RESEARCH
Original Research

Reduced-Sodium Lunches Are Well-Accepted by Uninformed Consumers Over a 3-Week Period and Result in Decreased Daily Dietary Sodium Intakes: A Randomized Controlled Trial

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ABSTRACT

Background Processed foods are major contributors to excessive sodium intake in Western populations. We investigated the effect of food reformulation on daily dietary sodium intake.

Objective To determine whether uninformed consumers accept reduced-sodium lunches and to determine the effect of consuming reduced-sodium lunches on 24-hour urinary sodium excretion.

Design A single-blind randomized controlled pretest-posttest design with two parallel treatment groups was used.

Participants/setting Participants chose foods in an experimental real-life canteen setting at the Restaurant of the Future in Wageningen, the Netherlands, from May 16 until July 1, 2011.

Intervention After a run-in period with regular foods for both groups, the intervention group (n=36) consumed foods with 29% to 61% sodium reduction (some were partially flavor compensated). The control group (n=38) continued consuming regular foods.

Main outcome measures Outcomes for assessment of acceptance were the amount of foods consumed, energy and sodium intake, remembered food liking, and intensity of sensory aspects. Influence on daily dietary sodium intake was assessed by 24-hour urinary sodium excretion.

Statistical analyses performed Between and within-subject comparisons were assessed by analysis of covariance.

Results Energy intake and amount consumed of each food category per lunch remained similar for both groups. Compared with the control group, the intervention group's sodium intake per lunch was significantly reduced by −1,093 mg (adjusted difference) (95% CI −1,285 to −901), equivalent to 43 mmol sodium. Remembered food liking, taste intensity, and saltiness were scored similarly for almost all of the reduced-sodium foods compared with the regular foods. After consuming reduced-sodium lunches, compared with the control group, intervention participants' 24-hour urinary sodium excretion was significantly lower by −40 mEq (adjusted difference) (95% CI −63 to −16) than after consuming regular lunches, and this reflects a decreased daily sodium intake of 1 g.

Conclusions Comparing the two treatment groups, consumption of reduced-sodium foods over a 3-week period was well accepted by the uninformed participants in an experimental real-life canteen setting. The reduced-sodium foods did not trigger compensation behavior during the remainder of the day in the intervention group compared with the control group, as reflected by 24-hour urinary sodium excretion. Therefore, offering reduced-sodium foods without explicitly informing consumers of the sodium reduction can contribute to daily sodium intake reduction.

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CURRENT LEVELS OF SODIUM INTAKE EXCEED HUMAN physiologic needs in Western populations.[1] High dietary sodium intake contributes to the development of high blood pressure[2] and thereby increases the risk of cardiovascular disease, coronary heart disease, and stroke.[3-5]

The sodium intake of more than 85% of Dutch adults is well above the recommended maximum intake of 2.4 g (ie, 6 g salt) per day.[6] Most recent estimates show a mean intake for adult men and women of 4 and 3 g sodium (ie, 9.9 and 7.5 g salt) per day, respectively.[6] Purchased processed foods

account for at least 75% of consumed sodium.[6-9] In the Netherlands, a lunch normally consists of a number of processed foods, namely, bread with savory fillings, and it often includes soup or a hot snack. A Dutch lunch therefore accounts for about 31% of daily dietary sodium intake.[10] One of the strategies to reduce sodium consumption is substantial food product reformulation,[6-9,11] which will result in making a healthier food choice easier for consumers. Longstanding efforts in Finland and the United Kingdom, for example, have been shown to be effective.[12-15] To reduce sodium intakes in the Netherlands, changing food choices and/or a considerable lowering of the sodium content of a wide range of food products is still necessary.

Sodium chloride (ie, table salt) is added to processed foods for palatability, preservation, and processing reasons.[16,17] In regard to the taste function, salt is appreciated for its saltiness, enhances the overall flavor, and suppresses bitterness.[18] Modest sodium reductions in foods tend to be acceptable to many consumers.[12,19] However, other studies suggest that reduced-sodium foods have an impaired palatability[20-22] and are preferred less by consumers.[16] In addition, it is believed that consumers may try to partially compensate with table salt when they are aware of consuming a reduced-sodium food.[23,24] Another possibility is that they might compensate for their lower sodium intake with salty foods at other mealtimes. If consumers respond by rejecting the reduced-sodium foods or show compensation behavior, food product reformulation will not lead to reduced daily sodium intake. Scientific research on this topic is scarce. This deficit is accentuated by the fact that sodium excretion in 24-hour urine collection—the best and most objective indicator of dietary sodium intake with high validity—is not measured in the majority of consumer acceptance studies on reduced-sodium foods. Consequently, these studies lack an objective marker of daily sodium intake.[25] Urinary sodium excretion accounts for 95% to 98% of dietary intake, if urine is collected correctly.[25] Completeness of urine collections can be easily verified by para-aminobenzoic acid (PABA), and reliable sodium concentration measurements with low coefficient of variation (lower than 5%) may be obtained through good laboratory practice.[25]

Previous research suggests that both the context and the environment of a test are likely to influence a person's food acceptance.[26-28] So far, the majority of studies on consumers' acceptance of reduced-sodium foods have been performed in a laboratory setting.[29-34] Only a limited number have been performed in an experimental real-life setting.[20,35-39] In addition, participants are often either explicitly informed or simply aware that the influence of sodium reduction is being studied.[20,35,36] Consequently, the results of these studies might not be a valid prediction of uninformed consumers' real-life eating behavior.

The first aim of this study was to determine whether uninformed consumers accept reduced-sodium lunches in an experimental real-life canteen setting during a 3-week period. The second aim was to investigate whether a reduced-sodium intake at lunch actually leads to a lower daily dietary sodium intake as measured via 24-hour urinary sodium excretion. We hypothesized that a reduced-sodium lunch would be well accepted by uninformed consumers and expected that daily dietary sodium intake would decrease if reduced-sodium lunch foods were consumed.

METHODS

Study Design

We followed a randomized pretest-posttest control group design with two conditions (see the Figure). Participants were blinded for the conditions and were randomly allocated (using a randomization table) to either the control group or the intervention group (1:1). The groups were balanced for sex and were instructed to choose foods from their own buffet. During the weekdays of the first 2 weeks (run-in), both groups could freely choose from regularly salted lunch foods, following which the intervention period of 3 weeks consisting of 12 weekdays in total (due to three public holidays) started. During this period, the control group continued to consume regular lunch foods, whereas the intervention group consumed lunch foods that were reduced in sodium content in one step by 29% to 61% (depending on food type). Some of these foods were partially flavor compensated. At the end of the run-in and the intervention periods, participants had to evaluate, from memory, liking and sensory aspects of the foods they had chosen during the previous study period. Halfway through the last week of each study period, participants collected 24-hour urine specimens. At the end of

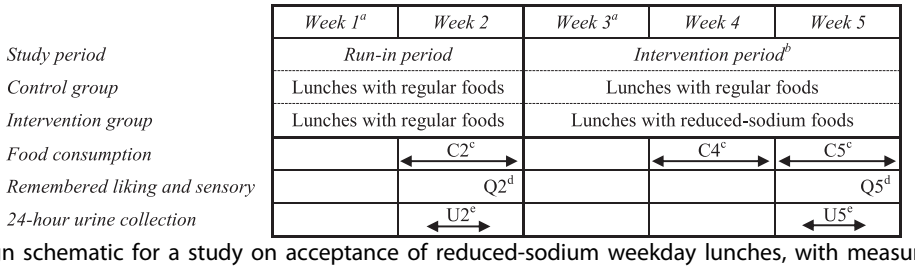

Figure. Study design schematic for a study on acceptance of reduced-sodium weekday lunches, with measured outcomes food consumption, remembered liking and sensory evaluation, and 24-hour urinary sodium excretion in 74 Dutch participants. [a]The first week of the run-in and of the intervention period was considered as a week during which participants need some time to get accustomed to a new food before they demonstrate their habitual behavior and therefore these weeks were not analyzed for food consumption. [b]During the intervention period there were three public holidays, so the total intervention period comprised 12 weekdays. [c]Food consumption: amount consumed (in grams), energy intake (in kilocalories), and sodium intake (in milligrams) during Weeks 2, 4, and 5. [d]Questionnaire to evaluate remembered liking and sensory attributes on a 100-mm visual analogue scale at the end of Weeks 2 and 5. [e]Twenty-four—hour urine collection at Wednesday or Thursday of Weeks 2 and 5 to determine 24-hour sodium excretion.