

A Global Review of National Strategies to Reduce Sodium Concentrations in Packaged Foods

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ABSTRACT

Strategies to reduce sodium concentrations in packaged foods are effective and cost-effective approaches to reducing the burden of disease attributable to high sodium intakes. This review aimed to comprehensively describe, and explore characteristics of, national strategies to reduce sodium concentrations in packaged foods, and assess progress toward achieving national goals. A secondary aim was to understand the number, type, and variation of food category sodium targets set by countries compared with WHO global sodium benchmarks. National sodium reduction reformulation strategies were identified from a search of peer-reviewed and gray literature up to December 2019 supplemented by verified information from key contacts and experts up to December 2020. Key characteristics of countries' strategies were extracted, synthesized, and descriptively analyzed, including details of reformulation strategies and evaluation data. Country targets were mapped to the WHO global sodium benchmarks, and the number and variation of country sodium targets by WHO food categories were determined. Sixty-two countries had reformulation strategies to reduce sodium in packaged foods, and 19 countries had evaluated their reformulation strategies. Forty-three countries had sodium targets, which varied in type of targets (maximum sodium concentration: $n = 26$; maximum concentration plus relative reduction/average/sales-weighted average: $n = 8$; relative reduction: $n = 7$; average: $n = 2$), number of food category targets (range: $n = 1$ to 150), and regulatory approach (voluntary: $n = 28$; mandatory: $n = 9$; both: $n = 6$). Eight of 34 countries mapped to the WHO benchmarks had targets for just 1 specified food category (bread products). One-third of all countries were implementing national strategies to reduce sodium concentrations in packaged foods including establishing targets and/or processes for industry engagement. This review determined that there is scope to improve most countries' strategies. There has been limited progress in implementing and evaluating strategies between 2014 and 2019, and regional and income-level disparities persist. The WHO global sodium benchmarks present an important opportunity to accelerate reformulation action globally. *Adv Nutr* 2022;13:1820–1833.

Statement of Significance: This is the first article to assess national strategies to reduce sodium in processed foods against the WHO's global sodium benchmarks. It also provides a comprehensive global overview of what countries are doing to reduce sodium in processed foods in response to the global targets. As such it provides important new evidence on the reach and potential impact of this cost-effective intervention to reduce the burden of noncommunicable diseases.

Keywords: food reformulation, sodium, salt, salt reduction, public health nutrition

Introduction

Diets high in sodium are the leading dietary risk factor for death and disease globally, accounting for >1.8 million deaths and 45 million disability-adjusted life years (1–3). Diets high in sodium also cause high blood pressure (4), which is responsible for >10 million deaths and 235,000 disability-adjusted life years (1–3). High sodium intakes and high blood pressure increase the risk of cardiovascular

diseases (CVDs) and kidney diseases (1–3). In fact, >50% of CVD deaths from ischemic heart disease and stroke, and 60% of kidney disease deaths are attributable to high blood pressure, with a further 7–10% of deaths due to high sodium intakes (1–3).

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(5–8). A key approach is reformulation, the process whereby manufacturers alter the nutritional composition of foods by reducing concentrations of adverse nutrients, such as sodium (9). Reformulation initiatives can be voluntary or mandatory and can include setting reformulation targets, signed agreements between government and industry bodies or specific manufacturers, and supporting manufacturers to reformulate through workshops and meetings (10, 11). In May 2021, the WHO released global sodium benchmarks, which were set as maximum concentration sodium targets (12). Benchmarks were set for food categories based on the lowest (most stringent) existing national and regional sodium targets globally and a case-by-case review of each proposed benchmark by experts to ensure the sodium targets were appropriate and feasible (12). The purpose of the benchmarks is to guide countries in setting national sodium targets and accelerate the reformulation of processed foods around the world (12). The WHO benchmarks complement existing literature on target setting (13), which when implemented together present the optimal approach to sodium reduction reformulation approaches.

Systematic reviews of national sodium reduction initiatives are regularly undertaken (10, 11). In 2014, 75 countries had a national sodium reduction strategy (11), and 61 of those were working with the food industry to reduce sodium in packaged foods (14). In 2019, this had increased to ≥ 96 countries with a national sodium reduction strategy (10). This review aimed to comprehensively describe, and explore characteristics of, national food reformulation strategies to reduce sodium in packaged foods [identified in the 2019 systematic review (10)] and assess reported progress toward achieving national goals. An additional objective of this study was to map countries' reformulation targets to the WHO global sodium benchmarks and determine the number of countries that have targets for each WHO food category and the variation in maximum target sodium concentrations.

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Supplemental Tables 1 and 2 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at <https://academic.oup.com/advances/>.

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Methods

We undertook a secondary analysis of data collected for the 2019 systematic review on national salt (sodium) reduction initiatives worldwide. The methods employed to identify countries with national salt reduction strategies have been previously published (10). Briefly, national initiatives were identified from a search of peer-reviewed and gray literature up to December 2019 using search terms related to dietary salt/sodium and salt/sodium reduction strategies (e.g., food reformulation, front-of-pack labeling schemes, salt taxation, interventions in settings, and consumer education). These were supplemented with country questionnaires sent to country program leaders, regional representatives, and experts in salt reduction to get further information (10). Relevant data were then extracted and entered into a purpose-built database, which was formerly established to systematically catalogue search results for the same review conducted in 2014 (11). Ethical approval for the systematic review was received from the University of New South Wales Human Research Ethics Committee (HC190243). The protocol was registered with PROSPERO (registration number CRD42019133145).

For the purpose of this study, data on food reformulation strategies and sodium reduction targets were extracted from the database. Because the aim was to comprehensively describe, and explore characteristics of, national food reformulation strategies to reduce sodium in packaged foods, additional targeted online searches and communication with other country contacts or sources (other than those contacted in 2019) were carried out up to December 2020 to gather primary sources of data (e.g., policy documents containing actual reformulation targets) and update the data reported from the previous review. This process resulted in adjustments to some previously reported data (10). Reasons for differences included: new evidence found (added country or initiative), inability to find primary evidence such as an actual policy document (excluded initiative), inability to determine if country plans were actually implemented (recategorized implemented initiative as planned) or definitive evidence that planned initiatives had been implemented (recategorized planned initiative as planned implemented), a difference in definition of voluntary agreements (recategorized some targets as voluntary agreements).

Inclusion and exclusion criteria

Studies and sources containing information on food reformulation strategies to reduce sodium in packaged foods were included. Strategies included voluntary and mandatory reformulation targets, and industry engagement including meetings, workshops, and voluntary agreements between government and industry bodies or specific manufacturers to reduce sodium concentrations in ≥ 1 food categories. Out-of-home sector interventions to reduce sodium were not included in this review. Taxation to incentivise reformulation was also not included. Evaluation data from before 2013 were

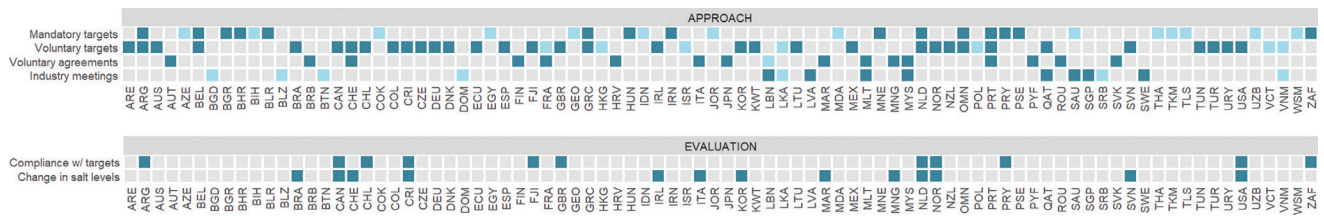


Figure 1 Overview of countries with national approaches to working with the food industry to achieve sodium reduction reformulation and evaluation. Dark blue indicates implemented; light blue represents planned approaches. International Organization for Standardization (ISO) 3166-1 alpha-3 codes for countries are displayed.

not reported because these have been previously published (14). If a country had multiple sources of data, or had multiple strategies or conducted >1 evaluation, all were included.

Data extraction and analysis

A comprehensive data extraction framework was developed by the authors. The framework expanded on domains included in the national salt reduction initiatives database (11) and split key details into different fields to allow new data analysis and synthesis.

Key characteristics of strategies were extracted, including type of initiative (reformulation targets, industry meetings, and voluntary agreements), government agency or organization responsible, and timeframe for implementation. Details of reported evaluations of these initiatives were also extracted including type (compliance with targets, monitoring of sodium concentrations), method (label survey, food analysis), evaluator (independent, government), timeframe, and outcomes. Country characteristics, such as region and income level, were also included. The above data were synthesized and analyzed descriptively.

For countries with reformulation targets, to understand the characteristics and comprehensiveness of sodium reformulation targets, the following data were extracted: type of target (e.g., maximum concentration, relative reduction), regulatory approach (mandatory, voluntary), number of food categories targeted (as described by countries), and actual sodium/salt targets. Data were synthesized and analyzed descriptively.

For countries with maximum concentration sodium reformulation targets, country-defined food categories for which targets were set were mapped to the food categories defined in the WHO global sodium benchmarks (12). Where a country-defined food category spanned >1 WHO-defined food category, the country target was mapped to multiple WHO benchmarks. Country targets that were set as salt targets (grams per 100 g) were converted to sodium targets (milligrams per 100 g) where required (1 g of salt is equal to 400 mg sodium). The number of countries with targets for each WHO category and subcategory was determined. The variation in sodium concentrations at which countries had set maximum targets for each WHO category and subcategory was assessed.

Results

Food reformulation strategies to reduce sodium in packaged foods

A total of 62 countries had food reformulation strategies to reduce sodium in packaged foods. This included the development of mandatory or voluntary targets, and/or establishment of processes for industry engagement. Forty-three countries had sodium reduction targets including 28 with voluntary targets, 9 with mandatory targets, and 6 with both mandatory and voluntary targets. Of these, 3 countries supplemented targets with industry engagement strategies. Nineteen countries had only industry engagement strategies, including 12 that had voluntary agreements with industry bodies or specific manufacturers, 5 that held meetings with the food industry, and 2 that used both approaches. Two countries that were currently using industry engagement approaches were also planning targets. A further 24 countries without existing strategies had planned food reformulation strategies. Of these, 13 were planning mandatory targets and 6 were planning voluntary targets (Figure 1).

Impact of food reformulation strategies on the sodium content of packaged foods

Nineteen of 62 countries had evaluated the impact of their food reformulation strategies on packaged foods since 2013; this included 16 of 43 countries with sodium reduction targets and 3 of 19 countries with industry engagement strategies (Figure 1).

Three countries had evaluation data on the impact of mandatory targets; the evaluation approach was to assess compliance with the targets through food label surveys. Overall compliance was 67% in South Africa, 88% in Paraguay (bread only), and 94% in Argentina. Food category compliance ranged from 27% for bread in South Africa to 97% for farinaceous foods (cereal and grain-based products) in Argentina (Figure 1, Table 1). One country, the Netherlands, had evaluation data on both mandatory (bread only) and voluntary targets, and the approach was assessing compliance with targets and changes in salt concentrations using a combination of food analysis and food labels data. There was a 20% reduction in sodium concentrations in bread in the Netherlands. For voluntary targets, food category compliance ranged from 79% for soups to 96% for

Table 1 Overview of the impact of national food reduction reformulation strategies on sodium concentrations in packaged foods

Country	Evaluation details	Outcomes
Mandatory targets		
Compliance with targets: Percentage of products at or below maximum concentration target overall and by category at end point (range is presented where subcategory data were reported)		
Argentina (15)	Measured by: Independent Method: Label survey Timeframe: 2017–2018	<u>Overall: 94.3%</u> Meat and meat products: 87.3% Farinaceous: 96.9% Soups, bouillons, and dressings: 95.5% Bread: 88%
Paraguay (16)	Measured by: Independent Method: Label survey Timeframe: 2015–2016	
South Africa (17)	Measured by: Independent Method: Label survey Timeframe: 2015–2016	<u>Overall: 67%</u> Bread: 27% Breakfast cereals: 91% Fat and butter spreads: 69% Savory snacks: 41–70% Processed meat: 45–91% Dry soup and sauces powders: 55–85% Stock cubes, powders, granules, emulsions, pastes, or jellies: 77%
Change in sodium concentrations: Mean percentage change by category		
Netherlands (18)	Measured by: Government or statutory agency Method: Food analysis + label survey Timeframe: 2011–2016	Bread: –20%
Voluntary targets		
Compliance with targets: Percentage of products at or below maximum concentration target overall and by category at end point (range is presented where subcategory data were reported)		
Chile (16)	Measured by: Independent Method: Label survey Timeframe: 2015–2016	Bread: 45%
Costa Rica (19)	Measured by: Independent Method: Label survey Timeframe: 2015–2018	<u>Overall: 87%</u> Condiments: 82% Cookies and biscuits: 95% Breads: 59% Processed meat: 86% Cakes: 83% Sauces: 83%
Fiji (20)	Measured by: Independent Method: Label survey Timeframe: 2018	<u>Overall: 59.5%</u> Biscuits: 80.5% Canned fish: 54.7% Meat and meat products: 23.4% Noodles: 20% Sauces and spreads: 59.3% Snacks: 47.8%
Netherlands (18)	Measured by: Government or statutory agency Method: Food analysis + label survey Timeframe: 2011–2016	Meat cold cuts: 90% Sauces: 86–96% Soups sold as liquid and instant prepared: 79%
Norway (21)	Measured by: Government or statutory agency Method: Food analysis Timeframe: 2014–2018	<u>Overall: 49%</u> Bread and cereal products: 56% Meat products: 49% Fish products: 45% Dairy and edible fats: 47% Ready meals, sauces, salads: 48%
United Kingdom (22)	Measured by: Government or statutory agency Method: Label survey Timeframe: 2017–2018	<u>Overall: 83%</u> Bread: 82–95% Breakfast cereals: 98% Cheese: 37–100% Butter: 73–73% Fat spreads: 80% Baked beans: 58–90%

(Continued)

Table 1 (Continued)

Country	Evaluation details	Outcomes
		Ready meals and meal centers: 88% Soups: 87% Pizzas: 87% Crisps and snacks: 81–90% Cakes, pastries, fruit pies, and other pastry-based desserts: 77–94% Sandwiches: Not applicable Table sauces: 57–91% Cook-in and pasta sauces, thick sauces, and pastes: 67–83% Biscuits: 66–93% Pasta: 94% Rice: 74–94% Other cereals: 71% Processed puddings: 83–89% Quiche: 81% Scotch eggs: 45% Canned fish: 94–94% Canned vegetables: 62–73% Meat alternatives: 34–68% Other processed potatoes: 80% Beverages: 95% Stocks and gravies: 89–91%
	Compliance with targets: Number (%) of subcategories overall and by food category where average sodium concentration at end point is at or below target	
Canada (23)	Measured by: Government or statutory agency Method: Label survey Timeframe: 2012–2016	Overall: 13/94 (14%) Bakery products: 0/16 (0%) Breakfast cereals: 0/2 (0%) Dairy products and substitutes: 2/7 (29%) Fats and oils: 0/4 (0%) Fish and seafood products: 2/8 (25%) Mixed dishes: 1/11 (9%) Meat products: 4/16 (25%) Meat substitutes: 1/2 (50%) Soups: 0/1 (0%) Snacks: 0/4 (0%) Sauces, dips, gravies, and condiments: 0/9 (11%) Vegetables: 0/7 (14%) Nut butters: 0/1 (0%) Seasoning mixes: 0/3 (0%) Infant and toddler foods: 0/3 (33%)
United Kingdom (22)	Measured by: Government or statutory agency Method: Label survey Timeframe: 2017–2018	Overall: 20/76 (26%) Meat products: 1/13 (8%) Bread: 2/4 (50%) Breakfast cereals: 1/1 (100%) Cheese: 2/7 (29%) Butter: 1/2 (50%) Fat spreads: 0/1 (0%) Baked beans: 1/2 (50%) Ready meals and meal centers: 0/1 (0%) Soups: 0/1 (0%) Pizzas: 0/1 (0%) Crisps and snacks: 3/4 (75%) Cakes, pastries, fruit pies, and other pastry-based desserts: 2/3 (67%) Sandwiches: 0/2 (0%) Table sauces: 0/6 (0%) Cook-in and pasta sauces, thick sauces, and pastes: 1/3 (33%) Biscuits: 0/2 (0%) Pasta: 1/1 (100%) Rice: 0/2 (0%) Other cereals: 0/1 (0%) Processed puddings: 2/4 (50%) Quiche: 1/1 (100%) Scotch eggs: 0/1 (0%)

(Continued)

Table 1 (Continued)

Country	Evaluation details	Outcomes
United States (24)	Measured by: Government or statutory agency Method: Label survey Timeframe: 2009–2014	Canned fish: 0/3 (0%) Canned vegetables: 0/2 (0%) Meat alternatives: 0/3 (0%) Other processed potatoes: 1/2 (50%) Beverages: 0/1 (0%) Stocks and gravies: 1/2 (50%) Overall: 2/61 (3%) Bakery products: 0/7 (0%) Cereal and other grain products: 0/3 (0%) Meats: 0/9 (0%) Dairy products and substitutes: 1/5 (20%) Fats and oils: 0/4 (0%) Sauces, dips, gravies, and condiments: 0/5 (0%) Snacks: 0/5 (0%) Soups: 0/3 (0%) Potatoes: 0/2 (0%) Mixed dishes: 0/8 (0%) Vegetables: 0/5 (0%) Legumes: 0/2 (0%) Canned fish: 1/1 (100%) Seasoning mixes: 0/1 (0%) Nut butters: 0/1 (0%)
Change in sodium concentrations: Mean percentage change overall and by category Brazil (25)	Measured by: Government or statutory agency Method: Label survey Timeframe: 2011–2017	Bread products: –14% Cakes: –28% to –15% Instant noodles: 19% Savory snacks: –13% to –1% Spreads: –34% to –20% Mozzarella cheese: 14% Condiments: –9% to –5% Biscuits: –18% to –9% Breakfast cereals: –16%
Canada (23)	Measured by: Government or statutory agency Method: Label survey Timeframe: 2012–2016	Bakery products: –24% to 2% Breakfast cereals: –29% to –21% Dairy products and substitutes: –39% to 55% Fats and oils: –15% to 3% Fish and seafood products: –43% to 28% Mixed dishes: –14% to 51% Meat products: –35% to 60% Meat substitutes: –69% to –6% Soups: –8% Snacks: –22% to –1% Sauces, dips, gravies, and condiments: –43% to 225% Vegetables: –65% to –4% Nut butters: –21% Seasoning mixes: –12% to 45%
Costa Rica (19)	Measured by: Independent Method: Label survey Timeframe: 2015–2018	Infant and toddler foods: –55% to –28% Condiments: –22% to 32% Cookies and biscuits: –12% to –10% Breads: –63% to –5% Processed meats: –24% to 16% Cakes: –25% Sauces: –50% to –16%
Ireland (26)	Measured by: Government or statutory agency Method: Food analysis Timeframe: bread: 2003–2018, meat: 2004–2015	Bread: –13% to –29% Sausages: –11% Bacon: –27% Cooked ham: –15% Pudding: no reduction
Korea (Republic of; “South”) (27)	Measured by: Government or statutory agency Method: Unknown Timeframe: 2010–2015	Overall: –22% Kimchi: –27.4% Noodles: –19.4% Soy sauce: –12.6%

(Continued)

Table 1 (Continued)

Country	Evaluation details	Outcomes
		Pickled foods: -34.7% Meat and egg products: -20.7% Seasoned foods and dressings: -29.1% Dairy products: -34.2% Confectionery: -50% Other: -24%
Netherlands (18)	Measured by: Government or statutory agency Method: Food analysis + label survey Timeframe: 2011–2016	Gouda cheese: -10% Meat cold cuts: -19% to 7% Sauces: -40% to 0% Soups sold as liquid and instant prepared: -8% Processed vegetables and legumes: -41% to -26%
Norway (21)	Measured by: Government or statutory agency Method: Food analysis Timeframe: 2014–2018	Breads and cereals: -42% to 19% Meat products: -25% to 22% Fish products: -7% to 41% Dairy and edible fats: -22% to 5%
Slovenia (28)	Measured by: Independent Method: Label survey Timeframe: 2011–2015	Ready meals, sauces, and mayonnaise-based salads: -24% to -2% Bread: -8% Processed meat: 13%
Switzerland (29)	Measured by: Government or statutory agency Method: Food analysis Timeframe: 2011–2015	Bread: -16%
United States (24)	Measured by: Government or statutory agency Method: Label survey Timeframe: 2009–2014	Overall: -6.8% Bakery Products: -17% to -1% Cereal and other grain products: -22% to -6% Meats: -9% to 12% Dairy products and substitutes: -16% to -3% Fats and oils: -11% to 6% Sauces, dips, gravies, and condiments: -12% to -2% Snacks: -12% to -1% Soups: -20% to 6% Potatoes: -5% to -2% Mixed dishes: -11% to 5% Vegetables: -26% to 3% Legumes: -7% to -2% Canned fish: -12% Seasoning mixes: -6% Nut butters: -7%
Voluntary agreements with the food industry		
Italy (30)	Measured by: Unknown Method: Unknown Timeframe: 2015	Bread: -15% Gnocchi: -15% Pasta and rice of frozen ready meals: -10% Soups and vegetable/legumes purée: -10%
Mongolia	Measured by: Unknown Method: Unknown Timeframe: 2019	Overall: -29.3%
Morocco (31)	Measured by: Unknown Method: Food analysis Timeframe: 2011–2016	Bread: -26.3%, -172.8 mg/100 g

pasta sauces, and changes in salt concentrations ranged from 0% for curry sauce to -41% for legumes (Figure 1, Table 1).

Twelve countries had evaluation data on the impact of voluntary targets; 3 countries assessed compliance with voluntary targets through food label surveys, 5 countries assessed changes in sodium concentrations (food label survey: $n = 2$; food analysis: $n = 2$; unknown: $n = 1$), and 4 countries assessed both compliance and changes in sodium concentrations (food label survey: $n = 3$; food analysis: $n = 1$). Overall compliance with voluntary maximum targets

ranged from 60% (Fiji) to 87% (Costa Rica); food category compliance ranged from 20% (noodles, Fiji) to 100% (cheddar cheese, United Kingdom). Overall compliance with voluntary average or sales-weighted average targets ranged from 3% [US National Salt Reduction Initiative (NSRI)] to 26% (United Kingdom) of subcategories complying; food category compliance ranged from 0% to 100% (multiple subcategories across multiple countries). Overall reductions in sodium concentrations across all targeted food categories were reported by 2 countries: the United States (NSRI: 7%)

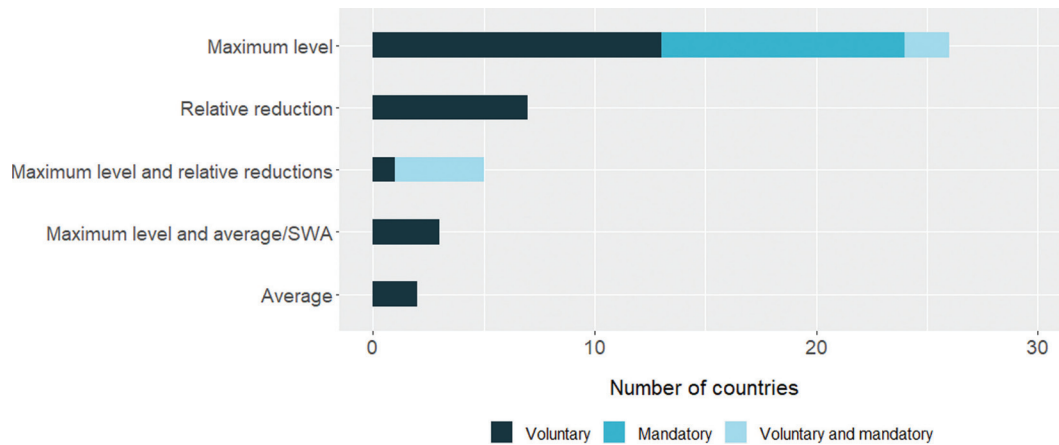


Figure 2 Types of sodium reformulation targets by regulatory approach. SWA, sales-weighted average.

and South Korea (22%). Other countries reported changes in sodium concentrations by food category (Figure 1, Table 1).

Three countries had evaluation data on the impact of voluntary agreements with the food industry; these countries assessed changes in sodium concentrations through food analysis ($n = 1$) or unknown methods ($n = 2$). Mongolia reported a 29% reduction in sodium concentrations across the food supply; Italy reported reductions in sodium concentrations of 10–15% in bread, gnocchi, ready meal components, and soups; and food analysis in Morocco revealed 26% reductions in sodium concentrations in bread products (Figure 1, Table 1) (15–31).

Characteristics of sodium reformulation targets

Of the 43 countries that had sodium reformulation targets for ≥ 1 food category, almost half were in Europe ($n = 19$) and one-quarter were from the Americas ($n = 11$). Countries in the Eastern Mediterranean ($n = 8$), Western Pacific ($n = 4$), and African ($n = 1$) regions also had sodium reformulation targets, whereas none were identified in the South East Asian region. Almost two-thirds of countries with targets were high-income countries ($n = 26$), and one-third were upper-middle-income countries ($n = 15$). Only 2 lower-middle-income countries had targets, and none were identified in low-income countries (Figure 1, Supplemental Table 1).

Four types of sodium reformulation targets were identified: maximum concentration, average (mean/median) sodium concentration, sales-weighted average sodium concentration, and relative reduction targets. Thirty-four countries had maximum concentration targets for ≥ 1 food category, including 26 countries that had maximum targets alone (13 voluntary, 11 mandatory, 2 both voluntary and mandatory), 5 countries that had maximum targets for selected food categories (3 mandatory, 1 voluntary, 1 both mandatory and voluntary) supplemented by voluntary relative reduction targets for additional food categories, and 3 countries that applied both voluntary maximum targets and either sales-weighted average or average targets to the same food category ($n = 2$ and $n = 1$, respectively). Seven

countries had voluntary relative reduction targets, and 2 had voluntary average targets. Overall, 10 countries had incremental sodium reformulation targets, including 6 with maximum targets (4 voluntary, 1 mandatory, 1 both), 3 countries that applied both voluntary maximum targets and sales-weighted average/average targets to the same food category, and 1 with mandatory maximum targets and voluntary relative reduction targets (Figure 2).

The number of food category targets ranged from 1 ($n = 16$) to 150 ($n = 1$, US FDA draft targets 2016). One target was the most common, and the median number of targets was 7. Countries with mandatory targets set between 1 and 24 targets (median = 3), whereas countries with voluntary targets set between 1 and 150 targets (median = 15). Countries with both types of targets set between 1 and 26 mandatory targets (median = 1) and between 1 and 45 voluntary targets (median = 7; Figure 3).

The number of food categories that countries set targets for varied by region, with countries in the Eastern Mediterranean region setting between 1 and 3 targets (median = 1) and countries in the Americas setting between 1 and 150 targets (median = 23). The number of targets set by countries varied by country income level, with lower-middle-income countries setting at most 1 target, upper-middle-income countries setting between 1 and 59 targets (median = 13), and high-income countries setting between 1 and 150 targets (median = 8; Figure 3).

National targets compared with WHO sodium benchmarks

Maximum targets from 34 countries were mapped to the 18 food categories listed in the WHO global sodium benchmarks (to date, benchmarks have been set for 12 main categories and the remaining categories could be considered for benchmarks in the future). Only 6 countries (18%) had targets for ≥ 9 (50%) of the WHO main food categories, including Canada and the United States ($n = 14$), the United Kingdom ($n = 13$), Turkey ($n = 11$), Denmark ($n = 10$), and

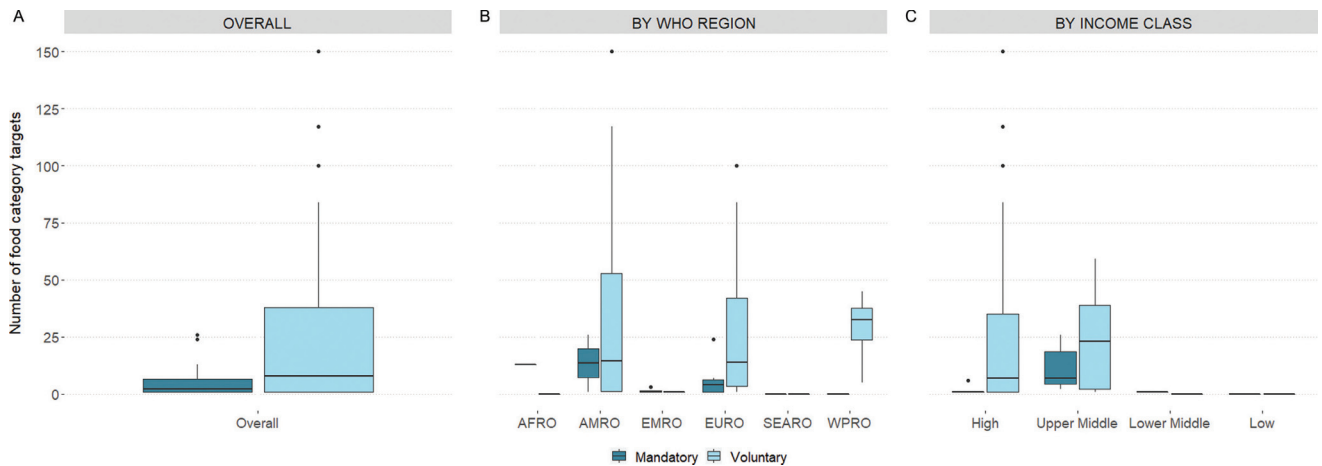


Figure 3 Variations in the number of sodium reformulation targets for countries: (A) overall, (B) by region, and (C) by income. The figure was generated using ggplot in R, where the central box shows the median, quartile 1, and quartile 3, and the whiskers were produced using the Tukey method. AFRO, Regional Office for Africa; AMRO, Regional Office for the Americas; EMRO, Regional Office for the Eastern Mediterranean; EURO, Regional Office for Europe; SEARO, Regional Office for South-East Asia; WPRO, Regional Office for the Western Pacific.

Brazil ($n = 9$). Eight countries (24%) had targets for only 1 WHO food category (Figure 4).

Overall, the most common food categories targeted by countries were bread and bread products ($n = 29$), processed meat and fish ($n = 20$), and savory snacks ($n = 17$). More than one-quarter of countries had targets for ready meals ($n = 15$), sweet bakery products ($n = 14$), sauces, dips, and dressings ($n = 13$), and cheeses ($n = 12$; Figure 4).

Within WHO-defined food categories, large variations were evident in the sodium concentrations at which countries had set targets. Sodium target concentrations ranged from as little as 500 mg sodium/100 g for plant-based foods to >20,000 mg sodium/100 g for sauces, dips, and dressings. The variation for all categories is illustrated in Figure 5, and WHO global sodium benchmarks and country target ranges for all subcategories are displayed in Supplemental Table 2.

Discussion

One-third of countries ($n = 62$) had established national food reformulation strategies to reduce sodium concentrations in packaged foods, including voluntary or mandatory targets and/or processes for industry engagement. Forty-three countries had set targets for packaged foods, although most commonly countries only set 1 food category target ($n = 16$). The other 19 countries had voluntary agreements or meetings with selected food companies or food manufacturing associations. The impact of national sodium reduction strategies on sodium concentrations in packaged foods has been evaluated in ~30% of countries with strategies ($n = 19$). Variations in strategies implemented and evaluation methods used did not allow an overall assessment of impact to be made; however, countries with evaluation data generally reported positive results across selected packaged food categories. Overall, it was evident that progress in implementing and evaluating food reformulation strategies around the

world varied, particularly by region and income level, and there is scope for increasing the impact of food reformulation strategies in most countries. The new WHO global sodium benchmarks present an important opportunity to accelerate packaged food reformulation action globally by providing practical and feasible targets for a broad range of food categories that can be adapted or adopted by countries to guide further action.

Progress in implementing and evaluating food reformulation strategies around the world

The number of countries with national food reformulation strategies, and sodium reformulation targets, has not changed substantially since 2014 ($n = 59$ and $n = 38$, respectively). Further, most countries with previously identified programs have not updated their reformulation strategies since the previous review (11, 14). This is despite the fact that the number of countries with national salt reduction strategies has increased from 75 to 96 countries (10, 11). Few of the newly identified countries' initiatives included food reformulation strategies, with many implementing interventions in publicly funded institutions (e.g., schools and hospitals) or front-of-pack labeling initiatives (10). All 3 of these interventions are WHO "best-buy" strategies (effective and cost-effective interventions) to reduce population sodium intake (5). The reasons why countries are preferentially implementing sodium reduction initiatives other than reformulation strategies are largely unknown, but could be related to broad-based political support for policies that present consumers with information to make informed food choices or create environments that will positively influence food choices, and also serve as incentives for the food industry to produce healthier foods through reformulation (32). Although food reformulation strategies can range from voluntary programs without regulatory

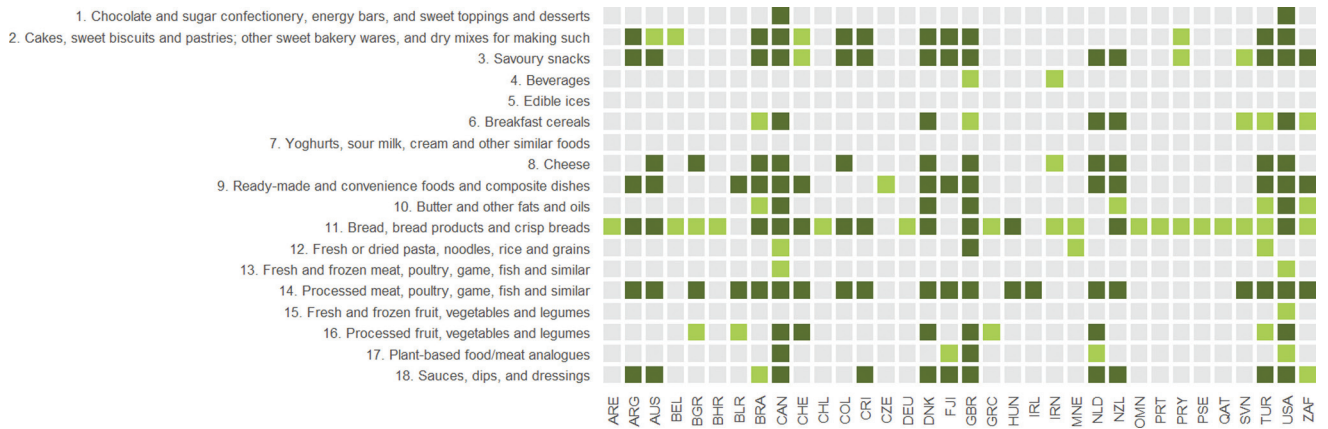


Figure 4 Presence of sodium reformulation targets by country and WHO food category. Light green represents 1 country target and dark green indicates >1 country target was mapped to the WHO food category. International Organization for Standardization (ISO) 3166-1 alpha-3 codes for countries are displayed.

mechanisms to legislation regulating the composition of foods produced by the food industry, these strategies generally aim to improve the food supply, facilitating healthier choices without relying on changes in consumer behavior (32). Overall, our data indicate limited global progress in implementing food reformulation strategies. Although this WHO “best-buy” strategy (5) should be implemented as part of a multifaceted national sodium reduction strategy for the greatest impact on diets and health (10, 33–35), it appears countries are prioritizing other sodium reduction interventions.

The lack of progress in setting and implementing sodium reduction targets was evident across most regions and income levels. Only minor changes were determined compared with the previous review (11), with an exception being the Eastern Mediterranean region where now 8 countries have targets compared with 2 previously. There continues to be very few countries in the Western Pacific and African regions with targets, and none in the South East Asian region. Similarly, there are still only 2 lower-middle-income countries and no low-income countries with targets. This pattern of disparities by region and income level is consistent with that found for other sodium reduction interventions,

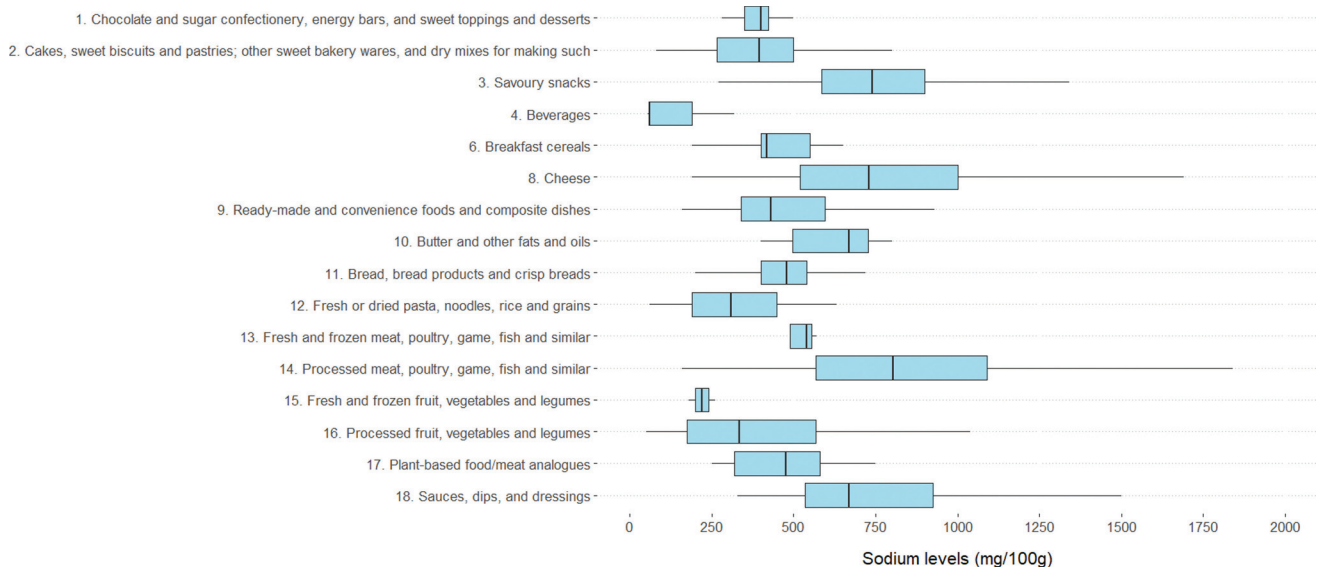


Figure 5 Variations in country maximum sodium concentration reformulation targets by WHO category. The figure was generated using ggplot in R, where the central box shows the median, quartile 1, and quartile 3, and the whiskers were produced using the Tukey method. Outliers were omitted from the figure.

and also in terms of which countries have measures of change in salt intake or sodium concentrations in foods (10). This limits the comparison between regions and income groups. Three factors are likely contributing to the disparities in implementing sodium reduction targets: insufficient resources and in-country capacity to develop and implement targets; regulatory barriers such as a lack of sodium labeling on packaged foods and consequently unknown concentrations of sodium in these products; and insufficient evidence on the major sources of dietary sodium intake in these countries (36). External technical support will be key to enabling many countries to overcome these barriers (36). In lower-income countries experiencing a nutrition transition toward diets higher in packaged foods (37), strategies that effectively limit the sodium content of packaged foods will be important to prevent increases in population sodium intake and the associated disease burden.

Less than half of countries ($n = 16$) with targets have evaluated the impact of their strategies since 2013. Of these, 7 countries had continued monitoring sodium concentrations in foods from prior to 2013 (14), and 9 had not previously reported evaluation data. Ten countries that reported evaluation data before 2013 (14) had not continued monitoring sodium concentrations in foods so it is not possible to know if any earlier changes in sodium concentrations have been sustained. Ongoing monitoring is necessary to ensure manufacturers do not increase the concentrations of sodium in foods and that sodium reduction efforts continue. Variable progress toward compliance with targets or changes in sodium concentrations in packaged foods was reported. Overall compliance was high (minimum 60% compliance) and there did not appear to be greater compliance with mandatory targets than voluntary targets, overall or by food category. Changes in sodium concentrations were only reported for voluntary targets and varied greatly by food category. Positively, reductions across all targeted food categories were reported by the few countries that measured this. This supports findings from a previous review that synthesized monitoring data for 10 food categories and determined that existing voluntary sodium reduction strategies (including through targets) reduced sodium concentrations in packaged foods by an average of 38 mg/100 g (38). However, data were mostly from 7 high-income countries (38), and the generalizability of findings to other countries is limited. Measuring sodium concentrations in foods over time allows monitoring of progress toward reducing sodium in the global packaged food supply, which should contribute to progress toward the global goal of a 30% reduction in population sodium intake (39). It also keeps governments accountable for their sodium reduction commitments and the food industry accountable for reformulation action (40, 41). However, with so few countries monitoring compliance and progress, likely because this can be time- and resource-intensive, the effectiveness of different sodium reformulation strategies remains unclear, and accountability is low.

Scope for increasing the impact of food reformulation strategies around the world

Sodium reduction targets can be an effective and cost-effective approach to reducing sodium concentrations in packaged foods (5). Previous modeling studies have demonstrated that population-wide sodium reduction interventions, including voluntary and mandatory sodium reduction targets, are among the most cost-effective interventions to reduce the burden of CVDs (7, 42, 43). Based on these findings, it can be speculated that the costs of implementing sodium reduction targets (including additional costs associated with monitoring and evaluating compliance and progress) will be offset by the population health gains. However, this study revealed many countries' strategies are suboptimal. To be effective, packaged foods contributing most to sodium intakes need to be identified and have targets set, with a view to incrementally lowering targets over time, and robust monitoring and evaluation mechanisms must be established (13, 36). Packaged foods contributing substantially to sodium intake vary globally (44), as do sodium concentrations within packaged foods (38, 45). Both these factors have implications for the creation of sodium reduction targets in each country. Yet, there was limited evidence that countries based the selection of food categories for sodium targets on dietary sources of sodium (44), and this has been cited as a challenge (36). When mapped to the WHO global sodium benchmarks, 8 countries only had targets for bread products, whereas for a further 3 countries a single target was mapped to >1 WHO category (bread products, bakery products, savory snacks). In many countries, bread and bakery products are a major source of sodium (44); however, unlike establishing a comprehensive suite of sodium reduction targets covering all the main contributors to sodium in the diet, strategies targeting just 1 or a limited selection of foods are likely not sufficient to achieve significant reductions in overall population sodium intake. Some countries' sodium targets were based on current sodium concentrations in packaged foods, whereas others did not report any rationale for the selection of targets. More than three-quarters of countries applied maximum targets (alone or as part of a combined approach), which is generally the most practical and feasible approach for both implementation and monitoring (13). Other countries applied relative reduction, average, and/or sales-weighted average targets, that have advantages (particularly when supplementing maximum concentration targets) but are often more difficult to implement and monitor (13). For example, sales-weighted average targets take into account product consumption rates, but do not address individual products high in sodium, and accessing market share data to monitor impact is difficult and expensive (46). Only 10 countries had incremental (or step-wise) targets, which facilitate the continued reduction of sodium concentrations in packaged food over time (13). There are several steps countries can take to improve, or develop new, sodium reduction targets for optimal impact on packaged foods and population diets. Countries with a limited set of targets, or without any targets, should consider the above

key activities, originally outlined as a 5-step approach to target setting by Downs et al. (13). Adapting the WHO global sodium benchmarks (12), which provide specific target setting guidance, offers countries (particularly those with fewer resources) an opportunity to set targets based on international evidence. Step-by-step guidance on how countries can adapt the WHO global sodium benchmarks to their local context is in progress.

The heterogeneous nature of monitoring and evaluation data reported by countries did not allow data synthesis, which prevented an assessment of global progress in reducing sodium concentrations in packaged foods. All countries measured sodium (or salt) concentrations in packaged foods per 100 g. However, some countries reported progress toward a goal: absolute and/or relative change in average (or sales-weighted average) sodium concentrations in packaged foods over time; whereas others reported against a standard: product and/or subcategory level compliance against sodium targets. Measuring changes over time allows detection of improving or worsening performance and progress toward goals and objectives of national sodium reduction strategies (47). This approach can be more reliable than comparing with a subjective target and enables corrective actions to be taken based on multiple period comparisons (47). On the other hand, reporting compliance (or benchmarking) allows detection of a level of achievement against a standard, can be less resource-intensive (if measured at a single timepoint), and facilitates accountability and enforcement, particularly because sanctions can be applied for noncompliance (40, 47). Importantly though, achievement of a target does not necessarily mean positive changes to sodium concentrations in packaged foods because compliance is relative to the target set and, to be effective, maximum targets need to be aspirational and lowered incrementally over time, which only one-quarter of countries are doing (13, 47). Differences in reporting were compounded by varying country food category/subcategory definitions preventing food category level synthesis, as well as different types of targets, target sodium concentrations, and implementation timeframes. This meant the effectiveness of current targets in reducing sodium concentrations in the global packaged food supply could not be determined in this study. More consistency in approaches across countries would facilitate understanding of global progress.

Considerations for future food reformulation strategies

Legislative approaches are often recommended to increase the impact of reformulation initiatives on population sodium intake; however, this study did not generate evidence to support greater effectiveness of legislative approaches over voluntary initiatives. About one-third of countries with targets (15/43) have mandatory targets for ≥ 1 food category. This has increased since 2014 ($n = 9$) and is primarily due to new initiatives in the Eastern Mediterranean region (14); however, the majority of country targets set globally remain voluntary. Around half of the countries with legislation (7/15) have a mandatory target for bread products only,

and 3 countries supplemented their mandatory target with voluntary targets for other food categories ($n = 5$ to $n = 45$). The latter is particularly interesting because these countries have already established the legislative mechanisms required but have chosen to limit the scope. Recent global evidence indicates mandatory approaches to reformulation will have a greater impact on population intakes of adverse nutrients, including sodium and *trans* fatty acids (33, 34). However, only 3 of the 15 countries with mandatory targets in this study had evaluation data, and the approach used was assessing compliance with targets. Although compliance for the 3 countries was high, it is not known whether there was a decrease in sodium concentrations in packaged foods that could have contributed to reductions in population sodium intake. With increasing global evidence to support the effectiveness of legislative approaches, countries with established legislative mechanisms have the opportunity to expand their reformulation strategies to include more food categories and thus have a larger impact. Countries planning to implement reformulation strategies, and those with voluntary initiatives, should explore the potential legislative mechanisms available and ensure strategies are aspirational and cover enough food categories to generate health impacts.

The diversity in national reformulation strategies, including food categories selected and sodium targets set, is a barrier to more effective implementation. The new WHO global sodium benchmarks, released in May 2021, offer an important opportunity to accelerate packaged food reformulation action globally (12). The benchmarks demonstrate the optimal target-setting approach because this is the most practical and feasible: maximum targets for specific food categories set at the lowest appropriate sodium concentration and intended to be incrementally reduced over time (12). The benchmarks are designed to be adapted by countries based on the main sources of sodium in the diet and current sodium concentrations in packaged foods (12, 13), although countries unable to obtain these data (e.g. due to resource constraints) could directly adopt the global benchmarks. Adapting the WHO global benchmarks will create consistency in food category definitions and targets globally, which should facilitate between-country comparisons of sodium targets and concentrations in packaged foods (40). The benchmarks also provide a uniform target for global food manufacturers rather than working toward different targets across multiple countries. The next key action is to develop guidance for global monitoring and evaluation of the impact of reformulation strategies on packaged foods (12), which WHO is generating. Such guidance should be based on performance measurement attributes and frameworks [e.g., see Lichiello and Turnock (47)] to ensure the global targets achieve optimal impact.

Strengths and limitations

This study comprehensively described national reformulation strategies and their reported impact on sodium concentrations in packaged foods. The thorough approach to data collection, namely systematic literature searches

supplemented by verified information from key contacts and experts, was a strength. To our knowledge, it is the first study to map country sodium reduction targets to the WHO global sodium benchmarks (12) and describe the variation in national sodium targets. Country targets are often long-term initiatives and ideally targets are regularly evaluated and incrementally reduced. Mapping these 2019/2020 data to the 2021 WHO global sodium benchmarks allows insight into the reductions in sodium targets that countries could feasibly adopt when next updating/revising their targets.

However, most reformulation programs are part of multifaceted sodium reduction strategies (10), and the impact of reformulation programs should be interpreted relative to that of the broader sodium reduction strategy. Where there was a lack of or insufficient evidence or an inability to verify the existence of a reformulation program, data were excluded. This could have resulted in the exclusion of a few countries with strategies to reduce sodium concentrations in packaged foods that were included in the previous review (10). Synthesis of evaluation data was not possible due to the heterogeneous nature of the data reported by countries.

Conclusions

This review demonstrated that by 2019 around one-third of all countries were implementing strategies to reduce sodium concentrations in packaged foods, including targets and industry engagement. Many countries' reformulation strategies were suboptimal; strategies should cover all major packaged food sources of dietary sodium, consider current concentrations of sodium in packaged foods, and aim to lower target sodium concentrations incrementally over time to be most effective. There has been little global progress in implementing and evaluating sodium reformulation strategies globally since our 2014 review, and strategies continue to be predominantly implemented and evaluated in European and American regions and high- and upper-middle-income countries. The WHO global sodium benchmarks present an important opportunity to accelerate sodium reduction reformulation action globally with adequate country uptake, implementation, and evaluation.

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