Achieving the WHO sodium target: estimation of reductions required in the sodium content of packaged foods and other sources of dietary sodium[1–3]

Helen Eyles,[4,5] Emma Shields,[4] Jacqui Webster,[6] and Cliona Ni Mhurchu[4]*

[4]National Institute for Health Innovation and [5]Department of Epidemiology and Biostatistics, University of Auckland, Auckland, New Zealand; and [6]George Institute for Global Health, University of Sydney, Sydney, Australia

ABSTRACT

Background: Excess sodium intake is one of the top 2 dietary risk factors contributing to the global burden of disease. As such, many countries are now developing national sodium reduction strategies, a key component of which is a sodium reduction model that includes sodium targets for packaged foods and other sources of dietary sodium.

Objective: We sought to develop a sodium reduction model to determine the reductions required in the sodium content of packaged foods and other dietary sources of sodium to reduce adult population salt intake by ∼30% toward the optimal WHO target of 5 g/d.

Design: Nationally representative household food-purchasing data for New Zealand were linked with branded food composition information to determine the mean contribution of major packaged food categories to total population sodium consumption. Discretionary salt use and the contribution of sodium from fresh foods and foods consumed away from the home were estimated with the use of national nutrition survey data. Reductions required in the sodium content of packaged foods and other dietary sources of sodium to achieve a 30% reduction in dietary sodium intakes were estimated.

Results: A 36% reduction (1.6 g salt or 628 mg Na) in the sodium content of packaged foods in conjunction with a 40% reduction in discretionary salt use and the sodium content of foods consumed away from the home would reduce total population salt intake in New Zealand by 35% (from 8.4 to 5.5 g/d) and thus meet the WHO 2025 30% relative reduction target. Key reductions required include a decrease of 21% in the sodium content of white bread, 27% for hard cheese, 42% for sausages, and 54% for ready-to-eat breakfast cereals.

Conclusions: Achieving the WHO sodium target in New Zealand will take considerable efforts by both food manufacturers and consumers and will likely require a national government-led sodium reduction strategy. *Am J Clin Nutr* 2016;104:470–9.

Keywords: sodium, salt, WHO, target, chronic disease

INTRODUCTION

High sodium intake is a major global risk that contributes ∼3% to total disability-adjusted life years (1). High-sodium diets increase blood pressure and the risk of stomach cancer and kidney disease (2, 3), and the argument for introducing a population strategy to reduce sodium consumption is compelling (1). Sodium reduction has been identified as one of the top 10 "best buys" for preventing noncommunicable diseases (4) and is likely to be cost saving (5). However, population sodium intake in most countries far exceeds the WHO guideline of 2000 mg/d (5 g salt/d) (6).

In 2013, the WHO set a target for countries to reduce population sodium intake by 30% toward 2000 mg/d by 2025 (7). Seventy-five countries to date have responded to the target by developing a national sodium reduction strategy—up from 32 in 2010 (8). National sodium reduction strategies are typically multifaceted in approach and include, for example, industry engagement, front-of-pack nutrition labeling, sodium reduction targets for food manufacturers, consumer education, and/or taxation on high-sodium foods (8).

One of the best-known national sodium reduction strategies was developed in the United Kingdom in 2003 and included 3 main components: improved nutrition labeling, a consumer awareness campaign, and a government-backed sodium reduction model that helped to inform a set of formal targets for food manufacturers to work toward within a given time frame. If the targets were met, it was estimated that population salt intake would fall from 9.5 to 6.3 g/d (9). To date, the United Kingdom strategy has contributed to an overall decrease of ≥7%

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[3] Supplemental Table 1 is available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at http://ajcn.nutrition.org.

*To whom correspondence should be addressed. E-mail: h.eyles@auckland.ac.nz.

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(2006–2011) and in some categories a decrease of ≤70% in the sodium content of packaged foods (2006–2011) (9, 10); this has corresponded with an initial achievement of a 15% decrease in population salt intake (from 9.5 to 8.1 g/d between 2001 and 2009) (11). More challenging targets will be set as sodium concentrations are further reduced in packaged foods, with the most recent voluntary United Kingdom-wide targets to be met by 2017 (12).

Although healthy diets should generally focus on whole fresh foods (13), in most high-income countries packaged and ultraprocessed foods make up most of the energy and sodium consumed (14–16). Therefore, sodium reduction targets for packaged foods are important and have been set by 39 of 75 countries with current national sodium reduction strategies (8). However, to the best of our knowledge none of these countries has reported the methods underpinning food category targets and how they relate to a population sodium intake target.

The objective of this work was to describe the development of a sodium reduction model for New Zealand. Our aim was to estimate the reductions required in the sodium content of packaged supermarket foods and other dietary sources of sodium to reduce adult population intake (currently 3373 mg Na/d) by ∼30% toward the optimal WHO target of 2000 mg Na/d (6).

METHODS

The United Kingdom sodium reduction model (17) provided an exemplar for the 6-step process used to develop the New Zealand salt reduction model (**Figure 1**). Ethical approval was not required because of the use of secondary observational data. Each step is described in detail below.

Step 1: Develop a template for the sodium reduction model and identify data sources for input

Template format and data sources

The New Zealand template was based on the United Kingdom sodium reduction model (17, 18) but with 2 additional variables: food wastage and sodium sourced from fresh foods and foods consumed away from the home (restaurants and takeaways). These variables were added because food-purchasing and store survey (food composition) data were used to develop the New Zealand sodium reduction model.

Food-purchasing and store survey data were considered more robust than dietary survey data because the most recent national nutrition survey data for New Zealand dates from 2008 to 2009 (19). In addition, food composition data from store surveys are brand specific, which is important when estimating required food category-specific sodium reductions. Furthermore, dietary intake data from traditional dietary assessment methods are prone to bias and underreporting (20, 21).

Food composition (sodium) data

In New Zealand it is mandatory for most foods to display a nutrition information panel (NIP) on the package (18). Information about the nutrient content (including sodium) of all packaged foods available for sale in 4 major supermarkets is collected directly from NIPs on an annual basis for the Nutritrack database (22). Supermarkets chosen for data collection represent the biggest retail brands of the 2 main national supermarket retailers, Foodstuffs (54% grocery market share) and Progressive Enterprises (38% market share) (23), and specific stores are selected based on size and to provide the largest product range possible. Package and NIP data are collected with the use of photographs of product packages and transcribed into an online

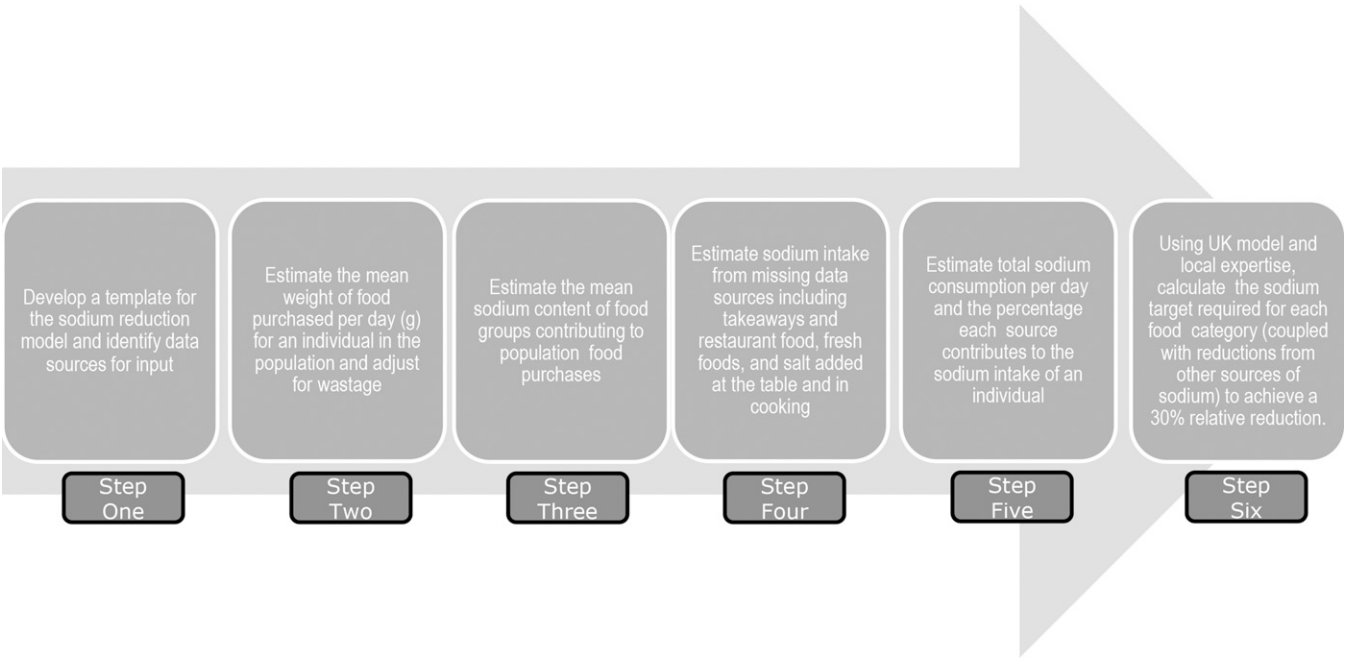

FIGURE 1 The 6-step process used to develop the sodium reduction model.

searchable database. Products are classified into 16 major food groups and >80 smaller food categories (24).

Food-purchasing data

Nutritrack data were combined with nationally representative food purchase data from the Nielsen Homescan market research panel (22, 25). Homescan includes ~2500 households whose members scan all grocery items brought into the home for consumption. Homescan panel data cover ~75% of total grocery purchases in New Zealand (~$11 billion in New Zealand dollars, equivalent to $6.3 billion US$) and 12 mo of data from 1 October 2011 to 31 September 2012 were used to develop the sodium reduction model (n = 1229 projected to 1,228,576 households). Before being linked to food composition information, the bottom 5% of products by sales (n = 9486) were removed for feasibility purposes. The final data set included 27,347 unique food and beverage products. Detailed information regarding the Homescan and Nutritrack data and the process for linking the 2 data sets is available elsewhere (22, 26). **Table 1** summarizes all data inputs for the New Zealand model.

Step 2: Estimate the mean weight of food consumed per adult per day, adjusting for wastage

Nielsen Homescan data were used to estimate the mean weight of food consumed by an individual adult household member for 1 d (Table 1). The total quantity purchased (in kg) for each food category by all households over the 12-mo period was calculated and divided by the number of days (365) and the number of households (1,228,576) to give the quantity purchased per household per day. The demographic make up of an average New Zealand household (2.11 adults + 0.56 children) (28) was used to adjust daily household food purchases to an estimate of the amount of food purchased for 1 adult/d.

The mean quantity purchased for an individual adult in each food category was adjusted to account for wastage that occurs during food preparation, at the table, and because of spoiled/unused food. Comprehensive food wastage data are not available for New Zealand, so United Kingdom estimates were applied (29).

TABLE 1
Key pieces of information included in the New Zealand sodium reduction model template[1]

No.	Information
1	Food group
2	Food category
3	Notes on types of foods included in each category
4	Food purchased for 1 adult, g/d
5	Proportion of each food category wasted, %
6	Estimated food intake per individual adult, g/d
7	Mean sodium content of each food category, mg/100 g
8	Mean sodium intake resulting from each food category, mg/d
9	Sodium contributed to the diet by each food category, %
10	Target mean sodium content for each food category, mg/100 g food
11	Target reduction required by each food category, %
12	Total reduction contributed by each food category, %

[1]It is mandatory for products in New Zealand to display a nutrition information panel (NIP) on the package. The NIP includes 7 mandatory nutrients, with sodium presented rather than salt (27).

TABLE 2
Data sets and food sources of dietary sodium in the New Zealand diet

Data and sources	Estimated sodium contribution, %
US NHANES data (30)	
Takeaway and restaurant foods	26.3
Modeling work by Wilson et al. (31)	
Fresh fish and seafood	1
Fresh fruits and vegetables	2.2
Fresh meats	4.5
New Zealand nutrition and the burden of disease study (32)	
Discretionary intake	15
Remaining (total)	
Packaged foods	51

Step 3: Estimate the mean sodium content of food categories

The mean sodium content of each food group was calculated with the use of Nutritrack data. The range, mean, median, minimum, and maximum were also calculated to estimate percentage reductions required to meet the target of 5 g/d (step 6).

Step 4: Estimate sodium intake from other sources

Nutritrack and Homescan data did not include information about sodium consumed from takeaways and restaurants, fresh foods, or salt added in cooking and at the table. Therefore, estimates of the proportion of sodium intake from these sources were obtained from the most current and relevant data sets and analyses available (**Table 2**).

Step 5: Estimate total sodium consumption and proportional contribution from each source

The most recent 24-h sodium excretion survey for New Zealand adults was undertaken in 2012; these data were used as the baseline dietary salt intake for the model [8.4 g (3373 mg Na/d)] (33). The proportion contributed by each main sodium source (fresh foods, takeaways/restaurant foods, and discretionary and packaged foods) that contributes to national sodium intakes was estimated by applying the food category proportions in Table 2 to the urinary sodium excretion value (3373 mg/d).

Absolute and proportional amounts of sodium contributed by food categories were compared to those in the United Kingdom sodium reduction model (17). The estimate for the absolute amount of sodium derived from packaged foods (1036 mg/d) in New Zealand was lower than expected (based on a total sodium intake of 3373 mg/d and a proportion of 51% for packaged foods, the expected contribution would be 1720 mg/d) (Table 2). Nonetheless, the proportional contributions for each food category were reasonable and comparable to the United Kingdom model. Likely reasons for the low absolute values were that Homescan data only includes 75% of total grocery purchases, and the bottom 5% (by sales) were removed from the data set for feasibility purposes before linking with Nutritrack. As such, absolute amounts of sodium for packaged food categories were scaled up with the use of a correction factor of 1.66 (1720/1036 mg Na/d).

TABLE 3
Final New Zealand sodium reduction model

Food groups and categories	Notes	Food purchased,[1] g/d	Proportion of food wasted,[2] %	Estimated food consumed,[3] g/d	Mean sodium content,[4] mg/100 g food	Sodium intake,[5] mg/d	Sodium contribution to diet,[6] %	Target mean sodium content,[7] mg/100 g food	Target mean reduction,[8] %	Total reduction contributed by food category,[9] %
Breads and bakery products										
White bread	Includes gluten-free	20.4	28	15	444	65	3.8	350	21	2.2
Whole-meal bread	Includes gluten-free	11.7	28	8	399	34	1.9	350	12	0.7
Mixed-grain bread	Includes gluten-free	31.8	28	23	410	94	5.4	350	15	2.2
Other bread	Includes flat bread, pizza bases, and rolls	11.4	28	8	477	39	2.3	300	37	2.3
Savory biscuits	Includes plain, dry, and flavored	7.8	5	7	668	49	2.9	300	55	4.3
Sweet biscuits	Includes filled and unfilled	16	5	15	263	40	2.3	120	54	3.5
Cakes, muffins, and pastries		6.2	5	6	321	19	1.1	120	63	1.9
Cereal and cereal products										
Breakfast cereals										
Hot		5.1	5	5	25	1	0.1	20	20	0.0
Cornflakes		2.7	5	3	511	13	0.8	300	41	0.9
Ready to eat (excluding cornflakes)		19.5	5	19	219	41	2.4	100	54	3.5
Cereal bars		6	5	6	169	10	0.6	80	53	0.8
Noodles		3.9	5	4	526	19	1.1	220	58	1.8
Pasta	Includes fresh, dry, canned, and packet	18.3	5	17	264	46	2.7	120	55	4.0
Rice	Plain and flavored	10.9	5	10	164	17	1.0	80	51	1.4
Couscous	Plain and flavored	0.3	5	0	573	2	0.1	300	48	0.1
Unprocessed cereals										
Flours		18.9	5	18	89	16	0.9	89	0	0.0
Other—breadcrumbs, etc.		1.8	5	2	1692	29	1.7	700	59	2.7
Other—quinoa, polenta, etc.		0.3	5	0	33	0	0.0	33	0	0.0
Confectionary	Includes sugar- and chocolate-based foods	15.4	5	15	73	11	0.6	50	32	0.5
Convenience foods										
Meal kits	Includes taco and burrito kits	0.6	5	1	225	1	0.1	225	0	0.0
Other frozen foods		0.4	5	0	578	2	0.1	400	31	0.1
Pizza	All toppings	2.4	5	2	412	9	0.5	300	27	0.4
Preprepared salads		1.8	43	1	325	3	0.2	150	54	0.3
Ready meals	Ambient, chilled, and frozen	4.1	5	4	354	14	0.8	150	58	1.3
Soups	Canned, chilled, and dry	6.4	5	6	334	20	1.2	180	46	1.5
Dairy										
Cheese										
Hard (e.g., block)		17.2	6	16	672	109	6.3	490	27	4.7

(Continued)

TABLE 3 (*Continued*)

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High-salt (e.g., feta, parmesan)		0.8	6	1	1070	8	0.5	750	30	0.4
Processed		1.7	6	2	1361	22	1.3	900	34	1.2
Blue		0.2	6	0	980	2	0.1	680	31	0.1
Soft/fresh		2.8	6	3	516	14	0.8	300	42	0.9
Cream[10]		6.7	6	6	38	2	0.1	38	0	0.0
Desserts	Mixes and prepared	3.2	6	3	199	6	0.3	100	50	0.5
Ice cream and edible ices		26.9	6	25	48	12	0.7	48	0	0.0
Milk[10]	All types	185.8	6	175	45	79	4.6	45	0	0.0
Yogurt	Includes drinking yogurt	29	6	27	45	12	0.7	45	0	0.0
Edible oils										
Cooking oils		7.3	5	7	0	0	0.0	0	0	0.0
Butter		9.5	5	9	500	45	2.6	350	30	2.2
Margarine		14.8	5	14	393	55	3.2	280	29	2.5
Eggs		16.4	5	16	133	21	1.2	133	0	0.0
Fish and seafood										
Canned fish		5.4	5	5	516	26	1.5	300	42	1.8
Chilled fish		0.5	5	0	628	3	0.2	400	36	0.2
Frozen fish		3.2	5	3	329	10	0.6	200	39	0.6
Seafood	Chilled and frozen	0.8	5	1	442	3	0.2	350	21	0.1
Fruits and vegetables										
Nonfresh fruit		21.4	5	20	36	7	0.4	20	44	0.5
Fresh packaged fruit and vegetables		0.7	43	0	36	0	0.0	36	0	0.0
Herbs and spices		1.4	5	1	3343	44	2.6	2500	25	1.8
Canned vegetables	Excludes baked beans	16.9	13	15	186	27	1.6	60	68	2.9
Baked beans		5.4	13	5	447	21	1.2	320	28	1.0
Frozen vegetables		17.9	13	16	42	7	0.4	42	0	0.0
Pickled vegetables		1.7	13	1	864	13	0.7	500	42	0.9
Frozen potato products		12.2	13	11	209	22	1.3	80	62	2.2
Nuts and seeds		2.5	5	2	141	3	0.2	100	29	0.2
Meat and meat products										
Bacon		5.8	5	6	1099	61	3.5	700	36	3.5
Canned meat		1	5	1	492	5	0.3	250	49	0.4
Frozen meat	Coated and uncoated	8.7	5	8	342	28	1.6	150	56	2.5
Meat pies		6.4	5	6	446	27	1.6	250	44	1.9
Meat burgers		1.5	5	1	477	7	0.4	300	37	0.4
Raw meats	Flavored and unflavored	0.6	45	0	277	1	0.1	200	28	0.0
Cured meats		0.7	5	1	1537	10	0.6	1000	35	0.6
Sausages and hotdogs		2.4	5	2	949	22	1.3	550	42	1.4
Sliced meat	Excludes cured meats	2.3	5	2	1068	23	1.4	500	53	2.0

(*Continued*)

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Other meat products	Includes smoked chicken and meat spreads	1.3	5	1	883	11	0.6	400	55	0.9
Meat alternative	Includes tofu, falafel, and meat-free products	0.4	5	0	451	2	0.1	380	16	0.0
Drinks										
Soft drinks[10]		120.5	7	112	8	9	0.5	8	0	0.0
Juices[10]	Includes vegetable and fruit	45.6	11	41	11	4	0.3	11	0	0.0
Water[10]		6.9	7	6	10	1	0.0	10	0	0.0
Energy drinks[10]		7.4	7	7	58	4	0.2	58	0	0.0
Dried beverages	Includes hot chocolate and flavored coffee	7.4	7	7	68	5	0.3	50	26	0.2
Beverage mixes and cordials		5.6	7	5	12	1	0.0	12	0	0.0
Sauces and spreads										
Mayonnaise and salad dressings		3.5	5	3	772	26	1.5	400	48	2.0
Asian sauces		0.7	5	1	4646	31	1.8	2500	46	2.3
Gravies and stocks		2.6	5	2	262	6	0.4	100	62	0.6
Meal-based sauces										
Curry pastes		0.2	5	0	3029	6	0.3	1500	50	0.5
Marinades		0.2	5	0	1505	3	0.2	1050	30	0.1
Asian cooking sauces		0.1	5	0	1676	2	0.1	1000	40	0.1
Liquid and ambient cooking sauces		0.2	5	0	742	1	0.1	450	39	0.1
Powdered mixes		0.5	5	0	4074	19	1.1	1500	63	1.9
Meat accompaniment sauces		1.1	5	1	996	10	0.6	450	55	0.9
Pasta sauces		4.8	5	5	442	20	1.2	220	50	1.6
Table sauces		6.7	5	6	1096	70	4.0	450	59	6.5
Tomato pastes		1.1	5	1	280	3	0.2	150	46	0.2
Dips		2.2	5	2	570	12	0.7	300	47	0.9
Nut spreads		3	5	3	282	8	0.5	130	54	0.7
Savory spreads	Includes relishes and chutneys	1.6	5	2	491	7	0.4	200	59	0.7
Sweet spreads		1	5	1	45	0	0.0	45	0	0.0
Yeast extract spreads		0.8	5	1	3513	27	1.5	2800	20	0.9
Extruded snacks		1.4	5	1	915	12	0.7	600	34	0.7
Potato chips	Excludes salt and vinegar	5	5	5	574	27	1.6	300	48	2.1

(*Continued*)

TABLE 3 (*Continued*)

Food groups and categories	Notes	Food purchased,[1] g/d	Proportion of food wasted,[2] %	Estimated food consumed,[3] g/d	Mean sodium content,[4] mg/100 g food	Sodium intake,[5] mg/d	Sodium contribution to diet,[6] %	Target mean sodium content,[7] mg/100 g food	Target mean reduction,[8] %	Total reduction contributed by food category,[9] %
Corn chips and whole-grain chips		2.3	5	2	567	12	0.7	300	47	0.9
Other snacks	Includes pretzels, rice snacks, legume-based snacks, and popcorn	2.6	5	2	692	17	1.0	400	42	1.1
Salt and vinegar snacks	Includes potato chips	0.8	5	1	820	6	0.4	500	39	0.4
Sugars and related products		29.1	5	28	31	9	0.5	31	0	0.0

[1]({[(Sum of units purchased × package size in kg · 365 d^{-1} · y^{-1})/1,228,576 households] × 1000 g} × 0.79 for adult adjustment)/2.11 adults in household.
[2]From reference 29.
[3]Food purchased − (food purchased × wastage factor from footnote 2).
[4]From New Zealand store surveys.
[5]Estimated food consumption × (current mean sodium intake/100).
[6](Sodium intake for category/total sodium intake) × 100.
[7]Based on (17), consumer acceptability, safety, functionality, and technical difficulty.
[8][(Current mean sodium intake − target mean sodium content)/current mean sodium content)] × 100.
[9][(Current sodium intake for category − target sodium intake for category)/(total current sodium intake − total target sodium intake)] × 100.
[10]Quantity in milliliters rather than in grams.

Step 6: Calculate the sodium targets required for each food category and reductions required in sodium intake from other sources

Because of the varying role salt plays in different foods, there is no standard formula for setting the sodium targets for food manufacturers in each food category (34–36). We used the 2017 United Kingdom sodium reduction targets as a benchmark to reflect consultation undertaken with the United Kingdom food industry (37). Sodium targets for food categories for which >10% of New Zealand products met the corresponding United Kingdom target were set at that target (considered challenging but feasible). Sodium targets for food categories for which <10% of New Zealand products met the corresponding United Kingdom target were set at a higher (easier) target. Conversely, sodium targets for food categories for which >50% of New Zealand products met the corresponding United Kingdom target were set at a lower (more difficult) target. As for the United Kingdom sodium reduction model, a 40% reduction in sodium from added (discretionary) salt as well as takeaway and restaurant foods was assumed (17).

The development of the draft targets are shown in **Supplemental Table 1**. Once the final food category targets were set (**Tables 3** and **4**), the model was completed by calculating the mean percentage and absolute reductions for each food category and the percentage reductions that each food category contributed to overall sodium intake (Table 3).

RESULTS

Relative contributions of food category sources of sodium to current population intake

Of the total 3377 mg Na currently consumed by the average New Zealander each day, the largest contributor was packaged foods (51%; 1724 mg), followed by takeaway and restaurant foods (26%; 887 mg) and discretionary intake from added salt (15%; 506 mg). Unpackaged fresh fruit, vegetables, meat, fish, and seafood provided the remaining 8% (260 mg). Packaged food categories contributing most to sodium intake were bread (all types; 13%), cheese (6%), butter and margarine (6%), milk (5%), bacon (4%), and table sauces (4%) (Table 3).

Overall reductions in sodium intake

The final sodium reduction model is presented in Table 3. A 36% mean reduction in the sodium content of packaged foods (from 1724 to 1096 mg Na/100 g) in conjunction with a 40% reduction in sodium obtained from takeaway and restaurant foods (from 887 to 532 mg Na/100 g) and discretionary intake (from 506 to 304 mg Na/100 g) would achieve a reduction in population sodium intake from 3377 to 2192 mg Na/d (8.4–5.5 g salt/d)—an overall 35% reduction. No change was assumed in the sodium content of fresh foods. It was not possible for the model to predict reductions required to reach a population intake of exactly 5 g salt/d because of unknown feasibility issues with manufacturers reducing sodium in their products. However, the reductions predicted would exceed the WHO target of a 30% reduction in population sodium intake (7).

TABLE 4
Summary of the final New Zealand sodium reduction model

	Current mean	Target mean
Sodium intake—food only, mg		
Packaged foods (NutriSales)	1724	1096
Unpackaged fruits and vegetables	74	74
Unpackaged fresh meat	152	152
Unpackaged fish and seafood	34	34
Takeaway and restaurant meals	887	532[1]
Total	2871	1888
Sodium intake—discretionary, mg	506	304[1]
Sodium intake including discretionary, mg	3377	2192
Salt intake including discretionary, g	8.4	5.5

[1]Assuming a 40% reduction.

Food category reductions (reformulation)

Because of low sodium contents and/or their fresh unprocessed forms, sodium reduction was not considered technically possible for 18 of 92 food categories. These categories included plain flour, milk, and most milk products (cream, yogurt, etc.), plain frozen vegetables, sugary drinks, and sweet spreads. The estimated percentage reductions required for the remaining 74 categories ranged from 68% (186–60 mg Na/100 g) for canned vegetables (excluding baked beans) to 12% for whole-meal bread (399–350 mg Na/100 g). Percentage reductions for other important food categories contributing to the sodium intake of New Zealand adults (22) were as follows: white bread (21%; 444–350 mg Na/100 g), table sauces (59%; 1096–450 mg Na/100 g), butter (30%; 500–350 mg Na/100 g), margarine (29%; 393–280 mg Na/100 g), bacon (36%; 1099–700 mg Na/100 g), and hard cheese (27%; 672–490 mg Na/100 g) (Table 3).

DISCUSSION

With the use of the successful United Kingdom model as a basis (17), we developed a national sodium reduction model for New Zealand. If the estimated reductions in sodium from foods consumed away from the home, discretionary intake, and packaged foods were achieved, our model would exceed the WHO target of a 30% reduction in population sodium intake; i.e., it would achieve a 35% overall reduction in sodium intake [from 3377 to 2192 mg Na (8.4–5.5 g salt)], thus getting close to the WHO target of 2000 mg Na/d (5 g salt/d) (7). Estimated percentages of reductions required in food categories ranged from 68% for canned vegetables to 12% for whole-meal bread.

There are 2 important strengths of our analysis. First, we had in-depth knowledge of the methods used to develop the successful United Kingdom sodium reduction model. Second, we used comprehensive, nationally representative food-purchasing and brand-specific nutrient composition. Food-purchasing data are collected objectively and thus not associated with the common limitations of traditional dietary assessment method surveys such as underreporting, recall bias, and social desirability bias (20, 21). Moreover, the food-purchasing data we used were more current than our most recent national nutrition survey (2012 compared with 2008–2009), sourced from a nationally representative consumer panel, and comprehensive because they spanned 12 mo of food purchases instead of only the 1–3-d dietary assessment usually used in national surveys. Finally, the use of brand-specific sodium content data collected via store surveys meant the resulting sodium reductions were directly related to the New Zealand food supply.

One limitation of our model is that ~30% of purchases were missing from the Nielsen Homescan data because of new products coming onto the market for which barcodes were not yet available for panel participants to scan and because participants failed to scan all products brought into the home. No information was available on the types of products missing; this resulted in an initial underestimation of the absolute amount of foods and beverages purchased by panel members and the need to adjust the purchase quantities upward to align with the best estimate of New Zealand population sodium intake. The lack of demographic information on individual households may have also resulted in an under- or overestimation of salt purchases. However, the proportional contribution food categories made to sodium purchases aligned well with comparable data from the most recent New Zealand adult nutrition survey (32) and a United Kingdom analysis of population sodium purchases (38). Therefore, missing data are unlikely to have affected the overall model.

Another limitation of our model is that it did not include impacts on children's salt intake. Preference for salt begins early in life (39), and including children may result in wider long-term impacts on population salt intake. Nonetheless, excluding children would produce a conservative model given that children generally consume less salt than adults (6). Finally, 2 assumptions were made regarding food wastage: that United Kingdom wastage factors are comparable to those in New Zealand (New Zealand food wastage data were not available), and that 5% would be an appropriate wastage factor for food categories for which no wastage information was available. These assumptions seem appropriate given that New Zealand and the United Kingdom have similar dietary patterns (40, 41). However, wastage factors could vary by food type. For example, the percentage of bread (a staple in both countries) wasted in the United Kingdom was 28%, which resulted in bread contributing only 13% to the sodium intake of New Zealanders. This compares to estimates of 35–43% of sodium intake from bread in other New Zealand studies (32, 42). Even so, these prior studies were conducted in 2003 and 2009, respectively. Bread consumption in New Zealand might have dropped between then and 2012, and the sodium content of New Zealand bread has fallen during this time frame (43).

Nevertheless, the final reductions in the sodium content of New Zealand-packaged foods were similar to those in the United Kingdom model. For example, the New Zealand model required a 36% reduction in the overall sodium content of packaged foods compared with 40% in the initial United Kingdom model (44). Furthermore, the range of sodium reductions across food categories was similar (12–68% in New Zealand compared with 10–81% in the United Kingdom). This is likely because of the similar dietary patterns of these countries and the fact that the United Kingdom and New Zealand models started from a similar baseline sodium intake from packaged foods (2760 and 2871 mg Na/d, respectively), despite the fact that the United Kingdom model started from a higher baseline salt intake than the New Zealand model (9.4 compared with 8.4 g/d, respectively) and had a higher final target (6 g compared with a 30% reduction toward 5 g/d, respectively).

Comparing the required reductions for New Zealand with efforts made by food manufacturers in response to targets set in

other countries provides some indication as to whether the New Zealand targets are likely to be feasible over the 10-y time frame (2015–2025). The United Kingdom strategy achieved an overall reduction of ≥7% and ≤70% in some categories in the sodium content of packaged foods over 6 y (2006–2011) (9, 10), and in Finland a range of national efforts, including mandatory high salt content warning labels on packaged foods, resulted in a global record reduction of 30% in population salt intake over the past 30 y (45). In Australia, there was a 9% reduction in bread and a 25% reduction in breakfast cereal in just 3 y (2010–2013) in response to voluntary targets set by the Australian Food and Health Dialogue. Recent modeling work with the use of Dutch national food consumption survey data has also illustrated that minimum technically feasible reductions equate to ∼50% in most packaged food categories (46). Furthermore, in New Zealand there have already been voluntary reductions in the sodium content of breakfast cereals (28%) and breads (14%) (43, 47).

Our model illustrates that manufacturers across the entire packaged food supply industry must work toward sodium reduction if the WHO 30% reduction is to be met by 2025. The targets outlined here are aspirational; 25 of 74 food categories considered for reformulation would require mean reductions in sodium of ≥50%. Such sizable reductions would likely pose considerable technical challenges and require considering sodium replacers and new technologies such as potassium salts and adjusted salt crystal size, which may have an impact on shelf life (34). More work should be done to identify barriers and enablers to sodium reduction for food manufacturing.

Support and monitoring of progress by the government is also key for successful sodium reduction. The United Kingdom has made important progress, with strong governmental leadership applying considerable pressure to reach voluntary targets, and this may be a good starting point for New Zealand and other countries (48, 49). Mandatory targets such as those set in South Africa and Argentina in 2013 could be implemented if voluntary targets do not result in action (50).

Finally, considerable efforts are needed by both food manufacturers and consumers if the WHO population target of a 30% reduction (toward the ideal of 5 g salt/d) is to be achieved by 2025. All member states signed up to meet this target, and it is key that governments take action to contribute to the global goal of a 25% reduction in all noncommunicable diseases by 2025 (51, 52). The sodium reduction model proposed herein should be just one component of an effective multifaceted national sodium reduction program, including a consumer awareness campaign and a range of interventions aimed at reducing salt consumption from all 3 sources of added sodium: takeaways and restaurants, packaged foods, and discretionary salt use by consumers. National interventions and policies are required to support consumers in making lower sodium food choices and switching to whole, fresh foods, which are naturally low in sodium and should ideally comprise most dietary intakes because of their association with reduced rates of all nutrition-related diseases (13).

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