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Review Article

Assessment of Dietary Salt and Sodium Intake: From Questionnaire to Device

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ABSTRACT

Salt is indispensable for the water balance homeostasis in the human body. Although it is well known that excess salt intake is related to hypertension, direct measurement of dietary salt intake is time consuming and lacks accuracy. In this review, we would like to review the literature reporting the tactics in measuring dietary salt intake and to how much extent it correlates with hypertension, as well as historical features on how the relationship between salt and hypertension earned general status. From the recent increase of processed foods, the term "salt intake" would not accurately be equal to "sodium intake". Sodium intake questionnaires may be inaccurate, but they will sure evoke awareness on the threatening consequences of excess sodium intake. Devices measuring urinary sodium excretion have been developed and evaluated on their accuracy and correlation with sodium intake. They must be handy, simple and capable of measuring large populations to be useful for monitoring the long term effects by sodium.

Keywords: Salt intake; Sodium intake; Devices; Questionnaires

Introduction

The relation of high salt-intake induced hypertension with cardiovascular diseases has received much attention. The top 10 causes of death reported from WHO (Fact sheet Nº310 (http://www.who.int/mediacentre/factsheets/fs310/en/)) shows ischemic heart disease as top (13.2%: 7.4 million people) and stroke as second (11.9%: 6.7 million people). Of the preventable risk factors, next to tobacco control and blood pressure control, salt intake control has been shown to contribute to prevent premature mortality, especially in the eastern Mediterranean region for men and western Pacific region for women [1]. Salt-intake remains high in rather low-income countries [2]. There are reports of high-salt intake influencing oxidative stress rather than blood pressure [3], which target organs such as the kidney [4], with no change of the renin-angiotensin system [5]. However, blood pressure control is the endpoint of most randomized trials of salt reduction [6].

Anciently, when there were no ways in measuring blood pressure, hardening of the arteries with high salt intake was described in Chinese medicine in the 3rd century BC [7]. In 1896, the sphygmomanometer was invented and hypertension was easily evaluated in the clinics [8]. The effect of salt restriction on hypertension has been documented shortly afterwards [9] and the earliest experimental evidence between salt intake and high blood pressure [10,11] was found in the era when hypertension was believed to be caused by toxic products. Reports of salt restriction on treating hypertension [12,13] did not change these myths, until the role of diet in various diseases was proposed in the 1930s. The low-protein, low-fat, and extremely low-salt "Kempner" rice diet showed effectiveness on severe hypertension evidenced by improvement of chest X-ray and eye examination [14-16]. The involvement of salt intake was confirmed in animals and humans, by the effect sodium chloride addition, while potassium chloride had not effect [17,18]. The famous Framingham Heart Study started at this time when half of the Americans including President Roosevelt, died of cardiovascular disease [19]. It was in the 1950s, when urinary electrolyte excretion was measured for the first time to find the relation of salt diet and hypertension [20].

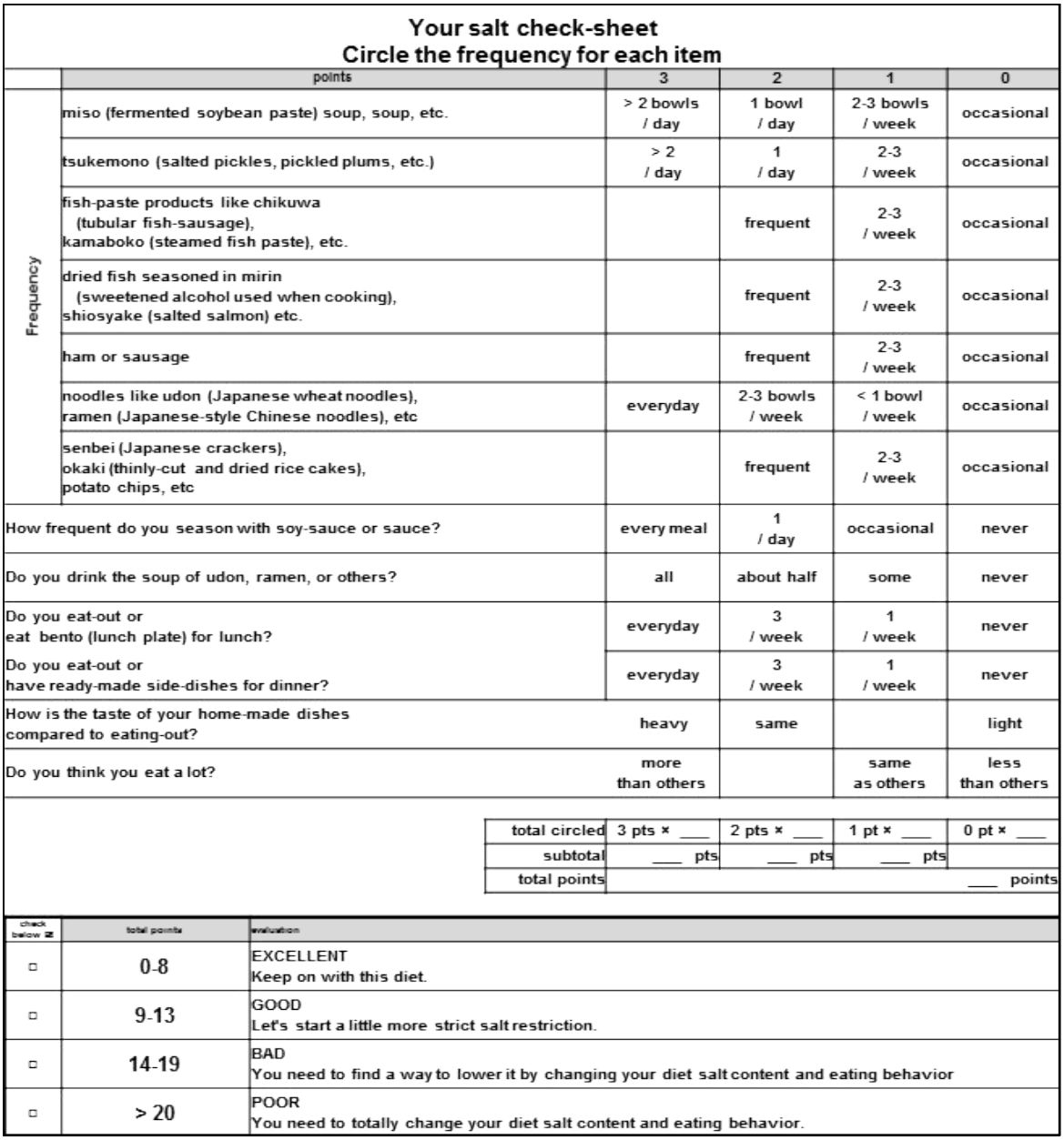
In this review, we will discuss on questionnaires and salt-measuring devices on salt intake, as tools which may be used to motivate people in regions of the world where high-salt intake is a deadly risk factor of mortality.

Questionnaires to Evaluate Sodium-Intake

Questionnaires or dietary assessment methods have been used for evaluating habitual diets where intervention and diet modification are key factors in preventing cardiovascular disease. The first questionnaires on salt intake were targeted on people with poor income [21] and on people who survived severe heat waves [22]. The issue of salt intake influence on high blood

pressure came from studies of hypertension in the Bahamas, where nearly 40% of the natives had high systolic blood pressure [23]. In order to find out the etiology, a questionnaire was distributed to physicians and a result of about 1,000 cases showing the incidence of hypertension very high even in young people. The death rate due to hypertensive complications was also very high. Urine examinations were not so reliable but the interesting finding was the high sodium concentration in well water, and the commonly used salt pork oil. It was estimated that 12 g or more salt was excreted in the urine [24]. The questionnaire in this study did not include questions on salt intake, but the importance of salt intake became aware in this period of the late 1950s. There are various regions in the world where salted fish is heavily consumed, as the Pacific islands including Japan, but not only coasted people have high salt-intake. Inland people, where salt was used as a preservative can be a source of high salt-intake. One of the first questionnaires including questions of salt intake was reported in a study on coronary heart disease asking the timing of salting [25]. Twenty years thereafter, the reliability and validity of these questionnaires were variable and difficult to state anything from the results. Two issues were a problem at this time. First is the difficulty to develop a method that targets both group and individual, and the second is accurate quantification or importance of categorization based on less accurate quantification. Several methods have been developed and evaluated since then. The first questionnaire method, "dietary history approach" or "dietary records", was actually developed far way back [26], and was concerned the gold standard where quantitative accurate information is provided. This method requires extensive interviews, where long-term history of the patterned intake is taken into account. Detailed preparation methods, recipes and portion size of food mixture are recorded. At the end of the recording, a trained interviewer reviews the record with the subject. This method is based on motivated interviewers and subjects to complete daily records which may limit the results to a proportion of the general population. The recording *per se* may even affect the amount and variety of food the subjects select, and have the tendency to be underreported. The second questionnaire method is the easier "24 h dietary recall" where the interview is often structured with specific probing questions to increase reliability of the questionnaire. However, diets vary day to day, individually but maybe not as a mean of a group [27] and a seven-day recall method ("history method") was attempted and modified to record the actual intake ("record method") since it is difficult to recall a meal a week before. Still, the method needs intense cooperation of the participants and is difficult for use in large epidemiologic studies. Short cut studies trying to circumvent these difficulties were developed between the 1950s and 1970s, but always could not confirm these results against the "truth", which they were trying to show. Comparing the same assessment at different times also had difficulties since it is difficult to seek correlation on one item when all other items are not always consistent. Validation of different methods were studied at this period and found that the "history method" had higher values than the "record method" [28-31]. This difference can be overcome by various regression techniques. Indeed, studies have been conducted for both methods to see whether they can categorize individuals in a similar manner [32-34]. Repeated dietary history was evaluated in the Framingham study, showing that a two-year interval showed a similar result, but not four [35]. Some studies on the 24 h dietary recall method have shown that serum and urine values reflect the reported intake [36], but other do not [37]. Thus, it has been reported that the history method (24 h recall method) may not be appropriate for the individual, but informative in evaluating groups [27,38-40]. A study comparing the 24 h dietary recall and seven-day intake record showed the results were comparable if the number of subjects was greater than 50 [41]. Methods tried to solve this problem by seeking a 24 h method with comparable validity as seven-day histories and records. Accordingly, the third questionnaire method is the "food frequency approach (or prediction equation approach)", where respondents report the consumed frequency of specific food for a specific period, was developed as one of the short-cut methods. In order to evaluate the accuracy of this approach, 33 specific foods were recorded for 50 subjects and the subjects were asked to recall the frequency of intake for the specific food. The approach was quite accurate, although the preference of food must be taken into concern. Short quantitative methods attempted to develop equations from simple questions of consumption to calculate precise level in the diet, but these did not always show satisfactory results [27,40]. In fact, this method is difficult to generalize due to different diet preferences in various regions throughout the world. In the late 1980s, coding of the foods and usage of automated software, has made data processing easier and accurate with standardized interviews (the third National Health and Nutrition Examination Survey) [42]. Nonetheless, concerning nutrition and disease, it is important to place the individual in broad categories with rough consumption levels, rather than focusing on the precise amount of the nutrient. It is also important to choose the appropriate item, which differs among population and research purpose. The number of questions is also an important factor, since long food lists overestimate and short food list underestimate the actual intake.

A special salt-check sheet (questionnaire) based upon special Japanese ingredients was developed [43], and applied to local residents [44] living in Fukuoka and Saga prefectures (Figure 1). Fukuoka and Saga prefectures are located in the western part of Japan where the salt intake ranks low (but still much higher than the WHO recommended 5 g/day) (Fukuoka: 36th out of 47 (11.4 g/day) (Men), 39th out of 47 (9.6 g/day) (women), Saga: 46th out of 47 (10.9 g/day) (men), 44th out of 47 (9.3 g/day) (women)) compared to other prefectures in Japan (mean: Men (11.8 g/day), Women (10 g/day)) according to the five year-report (2006-2010) from the Japanese Ministry of Health, Labour and Welfare. The scores of the special salt-check sheet correlated well with 24 h urinary sodium excretion and imply that the top seven salty ingredients are enough to validate the salt-intake. Of course, the top seven salty ingredients will differ between regions or countries. The relatively low salt intake in this region compared to other parts of Japan correlates well with the relatively low death rate for heart disease (Fukuoka ranking 47th out of 47 prefectures in Japan, Saga ranking 40th out 47 for both men and women) and cerebrovascular disease (Fukuoka: 40th (men) 37th (women), Saga: 36th (men) 39th (women)) found in the 2010 report from the Japanese Ministry of Health, Labour



Your salt check-sheet
Circle the frequency for each item

	points	3	2	1	0
Frequency	miso (fermented soybean paste) soup, soup, etc.	> 2 bowls / day	1 bowl / day	2-3 bowls / week	occasional
	tsukemono (salted pickles, pickled plums, etc.)	> 2 / day	1 / day	2-3 / week	occasional
	fish-paste products like chikuwa (tubular fish-sausage), kamaboko (steamed fish paste), etc.		frequent	2-3 / week	occasional
	dried fish seasoned in mirin (sweetened alcohol used when cooking), shiosyake (salted salmon) etc.		frequent	2-3 / week	occasional
	ham or sausage		frequent	2-3 / week	occasional
	noodles like udon (Japanese wheat noodles), ramen (Japanese-style Chinese noodles), etc	everyday	2-3 bowls / week	< 1 bowl / week	occasional
	senbei (Japanese crackers), okaki (thinly-cut and dried rice cakes), potato chips, etc		frequent	2-3 / week	occasional
How frequent do you season with soy-sauce or sauce?		every meal	1 / day	occasional	never
Do you drink the soup of udon, ramen, or others?		all	about half	some	never
Do you eat-out or eat bento (lunch plate) for lunch?		everyday	3 / week	1 / week	never
Do you eat-out or have ready-made side-dishes for dinner?		everyday	3 / week	1 / week	never
How is the taste of your home-made dishes compared to eating-out?		heavy	same		light
Do you think you eat a lot?		more than others		same as others	less than others

total circled	3 pts × ___	2 pts × ___	1 pt × ___	0 pt × ___
subtotal	___ pts	___ pts	___ pts	
total points	___ points			

check below ☑	total points	evaluation
□	0-8	EXCELLENT Keep on with this diet.
□	9-13	GOOD Let's start a little more strict salt restriction.
□	14-19	BAD You need to find a way to lower it by changing your diet salt content and eating behavior
□	> 20	POOR You need to totally change your diet salt content and eating behavior.

Figure 1: Salt check sheet for Japanese local residents. The typical salt concentration of each Japanese ingredient is as follows. Miso soup (3 g NaCL/250 mL), Tsukemono (0.46 g NaCL/ 20 g), Chikuwa/Kamaboko (0.6 g NaCL/ 30 g), Ramen (6 g NaCL/ 100 mL) The amount is calculated as estimated per meal.

and Welfare. Among the list, soy sauce is well known for its high concentration of salt (sodium calculated) (1.6 g/10 mL), but it should be also taken into account that the attractive "umami (amino acid)" taste is mainly evoked by monosodium glutamate [45], also found in soy sauce and is usually a sodium salt form. Since this is misleading, all-consuming products in Japan having been labeled by sodium content, have changed labeling to salt "equivalent" content which is easier to understand, starting on April 1st, 2015. Interestingly, in spite of the very high salt-intake in Japan, the Japanese people rank top class for longevity of life span in the world. This means further life span, or a further healthy life span can be expected with appropriate salt restriction. The salt-check sheet above may, in a sense, be categorized as a "brief dietary assessment method", the fourth questionnaire method, which is used for intervention or education for groups in clinical settings. For studying the whole diet of an individual, more than 100 questions are required, but for a particular nutrient only 15-30 items of food are said to be enough [46,47]. The selection of items is difficult and must be evaluated. For instance, a brief self-administered diet-history questionnaire for salt intake was validated by 24 h urinary salt excretion [48]. The fifth questionnaire method is the "diet history" which is not a simple frequency of food intake but also includes the preparation method, since processed food has increased during these decades [49]. An electronic questionnaire, 24 h dietary recall method has also been developed for assessing salt intake. It was compared with 24 h urinary sodium excretion with a correlation coefficient of 0.72 [50].

Urinary Sodium Excretion and Sodium Intake

In 1951, a report of the effect of various diets with different amounts of sodium chloride on urinary electrolyte

and blood pressure was documented [51]. The well tolerable anti-hypertensive drug, chlorothiazide, which increases salt excretion, was available in 1958 [52]. The randomized controlled trial for anti-hypertensive drugs including chlorothiazide at this time was so extremely beneficial that the control group receiving no medication was decided to dropout the study and start medication by ethical reasons. The effect was also found in patients with mild hypertension [53]. Thus, the importance of salt intake was widely recognized and the effect of salt restriction on blood pressure was evaluated in a randomized controlled trial [54]. Large group studies of the average population on urine analyses (salt intake evaluation) and blood pressure have been reported since then [55-64]. Though there are some conflicting meta-analysis short term trial reports questioning benefits from salt restriction [65,66], the main picture on salt restriction in preventing cardiovascular diseases has obtained unshakable status and a guideline on sodium intake for adults and children has been established by the World Health Organization (WHO) [67]. The guideline shows <2 g sodium/day (5 g salt/day) intake is related to prevention of high blood pressure, but with no direct effect on all-cause mortality, incident cardiovascular disease or non-fatal coronary heart disease. Since blood pressure is known to affect these outcomes, WHO strongly recommend sodium intake reduction. These is also for children, where the amount of <2 g sodium/day (5 g salt/day) should be adjusted by reduced energy requirements. The recommendations are applied to all individuals with or without hypertension, except for people with illness where sodium restriction will result in adverse effects.

Devices to Measure Sodium-Intake

Sodium research began from Michael Faraday, the namer of "ions". And from Svante Arrhenius who discovered that dissolved solid crystalline salts disassociate into paired charged particles, and won the 1903 Nobel Prize in Chemistry. Total sodium level of a 60 kg adult is 2,400-4,200 mmol. Extracellular fluid contains 55%, bones 43% and intracellular fluid 2%. Sodium is measured by photometry (wave length: 589 nm) excited by gas flame. The strength of light correlates with concentration and can also be measured by ion selective electrodes; directly by change in electric membrane level and indirectly by measuring the concentration of sodium in blood samples. Blood sodium level does not correlate with total sodium level, but with the proportion of total sodium level and extracellular fluid volume. Sodium is the main electrolyte found in extracellular fluid and potassium is the main intracellular electrolyte. Since 95% of blood sodium is excreted in urine, evaluation of blood sodium concentration can be measured by urine sodium level and extracellular volume. Blood sodium level can be influenced by various diseases including disruption of vasopressin (ADH: antidiuretic hormone) a hormone secreted from the posterior pituitary and regulating sodium homeostasis. Diabetes insipidus, where vasopressin secretion is impaired or sensitivity decreased can cause elevated blood sodium level. SIADH, frequently found in small cell lung cancer, can cause decreased blood sodium level by excess secretion of vasopressin. Thus, evaluation of sodium intake by urine sodium level needs precautions such as ruling out the above diseases and other related factors. Measurement of 24 h urine sodium excretion has been used as a golden standard for evaluating sodium intake. However, 24 h urine samples are inconvenient, costly for a large population. Alternative methods, such as spot, overnight, daily, timed urine samples have been taken into concern whether it can reflect sodium intake of individuals as well as large populations. There were studies showing correlation between spot and 24 h urine collection [58]. However, sodium excretion is not constant throughout the day, and intra-individual variation has to be concerned. A study suggested that at least a week of overnight samples is necessary to evaluate urinary sodium excretion level [55]. Fixing the amount of sodium intake of the subjects also showed the accuracy of 24 h urinary sodium measurements greater than overnight ones [57], while other studies showed a significant correlation [60,61,68]. A study using longer 12 h urinary sodium measurement was more accurate than an 8 h (overnight) measurement, and warned the use of partial samples due to inaccuracy [64]. Repeated measurements can increase the reliability of spot urine analyses [69]. Spot-urine evaluation is not always useless, because there are studies where evidence can be discovered by this simple, easier method, especially in clinical practice [70]. B-type natriuretic peptide levels correlated to salt intake in patients with permanent atrial fibrillation and heart failure [71,72].

Devices have been developed to measure urine sodium level. A urine-sampling pipe was used to trap overnight urine and estimate 24 h urine sodium excretion [73]. Electric devices have also been developed to monitor salt intake at home [74]. The KME-03 self-monitoring device (Kohno ME Laboratory, Kanagawa, Japan) contains a volume sensor and conductivity sensor (Figure 2) [75]. The volume sensor contains small resistant chips and conductivity sensor has two gold-plated nickel metal plates. The device measures urine volume, urinary chloride concentration and temperature. Estimate 24 h salt excretion is measured and calculated by collecting overnight urine of eight hours. NaCL concentration was modified because conductivity is affected by other electrolytes [75]. Overnight sodium content (X) can be converted to 24 h-salt excretion (Y) by $Y=5.76(X)^{0.53}$ g/day [74]. These self-monitoring devices have been considered inaccurate [76], but careful comparison of overnight with 24 h urine collection methods have developed

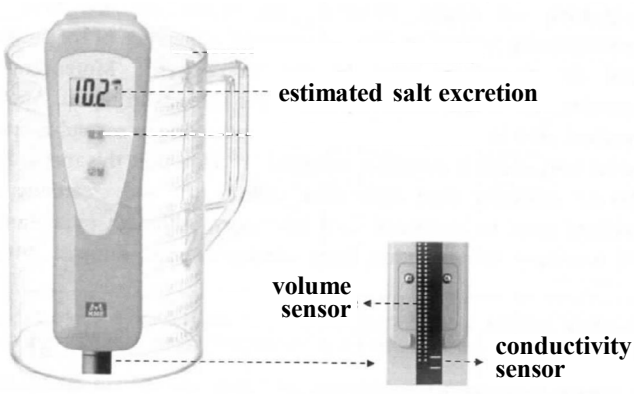


Figure 2: Estimated urine salt self-monitoring devise, KME-03 (Kohno ME Laboratory, Kanagawa, Japan). Eight-hour urine samples collected in the morning are measured of volume and NaCL concentration and converted to estimate sodium intake.

the above converting formula making these devices more reliable. The sodium ion is not always paired with chloride ion in processed food. Nonetheless, this device will be an effective motivational, educational [75,77-79] tool for personal salt restriction, when standardized by a normotensive population, especially for people living in regions of high salt-intake [80]. Salt restriction is a difficult task especially for young, obese males, and patients complicated with diabetes mellitus and hyperuricemia in a Japanese study [81]. Dietary habits start from younger ages and evaluation and intervention of salt-intake at young ages may have a better effect [82]. Salt-intake is Indeed, There is a tendency for Japanese females to be more aware of salt restriction (salt conscious) than males who are hypertensive. Importantly, these devices must be cheap, easy-to-handle, and easy-to-understand. Commercially available salt measuring devices (around 15 dollars) are not so accurate but have a simple indication of low, medium and high salt concentration, which can alert high-salt concentrated liquid intake. Once the cost is lowered, we believe it can be distributed to regions of the world with high-salt intake [1,2].

Conclusion and Perspectives

Historical improvement of questionnaires and devices on salt-intake are still on their way to prevent devastating cardiovascular, cerebrovascular diseases. Recent development of devices that measure urinary salt excretion correlate well with sodium intake making them promising tools for preventing these diseases. First, they will evoke awareness of high-salt intake in regions where high-salt intake prevails. Second, these tools will be helpful in evaluating salt intake on various upcoming trials on high salt intake-induced diseases. The key essence of this review is that "elaborate but simple" questionnaires and devices must be developed to evoke awareness of deadly consequences of high-salt intake in regions where high-salt intake prevails. Cardiovascular diseases are not only deadly, but once diagnosed; also have undesirable impact on the individual as well as health economics. Once a way to prevent high-salt intake is established, we will be able to live a happier healthier longer life.

REFERENCES

1. Kontis V, Mathers CD, Bonita R, Stevens GA, Rehm J, et al. Regional contributions of six preventable risk factors to achieving the 25 × 25 non-communicable disease mortality reduction targets: A modelling study. Lancet Glob Health 2015; 3: e746-757.
2. Asaria P, Chisholm D, Mathers C, Ezzati M, Beaglehole R. Chronic disease prevention: Health effects and financial costs of strategies to reduce salt intake and control tobacco use. Lancet 2007; 370: 2044-2053.
3. Imaizumi Y, Eguchi K, Murakami T, Arakawa K, Tsuchihashi T, et al. High salt intake is independently associated with hypertensive target organ damage. J Clin Hypertens 2016; 18: 315-321.
4. Ohta Y, Tsuchihashi T, Kiyohara K, Oniki H. High salt intake promotes a decline in renal function in hypertensive patients: A 10-year observational study. Hypertens Res 2013; 36: 172-176.
5. Ohta Y, Tsuchihashi T, Kiyohara K. Influence of salt intake on target organ damages in treated hypertensive patients. Clin Exp Hypertens 2012; 34: 316-320.
6. 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.
7. Chan EL, Ahmed TM, Wang M, Chan JC. History of medicine and nephrology in Asia. Am J Nephrol 1994; 14: 295-301.
8. Postel-Vinay EN. A Century of arterial hypertension 1896-1996. J R Soc Med 1996; 89: 213.
9. Widal F. Role du chlorure de sodium dans la pathogénie de certains oedèmes britiques. La Semaine Medicale 1903; 23: 199.
10. Ambard L, Beaujard E. Causes de l'hypertension arterielle. Arch Gen Med 1904; 1: 520-533.
11. Ambard L, Beaujard E. La retention chlorurée sèche. Semaine Med 1905; 25: 133-136.
12. Allen FM. Arterial hypertension. JAMA 1920; 74: 652.
13. Allen FM SJ. Treatment of arterial hypertension. J Metab Res 1922; 2: 429-545.
14. Kempner W. Treatment of kidney disease and hypertensive vascular disease with rice diet. JAMA 1944; 125: 48.
15. Kempner W. Treatment of hypertensive vascular disease with rice diet. Am J Med 1948; 4: 545-577.
16. Kempner W. Treatment of heart and kidney disease and of hypertensive and arteriosclerotic vascular disease with the rice diet. Ann Intern Med 1949; 31: 821-856.
17. Grollman A, Harrison TR. Effect of rigid sodium restriction on blood pressure and survival of hypertensive rats. Proc Soc Exp Biol Med 1945; 60: 52-55.
18. Grollman A, Harrison TR, James B, Joseph C, Francis R. Sodium restriction in the diet for hypertension. JAMA 1945; 129: 533-537.
19. Mahmood SS, Levy D, Vasan RS, Wang TJ. The Framingham heart study and the epidemiology of cardiovascular disease: A historical perspective. Lancet 2014; 383: 999-1008.
20. Fungers A, Kaiser K, Martini P. Relation of essential hypertension to sodium chloride III: Clinical and experimental investigations on the effectiveness of cation exchange in essential hypertension. Deutsches Archiv fur klinische Medizin 1958; 204: 637-648.
21. Kelly HT, Sheppard M. A dietary study of subjects from upper income groups. N Engl J Med 1943; 228: 118-124.
22. Friedfeld L. Prophylaxis and treatment of heat-reaction states. N Engl J Med. 1949; 240: 1043-1047.

23. Humphries SV. A study of hypertension in the Bahamas. S Afr Med J 1957; 31.

24. Kohlstaedt KG, Moser M, Francis T, Neel J, Moore F. Panel discussion on genetic and environmental factors in human hypertension. Circulation 1958; 17: 728-742.

25. Drake RM, Buechley RW, Breslow LV. An epidemiological investigation of coronary heart disease in the California health survey population. Am J Public Health Nations Health 1957; 47: 43-57.

26. Burke BS. A method of diet analysis. J Pediatr 1938; 12: 493-503.

27. Heady JA. Diets of bank clerk's development of a method of classifying the diets of individuals for use in epidemiological studies. J R Stat Soc 1961; Series A: 336-371.

28. Young CM, Hagan GC, Tucker RE, Foster WD. A comparison of dietary study methods II dietary history vs. seven day record vs. 24 h recall. J Am Diet Assoc 1952; 28: 218-221.

29. Paul O, Lepper MH, Phelan WH, Dupertuis GW, Macmillan A, et al. A longitudinal study of coronary heart disease. Circulation 1963; 28: 20-31.

30. Den Hartog C, Van S, Dalderup LM, Drion EF, Mulder T. The diet of volunteers participating in a long term epidemiological field survey on coronary heart disease at Zutphen, the Netherlands. Voeding 1965; 26: 184-208.

31. Jain M, Howe GR, Johnson KC, Miller AB. Evaluation of a diet history questionnaire for epidemiologic studies. Am J Epidemiol 1980; 111: 212-219.

32. Huenemann RL, Turner D. Methods of dietary investigation. J Am Diet Assoc 1942; 18: 562-568.

33. Hart ML, Cox AG. A comparison of dietary analysis methods using a computer. Nutrition 1967; 21: 146-153.

34. Lubbe AM. A survey of the nutritional status of white school children in Pretoria: Description and comparative study of two dietary survey techniques. S Afr Med J 1968; 42: 616-622.

35. Dawber TR, Pearson G, Anderson P, Mann GV, Kannel WB, et al. Dietary assessment in the epidemiologic study of coronary heart disease: The Framingham study 2 reliability of measurement. Am J Clin Nutr 1962; 11: 226-234.

36. Horwitt MK, Harvey CC, Hills OW, Liebert E. Correlation of urinary excretion of riboflavin with dietary intake and symptoms of ariboflavinosis. J Nutr 1950; 41: 247-264.

37. Balogh M, Kahn HA, Medalie JH. Random repeat 24 h dietary recalls. Am J Clin Nutr 1971; 24: 304-310.

38. Madden JP, Goodman SJ, Guthrie HA. Validity of the 24 h recall: Analysis of data obtained from elderly subjects. J Am Diet Assoc 1976; 68: 143-147.

39. Gersovitz M, Madden JP, Smiciklas-Wright H. Validity of the 24 h dietary recall and seven-day record for group comparisons. J Am Diet Assoc 1978; 73: 48-55.

40. Hankin JH, Reynolds WE, Margen S. A short dietary method for epidemiologic studies II: Variability of measured nutrient intakes. Am J Clin Nutr 1967; 20: 935-945.

41. Services UDoHaH. NHANES III dietary interviewer's manual. WESTAT Inc., Hyattsville, MD 1992.

42. Tsuchihashi TMK, Oniki H, Sakaki M, Arakawa K, Kameda W, et al. Assessment of salt intake by using a simple check sheet in hypertensive patients. Journal of blood pressure 2013; 20: 1239-1243.

43. Yasutake K, Miyoshi E, Kajiyama T, Umeki Y, Misumi Y, et al. Comparison of a salt check sheet with 24 h urinary salt excretion measurement in local residents. Hypertens Res 2016.

44. Zhao GQ, Zhang Y, Hoon MA, Chandrashekar J, Erlenbach I, et al. The receptors for mammalian sweet and umami taste. Cell 2003; 115: 255-266.

45. Pickle LW, Hartman AM. Indicator foods for vitamin A assessment. Nutr Cancer 1985; 7: 3-23.

46. Byers T, Marshall J, Fiedler R, Zielezny M, Graham S. Assessing nutrient intake with an abbreviated dietary interview. Am J Epidemiol 1985; 122: 41-50.

47. Sakata S, Tsuchihashi T, Oniki H, Tominaga M, Arakawa K, et al. Relationship between salt intake as estimated by a brief self-administered diet-history questionnaire (BDHQ) and 24 h urinary salt excretion in hypertensive patients. Hypertens Res 2015; 38: 560-563.

48. Thompson FE, Byers T. Dietary assessment resource manual. J Nutr 1994; 124: 2245S-2317S.

49. Satoh M, Kato N, Hosaka M, Elnagar N, Tsuchihashi T, et al. Validity of salt intake assessment system based on a 24 h dietary recall method using a touch panel computer. Clin Exp Hypertens 2014; 36: 471-477.

50. Corcoran AC, Taylor RD, Page IH. Controlled observations on the effect of low sodium dietotherapy in essential hypertension. Circulation 1951; 3: 1-16.

51. Novello FCSJ. Benzothiadiazine dioxides as novel diuretics. J Am Chem Soc 79: 2028-2029.

52. Freis ED, Wanko A, Wilson IM, Parrish AE. Treatment of essential hypertension with chlorothiazide (diuril); its use alone and combined with other antihypertensive agents. J Am Med Assoc 1958; 166: 137-140.

53. Parijs J, Joossens JV, Van der Linden L, Verstreken G, Amery AK. Moderate sodium restriction and diuretics in the treatment of hypertension. Am Heart J 1973; 85: 22-34.

54. Liu K, Dyer AR, Cooper RS, Stamler R, Stamler J. Can overnight urine replace 24 h urine collection to asses salt intake? Hypertension 1979; 1: 529-536.

55. Yamori Y, Kihara M, Fujikawa J, Soh Y, Nara Y, et al. Dietary risk factors of stroke and hypertension in Japan -- Part 1: Methodological assessment of urinalysis for dietary salt and protein intakes. Japanese Circulation Journal 1982; 46: 933-938.

56. Luft FC, Fineberg NS, Sloan RS. Estimating dietary sodium intake in individuals receiving a randomly fluctuating intake. Hypertension 1982; 4: 805-808.

57. Kawasaki T, Ueno M, Uezono K, Kawazoe N, Nakamuta S, et al. Average urinary excretion of sodium in 24 h can be estimated from a spot-urine specimen. Japanese Circulation Journal 1982; 46: 948-953.

58. Wolf JP, Henriet MT, Nguyen NU, Dumoulin G, Laroze M, et al. Expression of plasma renin activity in terms of urinary sodium excretion and posture in normal subjects on free sodium intake. Renal Physiol 1984; 7: 237-242.

59. Liu LS, Zheng DY, Lai SH, Wang GQ, Zhang YL. Variability in 24 h urine sodium excretion in Chinese adults. Chinese Medical Journal 1986; 99: 424-426.

60. Liu LS, Zheng DY, Jin L, Liao YL, Liu K, et al. Variability of urinary sodium and potassium excretion in north Chinese men. J Hypertens 1987; 5: 331-335.

61. Kawasaki T, Itoh K, Uezono K, Sasaki H. A simple method for estimating 24 h urinary sodium and potassium excretion from second morning voiding urine specimen in adults. Clin Exp Pharmacol Physiol 1993; 20: 7-14.

62. Costa Ede A, Rose G, Klein CH, Achutti AC. Diastolic pressure as an index of salt sensitivity. J Hum Hypertens 1994; 8: 703-709.

63. Pan WH, Chen JY, Chen YC, Tsai WY. Diurnal electrolyte excretion pattern affects estimates of electrolyte status based on 24-hour, half-day, and overnight urine. Chin J Physiol 1994; 37: 49-53.

64. Graudal N, Alderman MH. Response to "salt intake and mortality". Am J Hypertens 2014; 27: 1425.

65. Graudal N. Population data on blood pressure and dietary sodium and potassium do not support public health strategy to reduce salt intake in Canadians. Can J Cardiol 2016; 32: 283-285.

66. Guideline: Sodium intake for adults and children. Geneva 2012.

67. He J, Klag MJ, Whelton PK, Chen JY, Mo JP, et al. Agreement between overnight and 24 hurinary cation excretions in southern Chinese men. Am J Epidemiol 1993; 137: 1212-1220.

68. Sakaki M, Tsuchihashi T, Arakawa K, Fukui H, Kameda W, et al. Long-term variability of urinary salt excretion and blood pressure in hypertensive patients. Hypertens Res 2014; 37: 939-943.

69. Arakawa K, Sakaki M, Sakata S, Oniki H, Tominaga M, et al. Variability of urinary salt excretion estimated by spot urine in treated hypertensive patients. Clin Exp Hypertens 2015; 37: 445-448.

70. Sadanaga T, Ando K, Hirota S, Mitamura H, Tsuchihashi T, et al. B-type natriuretic peptide levels are decreased by reducing dietary salt intake in patients with compensated heart failure with preserved ejection fraction. Intern Med J 2013; 43: 663-667.

71. Hirota S, Sadanaga T, Mitamura H, Fukuda K, Ogawa S. B-type natriuretic peptide levels are decreased by reducing dietary salt intake in patients with permanent atrial fibrillation. Int J Cardiol 2013; 167: 294-296.

72. Kamata K, Tochikubo O. Estimation of 24 h urinary sodium excretion using lean body mass and overnight urine collected by a pipe-sampling method. J Hypertens 2002; 20: 2191-2197.

73. Yamasue K, Tochikubo O, Kono E, Maeda H. Self-monitoring of home blood pressure with estimation of daily salt intake using a new electrical device. J Hum Hypertens 2006; 20: 593-598.

74. Yasutake K, Horita N, Umeki Y, Misumi Y, Murata Y, et al. Self-management of salt intake: Clinical significance of urinary salt excretion estimated using a self-monitoring device. Hypertens Res 2016; 39: 127-132.

75. Kawano Y, Tsuchihashi T, Matsuura H, Ando K, Fujita T, et al. Report of the working group for dietary salt reduction of the Japanese society of hypertension: Assessment of salt intake in the management of hypertension. Hypertens Res 2007; 30: 887-893.

76. Yasutake K, Horita N, Murata Y, Koyama S, Enjoji M, et al. Estimated urinary salt excretion by a self-monitoring device is applicable to education of salt restriction. Hypertens Res 2015; 38: 143-148.

77. Tsuchihashi T, Kai H, Kusaka M, Kawamura M, Matsuura H, et al. Report of the salt reduction committee of the Japanese society of hypertension: Assessment and application of salt intake in the management of hypertension. Hypertens Res 2013; 36: 1026-1031.

78. Yasutake K, Sawano K, Yamaguchi S, Sakai H, Amadera H, et al. Self-monitoring urinary salt excretion in adults: A novel education program for restricting dietary salt intake. Exp Ther Med 2011; 2: 615-618.

79. Intersalt. Intersalt: An international study of electrolyte excretion and blood pressure, results for 24 h urinary sodium and potassium excretion. BMJ 1988; 297: 319-328.

80. Sakaki M, Tsuchihashi T, Arakawa K. Characteristics of the hypertensive patients with good and poor compliance to long-term salt restriction. Clin Exp Hypertens 2014; 36: 92-96.

81. Morinaga Y, Tsuchihashi T, Ohta Y, Matsumura K. Salt intake in 3 year old Japanese children. Hypertens Res 2011; 34: 836-839.

82. Ohta Y, Tsuchihashi T, Ueno M, Kajioka T, Onaka U, et al. Relationship between the awareness of salt restriction and the actual salt intake in hypertensive patients. Hypertens Res 2004; 27: 243-246.

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