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ORIGINAL ARTICLE

Nutritional impact of sodium reduction strategies on sodium intake from processed foods

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BACKGROUND/OBJECTIVES: Sodium intake in the Netherlands is substantially above the recommended intake of 2400 mg/day. This study aimed to estimate the effect of two sodium reduction strategies, that is, modification of the composition of industrially processed foods toward the technologically feasible minimum level or alteration of consumers' behavior on sodium intake in the Netherlands.

SUBJECTS/METHODS: Data from the Dutch National Food Consumption Survey (2007–2010) and the Food Composition Table (2011) were used to estimate the current sodium intake. In the first scenario, levels in processed foods were reduced toward their technologically feasible minimum level (sodium reduction in processed foods scenario). The minimum feasible levels were based on literature searches or expert judgment. In the second scenario, foods consumed were divided into similar food (sub)groups. Subsequently, foods were replaced by low-sodium alternatives (substitution of processed foods scenario). Sodium intake from foods was calculated based on the mean of two observation days for the current food consumption pattern and the scenarios.

RESULTS: Sodium levels of processed foods could be reduced in most food groups by 50%, and this may reduce median sodium intake from foods by 38% (from 3042 to 1886 mg/day in adult men). Substitution of foods may reduce sodium intake by 47% (from 3042 to 1627 mg/day in adult men), owing to many low-sodium alternatives within food groups.

CONCLUSIONS: In the Netherlands, reduction of sodium intake by modification of food composition or by alteration of behavior may substantially reduce the median sodium intake from foods below the recommended sodium intake.

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INTRODUCTION

Almost half of the Dutch population has an elevated blood pressure[1] and has therefore an increased risk of developing cardiovascular diseases.[2] Studies have shown a positive association between salt intake and blood pressure, and a reduction in daily sodium intake leads to a reduction in blood pressure levels.[3] In the Netherlands, sodium intake substantially exceeds the recommended intake of 2400 mg/day. Median sodium intake in adults was estimated to be 3400 mg/day.[4]

Worldwide, the prevention of cardiovascular diseases is considered an important action to reduce the burden of diseases. Reduction of the populations' sodium intake is mentioned among the five priority interventions by the World Health Organization.[5] In this context, many countries are committed to reduce the population sodium intake toward the recommended levels. Their sodium reduction strategies generally consist of two important components: reformulation of existing foods to achieve lower sodium content in foods and consumer awareness or behavior change programs to increase the knowledge of the adverse effects of excessive sodium intake and discretionary sodium use by consumers.[6]

Countries such as Finland and the United Kingdom have initiated sodium reduction strategies for many years. Consequently, the mean sodium intake in Finland over the period 1979–2002 decreased by more than 1200 to 3960 mg/day among men and to 3040 mg/day among women.[7] Sodium reduction in processed foods contributed substantially to this decrease in sodium intake, but also the consumer awareness of high sodium intake increased.[8] The British government initiated a salt reduction program through a media campaign to increase public awareness of high salt intake and engaged stakeholders to develop realizable targets for sodium content in processed foods. These interventions decreased the mean sodium intake from 3840 mg/day in 2001 to 3240 mg/day in 2011.[9] Despite the initiatives, sodium intake in both the countries is still above the recommended intake for a large group of the population.

In the Netherlands, population salt intake reduction is also an important objective to improve dietary intake. Sodium reduction in processed foods is considered the crucial intervention, whereas less attention is given to lower the use of discretionary salt and to consumption of foods that are high in sodium. Monitoring sodium levels in processed foods shows that there is much variation in sodium levels within product groups[10] and also shows that the food industry had not yet achieved its targets for sodium reduction in processed foods in the Netherlands of 10% in 2010.[10] A new voluntary agreement on sodium reduction between the Dutch Ministry of Health, food industry and caterers include a stepwise reduction in sodium levels.[11] Exploring the effects of both salt reduction strategies in the Netherlands will be essential in order to support salt reduction campaigns.

In the present study, we estimate the impact on sodium intake of the Dutch population of two salt reduction strategies. The first strategy is to lower sodium in processed foods to its technologically feasible minimum level. The second strategy is to reduce

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sodium intake by intentionally choosing for low-sodium alternatives within certain food groups.

MATERIALS AND METHODS

Food composition and food intake data

Sodium levels in foods were derived from the Dutch Food Composition Table (NEVO) published in 2011.[12] This table was updated for missing data, and outdated sodium levels were re-evaluated and updated if needed.

Food consumption data were obtained from the Dutch National Food Consumption Survey 2007–2010 (DNFCS 2007–2010).[13] In short, this survey included a representative sample of the Dutch population aged 7–69 years, and the dietary assessment was based on two nonconsecutive 24-h recalls. For children aged 7–15 years, the two 24-h recalls were carried out by means of face-to-face interviews during home visits with caregivers. Participants aged 16 years and older were interviewed unannounced by telephone. Each participant was interviewed twice with an interval of about 4 weeks. In total, 3819 subjects completed two 24-h recalls (net response rate 69%).

Scenarios

We established two scenarios representing the two most important strategies to reduce sodium intake: (1) modification of composition of industrially processed foods and (2) alteration of consumers' behavior. In the first scenario, sodium levels in industrially processed foods were reduced toward their technologically feasible minimum levels (sodium reduction scenario). In the second scenario, appealing to consumers' behavior change, actually consumed foods were replaced by low-sodium alternatives (substitution scenario).

Sodium reduction in processed foods scenario. The Dutch Food Composition Table 2011 was used to identify processed foods that contained added sodium chloride.[12] Foods were selected if the sum of the food consumed in the total study population was more than 500 mg sodium per day (*N* = 338 processed foods) based on the DNFCS 2007–2010.

Food technologists performed an assessment of the minimum technological feasible levels of sodium in processed foods based on experience and review of scientific and technological literature. The following criteria were considered. (1) Sodium reduction should be technologically feasible within 5 years. Processing and formulation adaptations may be mandatory, but should be technologically feasible within this time frame. If available, regular foods with a reduced sodium content were identified as proof of feasibility. (2) The foods should still be microbiologically safe. The boundaries of microbiological safety were assessed on water activity and specific food product composition. Reduction of refrigerated shelf life may be necessary in certain cases. (3) The products should be acceptable for consumers regarding taste and texture. The acceptability on taste was based on current knowledge on consumer acceptance of sodium-replacing ingredients and minerals. Furthermore, consumer taste preference adaptation to lower saltiness intensity was assumed as a result of gradual industry-wide implementation of sodium reduction.[14,15] The texture of the food should not be changed significantly to comply with consumer demands. In addition, we did not consider current legislative or economic hurdles restricting the reduction of sodium in processed foods. A summary of the results of technologically feasible sodium levels per food subcategory level are presented in the Supplementary information.

The sodium levels of the selected foods were replaced with their minimal technologically feasible level. In the Food Composition Database, some foods are used to calculate the sodium levels of other foods, as average food ('bread multigrain average'; *N* = 261) or as food item part of a recipe calculation ('brownies'; *N* = 77). If a sodium-reduced food was part of another food, then we recalculated the sodium level of these particular foods.

Substitution of processed foods scenario. Sodium reduction was simulated by substituting processed foods containing industrially added sodium by low-sodium alternatives within the same food group, as available in the Dutch Food Composition Table 2011. Foods belonging to the following food groups were included in this scenario: fruits and vegetables, legumes, potatoes, cereal and cereal products, dairy products, meat and meat products, fats, soups, condiments and sauces, snacks, cakes and pies, sandwich filling, main meals, mixed salads, lunches and unclassified. No food products were substituted in the food groups fruit juices, water, coffee and tea and (soft) drinks, because these foods hardly contain any industrially added sodium. All processed foods reported to be consumed in DNFCS 2007–2010 were classified according to the use of a food. If foods within a food group differed substantially in terms of common use, a subclassification was made in order to substitute all foods within a food group by an appropriate alternative. Within each food (sub)group, the food with the lowest sodium content was identified as the low-sodium alternative for the whole food (sub)group. Occasionally, the food product with the lowest sodium levels was not an appropriate substitute, because of undesirable levels of other components in this food or because it was a unique food. In such cases, it was decided not to use this food item as an alternative, but to select the food item with the second lowest sodium levels.

Data analyses

We calculated for each individual food item the percentage change in sodium level based on the current and new sodium levels of processed foods. The median sodium reduction of all individual foods was considered the percentage reduction that could be achieved.

Sodium intake distribution (median, 25th percentile (P25) and 75th percentile (P75)) was calculated for the current food consumption pattern and for both scenarios by summing the sodium levels in foods per subject per observation day and by dividing it by the number of observation days (that is, 2). We estimated the sodium intake for each individual food category for the total study population and for consumers of those food categories. We did not consider discretionary sodium use, as the purpose of this study was focused on the sodium intake from (processed) foods.

Energy intake was calculated for the substitution scenario in order to examine whether the scenario based upon replacement of foods by low-sodium alternatives might result in different energy intakes.

RESULTS

Sodium levels in foods

The Dutch National Food Composition Table contained a total of 1599 individual food items that were consumed during the DNFCS 2007–2010, of which 45% (*N* = 727) belonged to food groups that contributed most to sodium intake. The current sodium levels varied considerably between and within food (sub)groups (Table 1).

In the sodium reduction scenario, for majority of the foods (*N* = 630), we changed the sodium levels to their lowest technologically feasible level (40% in margarines to 100% in soft cheeses, processed meats, savory snacks, cakes, pastries and sauces (< 10% fat)). In most food groups, the realized sodium reduction was 50%, but it ranged from 36% in pastries to 70% in canned vegetables.

In the substitution scenario, 44% of the foods could be replaced by 124 foods that were lowest in sodium. In all food groups, the majority of the foods could be replaced by a low-sodium alternative (75–100%). In most food groups, the percentage reduction that can be obtained with a currently available low-sodium alternative is > 75%. However, some foods in certain food groups had almost similar sodium levels compared with the currently available low-sodium alternatives (for example, sauces < 10% fat 17% reduction; soups 19% reduction; Table 1).

Sodium intake by foods

The percentage of consumers per food groups differs substantially, ranging from 3% for meat substitutes to 99% for bread (Table 2). Bread has the highest contribution to sodium intake (651 mg/day) among the total population and among the consumers. In certain food groups, the percentage of consumers is limited, but the contribution to sodium intake among consumers is relatively high. For example, only a quarter of the population consumes soups, but the median sodium intake from soups among consumers is 505 mg/day.

Table 1. Sodium levels (mg/100 g) of processed foods in the present diet in sodium reduction in processed foods scenarios and in the substitution of processed foods scenario

Food (sub)group[a]	*Foods contributing most to present sodium intake*	*Foods with lowest technologically feasible sodium levels*			*Foods with sodium reduction by substitution*		
	Sodium level (mg/100 g), median (min–max)	*Number of foods with reduced sodium level, N (%)*	*Sodium level (mg/100 g), median (min–max)*[b]	*Median reduction, %*[c]	*Number of foods with reduced sodium level, N (%)*	*Sodium level (mg/100 g), median (min–max)*[b]	*Median reduction, %*[c]
Vegetables							
Canned vegetables (*N* = 52)	242 (1.7–7158)	32 (62)	91 (9–2648)	70	50 (96)	25 (1.7–7158)	88
Dairy products							
Hard cheese (*N* = 31)	770 (50–1032)	28 (90)	374 (78–501)	50	31 (100)	430 (50–450)	47
Soft cheese (*N* = 22)	614 (86–1750)	22 (100)	298 (43–875)	50	22 (100)	86 (86–250)	74
Cream cheese (*N* = 12)	1150 (60–1500)	11 (92)	520 (270–750)	50	12 (100)	250 (250–250)	78
Cereals and cereal products							
Bread (*N* = 75)	470 (30–661)	73 (97)	245 (145–342)	50	75 (100)	290 (30–432)	37
Bread substitutes (*N* = 24)	483 (5–800)	21 (88)	288 (2.5–400)	50	23 (96)	235 (5–235)	51
Breakfast cereals (*N* = 32)	200 (0–650)	20 (63)	181 (10–325)	50	32 (100)	10 (0–10)	95
Meat and meat products							
Processed meat (*N* = 61)	906 (246–1974)	61 (100)	400 (229–856)	59	61 (100)	704 (246–704)	23
Meat substitutes (*N* = 24)	500 (6–815)	22 (92)	271 (45–408)	50	24 (100)	6 (6–6)	99
Fat							
Low-fat margarine (*N* = 21)	20 (0–200)	11 (52)	130 (20–220)	50	21 (100)	0 (0–0)	100
Margarine (*N* = 10)	16 (0–482)	4 (40)	91 (65–166)	50	10 (100)	0 (0–0)	100
Cooking fat (*N* = 12)	390 (2.5–600)	5 (42)	200 (162–300)	50	9 (75)	2.5 (2.5–2.5)	99
Snacks							
Savory snacks (*N* = 23)	596 (123–776)	23 (100)	240 (47–394)	50	21 (91)	145 (97–145)	78
Chips (*N* = 29)	660 (2–1333)	25 (86)	338 (100–667)	50	29 (100)	2 (2–2)	100
Cakes and pies							
Cakes (*N* = 13)	388 (55–452)	13 (100)	150 (35–270)	46	13 (100)	55 (55–55)	86
Biscuits (*N* = 83)	220 (12–550)	79 (95)	120 (7–297)	46	82 (99)	12 (12–124)	93
Pastry (*N* = 14)	254 (180–457)	14 (100)	156 (97–247)	36	14 (100)	180 (180–180)	29
Pie (*N* = 48)	159 (14–330)	42 (88)	125 (9–232)	47	46 (96)	14 (14–14)	90
Condiments and sauces							
Sauces < 10% fat (*N* = 16)	717 (61–1300)	15 (94)	350 (2–650)	52	12 (75)	434 (61–1300)	17
Sauces > 10% fat (*N* = 25)	672 (61–1075)	25 (100)	320 (3–1825)	50	23 (92)	330 (61–880)	59
Meal sauces prepared (*N* = 71)	268 (0.6–1366)	57 (80)	226 (12–683)	52	70 (99)	1.8 (1.8–790)	92
Soups, bouillon							
Soups (*N* = 29)	337 (0–505)	27 (93)	171 (129–253)	50	29 (100)	272 (10–272)	19

Abbreviations: max, maximum; min, minimum. [a]Food (sub)groups represent food groups that contribute most to sodium intake from processed foods. Other food groups were also assessed, but are not reported here. [b]Median and range are foods that could have reduced sodium levels or could be substituted. [c]Percentage reduction is the median value of the percentage reduction that is obtained by the reduction of each individual food item.

The potential of sodium reduction intake in the sodium reduction scenario ranges from 16% for pies to 67% for cream cheeses for consumers of these food categories. In the substitution scenario, the potential ranges from 15% for soups to 100% for fats.

Daily sodium intake

Median sodium intake from all foods is 3042 mg/day in men aged 19–69 years and 2286 mg/day in women aged 19–69 years in the current situation (Table 3). Children and adolescents have a sodium intake of 2544 mg/day (boys) and 2194 mg/day (girls). When sodium levels are reduced toward the lowest technologically feasible levels, median sodium intake is reduced by 36% in boys, 37% in girls, 38% in men and 37% in women. In the substitution scenario, the sodium intake is reduced even further by 48% in boys, 50% in girls and 47% in both men and women.

The median energy intake increased by 700 kJ for adult men and by 800 kJ for adult women in the substitution scenario, which is a 6 and 9% increase compared with the reference energy intake ($P50 = 10.7$ MJ for men and 7.9 MJ for women (Table 3)). In the sodium reduction scenario, no changes in energy intake are to be expected, as food consumption remains the same and only the sodium content is modulated.

DISCUSSION

It was estimated that the level of sodium chloride in processed foods can be reduced by 50% in most food groups in the

Table 2. Sodium intake from processed foods in the present diet, in a technologically feasible scenario and in substitution scenario among consumers

	Current sodium intake		*Sodium reduction in processed foods scenario*		*Substitution processed foods scenario*	
	Consumers %	*Sodium intake (mg/day)[a] P50 (P25–P75)*	*Sodium intake (mg/day)[a] P50 (P25–P75)*	*Median reduction[b] %*	*Sodium intake (mg/day)[a] P50 (P25–P75)*	*Median reduction[b] %*
Vegetables						
Canned vegetables	40	67 (24–139)	35 (13–65)	48	9 (3–21)	87
Dairy products						
Hard cheese	73	241 (142–393)	120 (65–193)	50	126 (75–207)	48
Soft cheese	18	69 (35–140)	35 (15–83)	49	25 (12–44)	64
Cream cheese	8	162 (108–270)	54 (27–88)	67	35 (23–53)	78
Cereals and cereal products						
Bread	99	651 (450–887)	332 (230–447)	49	370 (259–508)	43
Bread substitutes	33	48 (24–85)	23 (10–44)	52	24 (12–38)	50
Breakfast cereals	20	20 (6–71)	14 (6–38)	30	3 (2–4)	85
Meat and meat products						
Processed meat	75	173 (94–293)	66 (38–124)	62	112 (68–211)	35
Meat substitutes	3	197 (122–345)	138 (73–190)	30	3 (2–3)	98
Fat						
Low-fat margarine	57	17 (6–35)	9 (3–17)	47	0 (0–0)	100
Margarine	40	15 (5–31)	6 (2–12)	60	0 (0–0)	100
Cooking fat	46	8 (2–22)	4 (1–10)	50	0 (0–0)	100
Snacks						
Savory snacks	20	235 (190–360)	193 (135–276)	18	51 (34–73)	78
Chips	41	147 (77–264)	85 (38–159)	42	1 (0–1)	99
Cakes and pies						
Cakes	12	65 (13–133)	30 (23–61)	54	11 (8–18)	83
Biscuits	66	55 (30–95)	30 (18–55)	45	3 (2–6)	95
Pastry	23	57 (29–77)	34 (16–45)	40	38 (16–54)	33
Pie	29	69 (33–122)	58 (27–87)	16	7 (5–10)	90
Condiments and sauces						
Sauces $<10\%$ fat	31	58 (30–113)	32 (16–63)	45	27 (13–59)	53
Sauces $>10\%$ fat	54	64 (28–118)	31 (12–61)	52	25 (9–58)	61
Meal sauces – prepared	52	93 (38–218)	59 (23–123)	37	15 (0–119)	84
Soups bouillon						
Soups	27	505 (350–739)	283 (175–459)	44	429 (227–618)	15

[a]Mean of two observation days. [b]Median reduction is the median value of the reduction in sodium intake of consumers of each food group.

Netherlands. This simulation study shows that such reduction will lead to a 38% lower sodium intake compared with the current overall sodium intake from foods. In most food groups, low-sodium alternatives are available, and substituting processed foods by their low-sodium alternatives will result in a sodium intake reduction from foods of 47%. The potential for sodium intake reduction varies widely between food groups (15–100%).

Data used in the present study reflects current Dutch food consumption patterns and up to-date sodium levels of currently available foods. This detailed information enables us to distinguish several sources of sodium intake, and to examine the shift in sodium intake in hypothetical situations.

However, we had to make some assumptions to estimate the impact on sodium intake reduction for both scenarios. In the substitution scenario, selection of appropriate low-sodium alternatives in predefined food groups may be arbitrary. Low-sodium alternatives may be rather extreme alternatives, although selected products are existing and commonly available. In addition, replacing all foods within a (sub)food group by a single low-sodium alternative is not likely to happen in real life. Food choices are influenced by many motives, such as taste, price and habitual behavior.[16–18] Changing consumer behavior may intervene at different levels and is challenging. Therefore, the sodium intake reduction observed in the substitution processed foods scenario should be considered as the maximal change in salt intake that can be achieved by currently available foods.

We classified foods in various food (sub)groups, but even within those groups foods may substantially differ in terms of use or composition. For example, all breakfast cereals such as cornflakes were replaced by muesli. Muesli is a relatively slightly processed food and it contains only cereals, nuts and dried fruit, without added salt. The selected low-sodium alternative muesli has a much lower sodium level than could ever be achieved by technological modifications of cornflakes. Therefore, the substitution processed foods scenario has much more potential in sodium reduction compared with technological modifications. To make

Table 3. Daily sodium and energy intake from processed foods in present diet, technologically feasible sodium reduction scenario and substitution scenario

	Current sodium intake		Sodium reduction in processed foods scenario			Substitution processed foods scenario		
	Sodium intake (mg/d)[a]	*Energy intake (MJ/d)*	*Sodium intake (mg/d)*[a]	*Reduction in median sodium intake*[b]	*Energy intake (MJ/d)*	*Sodium intake (mg/d)*[a]	*Reduction in median sodium intake*[b]	*Energy intake (MJ/d)*
	P50 (P25–P75)	P50 (P25–P75)	P50 (P25–P75)	%	P50 (P25–P75)	P50 (P25–P75)	%	P50 (P25–P75)
Boys 7–18 years (*N* = 856)	2544 (2000–3214)	9.6 (8.0–11.4)	1635 (1295–2071)	36	9.6 (8.0–11.4)	1319 (1008–1678)	48	10.0 (8.5–12.1)
Girls 7–18 years (*N* = 857)	2194 (1778–2632)	8.3 (7.2–9.5)	1392 (1153–1693)	37	8.3 (7.2–9.5)	1096 (882–1392)	50	8.9 (7.5–10.1)
Men 19–69 years (*N* = 1055)	3042 (2419–3718)	10.7 (8.9–12.9)	1886 (1468–2348)	38	10.7 (8.9–12.9)	1627 (1264–2060)	47	11.4 (9.5–13.6)
Women 19–69 years (*N* = 1051)	2286 (1806–2877)	7.9 (6.6–9.6)	1449 (1138–1779)	37	7.9 (6.6–9.6)	1215 (934–1542)	47	8.7 (7.3–10.4)

[a]Mean of two observation days. [b]Percentage reduction between the median current sodium intake (*P50*) and the median sodium intake (*P50*) in the processed foods scenario and the substitution scenario.

the simulation as realistic as possible, we have limited the alternatives to common food products that are comparable to the original foods in the (sub)group.

In the sodium reduction processed foods scenario, sodium reduction was based on what is expected to be the lowest feasible sodium level within 5 years. We considered the microbiological safety and technological aspects of sodium reduction in the assessment of the minimal technologically feasible level. However, technologically feasible adaptations such as a shorter shelf life, adjusted product formulation and processing conditions that can be realized by the food industry in the near future are needed. For example, in cold cuts, sodium replacement level is estimated by replacing sodium salts by alternative minerals, and the minimal sodium level is estimated by limits of sensory acceptability. Other industrially relevant factors such as cost and yield were not considered. The technologically feasible levels presented here are substantially higher than the voluntary levels of reduction in the current sodium reduction initiative in the Netherlands. In this, the food industry chooses for a more stepwise approach.[11] Therefore, in more recent sodium reduction initiatives, the food industry has increased its voluntary levels of salt reduction, although they are not yet close to the technologically feasible levels.

The level of reduction may compromise taste perception, and an immediate reduction in sodium in processed foods may lead to rejection of the product. However, the gradual adjustment of sodium levels over time will conceal changes in taste, as observed by a study in which substantial sodium reduction of 52% did not lead to lower consumption of bread as compared with a control group.[19]

We observed a large variation in sodium levels within food groups and within the current food consumption pattern. The availability of many low-sodium alternatives makes alterations of food consumption patterns an essential strategy to reduce sodium intake. In certain food groups, the narrow range in sodium levels indicates that sodium reduction of those foods will be essential compared with appealing to consumer behavior. In food groups such as bread, sauces, soups and processed meats, sodium reduction seems inevitable, as there are hardly any low-sodium alternatives. In other food groups, such as cheese, technological challenges or regulations cause the narrow range of sodium levels. Furthermore, a link between sodium and fat content of foods is apparent. In particular, in the (sub)groups meat, pastry and soups, the low-sodium alternatives have a relatively high fat content. This can also explain the higher energy intake as a negative side effect of this salt reduction strategy.

Sodium intake estimates in the present analyses are based on intake from foods and does not include the salt that is added during cooking at home, in restaurants and by caterers, or at the table. Consequently, estimates of total sodium intake will be higher than the estimated intake from foods in the present study. Average discretionary salt use is estimated to be 800 mg/day in adults.[20] In the current situation, median sodium intake from processed foods does already exceed the recommended intake of 2400 mg sodium for boys and men,[21] but it is slightly lower for girls and women. However, median sodium intake including discretionary salt will exceed the recommendation. In both the scenarios, median salt intake from processed foods is below 2400 mg sodium. In the sodium reduction scenario, additional discretionary salt use will not exceed the recommended intake in both men and women, but in the substitution scenario median total salt intake will be close to the recommended intake in men. An important additional strategy will be to reduce the level of discretionary salt, not only at home but also for meals that are eaten in restaurants or at caterers. These sectors are included in the present agreement of salt reduction as well.[11] Monitoring their sodium use will be essential.

The advantage of sodium reduction in processed foods is that consumers do not have to modify their habitual dietary food pattern.[22] Experiences from the United Kingdom show that sodium reductions in certain food groups of 20–30%, and in some other product groups even up to 70%, have been achieved over the period 2001–2011.[23] Unfortunately, sodium reduction did not take place in all food groups, and not all foods within a food group were sodium reduced. As a consequence, these actions led to an overall sodium reduction in the United Kingdom of 15% over this 10-year period.[9] Sodium intake remained above the recommended intake. In our best-case simulation, sodium levels should decrease by on average 50% in all processed foods to arrive at a sodium intake below the recommended intake. Comparison between the real-life intervention in the UK and our simulation study shows that major efforts from the food industry are needed.

Excessive salt intake is an important risk factor for high blood pressure and subsequently for cardiovascular diseases. Reducing salt intake is considered an important strategy to reduce the burden of disease related to cardiovascular disease. Substantial changes in food intake by intentionally choosing low-salt alternatives may lead to a sodium intake reduction of 48%, and reducing sodium levels in processed foods toward their minimal technological feasible sodium levels may lower the sodium intake by 37%. The changes are substantial and may contribute to a median sodium intake from processed foods below the recommended intake.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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