The Open Public Health Journal

Content list available at: https://openpublichealthjournal.com

RESEARCH ARTICLE

Prevalence and Potential Risk Factors Associated with High Sodium : Intake among Chinese-Haw Tribal in the Rural Area of Chiang Rai Province, Northern Thailand

Phatcharin Winyangkul[1], Lakkana Thaikruea[1,*], Penprapa Siviroj[1] and Sakda Pruenglampoo[2]

[1]*Department of Community Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand*
[2]*Research Institute for Health Sciences, Chiang Mai University, Chiang Mai, Thailand*

Abstract:

Background:

Sodium intake has a known association with increasing hypertension, cause of death from Cardiovascular Diseases (CVDs) worldwide. Ethnic group is increasingly exposed to risk factors to CVD causing of the urbanization and cultural changes.

Methods:

This cross-sectional study aimed to investigate the prevalence and potential factors associated with high sodium intake in the Chinese-Haw tribe in Chiang Rai province. Stratified random sampling was used to recruit participants. Face-to-face interviews were used for demographic data and assessment of dietary sodium knowledge, self-efficacy and food consumption. For dietary sodium intake, first-morning urine were collected for identifying concentration of sodium in millimoles per litre (mmol/L) using Atomic Absorption Spectrophotometer. Unconditional multiple logistic regression was used for determining risk factors associated with high sodium intake.

Results:

There were 302 participants of which majority were women (71.9%), with average age of 49.50 years (±12.12 S.D.). The prevalence of sodium intake was 90.70% more than 2,000 mg/day (High). The association between potential risk factors and high sodium intake revealed that men had higher risk than women (Risk Ratio 1.13, 95%*CI* 1.07 - 1.19). Multivariate analysis revealed only gender can predict a high sodium intake after adjusted for smoking patterns and alcohol consumption (adjusted odds ratio 13.73, CI 1.43 - 131.95).

Conclusion:

Prevalence of excess sodium intake per day in the Chinese-Haw tribe was high. This might lead to unhealthy effects. The population at risk should receive appropriate intervention urgently.

Keywords: Chinese-Haw Tribe, First - Morning Urine, Northern Thailand, Prevalence of Sodium Intake, Potential Risk Factors, Rural Area.

Article History	Received: November 11, 2019	Revised: December 30, 2019	Accepted: January 07, 2020

1. INTRODUCTION

In 2016, there were estimated 41 million people deaths from Non-communicable Diseases (NCDs) and three-quarters of those deaths were from cardiovascular disease [1]. In the United States, hypertension is one of the leading causes of heart and cerebrovascular diseases and it is also one of the leading causes of death in adults and older people. Recent national statistics suggest that between 30% and 50% of adults in the United States have high Blood Pressure (BP), or hypertension [2, 3]. It is also estimated that between 25% and 40% of patients have suffered from uncontrolled hypertension [4]. In the period 2009 to 2010, the prevalence of high blood pressure in the United States in men was as high as 30.5% and in women was 28.5% [5]. More than 40% of Chinese aged 45 years and older had hypertensive disorder and more than 40% of them were unaware of their condition such as approximately 50% did not receive medication as well as 80% of them had uncontrolled hypertension [6]. The prevalence of hypertension in Thai adults in 1991 was 5% but by 2004 it had risen to 21% which means over ten million people were affected by

* Address correspondence to this author at the Department of Community Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand; Tel: 66-08-6920-4243; E-mail: Lsayam@yahoo.com

hypertension [7]. In Thailand, nowadays, the number of hypertensive patients has been increased. This may be due to various factors such as socio-demographic, ageing, rising of obesity and dietary factors. The dietary factors especially, sodium intake was associated with the rising prevalence of hypertension in the population [8, 9]. Sodium intake was associated with an increase in blood pressure level [10]. Research reported that higher sodium intake and higher dietary sodium and potassium were associated with a higher risk of stroke. Also, reducing in higher sodium intake, dietary sodium and potassium can be considered as the approach to limit sodium intake which may have positive effect to decrease risk to stroke [11]. In addition, other studies suggested that high sodium intake was an important risk factor for heart disease and stroke [12, 13]. Similar report also points out that reducing sodium intake could decrease blood pressure level [14, 15].

In the United States, people consumed sodium at an average of 9 to 12 grams per day [15]; meanwhile, in Thailand, a survey found that the average intake of sodium among Thai population was 3,700 (mg/day), which is higher than the recommended by World Health Organization with not more than 2,000 mg/day [16]. However, there is an increase in the sodium consumption among Thai population in 2007 with approximately 4,351 milligrams per person per day [17].

There are many barriers toward the awareness of sodium consumption among Chinese-Haw ethnic group including lack of education, language barrier, and inaccessibility to the routine health education programs proving by health care providers. Various studies reported the prevalence of sodium intake and its associated risk factors among Thai population, but only few studies focusing on the prevalence of sodium intake and risk factors among hill tribe ethnic groups. Chiang Rai province is located in the northernmost part of Thailand shares the Thai-Myanmar border. There are many hill tribe ethnic groups such as Chinese-Haw, Akha, Lahu, Lisu, *etc*. The Chinese-Haw hill tribe has the largest population of the hill tribe groups. They are one of the indigenous populations from the China Yunnan province, living along the border of Thailand, especially in Mae Chan and Mae Fah Luang districts, Chiang Rai province [18]. Therefore, this study aimed to determine the prevalence of sodium intake of over 2,000 mg/day and to investigate the potential factors associated with this high sodium intake. The findings are useful information for planning appropriate intervention.

2. MATERIALS AND METHODS

The cross-sectional study was conducted among the Chinese-Haw tribe group with a total population of 1,500 from Patueng Village and Mae Chan district, Chiang Rai province. This village is located in a heavily forested and mountainous area. The study site is located on the hilltops and with scattered hamlet-population throughout the area (Fig. **1**). 568 Chinese-Haw tribes were residing in these areas with age of at least 30 years. Stratified random sampling was used to recruit participants (estimated sample size was at least 297) and 302 persons were recruited in this study. The study was conducted between February 18, 2016 and January 28, 2017. All participants needed to be able to communicate in Thai. Face-to-face interviews were used for demographic data and assessment of dietary sodium knowledge, self-efficacy and food consumption were also conducted. The household survey was performed for observing their cultural eating (Fig. **2**).

Fig. (1). Locations of studied areas.

Locations of 4 villages in Pa Tueng Sub-district, Mae Chan District, Chiang Rai Province as the selected area in this study (Source: Google Map). Reference Points: A: 20°06′16.8″N, 99°34′48.0″E; B: 20°07′08.4″N, 99°35′50.8″E; C: 20°06′12.0″N, 99°37′24.9″E; D: 20°06′08.6″N, 99°36′13.8″E

Fig. (2). Traditional Chinese Haw tribe food, the food items were laid on a round container like a small table. Family members sat and ate together.

The first-morning urine sample method was used for the measurement of dietary sodium intake. Each sample was centrifuged to separate sediment out, divided into two aliquots and kept in minus 80 degree Celsius freezer before sending to the standard laboratory. One aliquot from each sample was sent to the Science and Technology Service Center, Faculty of Science, Chiang Mai University (STSC-CMU) to determine the level of first-morning urine sodium in millimoles per litre (mmol/L) and another one was sent to laboratory of Maharajnakorn Chiang Mai Hospital, Faculty of Medicine, Chiang Mai University to determine the level of creatinine urine 24 - hour in gram/litre. The value of creatinine was used in the formula for calculating sodium intake.

Descriptive analysis included mean (Standard deviation-SD), median (Minimum-maximum), and percentage depend on data distribution. Univariate analysis included prevalence risk ratio (RR with 95% confidence intervals (*CI*)). For multivariate analysis, unconditional logistic regression was used to identify risk factors associated with high sodium intake according to

univariate analysis. P-value less than 0.05 was considered statistical significance. Data management and analysis were done by Epi Info for Windows version 7 (Centers for Disease Control and Prevention, Atlanta, GA) and SPSS version 22 (SPSS Inc., IBM Singapore Pte Ltd, Changi Business Park Central1, Singapore) [19].

2.1. Research instruments and measurements

2.1.1. Questionnaires

a. **Self-efficacy questionnaire**

Based on self-efficacy theory by Bandura (Albert Bandura, 1997), researchers developed self-efficacy questionnaire in order to assess self-confidence in the individual's ability of sodium reduction practicing. Its validity was 0.73, and its reliability was 0.83. There were 10 items, with a core range of 0-10 points, the cut-off point was 72 points.

b. **Food Frequency Questionnaire**

The Food Frequency Questionnaire (FFQ) [20] was the questionnaire constructed by the Health Education Division, Ministry of Public Health. Its validity was valued at 0.76, and its reliability was 0.80. There were 10 questions for assessing dietary consumption over the past 7 days. FFQ questionnaire was interpreted into categories: low level of energy and nutrient intakes (0-3 score), middle level of energy and nutrient intakes (4-7 score) and high level of energy and nutrient intakes (8-10 score).

c. **Knowledge regarding sodium consumption questionnaire**

There were fifteen items about knowledge of sodium consumption with choices. A correct answer was given one score, whereas a 0 score was given for a wrong answer. The original Bloom's cut-off points were used [21], with 80.0%-100.0%, 60.0%-79.0%, and less than 59.0%. The questionnaire was adapted from the knowledge of sodium consumption study developed from the researcher. Interpretation were either a pass or not pass. Its validity was 0.76, and its reliability was 0.89. The knowledge score range from 1 to 15 points and its was interpreted into two levels as follows: 1) Pass means total score was at least 50%: or 8-15 points; and 2) not pass means total score was less than 50%: or 0-7 points scores.

2.2. The Measurement of Dietary Sodium Intake

Most of the dietary surveys reported the problems of underestimation of sodium intakes. Consequence leads to the 24-hours pooled urinary becoming the preferred method of obtaining data on sodium intakes in population surveys but not convenience [22 - 24]. First-morning urine is a low-burden alternative more than to the 24-hours pooled urinary as fewer voiding is required, and the participants do not have to continue the collection during daily activities. As a result, a higher rate of compliance is likely in large epidemiological surveys [25]. The amount of sodium from the first-morning urine is relevant to the amount of sodium from the collection in 24-hour urine. This method need further calculation to get accurate amount of sodium because less sodium is excreted in the urine during night time (about 20% less than day time). The first-morning urine sample method was used for the measurement of dietary sodium intake in this study. Each urine sample was divided into 2 aliquots and kept in minus 80 degree Celsius freezer before sending to standard laboratory. One aliquot from each sample was sent to the STSC-CMU to determine the level of first-morning urine sodium (mmol/L) and another one was sent to the laboratory of Maharajnakorn Chiang Mai Hospital, Faculty of Medicine Chiang Mai University to determine the level of creatinine urine 24 - hours in gram/litre. The value of creatinine was used in the formula for calculating sodium intake [26] as following:

Male = $0.634 \times (Na_n / Cr_n) \times Pr.UCr24 + 104.7$

Female = $0.682 \times (Na_n / Cr_n) \times Pr.UCr24 + 62.6$

Na_n is the amount of sodium concentration in the urine during the night. The unit is mEq / L.

Cr_n is the amount of concentrations of creatinine in the urine during the night. The unit is g / L

$Pr.UCr_{24}$is the estimate of creatinine that is excreted from the urine in 24 hours. The unit is g / day.

$Pr.UCr_{24}$ = 0.027 x LBM in men and

$Pr.UCr_{24}$ = 0.022 x LBM in women

LBM (Lean body mass) = Body weight - Body fat mass

In male: LBM = (0.32810 x Weight (kg)) + [(0.33929 x Height (cm)] - 29.5336

In female: LBM = (0.29569 x Weight (kg)) + [(0.42813 x Height (cm)] - 43.2933

3. RESULTS

3.1. Prevalence of Sodium Intake Consumed More than 2,000 mg/day

The prevalence of Sodium intakes consumed more than 2,000 mg/day among Chinese-Haw tribe people was 90.70% (274 cased from total 302 cases) as shown in Table **1**.

Majority of the participants were women (71.90%), with average age of 49.50 (±12.12 S.D.), and 82.8% were married. About 80.80% of them had no education, 61.50% were agriculture workers and 80.80% had an inadequate income (51.70%) as shown in Table **2**.

Table 1. The prevalence of Sodium intakes among the Chinese-Haw tribe residing in Pa Tueng Village and Mae Chan district, Chiang Rai province (n=302)

Variables		n(302)	Percentage
Urine Sodium			
	≥ 2,000 mg/day	272	90.70
	< 2,000 mg/day	28	9.30

Table 2. Socio-demographic data of the Chinese-Haw tribe residing in Pa Tueng Village, Mae Chan district, Chiang Rai province (n=302).

Variables		n(302)	Percentage
Gender	Male	85	28.10
	Female	217	71.90
Status	Single	19	6.30
	Married	250	82.80
	Widowed	31	10.30
	Divorced	2	1.00
Occupation	Agriculture	186	61.50
	Merchant	12	4.00
	Contractor	55	18.20
	Official	14	4.70
	Unemployed	35	11.60
Education	No education	244	80.80
	Primary school	27	8.90
	Secondary school	27	9.00
	Tertiary degree	4	1.30
Income	Adequate	58	19.20
	Inadequate	224	80.80
Age (years) (mean± S.D.)		49.50±12.12	
Median Sodium intakes (range Minimum - Maximum, mg/day)		2,840 (1,554.19 - 13,575.58)	
Median Creatinine (range Minimum - Maximum, gram/litre)		95.56 (20.60 - 364.10)	

3.2. Association Between Potential Risk Factors and Sodium Intakes

a. Univariate analysis

From the univariate analysis, the following three factors were significantly associated with sodium intake at least 2,000 mg/day among Chinese Haw tribe residing in Chiang Rai province: gender, smoking and alcohol consumption. Male was likely to have sodium intakes greater than female 1.13 times (RR= 1.13, 95%*CI* 1.07 - 1.19). Participants who smoke were likely to have sodium intake higher than non-smokers 1.10 times (RR= 1.10, 95% *CI* 1.01 - 1.19) and participants who drink likely had sodium intakes greater than non-drinkers 1.09 times (RR=1.09, 95% *CI* 1.03 - 1.16) as shown in Table **3**

b. Multivariate analysis

Results from multiple logistic regression analysis revealed only gender can predict sodium consumption at least 2,000 mg/day among Chinese-Haw hill tribes residing in Chiang Rai province (adjusted odds ratio (OR) 13.73, CI 1.43 - 131.95) as shown in Table **4**.

4. DISCUSSION

The prevalence of a sodium intake at least 2,000 mg/day among Chinese Haw tribe ethnic group was 90.70%, which was higher than the rate of sodium chloride consumption among Thai population (80.30%) [27]. According to the Bureau of Non-Communicable Disease [28], the survey on sodium consumption among Thai population in 2007 using 24-hour urine output sample to detect urinary sodium excretion, reported that 87.50% of the samples had sodium intake above 2300 mg/day. Similar to the study in the U.S. population aged more than 19 years reported that 89% consumed sodium in excess of 2015-2020 mg/day [29]. Although, the joint WHO/FAO expert consultation on 'Diet, Nutrition and the Prevention of Chronic Diseases' recommends that sodium intake of adults should be less than 85 mmol/day (2,000 mg/day). From the study revealed, the sodium intake among Chinese-Haw hill tribes was higher than other groups of Thai population. Although the Chinese-Haw hill tribes are a minority ethnic group living in the rural area of northern Thailand, they consume sodium greater than 85 mmol/day (2,000 mg/day) [30], In the context of tribal groups in the highlands, they preserve food for long-term storage without electrical equipment. The majority of population in tribal groups in the highlands use food preservation method by adding salt to food [31].

In univariate analysis, alcohol consumption and smoking were associated with high sodium intake . However, only male gender remained significant in multivariate analysis. Part of the reason were that alcohol consumption associated with smoking and sodium seasoning snacks (with alcohol). Drinkers frequently used other addictive substances while drinking alcohol, including cigarette. Other studies in Lahu and Akha hill tribes found that the primary substance used while drinking alcohol was cigarettes as high as 98.78% [32]. Drinkers usually went out to drink with friends and had snacks (with alcohol), which contained high sodium. Thus, alcohol consumption associated with high sodium intake. When adjusted for confounders, only gender remained statistically significant.

Male gender was likely to have sodium intakes greater than female. This is in line with many studies such as sodium intakes assessed from a 24-hour urine collection among the United States population was 4,202 milligrams per day in male and 3,272 milligrams per day in female and similarly, in the United Kingdom it was found that sodium intakes in male was 3,818 milligrams per day and in female was 3,013 milligrams per day [33]. In addition, the INTERSALT Study [34] assessed the amount of sodium in a population (using an average of 24-hour urine collection) to create a standardized database from the urine sample (male and female aged 20-59) in 52 population groups from 32 countries worldwide. The results found that male had a sodium intake range between 100- 250 mmol/l (2,400 - 6,000 milligrams/dl) per day; meanwhile, female was in the range between 100 - 200 mmol/l (2,400-4,800 milligrams/dl) per day. Moreover, the quantitative research study carried out in 2007 by the Department of Health to assess sodium and salt consumption in the Thai population, and to explore about people beliefs regarding the relationship between sodium consumption and diet, research indicated that male had an average of sodium excretion at 131.0 mg per day which was higher than female who consumed only 128.5 mg per day [27]. Across all countries, most of studies reported that sodium intakes in male was higher than female, this is because of large differences in total food consumption [15]. The investigation of sodium excretion in urine reported that female had significantly lower ratios of 24-hour to overnight excretion of sodium than male, that female excreted sodium at a rate of 20-25% less than male [35, 36]. Furthermore, intracellular concentrations of sodium are different between male and female. Healthy female showed a significantly lower-average value of various types of intracellular sodium content when compared to male [37, 38]. As gender-related differences in intracellular sodium concentration were most likely to result from gender-related differences in the functioning of sodium transport systems [39].

Table 3. Association between potential risk factors and sodium intake in Chinese-Haw hill Tribes residing in Patueng village and Mae Chan district, Chiang Rai province.

Factors		Sodium Intake ≥2,000 mg/day n (%)	Sodium Intake < 2,000 mg/day n (%)	RR	95%CI for RR
Gender	Male	84(98.82)	1(1.18)	**1.13***	**1.07 - 1.19**
	Female	190(87.56)	27(12.44)	1	
Status	Married	230(92.00)	20(8.00)	0.97	0.87 - 1.09
	Single	18(94.74)	1(5.26)	1	
Occupation	Agriculture	173(93.01)	13(6.99)	1.07	0.99 - 1.16
	Unemployed	101(87.07)	15(12.93)	1	
Education	Educated	221(90.57)	23(9.43)	0.99	0.90 -1.08
	No education	53(91.38)	5(8.62)	1	
Income	Inadequate	191(83.25)	23(10.75)	0.95	0.88 - 1.01
	Adequate	83(94.32)	5(5.68)	1	
Co-morbidity					
Sick		31(93.94)	2(6.06)	1.04	0.95 - 1.14
Not sick		243(90.34)	26(9.66)	1	
Family health history of hypertension					
Family history		90(90.00)	10(10.00)	1.00	0.92 - 1.09
No family history		184(91.90)	18(8.90)	1	
Smoking pattern					
Current smoke		76(98.70)	1(1.30)	**1.10***	**1.01 - 1.19**
Never		198(88.00)	27(12.00)	1	
Alcohol consumption					
Yes		56 (96.55)	2(3.45)	**1.09***	**1.03 - 1.16**
No		218(89.34)	26(10.66)	1	
Physical exercise					
Not exercise		138(86.79)	21(13.21)	0.95	0.84 - 1.07
Regular Exercise		136(95.10)	7(4.90)	1	
Add sauce to food					
Yes		190(89.20)	23(10.80)	0.95	0.88 - 1.01
No		84(94.38)	5(5.62)	1	
Adding seasoning powder					
Yes		221(90.20)	24(9.80)	0.97	0.89 - 1.05
No		53(92.98)	4(7.02)	1	

(Table 3) contd.....

Factors		Sodium Intake ≥2,000 mg/day n (%)	Sodium Intake < 2,000 mg/day n (%)	RR	95%CI for RR
Self-Efficacy Score Median (range minimum – maximum, score) 72.00 (18 - 100)					
	Less than 72.00	143(90.51)	15(9.49)	0.99	0.93 -1.07
	At least 72.00	131(90.97)	13(9.03)	1	
Food Frequency Score					
	High Risk (8-10)	12(92.31)	1(7.69)	0.99	0.92 - 1.06
	Middle Risk (4-7)	76(92.68)	6(7.32)	0.99	0.84 - 1.16
	Low Risk (0-3)	294(93.33)	21(6.67)	1	
Knowledge Score					
	Not pass	20(71.43)	8(28.57)	1.01	0.79 - 1.29
	Pass	193(70.44)	81(29.56)	1	

RR, Risk Ratio: CI, confidence interval.

Table 4. Factors predictive of sodium consumption in excess of 2,000 mg/day among Chinese-Haw hill tribes Residing Patueng village and Mae Chan district, Chiang Rai province (n=302) using unconditional multiple logistic regression.

Variables	Adjusted	
	OR	95% CI
Gender(Men/Women)	**13.73***	**1.43 - 131.95**
Alcohol consumption (Current/Never)	0.85	0.15 - 4.81
Adding sauce (Yes/No)	0.42	0.14 - 1.24
Adding seasoning powder (Yes/No)	1.06	0.33 - 3.47
Self-Efficacy score (Less than 72/ At least 72)	1.08	0.48 - 2.46
Knowledge score (Pass/Not pass)	0.82	0.32 -2.09
Food frequency score (Middle/Low)	1.81	0.67 - 4.92
Food frequency score (High/Low)	1.24	0.14 - 2.46
Odd ratio adjusted for gender, alcohol consumption pattern, adding sauce, adding seasoning powder, self-efficacy score, knowledge score, food frequency score (low/middle/high).		

5. LIMITATION

According to the cross-sectional study, data on exposures and outcomes were collected at the same time, it may cause difficulty to explore any temporal changes in outcomes. A key strength of this study is the high-quality measurement tools using for assessing sodium from the first morning urine with a high response rate, which helped to ensure internal validity and allows for extrapolation of study results.

CONCLUSION

This study provides an insight into the epidemiological patterns of prevalence of sodium intakes, and the potential risk factors in the rural Chinese-Haw communities in northern Thailand. Health education about reduction of sodium intakes should be provided for Chinese-Haw hill tribes especially for male. This population should receive appropriate intervention in order to prevent them from diseases according to high sodium intake.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study protocol was approved by the Committee of Research Ethics in the Faculty of Medicine, Chiang Mai University, Thailand (Study code No. COM-2559-03677/Research ID: 3677).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures were followed in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

The legal protection of all participants was ensured and confirmed by written consent.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available on request from the corresponding author [L.T].

FUNDING

This study was supported by Faculty of Medicine, Chiang Mai University, Thailand.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

The authors would like to acknowledge all participants and staff in Pa Tueng sub-district and Mae Chan district, Chiang Rai Province for their cooperation in this study and also the Faculty of Medicine, Chiang Mai University for research funding support.

REFERENCES

[1] World Health Organization. monitoring health for the SDGs, sustainable development goals 2018.cited 2018 July 31, 2018 Available from: http://apps.who.int/iris/bitstream/handle/10665/272596/9789241565585-eng.pdf?ua=1

[2] Benjamin EJ, Blaha MJ, Chiuve SE, *et al.* American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart Disease and Stroke Statistics-2017 Update: A Report From the American Heart Association. Circulation 2017; 135(10): e146-603. [http://dx.doi.org/10.1161/CIR.0000000000000485] [PMID: 28122885]

[3] Whelton PK, *et al.* ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Soc Hypertens 2018; 12(8): e146-603.

[4] Brown VA, Bartholomew LK, Naik AD. Management of chronic hypertension in older men: an exploration of patient goal-setting. Patient Educ Couns 2007; 69(1-3): 93-9. [http://dx.doi.org/10.1016/j.pec.2007.07.006] [PMID: 17890042]

[5] Guo F, He D, Zhang W, Walton RG. Trends in prevalence, awareness, management, and control of hypertension among United States adults, 1999 to 2010. J Am Coll Cardiol 2012; 60(7): 599-606. [http://dx.doi.org/10.1016/j.jacc.2012.04.026] [PMID: 22796254]

[6] Feng XL, Pang M, Beard J. Health system strengthening and hypertension awareness, treatment and control: data from the China Health and Retirement Longitudinal Study. Bull World Health Organ 2014; 92(1): 29-41. [http://dx.doi.org/10.2471/BLT.13.124495] [PMID: 24391298]

[7] Aekplakorn W, Abbott-Klafter J, Khonputsa P, *et al.* Prevalence and management of prehypertension and hypertension by geographic regions of Thailand: the Third National Health Examination Survey, 2004. J Hypertens 2008; 26(2): 191-8. [http://dx.doi.org/10.1097/HJH.0b013e3282f09f57] [PMID: 18192831]

[8] Satheannoppakao W, Kasemsup R, Inthawong R, *et al.* Sodium intake and socio-demographic determinants of the non-compliance with daily sodium intake recommendations: Thai NHES IV. J Med Assoc Thai 2013; 96(Suppl. 5): S161-70. [PMID: 24851587]

[9] Puavilai W, Laorugpongse D, Prompongsa S, *et al.* Prevalence and some important risk factors of hypertension in Ban Paew District, second report. J Med Assoc Thai 2011; 94(9): 1069-76. [http://dx.doi.org/10.1097/01.hjh.0000408037.39237.2b] [PMID: 21970195]

[10] Elliott P, Stamler J, Nichols R, *et al.* Intersalt Cooperative Research Group. Intersalt revisited: further analyses of 24 hour sodium excretion and blood pressure within and across populations. BMJ 1996; 312(7041): 1249-53. [http://dx.doi.org/10.1136/bmj.312.7041.1249] [PMID: 8634612]

[11] Jayedi A, *et al.* Dietary sodium, sodium-to-potassium ratio, and risk of stroke: A systematic review and nonlinear dose-response meta-analysis. Clin Nutr 2018. [PMID: 29907351]

[12] He J, Whelton PK. Salt intake, hypertension and risk of cardiovascular disease: an important public health challenge. Int J Epidemiol 2002; 31(2): 327-31. [http://dx.doi.org/10.1093/ije/31.2.327] [PMID: 11980791]

[13] He FJ, MacGregor GA. Reducing population salt intake worldwide: from evidence to implementation. Prog Cardiovasc Dis 2010; 52(5): 363-82. [http://dx.doi.org/10.1016/j.pcad.2009.12.006] [PMID: 20226955]

[14] He FJ, Li J, Macgregor GA. Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomised trials. BMJ 2013; 346: f1325. [http://dx.doi.org/10.1136/bmj.f1325] [PMID: 23558162]

[15] Brown IJ, Tzoulaki I, Candeias V, Elliott P. Salt intakes around the world: implications for public health. Int J Epidemiol 2009; 38(3): 791-813. [http://dx.doi.org/10.1093/ije/dyp139] [PMID: 19351697]

[16] Thai Health Promotion Foundation. 2015.https://www.lowsaltthai.com/

[17] Kriengsinyos W. Reduce sodium prolongs life. In: Food and Drug Administration. wvothaiprinting, Bang kok: Institute of Nutrition, Mahidol University and Bureau of Non Communicble Disease 2012; Vol. 1.

[18] Royal Project Foundation. History of Chinese from Yunnan 2017.http://www.royalprojectthailand.com/haw

[19] Corp IBM. IBM SPSS statistics for windows, version 22.0 2013.

[20] Health Education Division. Health Behavior Monitoring System to Modify Risk Behavior of Normal / Risk / Diabetic Mellitus Hypertension in Thailand: Policy for Practice for Primary Care Facilities. Health Education Division, Ministry of Public Health 2013.

[21] Bloom BS. Taxonomy education. New York: David McKay 1956.

[22] Bingham S. The dietary assessment of individuals; methods, accuracy, new techniques and recommendations In: Nutr Abstr Rev A Hum Exp. 1987; 57: pp. 705-42.

[23] Bates CJ. TDMB, Nelson M, Biochemical markers of nutrient intake, Design Concepts in Nutritional Epidemiology. OxfordOxford University Press 1991.

[24] Hunter D, Willett W. Biochemical indicators of dietary intake, Nutrional Epidemiology. 2nd ed. OxfordOxford University Press 1998.

[25] Pietinen PI, Findley TW, Clausen JD, Finnerty FA Jr, Altschul AM. Studies in community nutrition: estimation of sodium output. Prev Med 1976; 5(3): 400-7. [http://dx.doi.org/10.1016/0091-7435(76)90056-6] [PMID: 987585]

[26] Nagata C, Takatsuka N, Shimizu N, Shimizu H. Sodium intake and risk of death from stroke in Japanese men and women. Stroke 2004; 35(7): 1543-7. [http://dx.doi.org/10.1161/01.STR.0000130425.50441.b0] [PMID: 15143292]

[27] Department of Health. MoPH, Report on the consumption of sodium chloride in the Thai population. Department of Health, Ministry of Public Health 2007.

[28] Sringanyuang L. TWaAT, Situation of sodium intake in Thai population: Quantitative study. Department of Health, Ministry of Public Health 2012.

[29] Sandra L Jackson, Sallyann M Coleman King, Lixia Zhao, Mary E Cogswell. Prevalence of Excess Sodium Intake in the United States - NHANES, 2009–2012 In: 2016; pp. 1392-7.

[30] WHO/FAODiet, nutrition and the prevention of chronic diseases, Report of a joint WHO/FAO expert consultation. Technical Report Series 916 2003.

[31] Royal Project Foundation. History of Chinese from Yunnan 2016.cited October 20, 2016 Available from: http://www.royalprojectthailand.com/haw

[32] Apidechkul Thawatchai. Behavior and impact on alcohol consumption among Lahu and Akha hill tribe youths (Phase 1) 2017.

[33] Elliott PBI. Sodium intake around the world. Background document prepared for the forum and technical meeting on reducing salt intake in populations 2007.cited 2006 5-7 October 2006 Available from: http://www.who.int/dietphysicalactivity/Elliot-brown-2007.pdf

[34] Intersalt Cooperative Research Group. Intersalt: an international study of electrolyte excretion and blood pressure. Results for 24 hour urinary sodium and potassium excretion. BMJ 1988; 297(6644): 319-28. [http://dx.doi.org/10.1136/bmj.297.6644.319] [PMID: 3416162]

[35] Beard TC, Eickhoff R, Mejglo ZA, Jones M, Bennett SA, Dwyer T. Population-based survey of human sodium and potassium excretion. Clin Exp Pharmacol Physiol 1992; 19(5): 327-30. [http://dx.doi.org/10.1111/j.1440-1681.1992.tb00464.x] [PMID: 1521364]

[36] Dyer AR, Stamler R, Grimm R, *et al.* Do hypertensive patients have a different diurnal pattern of electrolyte excretion? Hypertension 1987; 10(4): 417-24. [http://dx.doi.org/10.1161/01.HYP.10.4.417] [PMID: 3653970]

[37] Smith JB, Wade MB, Fineberg NS, Weinberger MH. Influence of

race, sex, and blood pressure on erythrocyte sodium transport in humans. Hypertension 1988; 12(3): 251-8.
[http://dx.doi.org/10.1161/01.HYP.12.3.251] [PMID: 3169940]

[38] Taylor EA, Goh CR, Oh VM. Influence of family history of cryptogenic hypertension, age, sex and race on lymphocyte sodium/potassium pumps. Ann Acad Med Singapore 1991; 20(3): 308-13.
[PMID: 1656841]

[39] Grikiniene J, Volbekas V, Stakisaitis D. Gender differences of sodium metabolism and hyponatremia as an adverse drug effect. Medicina (Kaunas) 2004; 40(10): 935-42.
[PMID: 15516815]