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RESEARCH

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Achieving the Salt Intake Target of 6 g/Day in the Current Food Supply in Free-Living Adults Using Two Dietary Education Strategies

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ABSTRACT

There are national targets for salt intake of 6 g salt/day in Australia and the United States. Despite this, there is limited knowledge about the effectiveness of dietary education in reducing salt intake to this level. The objective of this study was to investigate whether dietary education enabled a reduction in salt consumption. In an 8-week parallel study, 49 healthy free-living adults were recruited from the Adelaide community by newspaper advertisement. In a randomized parallel design, participants received dietary education to choose foods identified by either Australia's National Heart Foundation Tick symbol or by the Food Standards Australia and New Zealand's low-salt guideline of 120 mg sodium/100 g food. Sodium excretion was assessed by 24-hour urinary sodium collections at baseline and weeks 4 and 8. Participants' experiences of following the education strategies were recorded by self-administered questionnaire. These data were collected between August and October 2008. Forty-three participants completed the study. After 8 weeks, urinary sodium excretion decreased from 121±50 to 106±47 mmol/24 hours (7.3±3.0 to 6.4±2.8 g salt/24 hours) in the Tick group and from 132±44 to 98±50 mmol/24 hours (7.9±2.6 to 6.0±3.0 g salt/24 hours) in the Food Standards Australia New Zealand group ($P<0.05$, with no between-group difference). Barriers to salt reduction were limited variety and food choice, difficulty when eating out, and increased time associated with identifying foods. In conclusion, dietary sodium reduction is possible among free-living individuals who received dietary advice.

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Cardiovascular disease (CVD) risk increases along a continuum of blood pressure from relatively low levels (1). A greater proportion of CVD events occur in individuals with normal blood pressure than in those with hypertension (2). Simple strategies to lower blood pressure to the lower limits of the normal range, such as salt reduction, can potentially have more impact on CVD events than interventions targeting individuals with existing hypertension only.

As sodium intake increases, so does blood pressure (3-6). Law and colleagues (7,8) predicted that the decrease in blood pressure from a population reduction in salt intake of 3 g/day would reduce stroke and ischemic heart disease deaths by 22% and 16%, respectively (9,10).

In Australia, the estimated average sodium requirement for adults is 20 to 40 mmol (1.2 to 2.4 g salt) per day, with a recommended upper limit of 100 mmol (6 g salt) per day (9). Sodium intakes during 1993 to 1995 were in excess of this, at 150 mmol/day (9 g salt/day) (10,11). Sodium intakes have not decreased, as sodium excretion of 136 to 181 mmol/24 hours (8.2 to 10.9 g salt/24 hours) was observed recently (12,13). Similar sodium intakes have been reported in the United States (14,15). This is considerably higher than the national target of the 6 g/day recommended by Australia and the United States (9,16).

Studies of dietary education to reduce sodium intake have employed intensive individualized education or were part of an intensive lifestyle program (8,17,18). There is limited information on the effectiveness of simple dietary education in reducing sodium intake. Two strategies available in Australia are the National Heart Foundation's (NHF) Tick Program and the Food Standards Australia New Zealand's low-salt labeling regulation of <120 mg sodium/100 g food. The Tick Program assists individuals to identify healthier supermarket items using a tick icon, signifying that they meet nutritional criteria that include sodium reduction. The Food Standards Australia New Zealand regulation facilitates the identification of low-salt foods by defining a low-salt product as one containing <120 mg sodium/100 g food. The aim of this study was to investigate whether information provided by either the NHF Tick Program or the Food Standards Australia New Zealand guideline enabled participants to reduce their sodium intake. The hypothesis was the Food Standards Australia New Zealand group would have a greater reduction in sodium excretion than the NHF group because of the quantitative nature of the guideline.

METHODS

Participants

Forty-nine healthy adults were recruited from the community by means of newspaper advertisements and from the Commonwealth Scientific and Industrial Research Organization volunteer database, which contains potential study participants who have given their consent to be contacted. Inclusion criteria were participants aged 20 to 75 years who had control over food purchasing and preparation. Exclusion criteria were metabolic disease or CVD, systolic blood pressure >160 mm Hg, taking diuretics or antihypertensive drugs with a diuretic component, pregnancy, or lactation. The study was approved by the Commonwealth Scientific and Industrial Research Organization Human Research Ethics Committee and all participants gave informed written consent. The trial was registered with the Australian New Zealand Clinical Trials Registry (Unique Identifier: ACTRN12608000528358). These data were collected between August 2008 and October 2008.

Study Design

In an 8-week parallel design, participants were randomized to consume foods identified by the NHF Tick symbol (Tick group, n=22), or low-salt foods, defined by the Food Standards Australia New Zealand low-salt guideline of 120 mg sodium/100 g food (Food Standards Australia New Zealand group, n=21). Participants collected a 24-hour urine sample on the day before they attended the clinic. All other measures including the 24-hour dietary recall were collected on the same day by the same investigator. Outcomes measures were recorded at 0 (baseline) and 4 and 8 weeks.

Dietary Education, Intake, and Analysis

Dietary education was provided in groups of four to five in 15-minute sessions by the same investigator, who was a trained nutritionist. Participants were informed that the purpose of the study was to reduce salt intake and advised to continue their usual dietary patterns using either the Tick symbol or the Food Standards Australia New Zealand guideline (120 mg sodium/100 g) to identify reduced salt foods. When shopping, participants identified suitable foods with the Tick symbol on the front of the pack (Tick group) or identified the sodium content of the food in the nutrition information panel on the back of the pack (Food Standards Australia New Zealand group). Participants in both groups were provided with a list of low-sodium foods, including fruit and vegetables, fresh unprocessed meat, fish and poultry, eggs, raw nuts and legumes, plain rice and pasta, and fresh or dried herbs and spices. A second 10-minute individual session was conducted at week 4.

Dietary assessment was conducted using the multiple-pass 24-hour recall by the same investigator, who was a trained nutritionist, at each visit to the research unit (19). This method has been used previously to estimate sodium intakes (14). This methodology was chosen to limit the burden on the participants. The food intake data were analyzed using a computerized database of Australian foods (Foodworks Professional Edition, version 5 software, Xyris Software 2007, Highgate Hill, Australia) based on the Australian nutrient database (20).

Body Weight and Height

Body weight was measured at 0, 4, and 8 weeks to the nearest 0.02 kg using a calibrated electronic digital scale (PW 200, A&D Mercury Pty Ltd, Adelaide, Australia) with participants in light clothing and barefoot. Standing height (once only) was measured without shoes to the nearest 0.25 cm using a stadiometer (SECA, Hamburg, Germany). Body mass index (BMI) was calculated as kg/m^2.

Laboratory Analysis

Sodium, potassium, creatinine, and urea excretion were measured in urine from 24-hour collections. Urinary urea was used to validate protein intake from the 24-hour food recall (21). Biochemical analyses were performed at the Institute of Medical and Veterinary Sciences (Adelaide, Australia), an accredited laboratory that participates in an Australia-wide quality-assurance program, the National Association of Testing Authorities.

Qualitative Data

Experiences of the participants were recorded after the intervention using a short self-administered questionnaire. They were asked to indicate on a Likert scale the extent to which they adhered to the program ("None of the foods I ate met requirements" to "All of the foods I ate met requirements"), how easy or hard it was to do so ("extremely easy to extremely hard"), and whether they encountered any specific barriers.

Statistical Analysis

Based on data from previous studies, 60 participants (30/group) were required for 80% power to detect a 35 mmol (2.1 g salt) difference in sodium excretion between groups. Significance was set at $P<0.05$. Repeated measures analysis of variance was used to determine changes in sodium excretion with time as the within-subject factor and group as the between-subject factor. One-way analysis of variance was used to detect between-group differences at baseline. Relationships between variables were examined using Pearson correlation analysis. All analyses were performed using SPSS (version 16.0, 2008, SPSS Inc, Chicago, IL). Data are presented as mean±standard deviation.

Table. Change in sodium and potassium excretion, weight, body mass index, and energy, sodium, and potassium intake after 8 weeks by intervention group and sex in an 8-week parallel study in 49 healthy free-living adults[a]

	Diet group Tick (n=22) FSANZ[b] (n=21)	Sex Tick men (n=5); women (n=14) FSANZ men (n=5); women (n=14)[c]	Week 0	Week 4	Week 8
			←mean±standard deviation→		
uNa[d] (mmol/24 h)*	Tick	Males	123±65	106±62	97±28
		Females	118±51	106±43	106±45
	FSANZ	Males	161±30	105±29	121±55
		Females	119±41	95±37	86±55
uK[e] (mmol/24 h)	Tick	Males	80±48	83±44	62±36
		Females	68±17	71±19	78±30
	FSANZ	Males	86±24	117±39	106±32
		Females	78±20	83±24	82±24
Weight (kg)***	Tick	Males	88.9±9.2	88.9±8.8	87.7±9.3
		Females	69.6±15.2	68.6±15.1	67.7±15.1
	FSANZ	Males	95.0±13.6	94.3±12.9	94.1±11.8
		Females	71.7±10.7	70.9±10.5	70.6±10.6
BMI[f]		Females	25.6±2.7	25.3±2.6	25.2±2.7
Na intake (mg/day)[g]**	Tick	Males	3,439±1,535	2,452±1,400	4,101±2,622
		Females	2,767±1,636	2,058±1,113	2,400±1,275
	FSANZ	Males	2,815±1,084	2,001±978	2,576±1,101
		Females	3,062±1,489	1,104±624	1,310±766
K intake (mg/day)	Tick	Males	3,249±597	3,755±1,031	3,572±1,241
		Females	3,180±949	3,192±991	3,699±1,284
	FSANZ	Males	3,564±1,073	4,684±1,118	4,786±1,500
		Females	3,548±829	3,462±665	3,192±729
Energy intake (kJ/day)	Tick	Males	8,691±2,130	9,469±2,608	10,131±4,611
		Females	8,166±1,074	7,407±2,574	7,743±1,560
	FSANZ	Males	12,003±2,511	10,627±339	11,529±3,058
		Females	8,677±1,769	7,104±1,678	7,322±1,847

[a]Data were analyzed using repeated measures analysis of variance.
[b]FSANZ=Food Standards Australia and New Zealand.
[c]There were no group-by-sex interactions.
[d]Urinary sodium excretion.
[e]Urinary potassium excretion.
[f]BMI=body mass index; calculated as kg/m^2.
[g]There was a time-by-group interaction such that sodium intake decreased in the FSANZ group only.
*Significantly different from baseline at weeks 4 and 8 ($P<0.05$).
**Significantly different from baseline at 4 weeks and 8 ($P<0.01$).
***Significantly different from baseline at weeks 4 and 8 ($P<0.001$).

RESULTS AND DISCUSSION

Participants

Twenty-two participants in the Tick group (age: 57.2±12.9 years, 5 men, 17 women) and 21 in the Food Standards Australia New Zealand group (age: 54.9±11.1 years, 5 men, 16 women) commenced the study. All participants were white.

Urinary Sodium Excretion

Urinary sodium excretion decreased from 121±50 to 106±47 mmol/24 hours (7.3±3.0 to 6.4±2.8 g salt/24 hours) in the Tick group and from 132±44 to 98±50 mmol/24 hours (7.9±2.6 to 6.0±3.0 g salt/24 hour) in the Food Standards Australia New Zealand group ($P<0.05$, with no between-group difference). Health authorities recommend adults limit their sodium intake to 100 mmol/day (6 g salt/day); despite this, the estimated average intake of sodium of adults is 150 mmol/day (9 g salt/day) (12,15). These results demonstrate that a reduction in sodium intake to recommended levels is possible in free-living individuals receiving simple dietary education. The magnitude of change in sodium excretion was about half that reported in the Trials of Hypertension Prevention (I and II) (−55.7 and −78.0 mmol/24 hours [3.3 and − 4.7 g salt/day], respectively) (22,23) and Trial of Nonpharmacologic Interventions in the Elderly (TONE) studies (−46.6 mmol/24 hours [−2.8 g salt/day]) (24). Reductions in the present study were remarkable given the difference in intensity of dietary intervention, as participants in these trials received intensive education, including tailored dietary advice in both individual and group sessions. A longer study is needed to establish whether the changes achieved are sustainable, as long-term lifestyle change can be difficult to maintain (25-27). The reduction in sodium excretion in the Tick group was relatively small and in the Food Standards Australia New Zealand group was numerically greater, but the difference between the groups was not statistically significant. There was no change in urinary potassium excretion.

Weight and Dietary Intake

Considerable weight loss was observed, but it is unclear why this occurred because there was no change in reported energy intake in the Tick group and the decrease in energy intake in the Food Standards Australia New Zealand group was not significant (Table). Participants may also have underreported their dietary intake (28).

A reduction in sodium intake was observed ($P<0.05$) (Table). There was a time-by-group interaction and post-hoc analysis revealed that sodium intake decreased in the Food Standards Australia New Zealand group only (mean difference, Food Standards Australia New Zealand= −1,284.9 mg sodium/day [−55.9 mmol sodium/day], P= 0.003; vs Tick=−33.6 mg/day [−1.5 mmol sodium/day]; not significant), suggesting that the quantitative nature of the Food Standards Australia New Zealand guideline was more effective, but this was not supported by the sodium excretion data. Estimations of sodium intake by dietary recall have been criticized as unreliable whereas 24-hour urinary sodium excretion is considered the most reliable method of assessing sodium intake (29,30). There was a positive correlation between reported sodium intake and 24-hour urinary sodium excretion (r=0.36; $P<0.05$), providing support for 24-hour diet recalls as a useful method for estimating sodium intake. There was a weak-to-moderate correlation between protein intake (data not shown) and urea excretion (data not shown) (r=0.37; $P<0.05$). Similar correlations have been reported for protein intake using many more (n=16) days of weighed food records (31). There was a positive correlation between sodium intake and energy intake (r=0.69; $P<0.001$), suggesting that sodium intake increases with increasing energy intake.

There were no substantial changes in dietary potassium intake, energy, or macronutrient intake from baseline to week 8, indicating that participants maintained their usual intake of foods in the context of reducing sodium intake.

Qualitative Data

Common themes about difficulties adhering to the dietary education included limited variety of appropriate foods, eating out, and increased time for shopping. Presenting nutrient information in an easy-to-read format and positioning the Tick icon where it is easy to see on the packaging can assist in product identification. Other strategies for easy identification of appropriate options include symbols to indicate the nutritional quality of the food as employed in the North Karelia Salt project on salt content (32). Taste preference is important and there is evidence that the taste of salt is innately appealing and responses to salty foods are influenced by environmental factors (33). Restricting exposure to high-salt foods for 8 to 12 weeks, as in this study, can enhance the appeal of reduced-sodium foods in both normotensive and hypertensive individuals (33). There is also a need to increase the availability of reduced-salt foods, because lack of variety was identified as a difficulty for the study participants. An overall reduction in sodium of processed foods would assist in population sodium reduction.

Limitations

Limitations to this study include the small sample size, the majority of whom were female, making it difficult to extrapolate results to the wider population. As with many lifestyle interventions, blinding of participants and observer was not possible (34), possibly causing an intervention and/or observer bias. The aim to recruit 60 participants was not achieved. For the observed difference to be significant, 160 people would have been required and this was beyond the resources available. Finally, dietary intake data were limited by the collection of only 1 day of dietary intake.

CONCLUSIONS

In conclusion, simple dietary education was effective in reducing dietary sodium intake in free-living individuals in this short-term study. Further work is needed to determine whether these changes can be sustained and to understand the barriers to salt reduction.

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