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East salt sparingly - sprinkle, don't shake!

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Abstract
The salt-blood pressure hypothesis states that an excessive salt intake leads to an increase in blood pressure in genetically susceptible persons and, if high intake is maintained long term, ultimately leads to sustained hypertension. It is estimated that about 3.3 million South Africans (12.6% and 16.3% of adult men and women, respectively) are hypertensive. However, not all subjects within a particular population respond equally to exposure to high-salt diets. Methods to identify those who are 'salt sensitive' remain in the research domain; therefore a population approach to the restriction of dietary salt intake is warranted. The message to 'eat salt sparingly' will not interfere with the current nutritional and legal requirements regarding iodation of table salt. A salt intake as low as 5 g per day would provide an adequate amount of iodine, provided the salt is sufficiently iodated. Dietary factors other than sodium which have been shown to influence blood pressure include potassium, magnesium, calcium and alcohol. The 'Dietary Approaches to Stop Hypertension' (DASH) randomised controlled trial found that subjects fed a diet rich in fruit and vegetables for 8 weeks significantly reduced both systolic and diastolic blood pressure, compared with subjects on a typical American control diet. A 'combination' diet, rich in fruit, vegetables and low-fat dairy products, and with a reduced saturated and total fat intake, resulted in an even greater reduction in blood pressure. Translated into a practical diet, this information suggests a daily diet that includes large amounts of fruit and vegetables, a moderate intake of low-fat dairy products, lean meat and chicken, and a prudent alcohol intake. Salt should be used sparingly, if at all, at the table and in the preparation of meals, and the intake of processed foods high in salt should be limited. This would result in a reduction in intake from an average of around 9 g salt to about 6 g salt per day, which is the current USA recommendation. These blood pressure-related recommendations incorporate many of the various foodbased dietary guidelines, emphasising that the recommendations are congruent and mutually substantiative.

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EAT SALT SPARINGLY — SPRINKLE, DON'T SHAKE!

K E Charlton, P L Jooste

The salt-blood pressure hypothesis states that an excessive salt intake leads to an increase in blood pressure in genetically susceptible persons and, if high intake is maintained long term, ultimately leads to sustained hypertension. It is estimated that about 3.3 million South Africans (12.6% and 16.3% of adult men and women, respectively) are hypertensive. However, not all subjects within a particular population respond equally to exposure to high-salt diets. Methods to identify those who are 'salt sensitive' remain in the research domain; therefore a population approach to the restriction of dietary salt intake is warranted.

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Salt restriction as a form of treatment for hypertension was introduced at the beginning of the century when chloride could first be measured. Interestingly almost 100 years later, the merits of the salt hypothesis and the utility of its application are still being debated. The medical community is seldom as bewildered and polarised about a public health policy issue as it is regarding the role of salt in health and disease. Two opposing arguments (for[1] and against[2]) regarding the appropriateness of the current USAdietary guideline for sodium (Na), which recommends less than 6 g sodium chloride (or < 2.4 g Na) per day, were recently published back-to-back in the *American Journal of Clinical Nutrition*.

Ecological studies have demonstrated an association between average salt consumption and blood pressure levels in populations with differing lifestyles.[3] In several developing countries where the average daily salt consumption is < 3 g, blood pressure does not rise with age, and hypertension is virtually non-existent,[4-6] whereas in populations with a typically western lifestyle, both salt intake (8 - 10 g / day) and the prevalence of hypertension are far higher.[7,8] The INTERSALT study which included an examination of 10 074 participants from 52 centres in 32 countries, using standardised methodology, demonstrated a positive association between sodium excretion and median blood pressure when the data from all centres were included. However, when four distinctly disparate populations with very low sodium excretion values were excluded, the association no longer remained.[9] The scientific community is generally in agreement that the INTERSALT data did not provide compelling evidence that salt intake causes hypertension.

Meta-analyses of intervention trials have demonstrated a modest reduction in blood pressure associated with sodium restriction.[10-15] A review of 23 randomised controlled trials (N = 1 536 subjects) found that a daily reduction in sodium intake of 1.7 g (i.e. 4.5 g salt) resulted in an average drop in systolic and diastolic blood pressure of 4.9 and 2.6 mmHg, respectively in hypertensive subjects, and 1.7 and 1.0 mmHg respectively, in non-hypertensives.[13] In summary, the effects of salt restriction have been found to be as effective as the addition of a diuretic therapy (i.e. thiazide) to an ACE inhibitor in hypertensives.[16] The advantage of salt restriction over diuretic therapy is that no fall in plasma potassium levels, as occurs with thiazide therapy, is seen.

DIETARY FACTORS, OTHER THAN SALT, WHICH AFFECT BLOOD PRESSURE

The adoption of a food-based dietary guideline (FBDG) approach to nutrition education begs consideration of other foods which may contribute to blood pressure regulation. Dietary factors other than sodium which have been shown to influence blood pressure include potassium, magnesium, calcium and alcohol.[17] The 'Dietary Approaches to Stop Hypertension' (DASH) randomised controlled trial,[18] conducted in a group of 459 normotensive adults (i.e. systolic BP< 160 mmHg and diastolic BP80 - 95 mmHg) found that subjects fed a diet rich in fruit and vegetables for 8 weeks significantly reduced systolic and diastolic blood pressure by 2.8 and 1.1 mmHg more, respectively, than subjects on a typical American control diet. Subjects randomised to a 'combination' diet, rich in fruit, vegetables and low-fat dairy products, and with a reduced saturated and total fat intake (Table I) had an even greater reduction in both systolic and diastolic blood pressure, as compared with the control diet group (5.5 and 3.0 mmHg, respectively). In subjects who were hypertensive the effects were more marked; the fruit-and-vegetable-rich diet resulted in reductions of systolic and diastolic blood pressure of 3.5 and 2.1 mmHg, respectively, while the 'combination' diet resulted in corresponding reductions of 11.4 and 5.5 mmHg, respectively. It was estimated that a population-wide reduction in systolic or diastolic blood pressure of the magnitude observed with the 'combination' diet would reduce incident coronary heart disease by approximately 15% and stroke by about 27%.

The follow-up DASH II study[19] has now been completed, in which the additional benefits of salt restriction over and above the merits of the DASH diet, have been demonstrated. Reducing sodium intake from the standard 3.5 g / day to either 2.4 g or 1.5 g / day in subjects on the DASH diet resulted in a minimal further drop in blood pressure. At an intake of 1.5 g sodium per day, differences between the standard diet and the DASH diet were only 2.2 mmHg. The combination of the low sodium and DASH diet lowered blood pressure by 11.5 mmHg in subjects with hypertension. It may be concluded that the greatest benefits in sodium restriction are seen in those with a poor diet (i.e. typical 'American' high-fat, low-nutrient-dense diet), particularly hypertensive subjects, and that subjects who include a large amount of fruit and vegetables, together with low-fat dairy products, may be able to tolerate higher amounts of salt. This compelling evidence further supports the shifting paradigm in provision of nutrition messages to the (often confused) public, in that a holistic approach needs to be taken, rather than the targeting of individual messages.

Epidemiological studies over the past two decades have firmly established a relationship between regular, excessive alcohol consumption and hypertension. This association has been found in both sexes of differing ethnicity, and is independent of the type of alcoholic beverage, adiposity, education, smoking, salt intake and several other factors.[20] It has been shown that a habitual intake of alcohol greater than 30 - 60 g per day (i.e. 3 - 5 alcoholic drinks per day) results in blood pressure elevation in both men and women.[21] As well as its direct effect on blood pressure, alcohol can cause resistance to antihypertensive therapy[22] and is an independent risk factor for stroke.[23]

Table I. The DASH diet[18]

Food group	Daily servings	Serving sizes	Examples and notes	Significance of the Dash diet pattern
Grains and grain products	7 - 8	1 slice bread 1/2 cup (125 g) dry cereal 1/2 cup (125 g) cooked rice, pasta or cereal	Wholewheat bread, muffin, pita bread, bagel cereal, oatmeal	Major sources of energy and fibre
Vegetables	4 - 5	1 cup (250 g) raw, leafy vegetables 1/2 cup (125 g) cooked vegetables 200 ml vegetable juice	Tomatoes, potatoes, carrots, peas, squash, broccoli, turnip greens, kale, spinach, artichokes, green beans, sweet potatoes	Rich sources of potassium, magnesium and fibre
Fruits	4 - 5	1 medium fruit 1/4 cup (50 g) dried fruit 200 ml fruit juice 1/2 cup (125 g) fresh, frozen or canned fruit	Apricots, bananas, dates, oranges, orange juice, grapefruit, grapefruit juice, mangoes, melons, peaches, pineapples, prunes, raisins, strawberries, tangerines	Important sources of potassium, magnesium and fibre
Low-fat or non-fat dairy foods	2 - 3	250 ml milk 1 cup (250 ml) yogurt, 45 g cheese	Skim or low-fat (2%) milk, skim or low-fat buttermilk, non-fat or low-fat yoghurt, non-fat or low-fat cheeses	Major sources of calcium and protein
Meats, poultry and fish	≤ 2	85 g cooked meats, poultry or fish	Select only lean meats; trim away visible fats; broil, roast, or boil, instead of frying; remove skin from poultry	Rich sources of protein and magnesium
Nuts, seeds and legumes	4 - 5/wk	45 g or 1/3 cup nuts 15 g or 2 tbsp seeds 1/2 cup (125 g) cooked legumes	Almonds, mixed nuts, peanuts, walnuts, sunflower seeds, kidney beans, lentils, split peas	Rich sources of energy, magnesium, potassium, protein and fibre

The DASH eating plan shown above is based on 2 000 kcal a day (8 400 kJ/d). Depending on energy needs, the number of daily servings in a food group may vary from those listed.

The most recent US Joint National Council (JNC) VI guidelines[24] on lifestyle modification for the prevention and management of hypertension includes dietary changes, reduction in alcohol intake, weight loss if overweight, increased physical activity levels and smoking cessation (Table II).

Table II. Lifestyle modifications for hypertension prevention and management (JNC VI)[24]

- Lose weight if overweight
- Limit alchohol intake to no more than 25 g ethanol (e.g. 2 cans beer, 2 glasses wine, or 2 tots spirits) per day or 12 g ethanol for women and lighter weight people
- Increase aerobic physical activity (30 - 45 min most days of the week)
- Reduce sodium intake to no more than 100 mmol/d (2.4 g sodium or 6 g sodium chloride/salt)
- Maintain adequate intake of dietary potassium (approximately 90 mmol/d)
- Maintain adequate intake of dietary calcium and magnesium for general health
- Stop smoking and reduce intake of dietary saturated fat and cholesterol for overall cardiovascular health

THE SALT SENSITIVITY PARADIGM

Blood pressure is a function of flow and resistance. The kidneys are responsible for managing the electrolyte and water content in the body, since the kidneys excrete almost all ingested electrolytes and much of the water consumed daily. Volume content is tightly controlled by the regulation of sodium (and thereby chloride) excretion. A relationship between renal salt and water excretion and blood pressure can be created for any level of blood pressure and is termed the renal pressure-natriuresis or diuresis relationship. All forms of hypertension in animal models tested to date feature a shift in the pressure-natriuresis relationship, so that a higher level of pressure is required to excrete any given amount of salt and water. The salt sensitivity of any form of hypertension is a function of the steepness of the pressure-natriuresis relationship when mapped on a graph. In normotensive individuals, the relationship between salt and water intake (and excretion) is very steep, so that little change in blood pressure occurs when salt and water intake (and excretion) are modified over a large range. Fairly flat pressure-natriuresis curves indicate salt sensitivity since blood pressure is significantly influenced by salt intake. Steep pressure-natriuresis curves indicate that blood pressure, even if elevated, is little influenced by salt.

Almost all people living in westernised societies ingest a high sodium diet; however, not all individuals respond similarly to a high salt intake. Three types of responders have been described:

Salt sensitive

Salt sensitivity can be defined as a rise in blood pressure occurring during salt administration and/or a fall in blood pressure when salt is taken away. Salt sensitivity has been shown to be reversible with weight loss — at least in young white adolescents. Definitions of salt sensitivity, in terms of absolute change in blood pressure in response to salt loading or salt depletion have been arbitrary and varied, but are generally in the region of a 3 - 5 mmHg decrease in mean arterial pressure (i.e. one-third of pulse pressure added to diastolic pressure), from baseline in response to salt depletion.

Salt resistant

Mean arterial blood pressure levels remain consistent (i.e. generally within 5 mmHg) over a wide range of salt intake.

Counter regulators

Mean arterial blood pressure levels fall during high salt intake, compared with a low salt intake. It has been suggested that this may be partially due to an overstimulation of the renin-angiotensin-aldosterone system during salt restriction.

There is no quick and easy way to predict whether an individual is salt sensitive or not. The classification has therefore remained in the research domain.

PREVALENCE OF HYPERTENSION IN SOUTH AFRICA

In South Africa, it is estimated that about 3.3 million people are hypertensive (defined as blood pressure ≥ 160/95 mmHg and/or on antihypertensive medication). The first South African Demographic and Health Survey (DHS), in which blood pressure was measured in a nationally representative sample of 13 826 adults, identified the prevalence of hypertension to be 12.6% in men and 16.3% in women. Differences in the prevalence of hypertension between the various ethnic groups in the country are shown in Fig. 1. In contrast to studies published 10 - 20 years ago, urban/non-urban differences were negligible. Overall, only 26% of hypertensive men and 38% of hypertensive women had controlled (≤ 160/95 mmHg) blood pressure levels. Women fared better than men in terms of diagnosis status — 67% of all hypertensive women had previously been diagnosed, compared with 41% of hypertensive men. This finding suggests that screening for raised blood pressure, at primary level, is satisfactory, particularly for middle-aged and older women (over 60% of hypertensive women aged 45 years and older

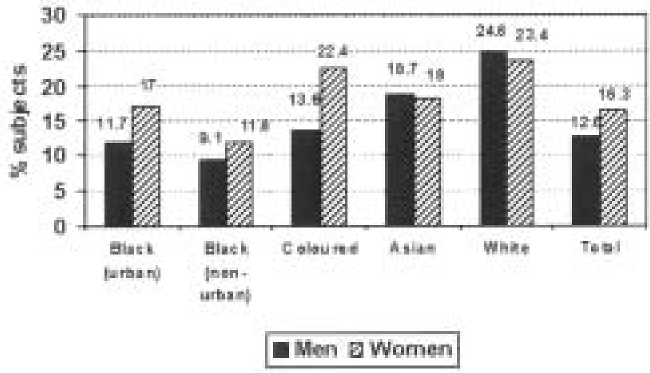


Fig. 1. Prevalence of hypertension in the South African population, according to ethnicity (N = 5 671 men; 8 155 women).

reported being previously diagnosed). However, treatment status appears to be wholly inadequate. The high prevalence of hypertension in the country, together with the poor management of the condition, further emphasises the importance of lifestyle modification in reducing the burden of chronic diseases of lifestyle associated with raised blood pressure, namely cardiovascular disease and stroke.

High-risk groups — black South Africans, older adults and those with a family history

The salt-blood pressure hypothesis regards salt as the essential pathogenic factor. The influence of salt intake however interacts with both genetic predisposition as well as other environmental factors. In the USA, the greater susceptibility of African-Americans than whites to hypertension and pressure-related target-organ damage has been linked to a higher prevalence of salt sensitivity (although at least 50% of white hypertensives are also salt sensitive), lower urinary potassium excretion, lower plasma renin activity, and higher circulating levels of immunoreactive parathyroid hormone and 1,25 dihydroxyvitamin D. Weinberger and colleagues have reported that 73% of black hypertensive patients are salt sensitive, compared with 56% of a white hypertensive group. Studies conducted in South Africa have also suggested diminished activity of the sodium-potassium ATPase pump in black hypertensives. Both black South Africans and African-Americans manifest higher average blood pressure responses to calcium antagonists than to ACE inhibitors, an observation consistent with the thesis that hypertension among these groups is often salt sensitive. More research in this area is required, particularly in light of the massive migration of black South Africans to urban areas, and the accompanying change in dietary habits, dubbed the 'nutrition transition,' which results in a higher intake of processed foods, and therefore salt.

Increasing sensitivity to salt is observed with increasing age. A randomised controlled trial in 47 people aged 60 - 78 years who were not receiving antihypertensive medication found that a modest salt restriction from 10 g to 5 g/day resulted in a reduction of systolic and diastolic blood pressure by 7.2 and 3.2 mmHg, respectively, over a 4-week period. More importantly, unlike studies in younger subjects, similar falls in blood pressure were seen for both normotensive and hypertensive subjects. The findings are consistent with the predictions of Law and colleagues, who estimate that a reduction in sodium intake of 50 mmol/day (about 3 g salt) in older people would lower the population's systolic blood pressure by an average of 5 mmHg. This reduction is similar to trials of drug therapy with thiazide diuretics in this age group, in which a 36% reduction in the 5-year incidence of stroke has been estimated. These studies provide convincing motivation for universal sodium restriction in all older people.

Children with a family history of hypertension are 30% more likely to remain in the upper quartile of systolic blood pressure than their peers. It has been postulated that a family history of hypertension is associated with salt sensitivity; however, it is unclear which genotypes, if any, may account for an increased sensitivity to salt. For the present, it is probably prudent to target individuals with a family history of hypertension to lower their salt intake as much as possible.

SALT INTAKE PATTERNS

Dietary sources of salt

Sodium chloride is approximately 40% sodium and 60% chloride. In order to calculate the salt content of food (in mg), the sodium value (in mg) should be multiplied by 2.5. In terms of quantification of salt intake, one teaspoon of salt equates to approximately 6 g sodium chloride.

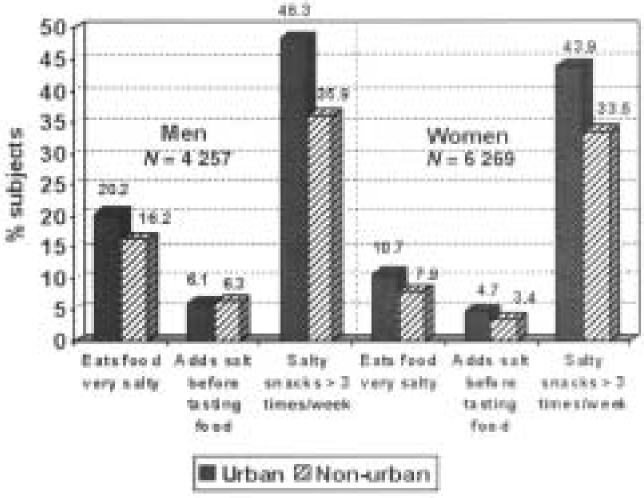
The mean dietary sodium intake of American adults is 3 289 mg/day (equivalent to a salt intake of about 8 g/day), which greatly exceeds the estimated minimum requirements of healthy non-pregnant, non-lactating adults of about 500 mg/day. Studies of the sources of dietary sodium estimate that about three-quarters of sodium intake comes from food processing, 10 - 11% is naturally occurring (inherent) in foods, about 15% is discretionary (half of which is contributed by table salt and half by added salt in cooking) while less than 1% is provided by water. National dietary survey data from the NHANES II study which used a 24-hour recall method has demonstrated that the main sources of sodium in the American diet are provided by grain products, including bread, which contributes about a quarter of total intake.

Sources of salt in the South African diet have not yet been adequately described. However, from the limited amount of information provided on some products, it is likely that grain products, particularly bread, will be a significant contributor to daily salt intake. For example, 3 - 4 slices (i.e.. 150 g) of Sasko bread (figures obtained from nutritional labelling on various Sasko products — other brands of bread are not labelled) will provide between 480 and 675 mg sodium (1.2 - 1.7 g salt), depending on the type of bread. The addition of 30 g margarine to this amount of bread will provide an extra 480 mg of sodium (1.2 g salt), which totals 2.9 g salt — almost half of the USAdietary guideline of the maximum recommended intake of 6 g salt per day!

Data from the BRISK survey suggest that the average dietary intake of sodium (non-discretionary sources) in black South African subjects in peri-urban areas is highest in adolescents aged 15 - 18 years, compared with the age groups 19 - 44 and 45 - 64 years for both men (5.1; 4.0; 3.3 g/day, respectively) and women (3.3; 2.8; 2.4 g/day, respectively). However, added (discretionary) salt sources were not included in the dietary assessment method.

It is difficult to identify patterns of food intake which are associated with a high salt intake. Almost half of urban black men and women in the recent DHS (48.3% and 43.9%, respectively) reported consuming salty snacks more than three times a week (Fig. 2). Slightly lower prevalences were reported for non-urban black men and women (35.9% and 33.5%, respectively). Overall, a strong age trend was seen, with the 15 - 24-year age group reporting the highest consumption of salty snacks (Fig. 3). This probably relates to the higher contribution of foods eaten outside the home by adolescents and younger adults.

In the total sample, between 16% and 21% of men reported enjoying very salty food (with the exception of Asian men (6%)), compared with 8 - 17% of women (Asian women = 4%). Little differences in salt taste preferences were seen between black subjects living in urban compared with non-urban areas (Fig. 2). Practices of adding salt to food before tasting was identified in 14% of white men and women, while in the other population groups the practice was generally reported in less than 6% of subjects.



non-urban black South Africans.

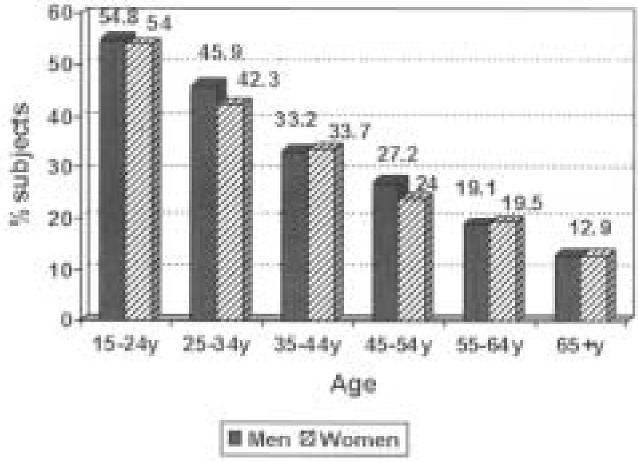


Fig. 3. Consumption of salty snacks three or more times a week by urban black South Africans, according to age group (N = 2 375 men; 3 349 women).

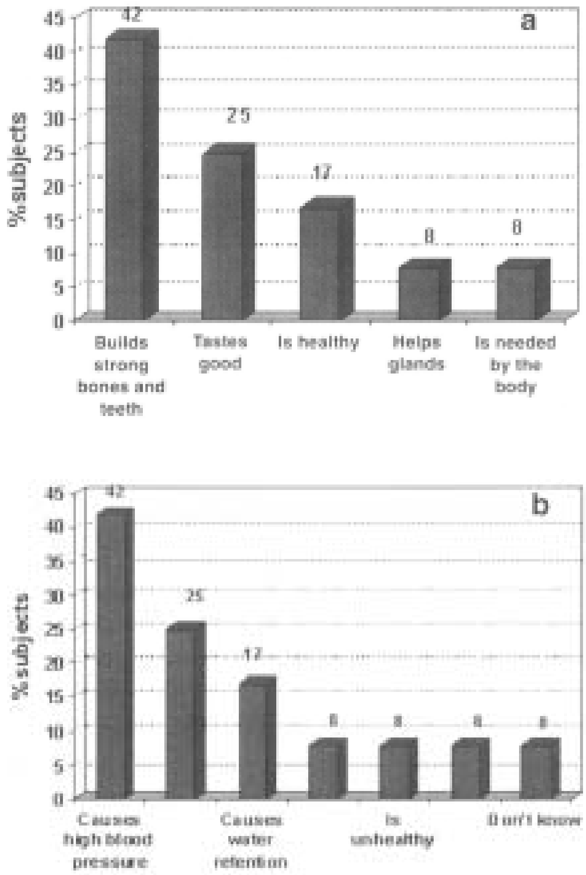


Fig. 4. Perceptions of reasons why salt is either good (a) or bad (b) for health in 30 women in the Western Cape.

In-depth interviews which were held with 30 Afrikaans- and Xhosa-speaking women in the Western Cape to test the preliminary FBDGs revealed that subjects were confused about the health (negative or positive) effects of salt. Sixty per cent of subjects claimed that salt was 'bad for you,' while 50% thought it was 'good for you' (indicating that some subjects reported both good and bad health perceptions). The most common reason given for health benefits of salt was that it 'builds strong teeth and bones' (42%), while that given for adverse health effects was that it 'causes high blood pressure' (31%) (Fig. 4).

Difficulties in measuring salt intake

Inconsistencies between authorities in the salt-blood pressure debate may be related to the difficulties in assessing salt intake. High intra- and inter-subject variability for reporting of non-discretionary sources (i.e.. salt intake which excludes table salt and salt added in cooking) has implications for the reliability of food record estimates. Indeed, it has been estimated that 81 days of dietary recording would be required to estimate an individual's intake within 10% of the observed mean. Seven-day recording of food intake is generally considered to be the maximum time feasible for dietary data collection. The gold standard for assessment of salt intake is considered to be the analysis of repeated 24-hour urinary sodium estimations; however, this method will not identify specific dietary sources of salt.

Does salt appetite exist?

The question arises why humans consume sodium in quantities which far exceed physiological requirements and whether a 'salt appetite' manifests in certain individuals, as a result of either genetic programming or learned taste through exposure to high salt intakes. As Mattes points out, cultural practices may contribute to salt intake patterns. A 10-fold difference in sodium intake has been reported between two Solomon Island populations which has been attributed to the one group's practice of steaming foods with fresh water whereas the other group cooked with sea water.

The transduction of the salty taste involves passage of sodium through a specific ion channel in the apical membrane of receptor cells. The channel can be blocked with the drug amiloride, a potassium-sparing diuretic, and is specific; lithium, which can pass through readily is salty, whereas other cations such as potassium, which do not fit, do not taste salty. The specificity explains the difficulty in finding an acceptable salt substitute. It has been proposed that a diminished perception of the taste of salt exists in old age, which results in an increased sodium consumption. However, Drewnowski and colleagues found no evidence for an age-associated sensory deficit in salt taste perceptions and preferences in studies of young and older subjects.

Locally, salt taste preference was tested in a sample of 22 Afrikaans-speaking women from Mitchell's Plain (mean age 43 years), drawn from a population in which hypertension has been reported to be excessively high. Self-rated enjoyment of five differing concentrations of salt in vegetable soup was tested in random order; followed by rating of saltiness of each concentration. Ratings of the saltiness taste in the soup did not match enjoyment ratings, in which the two highest concentrations (ie. 5.06 g/l and 7.36 g/l) were rated the same, despite evidence of a drop-off of enjoyment at the highest salt concentrations (Fig. 5). The data, although limited, support the hypothesis that certain sectors of the South African population may not be able to distinguish between high salt concentrations.

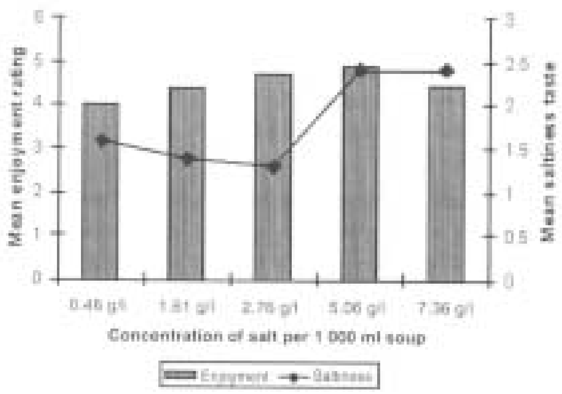


Fig. 5. Salt taste perception and enjoyment ratings of soup of various sodium concentrations in 30 women in the Western Cape.

Support for the existence of a salt appetite, defined as 'a strong motivation to seek, obtain and ingest sodium,' that is typically manifest in cases of salt-wasting or need, originates largely from a case study in which a strong craving for salt was observed in a child with undiagnosed Addison's disease, as well as reports of self-medication by the ingestion of liquorice, which possesses mineralocorticoid properties, in individuals with salt-wasting diseases. Salt-craving has, however, only been described as being present in about 15% of patients with Addison's disease and sodium depletion in humans is not accompanied by a strong and consistent craving for salt.

Food labelling — how much salt is too much?

Food labelling legislation in South Africa falls under the Foodstuffs, Cosmetics and Disinfectants Act of 1972. The food labelling regulations are currently in the process of being revised. The following categories have been proposed, with regard to health claims relating to the sodium content of foodstuffs:

- Low sodium — 120 mg per 100 g serving
- Very low sodium — 40 mg per 100 g serving
- Sodium free — 5 mg per 100 g serving.

Food manufacturers will be allowed to state the following claim on a product which complies with the above criteria: 'Diets low in sodium may reduce the risk of high blood pressure, a disease associated with many risk factors.' Generally, foods containing less than 300 mg sodium per 100 g food may be considered relatively low in sodium. This is approximately the concentration of sodium in body fluids.

Introduction of sodium on food labels will require a standardised approach by industry (e.g. whether sodium or salt (sodium chloride) content is displayed, and whether the units are given in millimoles or milligrams), and will need to be accompanied by extensive consumer training. The current South African dietary guideline has not adopted a quantitative approach with an upper recommended intake per day. This is because of a lack of information on habitual levels of dietary salt intake in various populations and also because a level of sodium restriction which is feasible to maintain long term will require the co-operation of the food industry in changing food processing techniques, rather than the targeting of individual dietary practices and food choices.

ISSUES REGARDING SALT RESTRICTION

Can excessive salt restriction have adverse health effects?

It may be argued that, providing widespread advice to the general public to reduce salt intake may be warranted if health benefits are gained by at least those individuals who are 'salt sensitive,' while at the same time those who are salt-resistant experience neither benefit nor risk. A cohort study of 2 937 mildly and moderately hypertensive men which investigated the effects of a low salt intake on cardiovascular disease over an average of 3.8 years of follow-up, demonstrated a significant, inverse association between baseline 24-hour urinary sodium excretion (antihypertensive therapy was discontinued for 3 - 4 weeks before urine collection) and myocardial infarction, independent of several known coronary heart disease risk factors. The methodological limitations of observational studies may have contributed to the occurrence of this surprising finding.

Nevertheless, the findings of a much larger cohort study also provided some disconcerting results for the advocates of salt restriction. The first National Health and Nutrition Examination Survey (NHANES I) established baseline information during 1971 - 75 in a representative sample of 20 729 American adults aged 25 - 75 years. Half of the sample underwent medical examination and nutritional examination based on 24-hour recall. Vital status was obtained on 11 346 persons almost 20 years later and mortality was examined in gender-specific quartiles of sodium intake. In a Cox multiple regression analysis, sodium intake at baseline was significantly inversely associated with both all-cause and cardiovascular mortality. However, when sodium intake was expressed as a function of energy intake (sodium / kcal), a direct association between sodium intake and all-cause and cardiovascular mortality was found. The authors interpreted their results cautiously and concluded that the data did not provide support regarding either an increased or decreased salt intake. The validity of a single 24-hour dietary recall method to assess habitual salt intake has been questioned.

Salt restriction: how feasible is it?

If a person is prepared to give up adding salt to food at the table, adding salt in cooking and eating processed foods which contain high amounts of salt (Table II), it is easy to reduce salt intake from the average intake of around 9 g salt (144 mmol or 3 310 mg sodium) to about 6 g salt (96 mmol or 2 200 mg sodium) per day. This is the level of sodium restriction which is usually referred to as 'no added salt' regimen (i.e. 80 - 100 mmol / day). To reduce sodium intake further requires bread and milk intake to be limited and usually results in poor compliance. Low-salt versions of bread are available in other countries, but not in South Africa at present. The trial of salt restriction in older people cited earlier in this article[36] made salt-free bread available to study subjects, which greatly enhanced their compliance with the level of salt restriction. As long ago as 1984, it was suggested that a relatively easy way to lower habitual sodium intakes in Australians would be to encourage the food industry to use less sodium in bread.[61]

It is important to inform individuals trying to lower their salt intake that their food may taste bland initially and the use of herbs and spices as alternative seasonings should be encouraged.

There is some evidence that long-term adherence to a diet low in sodium can lead to a hedonic shift whereby both normotensive[62] and hypertensive[63] persons develop an increased acceptance of foods with a reduced sodium content, presumably because the salt taste receptors become more sensitive, and a lower sodium concentration provides the same salty taste as previously. However it is unclear how long such a taste adaptation would take to manifest, and whether or not the adaptation is determined by habitual salt intake.

The salt-lowering message is compatible with the national iodisation programme

Fortification of salt with iodine has been shown to be the most successful long-term public health strategy to eliminate iodine deficiency and its disastrous health consequences in more than 90 countries in the world. Iodine deficiency results in goitre, hypothyroidism and miscarriages, but its most devastating consequence is mental retardation and impaired educational attainment. While cretinism is the most extreme manifestation, of considerably greater significance are the more subtle degrees of mental impairment that lead to poor school performance, reduced intellectual ability and impaired work capacity.

Once a deficiency of iodine has been identified in a country, iodine fortification in the form of iodated salt needs to be sustained indefinitely because of the lack of this essential micronutrient in the environment and therefore also in the food chain. In South Africa endemic goitre and iodine deficiency were observed in several areas prior to 1995.[64,65]

To avoid the potential risk of iodine-induced hyperthyroidism associated with a rapidly increased iodine level in salt, WHO, UNICEF and ICCIDD recommend that salt should be iodated in the range of 20 - 40 ppm at the point of production.[66] When non-iodated salt is used by the food industry, the upper limit for fortification of table salt of 40 ppm is recommended, while the lower limit of 20 ppm applies when iodated salt is used in food processing. This recommendation assumes that approximately 20% of the iodine may be lost from production to the consumer and an additional 20% loss occurs during cooking.

Since 1995 salt producers have been legally obliged to fortify salt for human consumption at a concentration of between 40 and 60 parts of iodine per million parts of salt using potassium iodate. Salt packaged in quantities exceeding 20 kg per bag is exempted from this regulation. This regulation does not apply to salt used in the agricultural industry for animal nutrition and other purposes. The salt industry responded positively to the introduction of compulsory iodisation. Within 1 year, the mean iodine content of table salt in food shops increased from 14 to 33 ppm, at no extra cost to the consumer.[67] This mean value further increased to 42 ppm over the next 2 years. This level of iodisation appears appropriate in view of the use of non-iodated salt in the production of processed food, and the improved iodine status of children subsequent to the introduction of compulsory iodation.[68] Despite this progress, vulnerable groups still exposed to under- or non-iodated salt in South Africa include people living in the three northern provinces of the country, rural dwellers, people using predominantly inadequately iodated coarse salt or non-iodated agricultural salt, and low socio-economic households.[69]

An iodine concentration of 40 to 60 ppm in our salt is compatible with advice to lower salt intake levels. A salt intake as low as 5 g per day would provide an adequate amount of iodine, provided that the salt is sufficiently iodated. Thus, the message to 'eat salt sparingly' will not interfere with the current nutritional and legal requirements for iodine intake in the country.

CONCLUSION

The controversy about the causal link between salt intake and hypertension, and even with cardiovascular disease, is continuing. Evidence for and against sodium restriction to control hypertension may confuse health providers and salt consumers to the extent that opposing arguments may result in a loss of credibility in any salt-related dietary guidelines. These opposing views appear to have originated because of the difficulty of accurately measuring sodium intake in large groups of study participants, as well as the several confounders potentially affecting the salt / hypertension relationship.

Despite the controversial issues surrounding the salt-hypertension relationship, strong evidence does point to the validity of restricting salt intake to lower blood pressure. Salt-sensitive people would benefit more from salt restrictions than salt-resistant people, but the identification of these groups remains unsolved. In view of the large number of hypertensives in the population and the harmlessness of salt restrictions, it would be sensible to recommend a reduction in salt intake to the public in general and to hypertensives in particular.

Salt restriction could be achieved by reducing the amount of salt added during the cooking process and at the table. As processed foods such as bread, tinned food, cheese and snacks contain substantial amounts of salt, comprehensive labelling will allow the consumer to select low-salt products, or limit their intake of processed foods with a high-salt content. It is important to note that even a salt-restricted diet will still provide an adequate amount of iodine, provided the salt is sufficiently iodated.

Translated into a practical diet, this information suggests a daily diet that includes large amounts of fruit and vegetables, a moderate intake of low-fat dairy products, lean meat and chicken, and a prudent alcohol intake. Salt should be used sparingly, if at all, at the table and in the preparation of meals, and the intake of processed foods high in salt should be limited. These recommendations are in line with many of those of the various FBDGs, emphasising their congruent and mutually substantiative suggestions.

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