AN ESTIMATION OF SODIUM CHLORIDE INTAKE BY ADULTS IN SINGAPORE

H P Lee
C N Ong
C B Chia

SYNOPSIS

Inter-population studies have shown a strong correlation between sodium chloride intake and increased blood pressure. Animal experiments have also demonstrated such a relationship, although studies between-individuals have produced inconclusive results. This is to be expected in view of the diurnal intra-individual variation of both parameters. Nevertheless, the circumstantial evidence is highly suggestive and further 'proof' must now come from interventive studies. Singapore has a relatively high prevalence of 14% definite hypertension among adults. From this study of 30 freeliving adults, the estimated daily sodium chloride intake is 8-12 gm (137-205 mEq) based on 24-hour urinary excretion. This is also on the high side. It was found that salt usage could not be reliably determined by questionnaire-response in terms of taste for salt, use of salt at the table and intake of salted foods. The need is for the general population to acquire a taste for less salt (5-7 gm a day) so that overall blood pressure can be lowered by up to 10 mm Hg. In bringing about this shift to the left, the majority of hypertensives in the borderline and mild-to-moderate groups will be helped without the use of expensive screening programmes and anti-hypertensive drugs.

INTRODUCTION

In the history of disease control, conclusions and actions made on the basis of circumstantial evidence are not unusual. John Snow controlled the famous cholera outbreak before the vibrio was identified, and James Lind treated scurvy with lime juice before vitamin C was known. Today, the stage may be set for yet another empirical trial in disease control — that of salt intake and hypertension.

Estimates of the prevalence of definite hypertension in many developed and developing countries vary between 8-18% of adults (1). In Singapore, a nationwide survey of blood pressures found a prevalence of 14% adults with definite hypertension and 11% borderline (2). However, the risks of complications and the shortening of life-expectancy increase with the blood-pressure gradient from levels as low as 120 mm Hg systolic and 80 mm Hg diastolic. Thus, a much greater proportion of the community is actually at risk notwithstanding the accepted criteria for definite hypertension.

Many inter-population comparisons have demonstrated a fairly consistent correlation between the level of salt intake and prevalence of hypertension. Salt intake can vary from a high mean of 30 gm per person daily in north-eastern Japan (3) to the very low levels in some isolated primitive societies (4). From a review of these studies, it has been found that daily intake of sodium chloride has an influence on

Department of Social Medicine & Public Health

H P Lee, MBBS, M Sc, AM
Senior Lecturer

C N Ong, M Sc, Ph D
Senior Lecturer

C B Chia
Senior Laboratory Technician

mean blood pressures. Populations with daily intakes of 3 gm or less have low mean blood pressures, with little tendency to rise with age. When intakes are at 7-8 gm or more, blood pressures increase proportionately, especially with increasing age (1). Of course, there are many possible confounding factors like psychosocial changes, other dietary differences and changes in body weight which may be associated with increased salt intake. Thus, it is generally recognised that salt intake can only be partially responsible for the increase in blood pressure, although it is probably the factor most amenable to measurement and intervention (5).

Having obtained an idea of the prevalence of hypertension in Singapore, it would be useful to estimate the average intake of sodium chloride in the adult population. A survey was conducted with the following objectives:

(1) to study the feasibility of classifying salt users by questionnaire;
(2) to estimate the mean sodium chloride intake among adults in Singapore.

Mindful of the many pitfalls in intra-population studies, no attempt was made to correlate individual salt intake and blood pressure levels.

MATERIALS AND METHODS

There are various methods of estimating salt intake. Some depend on subject-interviews e.g. taste for salt, use of salt at the table and average household consumption of salt. They have been found to be unreliable and poorly repeatable, partially because the salt content already present in food is not taken into consideration.

Another approach is by chemical analysis — either of the food taken or in the bodily excrements. The former, usually conducted as 'duplicate-portion analysis', is very cumbersome. The most widely accepted method is to measure sodium excretion in the urine which reflects very closely the daily intake levels.

For epidemiological purposes, only one specimen is sufficient, although some workers prefer the mean of 3 specimens. While the majority would prefer a 24-hour urine collection, others have been able to show good correlations between 8-hour overnight specimens and the 24-hour ones (6). For this study, single 24-hour specimens were collected.

30 free-living subjects aged 20 years and above were interviewed and asked to contribute urine samples.

The questionnaire covered questions on their taste for salt, use of salt at the table and preference for salted foods. A likely cause for under-estimation of sodium intake, the tendency to sweat excessively, was also elicited.

Urinary sodium was estimated with the use of an atomic absorption spectrophotometer. The average of three readings was taken as the urinary sodium concentration, measured in mEq per litre (1000 mEq ≡ 58.5 gm NaCl). The total excretion in 24-hours was then calculated for each subject.

RESULTS

Questionnaire

From Table 1, it can be seen that all the subjects tended to prefer 'just sufficient' or 'a little' salt in their salt. Most (86.7%) do not add salt or soya sauce at the table.

About 46.7% indicated a liking for salted foods (e.g. fish, eggs and vegetables), although the consumption was confined to once or less a week. Nobody took salted foods everyday.

Two-thirds tended to 'sweat a lot' on most days.

Table 1 Distribution of salt usage, by questionnaire-response

Item	No.	%
TOTAL SUBJECTS	30	100
1. Preference for salt in food:		
very much	0	—
just sufficient	23	76.7
just a little	7	23.3
2. Use of salt at table:		
yes	4	13.3
no	26	86.7
3. Intake of salted foods:		
everyday	0	—
once a week	5	16.7
less than once a week	9	30.0
no	16	53.3
4. Tendency to sweat excessively:		
yes	20	66.7
no	10	33.3

Urinary Estimation

Figure 1 shows the distribution of estimated daily sodium chloride excretion in the urine. The values range from 3.3 gm (57.2 meq) to 26.4 gm (452.0 meq), with the modal levels at 6-8 gm (102.6 — 136.8 meq).

The mean and standard error of the mean are 9.7 gm ± 0.97 sodium chloride (166.4 meq ± 16.6).

24-HOUR URINARY SODIUM CHLORIDE EXCRETION

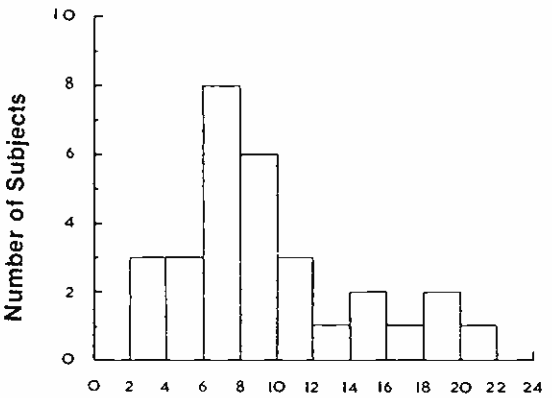

Fig 1 — 24-Hr NaCl Excretion (gm)

Comparison of History and Urinary Estimations

Table 2 gives the mean daily sodium chloride excretion (± standard error of the mean) for each category of salt-usage as determined by the questionnaire.

There are no significant differences in mean sodium chloride levels between relevant categories.

Table 2 Mean daily sodium excretion, by categories of questionnaire-response

Item	Mean (± SEM) daily NaCl excretion (gm)	
1. Preference for salt:		
very much	—	
just sufficient	9.77 (± 1.13)	
just a little	9.61 (± 2.06)	n.s.
2. Use of salt at table:		
yes	10.45 (± 0.99)	
no	9.63 (± 1.11)	n.s.
3. Intake of salted foods:		
yes	9.85 (± 1.40)	
no	9.63 (± 1.39)	n.s.
4. Tendency to sweat excessively:		
yes	9.13 (± 0.94)	
no	10.94 (± 2.27)	n.s.

DISCUSSION

Like most behaviour-related characteristics, there is great variation in daily salt intake even for the same individual. This intra-individual variation is an important consideration in clinical studies which seek to characterise habitual salt intake in a single subject. Combined with an equally marked variation in blood pressure readings, it is understandable why research workers have experienced great difficulty in demonstrating correlations between salt intake and blood pressure in individuals.

Another reason for this difficulty may be attributed to what is termed the "saturation effect" (7). When an entire population consumes excessive levels of salt, hypertension will develop among those genetically susceptible. Differences between hypertensive and normotensive groups will then be based on other characteristics, and not salt-intake which is equally high in both. But in societies where salt intake is not excessive, then the relationship may well be seen.

One must not, however, ignore the strong correlations seen between populations. Grouped data have the capability of smoothening out individual fluctuations. For example, mean heights and weights are strongly correlated although there are great individual variations. Similarly, unless one is able to monitor very closely sodium intake and blood pressure levels in a prospective cohort study, one will have to be content with grouped correlations and seek other circumstantial evidence (5)

Experimental data on animals (8, 9) and even limited groups of humans (10) have shown that excessive salt intake can cause blood pressure to increase. Whether sodium acts through the extra-cellular fluid or other mechanisms, its role is physiologically credible. The fact that some subjects have been identified as having a genetically-determined inability to handle Na^+ properly in their cells (e.g. erythrocytes) lends further weight to the salt-theory (11). There is little that one can do about a genetic defect, but something can be done about an environmental trigger.

Drug treatment of the severe hypertensive group is imperative, as the benefits far outweigh costs and side-effects. However, they form a small proportion of hypertensives. The majority are in the borderline and mild to moderate group for which drug treatment is still a subject of great controversy. Benefits may be marginal, but weighed against that are the side-effects and tremendous costs involved.

The clinician would probably be satisfied with treating those that, in his judgement, could benefit from treatment. Unfortunately, about half to two-thirds the people with high blood pressure are not aware of their condition, and even among those under treatment non-compliance with medication is a major problem.

From the community angle, it has been determined that any strategy which can shift the general blood pressure; distribution about 10 mm Hg to the left (meaning an overall reduction) would achieve just as much as normalizing the blood pressure of only hypertensives (12). Until such time that genetic susceptibility can be identified easily and cheaply, it would be prudent to apply this strategy to the whole population. Obviously, this should not involve the widespread use of costly anti-hypertensive drugs.

More and more interventive studies are showing the effectiveness of general salt restriction in reducing blood pressures by the desired 10 mm Hg (12, 13). In fact, the use of diuretics and salt-restriction in bringing about some reduction of blood pressure is a well established practice (e.g. the Kempner rice-fruit diet). This is not meant for the severe hypertensives who must be given drugs, although their efficacy would still be enhanced in the presence of lowered salt intake. The moderate salt restriction is aimed at reducing the overall risk of developing hypertension. In this way, the community attributable risk can be lowered without having to resort to expensive screening and therapeutic services.

This study has shown that the estimated mean daily sodium chloride intake among adults in Singapore is about 8-12 gm (137 — 205 mEq). The range of intake can be from 3 gm to 27 gm. The mean intake is high, although it is not near the Japanese levels.

It has also been demonstrated the difficulty and unreliability of classifying salt-usage with the use of a questionnaire. Dahl and Love(14).were able to do so probably because the Western diet contained less food items, with very little salt added during cooking. Even then, other studies in the West have not been able to repeat their findings(15).

Estimation of urinary sodium is accepted as the method of choice. In clinical studies, it has been recommended that fourteen urinary samples be taken in order to reduce intra-individual variation(6). But for epidemiological purposes, where comparisons are based on grouped data, single or at most three samples are sufficient. In fact, 8-hour overnight samples have been shown to correlate well with 24-hour estimations. This will certainly remove the inconvenience of having to collect 24-hour samples.

Some public health workers maintain that the recommended intake of 3 gm a day by the US Senate Committee on Nutrition is unrealistic(16).In fact, this will entail the consumption of salt-free foods, with restriction on milk and proteins as well. The prudent advice of keeping salt intake at 5-7 gm a day is more likely to be acceptable by the majority. To achieve such intake levels, one need only refrain from highly salted foods and free salt at the table.

In Singapore, there should be a concerted community effort:

(a) to get food manufacturers and processors not to add unnecessary salt to their products;
(b) to persuade food handlers to add minimal salt at the time of cooking (so as to allow for individual adjustment according to taste);

(c) to educate the general public to acquire a taste for less salt, by avoiding excessive usage at the table.

With the above measures, intake can be reduced from 8-12 gm to 5-7 gm.

A further measure suggested by some workers is to increase potassium intake at the same time[7]. This will serve to reduce the Na/K ratio which may have a reducing effect on blood pressure levels. Potassium is easily increased by ingestion of fresh fruits, which is a well accepted health-promoting habit (except in cases of renal failure).

As in all public health measures, there will be some exceptional instances in which salt restriction would not be applicable. These include hypotensive-prone subjects and those with sodium-depleting conditions (including excessive sweating). Be that as it may, salt intake is definitely a far easier habit to control than that of smoking. The need is for young and old to acquire a taste for minimal salt in one's food without much sacrifice on palatability.

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