium excretion in 6th-8th grade children in Chicago ranged from 3,125.7 to 3,854.8 mg for boys and from 2,527.7 to 3,141.8 mg for girls. The 2000-2001 National Diet and Nutrition Survey in the United States of America reported mean sodium intake was 3,877 mg per day for males and 2,896 mg per day for females based on 24 hour urinary sodium

excretion⁽¹¹⁾. The findings of this study showed that sodium consumption was higher than the recommended amount. However, the SFFQ may have some limitations when applied to adolescent subjects. Difficulty to recalling how often foods were consumed and the large number of items in the questionnaire may have resulted in inaccurate reporting. In addition, estimation of food portion size might cause under or over estimation of sodium intake⁽¹³⁾.

All students consumed one plate meals in the cafeteria near their dormitory. Therefore, the main source of sodium in this study was one plate meals, they represented around 50% of total sodium intake. The top 2 types of one plate meals for both males and females were rice noodles with meat balls and soup, and rice with fried meat and holy basil leaves. These dishes are common in Thailand, so they are easy to find on menus in cafeterias. More than half of students added ≥ 1 teaspoon of seasoning to one plate meals. One-third of students stated that added seasonings made food taste better. The favorite seasonings added were fish sauce, tomato ketchup, soy sauce and chili ketchup. Findings were consistent with data from the 2003 National Food and Nutrition Survey of Thailand, which showed that most of the population aged 15-19 years (90.4%) added salt and, or sauces to foods⁽⁶⁾. A study of hypertensive persons reported major sources of sodium intake were seasoning followed by mixed food dishes or one plate meals^(21,22). The three most consumed items affecting mean daily sodium intake in hypertensive persons were salt, fish sauce and monosodium glutamate. Seasoning was mainly used in the cooking process, additional seasoning was added at the dining table during consumption. Seasoning consumption may be an eating habit of Thai people. Eighty percent of students in this study added seasoning to their meal. Moreover, 20% of these added extra seasoning before tasting their food. Seasoning is available on the dining tables in the university's cafeteria. This indicates availability of a sodium source which can contribute to high sodium intake among students.

The minor sources of daily sodium intake were meat products, flour and nut or seed products, snacks and desserts, fast food, and beverages. Each source represented around 10% of total sodium intake. The top 3 most frequently eaten meat products were omelets, fried meat balls and sausages. These foods were consumed twice per week as they easy to cook or buy. It is important to note that these items are generally eaten with added sauce. This finding was consistent

Table 4. Food frequency consumption among undergraduate students in each food group

Males (n = 83)	Time/week	Females (n = 87)	Time/week
Seasoning added during intake			
1. Fish sauce	4	1. Fish sauce	3
2. Tomato ketchup	2	2. Tomato ketchup	2
3. Soy sauce	2	3. Chili ketchup	2
Flour, Nut, Seed products			
1. Instant wheat noodle	2	1. Instant wheat noodle	3
2. Instant rice porridge	2	2. Instant rice porridge	2
3. Rice noodle (Mee sua)	1	3. Rice noodle (Mee sua)	1
Meat products			
1. Omelets	3	1. Fried meat balls	2
2. Fried meat balls	2	2. Omelets	2
3. Sausages	2	3. Sausages	2
One plate meals			
1. Rice noodle with meat ball and soup	2	1. Rice noodle with meat ball and soup	2
2. Rice with fried meat and holy basil leaves	2	2. Rice with fried meat and holy basil leaves	2
3. Rice and chicken cooked	2	3. Salad, papaya	2
4. Fried rice	2		
5. Rice with fried streaky pork	2		
Fast food			
1. French fries	1	1. French fries	2
2. Salad	1	2. Salad	2
3. Hamburger	1	3. Sandwich, tuna	1
Snacks and desserts			
1. Potato chips	2	1. Potato chips	2
2. Bun	1	2. Bun	2
3. Fish minced strips (TARO)	1	3. Cookie	2
Beverages			
1. Milk, UHT	4	1. Milk, UHT	5
2. Coffee	4	2. Yogurt, drinking, pasteurized	3
3. Yogurt, drinking, pasteurized	3	3. Energy drink, chocolate flavored	2

with the 2003 National Food and Nutrition Survey of Thailand that reported 81.9% of the population aged 15-19 years consumed processed food or preserved food⁽⁶⁾. The high frequency items were in the flour, nut and seed products category which included ready-to-eat foods, such as instant wheat noodles and instant rice porridge. In our study, the students consumed instant wheat noodles at least 2 times per week. Many people in this age group live in the dormitories with access to a microwave and hot pot. These appliances lend themselves to cooking ready to eat food, such as instant wheat noodles which are low in cost and high in convenience. The 2003 report of the National Food and Nutrition Survey of Thailand showed that 88.3% of the population aged 15-19 years consumed instant wheat noodles 1-4 times per week⁽⁶⁾.

The sources of daily sodium intake in this study were somewhat different from western food

consumption. Adolescents in western countries commonly consume highly processed food or preserved food, industrial foods and fast food⁽²³⁻²⁵⁾. Our study indicated that fast food was consumed only once a week. The availability of fast food restaurants may play a role because there are rarely found in and around the main campus of Mahidol University. In addition, many considered fast food as a snack rather than a meal. Our findings were consistent with data from the 2003 National Food and Nutrition Survey of Thailand that reported one-third of adolescents consumed fast food at least once per month and only 1.1% of them consumed fast food everyday⁽⁶⁾. College students in Korea consumed fast food 1-3 times a month and females showed a higher frequency of visiting fast food restaurants than males⁽²⁶⁾. Adolescents preferred to consume crispy snacks and salty snacks^(6,11,27), also in this study showed they

consumed potato chip, bun and cookies 2 times per week.

The findings indicated that only 11.2% of students had daily sodium intake within the limits of the daily recommended allowance. This is of concern as the students participating in this study were enrolled in the health science education program at Mahidol University. Reduction in sodium intake will help to decrease risk of developing hypertension and renal disease. Education and behavior modification should be started in childhood⁽²⁾. Health promotion emphasizing on low sodium consumption is essential for these students that are going to be health professionals in the near future. Moreover, nutrition education particularly in preparation of low-sodium foods among food vendors is considered necessary.

In conclusion, dietary sodium intake among undergraduate students living in the dormitory at Mahidol University was 2 times higher than recommended level. Most students (88.8%) consumed more sodium than the recommended amount of 2,400 mg/day. Male students consumed higher sodium than females. The main source of sodium was one plate meals. One-third of the students had family history of hypertension. Two students had stage 1 hypertension, and 8.3% of students were prehypertensive. Promotion of a healthy lifestyle with emphasis on low sodium consumption is essential in encouraging students to adopt habits that will help prevent hypertension and renal disease in later life. Furthermore, nutrition education in preparation of low-sodium foods among food vendors is needed.

Acknowledgements

This study was partial supported by grant from Faculty of Graduate Studies, Mahidol University. The authors would like to thank Associate Professor Mandhana Pradipasen and Assistant Professor Rewadee Chongsawat for her advise and correction of the manuscript.

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**ปริมาณโซเดียมที่ได้รับจากอาหารโดยใช้แบบสอบถามความถี่อาหารบริโภคถึงปริมาณ ในกลุ่ม
นักศึกษาระดับปริญญาตรีของมหาวิทยาลัยมหิดล**

พัชราณี ภาวัตกุล, สุภาวดี สุนทรวรลักษณ์, สุวัฒน์ ศรีสรณ์, ภารดี เต็มเจริญ

วัตถุประสงค์: เพื่อประเมินปริมาณโซเดียมที่ได้รับ และแหล่งของโซเดียมของนักศึกษาระดับปริญญาตรีที่มีอายุระหว่าง 17 ถึง 20 ปี ที่อยู่ในหอพักของมหาวิทยาลัยมหิดล วิทยาเขตศาลายา

วัสดุและวิธีการ: การศึกษาแบบภาคตัดขวางทำในนักศึกษาจำนวน 170 คนในเดือนกรกฎาคม พ.ศ. 2550 เก็บข้อมูลโดยใช้แบบสอบถามความถี่อาหารบริโภคถึงปริมาณ

ผลการศึกษา: ปริมาณโซเดียมเฉลี่ยที่ได้รับต่อวันจากอาหารทั้งหมดในนักศึกษาชายคือ $5,225.0 \pm 2,228.9$ มก. และในนักศึกษานหญิงคือ $4,497.9 \pm 2,091.2$ มก. นักศึกษาชายได้รับโซเดียมสูงกว่านักศึกษานหญิงอย่างมีนัยสำคัญทางสถิติ ($p = 0.030$). แหล่งของโซเดียมของนักศึกษาส่วนใหญ่มาจากอาหารจานเดียวซึ่งบริโภคที่โรงอาหารของมหาวิทยาลัย โดยปริมาณโซเดียมเฉลี่ยในชายคือ $2,852.3 \pm 1,421.8$ มก.ต่อวัน และในหญิงคือ $2,042.4 \pm 1,214.2$ มก.ต่อวัน นักศึกษาชายได้รับโซเดียมจากอาหารจานเดียวสูงกว่านักศึกษานหญิงอย่างมีนัยสำคัญทางสถิติ ($p < 0.001$) นอกจากนี้ปริมาณโซเดียมเฉลี่ยที่ได้รับจากเครื่องปรุงรสที่เติมขณะรับประทานอาหารในชายคือ 539.8 ± 498.8 มก.ต่อวัน และในหญิงคือ 473.3 ± 514.5 มก.ต่อวัน ปริมาณโซเดียมที่ได้รับจากอาหารของนักศึกษาเกินปริมาณที่แนะนำถึง 2 เท่า (2,400 มก.ต่อวัน)

สรุป: การศึกษานี้ชี้ให้เห็นว่านักศึกษาระดับปริญญาตรีซึ่งรับประทานปรุงสำเร็จประเภทอาหารจานเดียวเป็นหลักเสี่ยงต่อการได้รับโซเดียมในปริมาณที่สูง การส่งเสริมสุขภาพด้านโภชนาการเพื่อลดการบริโภคอาหารที่มีโซเดียมสูงแก่นักศึกษาและผู้ขายอาหารเป็นสิ่งจำเป็น เพื่อป้องกันการเกิดโรคเรื้อรังในอนาคต
