Original Article

Comparison of salt taste thresholds and salt usage behaviours between adults in Myanmar and Korea

Hyungjin Cho MD[1], So Mi Kim PhD[2], Seong Su Jeong[3], Soon Bae Kim PhD[1]

[1]*Division of Nephrology, Department of Internal Medicine, College of Medicine, University of Ulsan, Asan Medical Center, Seoul, Korea*
[2]*Division of Nephrology, Department of Internal Medicine, Jeju National University Hospital, Jeju, Korea*
[3]*College of Medicine, University of Ulsan, Asan Medical Center, Seoul, Korea*

Background and Objectives: Excessive oral salt intake can induce hypertension. According to previous studies, the prevalence of hypertension is higher in Myanmar than in Korea. We postulated that Myanmar adults had higher salt taste thresholds and eat much saltier food. This study aimed to compare salt taste thresholds and salt usage behaviour scores between adults in Myanmar and Korea. **Methods and Study Design:** This cross-sectional study enrolled patients who visited volunteer medical service clinics at Ansung in Korea and Hlegu and Bago in Myanmar in August 2014. We measured the vital signs, heights, and weights of each patient and evaluated detection thresholds, recognition thresholds, and salt preferences. All patients underwent urinalysis and spot urine Na tests. Additionally, they each completed a salt usage behaviour questionnaire. **Results:** A total of 131 patients were enrolled, including 64 Myanmarese patients and 67 Korean patients. Blood pressure was significantly higher in the Myanmarese than in the Koreans. Detection and recognition thresholds, salt preferences, and spot urine sodium and salt usage behaviour scores were also higher in the Myanmarese than in the Korean subjects. We calculated correlation coefficients between systolic blood pressure and parameters that were related to salt intake. The detection and recognition thresholds were significantly correlated with systolic blood pressure. **Conclusion:** All parameters related to salt intake, including detection and recognition thresholds, salt preference, salt usage behaviour scores and spot urine sodium concentrations, are significantly higher in Myanmarese than in Korean individuals.

Key Words: dietary sodium, hypertension, taste threshold, Myanmar, Korea

INTRODUCTION

High dietary salt intake can lead to increased blood pressure in both patients with hypertension and individuals with previously normal blood pressure.[1] It has pathological effects in coronary artery disease, stroke, and progressed renal failure. However, salt restriction is very difficult to achieve. One of the most important causes of failure to restrict salt intake is insensitivity to salt taste. If an individual cannot detect a salty taste, then the dietary salt intake of that individual is likely increasing. Generally, to evaluate the accuracy of gustation, several salt taste thresholds, such as the recognition threshold, detection threshold, and salt preference, have been used. The detection threshold refers to the concentration of salt in fluid that can be distinguished from de-ionized water, irrespective of its taste. The recognition threshold indicates the lowest concentration of a solution that can be both differentiated from de-ionized water and properly identified.

Based on numerous studies, the prevalence of hypertension in individuals in Myanmar is higher than that in Koreans. According to the World Health Organization (WHO) global health risk reports in 2008, the age-standardized prevalence of hypertension (defined as systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥90 mmHg, or use of antihypertensive drugs) in 7,429 adults greater than 25 years old in Myanmar was 42%.[2] In Korea, based on a report from the Korean National Health and Nutrition Examination Survey in 2009, the prevalence of hypertension among 5,495 adults who were 30 years of age and above was 30.4% in males and 22.2% in females.[3]

Based on these reports, we postulated that adults in Myanmar had higher salt taste thresholds and ate much saltier food. This study was performed to compare the salt taste thresholds and salt usage behaviour scores between adults from Myanmar and Korea.

MATERIALS AND METHODS

Subjects

This cross-sectional study enrolled patients who visited the volunteer clinic. We excluded patients with any seri-

Corresponding Author: Dr Soon Bae Kim, Division of Nephrology, Department of Internal Medicine, College of Medicine, University of Ulsan, Asan Medical Center, 88 Olympic-ro, 43-gil, Songpa-gu, Seoul, 138-736, Korea.
Tel: 82-2-3010-3264; Fax: 82-2-3010-6963
Email: sbkim@amc.seoul.kr
Manuscript received 19 April 2015. Initial review completed 15 June 2015. Revision accepted 14 July 2015.
doi: 10.6133/apjcn.092015.32

ous diseases that would affect taste acuity, such as fever, malignancy, acute or chronic liver disease, and congestive heart failure, as well as those taking diuretics. This study was performed at Ansung in Korea, which is located within a 1-hour drive from Seoul, on August 7, 2014, and at Hlegu and Bago in Myanmar, which are located within a 1-hour drive from Yangon from August 11-13, 2014. All research procedures were approved by the Institutional Review Board of Asan Medical Center (2014-0856).

Blood and urinary examinations and blood pressure measurements

We checked the vital signs, height, weight, blood pressure, and pulse rate in the study participants from both countries. Blood pressure and pulse rate were monitored using a wrist-type electronic blood pressure monitor (BC16, Beurer, Germany) in both countries. Hypertension was defined as systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥90 mmHg, or use of antihypertensive medications. We measured blood pressure twice and used the lower of the two readings. Urinalysis was measured using Multistix 10 Test Strips (GH Medical, Minneapolis, MN). Spot UNa was measured using a Digital Handheld Salt Tester DMT-20 (SRTEC, Seoul, Korea).

Determination of the detection threshold

The detection threshold was defined as the concentration of a fluid that can be distinguished from de-ionized water, irrespective of the type of differential stimulus.[4] To define the detection threshold, a three alternative, forced choice question was used.[5] Concentrations of NaCl solutions used for the detection and recognition thresholds were 0.01%, 0.025%, 0.05%, 0.075%, 0.10%, 0.125%, 0.15%, 0.20%, 0.3%, 0.4%, and 0.5% (11 stages). The NaCl solution was made using deionized water and stored at 4°C. Prior to the test, the solution was stored at room temperature. A total of three cups of solution, which consisted of a cup of NaCl and two cups of de-ionized water, were placed on the table before the participants entered the room. Each cup contained 10 mL fluid and was labelled with a five-digit code. The researchers could note which cup contained the salt solution or de-ionized water, whereas the participants could not. A researcher explained to each participant how to carry out the taste test. After each participant tried to taste the three different concentrations of solutions, they were asked to discriminate the different solution from the cups containing deionized water. The participants were permitted to re-taste the solution before they determined their answers. Before each application of a solution, subjects gargled using deionized water. The lowest concentration that could be detected successfully in two successive trials was recorded as the detection threshold.[5]

Determination of the recognition threshold

The definition of the recognition threshold was the lowest concentration of a fluid at which the participants could precisely distinguish the type of taste. Participants held the solution in their mouths for a few seconds to assess the salt concentration and were then asked, "Is there any taste? If yes, what kind of taste?" If the participant could not sense the saltiness, the next highest concentration was presented. The same concentration was reapplied if the subject could sense the saltiness. The recognition threshold was defined as the concentration at which the participants could properly sense a "salty" taste twice.[6]

Determination of salt preference

To determine salt preferences, bean sprout soup was used as it is one of most commonly consumed soups among all age groups in Korea. To make this soup, 900 g bean sprouts and 1,500 mL deionized water were combined and brought to a boil for 20 mins. After the fluid volume had been measured, refined salt was added to obtain final salt concentrations of 0.15% and 1.0%. The soup was stored at 4°C for use within 24 h, and was brought to room temperature prior to tasting. Participants first tried the soup with the least amount of salt (0.15%) and then added the saltier 1.0% soup to meet their preferred taste. Next, the salt concentration of the soup was measured twice using a Digital Handheld Salt Tester DMT-20 (Daeyoon Scale Industry Co., Seoul, Korea), and the average value of the two measurements was considered to be the salt preference. Each participant gargled with water every time after they tried the soup.[7]

Salt usage behaviour questionnaire

The salt usage behaviour questionnaire was modified from Kim et al.[8] We chose four behaviour items that were common to adults in both Myanmar and Korea. The subjects scored these statements from 1 to 5, with a higher score implicating more salt consumption.

1. Typical salt content of food eaten
   (Very salty=5, A little salty=4, Modestly salty=3, Little salt=2, Not salty=1)
2. Add salt or soy sauce to cooked dishes
   (Always=5, Frequently=4, Usually=3, Seldom=2, Never=1)
3. Add salt to food before tasting
   (Always=5, Frequently=4, Usually=3, Seldom=2, Never=1)
4. Salt usage in thick broth or soup
   (More than a tsp=5, As much as a tsp=4, Half a tsp=3, Little salt=2, No salt=1)

Statistical analyses

All values are expressed as means with the standard deviation when applicable. Differences in categorical variables, such as gender, hypertension, diabetes, and smoking, between Myanmar and Korean adults were compared using the chi-square test. Differences in numerical variables were evaluated using the unpaired Student's *t*-test. Correlations between variables were assessed using Spearman's rank correlation coefficient (*r*). All statistical analyses were performed using SPSS 21.0 (SPSS, Inc., Chicago, IL) and *p*-values less than 0.05 were considered to denote statistically significant differences.

RESULTS

Table 1 lists the results of a comparison of the clinical characteristics between adults in Myanmar and Korea. There was no difference in gender or age between these two groups of adults. The BMI of adults from Myanmar was significantly lower than that of adults from Korea.

Table 1. Comparison of clinical characteristics between the adults from Myanmar and Korea who participated in the study

	Myanmar (n=64)	Korea (n=67)
Gender (M/F)	24/40	25/42
Age (years)	53.3±9.4	56.4±10.7
BMI (kg/m^2)**	22.5±2.9	24.1±2.9
Hypertension (%)*	30 (47)	19 (28)
Percentage of adults with hypertension taking anti-hypertensive drugs (%)	33 (10/30)	68 (13/19)
SBP (mmHg)**	137±25.5	125±15.6
DBP (mmHg)***	86.0±14.9	76.8±10.1
Diabetes (%)	10 (16)	13 (19)
Smoking (%)	8 (13)	6 (9)
Chief complaint (%)		
Musculoskeletal pain	26 (39)	20 (31)
Cough	5 (8)	2 (3)
Headache	4 (6)	5 (7.8)
General weakness	2 (3)	3 (5)
Chest pain	2 (3)	1 (2)
Dyspnea	0 (0)	3 (5)
Abdominal pain	1 (2)	3 (5)
Miscellaneous*	3 (5)	11 (17)
No symptom	24 (36)	16 (25)

*p<0.05, **p<0.01, ***p<0.001

Table 2. Comparison of parameters related to salt intake between adults from Myanmar and Korea who participated in the study

	Myanmar (n=64)	Korea (n=67)
Detection threshold (%)***	0.102±0.108	0.046±0.026
Recognition threshold (%)**	0.174±0.163	0.103±0.115
Salt preference (%)**	0.44±0.16	0.37±0.10
Spot urine sodium (mg/dL)**	158±84.3	117±62.1
Salt usage behaviour score*	11.4±2.5	10.4±2.4
1) Typical salt content of food eaten	2.7±1.4	2.6±0.9
2) Add salt or soy sauce to cooked dishes*	3.5±1.0	3.1±1.0
3) Add salt to food before tasting*	2.8±1.2	2.5±0.8
4) Salt usage in thick broth or soup	2.4±1.0	2.2±0.8

*p<0.05, **p<0.01, ***p<0.001

The prevalence of hypertension was significantly higher in adults from Myanmar (47%, 30/64) than in adults from Korea (28%, 19/67, p<0.05). The percentage of adults with hypertension who took antihypertensive drugs was significantly lower in Myanmar (33%, 10/30) than in Korea (68%, 13/19, p<0.05). Both systolic and diastolic blood pressure measurements were higher in adults in Myanmar than in those from Korea. The smoking status and prevalence of diabetes and were not different between adults from Myanmar and Korea. There was no difference in chief complaints between Myanmarese and Korean adults.

Table 2 presents a comparison of parameters related to salt intake between adults from Myanmar and Korea. All parameters related to salt intake, such as the detection threshold, recognition threshold, salt preference, salt usage behaviour score, and spot UNa concentration, were significantly higher in adults from Myanmar than in those from Korea. For the four criteria that were used to determine the salt usage behaviour score, "Add salt or soy sauce to cooked dishes" and "Add salt to food before tasting" were higher in Myanmar adults than in Korean adults, while "Typical salt content of food eaten" and "Salt usage in thick broth or soup" were not different between the two groups.

Table 3 lists the correlation coefficients between the systolic blood pressure and other parameters that could indicate the salt intake of the participants. The detection and recognition thresholds significantly correlated with systolic blood pressure. Urine Na, the salt usage behaviour score, and salt preference did not correlate with the systolic blood pressure.

DISCUSSION

To the best of our knowledge, our present study is the first to compare parameters related to salt intake, such as detection thresholds, recognition thresholds, salt preferences, and salt usage behaviour scores, between adults from Korea and Myanmar. From our analysis, we found that parameters related to salt intake were higher in Myanmarese than in Korean adults.

It is well-known that the use of refrigerators can affect salt intake.[9] When individuals use refrigerators, they no longer need to use as much salt as a food preservative. The rate of refrigerator use in Myanmar was only 12% in 2012.[10] By contrast, in Korea the number of refrigerators

Table 3. Correlation coefficients between systolic blood pressure and other parameters in all study subjects

	Correlation coefficient	*p*-value
Detection threshold	0.242	0.005
Recognition threshold	0.179	0.041
Salt usage behaviour score	0.137	0.118
Urine Na	0.122	0.164
Salt preference	0.060	0.494

per household was greater than 1.0 in 1989.[11] The climate in Myanmar is hotter than that in Korea, and the rate of refrigerator use is lower than that in Korea. This difference likely contributes to the high salt intake in adults from Myanmar.

The higher detection and recognition thresholds in Myanmar adults might also be associated with poorer oral hygiene in Myanmar. Poor oral hygiene, periodontal disease, and changes in oral hygiene regimens represent obvious potential sources of taste dysfunction.[12] We previously analyzed oral hygiene data from 12 year-old children from each country. The frequency of "no history of tooth brushing" in 12-year-old children was 38.8% in Myanmar[13] and 0.85% in Korea.[14] The prevalence of dental calculus in 12-year-old children was 40.0% in Myanmar[13] and 24.8% in Korea.[14] The prevalence of gingival disease in 12-year-old children was 40.0% in Myanmar (community periodontal index score=2)[13] and 16.2% in Korea (community periodontal index score ≥1).[14] Similar results were observed in another study of adults from both countries. The mean DMFT (decayed missing filled teeth) scores in 65–74-year-old adults in urban Myanmar, rural Myanmar, urban Korea, and rural Korea in 2003 were 11.78, 13.91, 10.92, and 11.30, respectively.[15,16]

In our current study, all parameters that can reflect the salt intake of participants were higher in Myanmarese individuals, whose blood pressure also tended to be higher than in Korean individuals. However, systolic blood pressure was significantly correlated with the detection and recognition thresholds, but not with UNa. Spot UNa could vary with daily sodium intake, whereas the detection threshold and recognition threshold cannot be changed within a short period of time. Those parameters might reflect long-term sodium intake.

This study had several significant limitations of note. The main limitation was that the participants did not fully reflect the general population of either country because they were actual patients visiting a clinic. Notably, the prevalence of participants with hypertension in Myanmar was 47%, which was much higher than what has been found in the general population in that country. This discrepancy might have affected some results, such as for high salt prevalence or the abnormal taste threshold, in the Myanmar group. The study participants also resided in a specific area in each country and the number of participants was too small to be representative of the population of either country.

A second limitation was that we did not obtain data that might affect the amount of sodium intake, such as the percentage of refrigerator ownership or false teeth use among the study participants. Poor oral hygiene, periodontal disease, or changes in oral hygiene regimens represent obvious potential sources of taste dysfunction.[12]

A third limitation was that only a single spot UNa measurement was used as an indicator of salt intake. It is well known that measuring 24 hour urinary sodium excretion is the most reliable way to evaluate daily salt intake. However, it was not feasible to measure 24 hour urinary sodium excretion for the entire study population. In many instances a patient might forget to collect their urine, which makes the test results inaccurate. Moreover, we have reported previously that a single spot UNa measurement significantly correlated with 24HUNa, with a correlation coefficient of 0.37-0.471 in chronic kidney disease patients.[17] Therefore, we used the spot UNa measurement as a marker of salt intake in our present analyses. Although the mean spot UNa values were higher in the Myanmarese than in the Korean adults who participated in our present study, we did not find a direct correlation with a single spot UNa measurement and systolic blood pressure. These single measurements of the spot UNa might be biased by circadian variations in sodium that occur among the general population[18] and in patients with CKD.[19]

Further study is needed to evaluate the correlations between salt intake and blood pressure in adults in Myanmar and Korea.

Conclusion

All parameters related to salt intake, such as detection and recognition thresholds, salt preference, salt usage behaviour scores, and spot urine sodium concentrations, are significantly higher in Myanmarese than in Korean adults. Higher salt intake in Myanmar might contribute to the higher prevalence of hypertension in that country. Our findings may also support the potential benefits of educating patients with hypertension about the positive impacts of a low salt diet.

ACKNOWLEDGEMENTS

We thank the missionaries from Global Image Care to Myanmar, Cheol Ho Chang and Hye Kyong Hahn.

AUTHOR DISCLOSURES

None of the authors had any conflicts of interest.

REFERENCES

1. Brown IJ, Tzoulaki I, Candeias V, Elliott P. Salt intakes around the world: implications for public health. Int J Epidemiol. 2009;38:791-813. doi: 10.1093/ije/dyp139.
2. Krishnan A, Garg R, Kahandaliyanage A. Hypertension in the South-East Asia Region: an overview. Reg Health Forum. 2013;17:7-14.
3. Kim HJ, Kim Y, Cho Y, Jun B, Oh KW. Trends in the prevalence of major cardiovascular disease risk factors among Korean adults: results from the Korea National Health and Nutrition Examination Survey, 1998-2012. Int J Cardiol. 2014;174:64-72. doi: 10.1016/j.ijcard.2014.03.163.
4. Gomez FE, Cassis-Nosthas L, Morales-de-Leon JC, Bourges H. Detection and recognition thresholds to the 4 basic tastes in Mexican patients with primary Sjogren's syndrome. Eur J Clin Nutr. 2004;58:629-36. doi: 10.1038/sj.ejcn.1601858.
5. Kim GH, Lee HM. Frequent consumption of certain fast foods may be associated with an enhanced preference for

salt taste. J Hum Nutr Diet. 2009;22:475-80. doi: 10.1111/j.1365-277X.2009.00984.x.
6. Kusaba T, Mori Y, Masami O, Hiroko N, Adachi T, Sugishita C et al. Sodium restriction improves the gustatory threshold for salty taste in patients with chronic kidney disease. Kidney Int. 2009;76:638-43. doi: 10.1038/ki.2009.214.
7. Choe JS, Kim EK, Kim EK. Comparison of salty taste acuity and salty taste preference with sodium intake and blood pressure based on zinc nutritional status in two rural populations in Korea. Nutr Res Pract. 2012;6:534-41. doi: 10.4162/nrp.2012.6.6.534.
8. Kim HJ, Paik HY, Lee SY, Shim JE, Kim YS. Salt usage behaviors are related to urinary sodium excretion in normotensive Korean adults. Asia Pac J Clin Nutr. 2007;16:122-8. doi: 10.6133/apjcn.2007.16.1.16.
9. Wiseman M. The second World Cancer Research Fund/American Institute for Cancer Research expert report. Food, nutrition, physical activity, and the prevention of cancer: a global perspective. Proc Nutr Soc. 2008;67:253-6. doi: 10.1017/s002966510800712x.
10. Nam J, Kang JH. Recent Japanese movement to Myanmar. 2012/12/11 [cited 2015/4/20]; Available from: http://www.kiet.re.kr/kiet_web/?sub_num=8&state=view&idx=35709. (In Korean).
11. Korean statistical information service. Regional electronic appliance ownership ratio. 2013/10/31 [cited 2015/4/20]; Available from: http://kosis.kr/statHtml/statHtml.do?orgId=388&tblId=TX_38802_A051&vw_cd=MT_STOP_TITLE&list_id=388_38802&seqNo=&lang_mode=ko&language=kor&obj_var_id=&itm_id=&conn_path=E1#. (In Korean)
12. Cowart BJ. Taste dysfunction: a practical guide for oral medicine. Oral Dis. 2011;17:2-6. doi: 10.1111/j.1601-0825.2010.01719.x.
13. Chu CH, Chau AM, Wong ZS, Hui BS, Lo EC. Oral health status and behaviours of children in Myanmar - a pilot study in four villages in rural areas. Oral Health Prev Dent. 2012;10:365-71.
14. Ministry of health & welfare. 2012 Korean national oral health survey. 2013 [cited 2015/4/20]; Available from: http://stat.mw.go.kr/front/statData/publicationView.jsp?menuId=47&bbsSeq=13&nttSeq=20810&searchKey=&searchWord=&nPage=1&topSelect=B00005. (In Korean)
15. Ogawa H, Soe P, Myint B, Sein K, Kyaing MM, Maw KK, Oo HM, Murai M, Miyazaki H. A pilot study of dental caries status in relation to knowledge, attitudes and practices in oral health in Myanmar. Asia Pac J Public Health. 2003;15:111-7. doi: 10.1177/101053950301500207.
16. Korean statistical information service. 2003, 2010 Korean national oral health survey. 2010 [cited 2015/4/20]; Available from: http://kosis.kr/common/meta_onedepth.jsp?vwcd=MT _OTITLE&listid=117_11751. (In Korean)
17. Kang SS, Kang EH, Kim SO, Lee MS, Hong CD, Kim SB. Use of mean spot urine sodium concentrations to estimate daily sodium intake in patients with chronic kidney disease. Nutrition. 2012;28:256-61. doi: 10.1016/j.nut.2011.06.006.
18. Centonza L, Castoldi G, Chianca R, Busca G, Golin R, Zanchetti A, Stella A. Short-term analysis of the relationship between blood pressure and urinary sodium excretion in normotensive subjects. Clin Sci (Lond). 2000;98:495-500. doi: 10.1042/CS19990185.
19. Agarwal R. Relationship between circadian blood pressure variation and circadian protein excretion in CKD. Am J Physiol Renal Physiol. 2007;293:F655-9. doi: 10.1152/ajprenal.00188.2007.

Original Article

Comparison of salt taste thresholds and salt usage behaviours between adults in Myanmar and Korea

Hyungjin Cho MD[1], So Mi Kim PhD[2], Seong Su Jeong[3], Soon Bae Kim PhD[1]

[1]*Division of Nephrology, Department of Internal Medicine, College of Medicine, University of Ulsan, Asan Medical Center, Seoul, Korea*
[2]*Division of Nephrology, Department of Internal Medicine, Jeju National University Hospital, Jeju, Korea*
[3]*College of Medicine, University of Ulsan, Asan Medical Center, Seoul, Korea*

缅甸和韩国成年人盐味阈值与盐使用行为比较

背景与目的：过量盐摄入可诱发高血压。根据以往研究，缅甸高血压的患病率高于韩国。我们推测，缅甸的成年人有更高的盐味阈值及多吃咸食物的习惯。该研究的目的是比较缅甸和韩国成人的盐味阈值和盐使用行为分数之间的差异。**方法与研究设计：**采用横断面研究，于 2014 年 8 月，在韩国安城和缅甸的莱古及勃固的医疗诊所招募志愿者。我们测量了每个患者的生命体征、身高和体重，并评估检测阈值、识别阈值和盐偏好。所有患者均行尿常规和尿钠检测。此外，他们每人完成了一份盐使用行为问卷调查。**结果：**共入选 131 例患者，包括 64 例缅甸患者和 67 例韩国患者。缅甸患者的血压显著高于韩国患者，且检测阈值、识别阈值、盐偏好、尿钠以及盐使用行为评分也高于韩国患者。我们计算发现收缩压与盐摄入量相关参数之间有相关关系，检测阈值和识别阈值与收缩压显著正相关。**结论：**缅甸人群盐摄入量相关的所有参数，包括检测和识别阈值，盐偏好、盐使用行为评分和尿钠浓度均显著高于韩国。

关键词：膳食钠、高血压、味觉阈值、缅甸、韩国