

Adherence to voluntary sodium reduction agreements in Brazil

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Abstract *The objective was to assess adherence to voluntary agreements for sodium reduction firm-ed between the food industries and the Ministry of Health in Brazil and to compare their targets with the limit proposed in the Pan American Health Organization (PAHO) nutritional profile model. We used data from 1.553 foods from 32 categories included in the agreements and sold in the largest Brazilian supermarket chains in 2017. The frequency of products with sodium equal or below the cut-offs proposed by the voluntary agreements and by PAHO was calculated. Classification concordance according to the two was evaluated with Cohen's kappa coefficient (k). Our results showed that 77.7% of products were adequate according to the voluntary agreements, and only 35.9% of them, according to the PAHO model. We identified a weak degree of concordance between both criteria in classifying a product as adequate about sodium content ($k = 0.199$). In conclusion, the voluntary agreements for sodium reduction are limited in their scope and rigor. The adoption of measures oriented for all products, with more restrictive and mandatory targets, should be considered in the country.*

Key words *Sodium chloride, Dietary, Food labeling, Nutrition programs and policies*

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Introduction

Non-communicable diseases (NCDs) are the leading cause of death worldwide, being responsible for more than 40 million deaths in 2016, which is equivalent to 71% of all deaths¹. The NCDs that contribute most to the morbidity and mortality burden have several common modifiable lifestyle risk factors, including harmful use of alcohol, smoking, physical inactivity and unhealthy diet¹.

One of the diet-related factors is excessive sodium consumption, which is associated with high blood pressure and the development of cardiovascular disease (CVD)^{2,3}. Worldwide mean sodium intake is 10 g/day, which is double the amount recommended by the World Health Organization (WHO). Government programs to reduce population intake of sodium are a cost effective means of preventing CVD and premature deaths⁴. The WHO has prioritized sodium reduction to prevent and control NCDs, setting a target of a 30% relative reduction in mean population intake by 2025⁵. The Pan American Health Organization (PAHO) has also recognized that sodium consumption is a priority, launching a series of recommendations to reduce intake to less than 2 g or 5 g salt per person per day by 2020⁶.

The situation in Brazil in relation to sodium intake, prevalence of NCDs and NCD deaths is similar to global trends. In 2016, it was estimated that NCDs accounted for 74% of total deaths, 28% of which were caused by CVD¹, while sodium intake was double the WHO recommended limit^{1,7,8}. Although the main sources of sodium in the country are table salt and salt-based condiments, data from Brazil's household budget surveys conducted between 2003 and 2009 have shown that the contribution of processed and ultra-processed foods to sodium availability has increased significantly⁸. A study using consumption data from a household budget survey of 34,000 Brazilians aged over 10 years in 2009 showed that processed and ultra-processed food products accounted for more than half of dietary sodium⁹.

In view of the above, since 2010, the Ministry of Health has been discussing strategies to reduce sodium intake, defining priority actions such as promoting the consumption of minimally processed staple foods, food education, guidance on nutrition labeling, and the reformulation of processed foods¹⁰. In 2011, the Ministry of Health and Brazilian Food Industry Association (ABIA)

signed the first voluntary agreement aimed at reducing the sodium content of packaged foods sold in the country. Five agreements were signed between 2011 and 2017, setting sodium reduction targets for 35 food categories¹¹⁻¹⁵. It is worth mentioning that these agreements are part of the strategy to reduce population salt consumption to less than 5 g/day by 2020, in line with PAHO and WHO targets¹¹⁻¹⁵.

With the aim of providing evidence on sodium levels in packaged foods available on the Brazilian market and helping shape national policies to reduce population intake of this nutrient, this study assessed compliance with voluntary sodium reduction targets for packaged food products sold in the country and compared the amount of sodium in these foods to the limits recommended by the PAHO for the prevention of NCDs.

Methods

The data were collected between April and July 2017 by photographing the labels of foods sold by Brazil's biggest supermarket chains in São Paulo and Salvador¹⁶. São Paulo was chosen because it is the country's largest city. As one of the selected supermarket chains only has stores in the country's Northeast region, the data from the products sold by this chain were collected in Salvador, the largest city in the region.

All stores owned by the respective supermarket chains in the selected locations were georeferenced and the socioeconomic status of the surrounding areas was determined based on the average family head income in census tracts within a 1,000-meter radius, using data from the latest census (2010)¹⁷. The stores were then divided into income terciles and the largest outlets in terms of area in the first and third terciles were included in the sample. Two outlets from each chain were visited, except for one chain, which stipulated that data could only be collected in its distribution centers, where all the products were available. Data collection followed the approach proposed by the International Network for Food and Obesity/Non-Communicable Diseases Research, Monitoring and Action Support (INFORMAS), described in detail by Kanter *et al.*¹⁸. Formal permission for data collection was obtained from the supermarket chains.

Photographs were taken of all sides of the packaging. The data were entered into the RED-Cap platform using a form developed by the University of North Carolina at Chapel Hill and

Institute of Nutrition and Food Technology in Chile adapted for use in the present study. Duplicate products, different package sizes, packages that contained multiple individual items, and products without information were excluded, resulting in 11,434 products.

Only products from the 35 food categories included in the voluntary agreements signed before data collection were analyzed (Chart 1). The agreement signed in 2017, setting new targets for instant noodles, sliced bread and mini bread rolls for 2018 and 2020, was therefore not considered¹⁵. We did not find any items in the categories 'bread roll', 'roulade' and 'liquid/gelatinous stock'. The final sample comprised 1,553 items from 32 food categories.

The following descriptive statistics were used to analyze the data: means and standard deviations; 25th, 50th and 75th percentiles; and minimum and maximum sodium content in each food category. The Shapiro-Wilk test was used to determine whether the sodium content data were normally distributed, adopting a significance level of $p \leq 0.05$. For most of the categories (20 of 32, or 62.5%), the data did not have a normal distribution. As the reduction targets were set based on mean sodium content, both mean and median sodium content are presented.

To assess adherence to the voluntary agreements, we calculated the prevalence of products with sodium content below the latest targets set for each respective category. As we collected all products, regardless of manufacturer, we analyzed whether brands with at least five products with sodium content above the targets belonged to companies that signed the agreements.

We also verified compliance with the PAHO Nutrient Profile Model, which establishes the following criterion for identifying products excessive in sodium: ≥ 1 mg of sodium per 1 kcal¹⁹. This tool was developed to help PAHO member countries identify inappropriate nutrient profiles in non-alcoholic foods and beverages covered by regulations to prevent and control diet-related NCDs¹⁹.

We chose this criterion to assess the rigor of the voluntary agreements, as it is consistent with discussions on policies in the region and because, as far as we know, the PAHO and WHO have yet to develop specific thresholds for the reformulation of products containing sodium.

Level of agreement for the classification of the foods based on the thresholds proposed by the voluntary agreements and PAHO was determined using the Cohen's kappa coefficient (k).

The following classifications were used to assess the extent of agreement between the methods: poor, $k < 0.00$; slight, $0.00 \leq k \leq 0.20$; fair, $0.21 \leq k \leq 0.40$; moderate, $0.41 \leq k \leq 0.60$; substantial, $0.61 \leq k \leq 0.80$; and almost perfect, $k > 0.80$ ²⁰.

The analyses were performed using Stata version 16.0.

Results

Table 1 shows sodium content by food category. The categories with the highest sodium content were condiments ['rice seasoning' (mean 20,075.7; median 19,730.0 mg/100g), 'stock cubes/powder' (mean 20,029.7; median 20,505.3 mg/100g), 'seasoning paste' (mean 19,596.2; median 26,840.0 mg/100g), 'other types of seasoning' (mean 13,807.7; median 14,780.0 mg/100g)] and meat products ['refrigerated mortadella' (mean 1,443.5; median 1,320.0 mg/100g), 'mortadella kept at room temperature' (mean 1,417.9; median 1,350.0 mg/100g), 'hams' (mean 1,329.9; median 1,160.0 mg/100g), 'cooked sausage kept at room temperature' (mean 1,193.6; median 1,187.0 mg/100g) and 'refrigerated cooked sausage' (mean 1,136.6; median 1,320.0 mg/100g)]. Mean sodium content was above the voluntary targets in 25.0% of the 32 categories ('sponge cake mix', 'moist cake mix', 'salty corn snacks', 'savory cookies', 'cheese spread', 'refrigerated mortadella', 'mortadella kept at room temperature' and 'hams'). Median sodium content was above the targets in four categories ('sponge cake mix', 'moist cake mix', 'uncooked sausage' and 'refrigerated mortadella').

Table 2 shows the proportion of foods that met the limits proposed by the voluntary sodium reduction agreements and PAHO Nutrient Profile Model. Considering the overall sample, 77.7% met the voluntary sodium reduction targets. The categories with the largest proportion of products that met the voluntary targets were 'mini bread rolls' (100.0%) and 'rice seasoning' (100.0%), followed by 'breakfast cereal' (97.5%), 'breaded foods' (95.3%) and 'mayonnaise' (95.2%). The category with the smallest proportion of products that met the limits was 'refrigerated mortadella' (23.8%), followed by 'sponge cake mix' (29.5%), 'moist cake mix' (37.5%) and 'uncooked sausage' (45.0%). The products with sodium content above the limits belonged to more than 100 brands. Seventeen of these brands had at least five products that failed to comply with the limits. Together, these brands accounted

Chart 1. Summary of the voluntary cooperation agreements between the Ministry of Health and food industry for the reduction of sodium in foods in Brazil.

Agreement/date	Food category	Target (mg/100g)a/year				
		2013	2014	2015	2016	2017
Agreement N° 04/2011/07-04-2011	Instant noodles	1,920.7				
	Sliced bread	645		522		
	Mini bread rolls	531		430		
Agreement N° 35/2011/13-12-2011	Cake without filling	392		332		
	Sandwich cakes	282		242		
	Sponge cake mix	476		398		334
	Moist cake mix	349		295		250
	Roulade	221		204		
	Bread roll	616		586		
	Salty corn snacks	1,090		852		747
	Chips/potato sticks	650		586		529
	Mayonnaise	1,283		1 051		
	Sweet cookies	419		359		
	Savory cookies ^b	923		699		
	Sandwich cookies	389		265		
Agreement/ 28-08-2012	Breakfast cereal		579		418	
	Margarine		1,089		715	
	Stock cubes/powder ^c		1,100		1,025	
	Liquid/gelatinous stock		928		865	
	Seasoning paste		37,901		33,134	
	Rice seasoning		32,927		32,076	
	Other types of seasoning		23,775		21,775	
Agreement/ 05-11-2013	Yellow cheese			559		512
	Cheese spread			587		541
	Soup ^d				327	314
	Individual/instant soup ^e				334	330
	Breaded foods ^f				690	650
	Hamburger ^g				780	740
	Cooked sausage kept at room temperature			1,560		1,500
	Refrigerated cooked sausage				1,310	1,210
	Uncooked sausage				1,080	970
	Refrigerated mortadella				1,270	1,180
	Mortadella kept at room temperature				1,380	1,350
	Hotdogs ^h				1,140	1,120
	Hams ⁱ				1,180	1,160

^a Target expressed in 100 g of the product for sale, except for stock cubes/powder, soups. See notes below. ^b Cream cracker, water and salt cracker. ^c Threshold expressed in mg/portion. ^d Clear or creamy soups made from meat, poultry, vegetables, grains, and other ingredients that when not ready-to-eat need to be cooked. Onion sauce exclusively for culinary use were excluded from this category. Threshold expressed in mg/100mL of the ready-to-eat product. ^e Soups prepared by adding boiling water and homogenization without needing to be cooked. Threshold expressed in mg/100mL of the ready-to-eat product. ^f Breaded fish and breaded foods made mainly from vegetables were excluded. ^g Hamburgers made mainly from vegetables were excluded. ^h Canned or jarred hotdogs were excluded. ⁱ Includes ham (cooked and poultry).

Source: Brasil, 2011¹¹, 2011¹², 2012¹³, 2013¹⁴.

Table 1. Number of foods and sodium content in milligrams per 100 g of the product, by food category.

Food categories	n	Sodium (mg) in 100 g of food						
		Mean	SD	Min	p25	p50	p75	Max
Instant noodles	80	1,626.9	281.6	843.8	1,504.7	1,730.0	1,828.6	1,960.0
Sliced bread	112	366.9	98.5	146.0	300.0	370.0	436.0	598.1
Mini bread rolls	9	335.3	38.9	262.0	316.0	358.0	364.0	366.0
Cake without filling	90	272.1	144.1	35.7	176.7	259.2	323.3	713.3
Sandwich cakes	46	194.2	82.5	0.0	155.0	195.8	220.0	470.0
Sponge cake mix	78	433.1	190.7	14.3	329.7	427.6	502.7	967.6
Moist cake mix	8	269.2	88.1	110.3	200.1	314.1	336.7	341.2
Salty corn snacks	48	752.6	252.2	50.0	620.0	720.0	884.0	1,196.0
Potato chips/sticks	81	434.6	151.0	22.8	352.0	476.0	524.0	748.0
Mayonnaise	21	842.1	156.6	541.7	758.3	833.3	958.3	1,066.7
Sweet cookies	37	304.6	91.9	1.3	286.7	326.7	356.7	476.7
Savory cookies	45	724.2	298.7	1.2	600.0	696.7	700.0	1,613.3
Sandwich cookies	103	228.5	76.4	0.0	190.0	233.3	260.0	600.0
Breakfast cereal	157	138.7	147.6	0.0	15.0	112.5	223.3	761.9
Margarine	14	650.7	146.2	400.0	600.0	620.0	710.0	1,050.0
Stock cubes/powder ^a	38	20,029.7	4,800.3	40.6	18,419.1	20,505.3	23,157.9	27,253.3
Seasoning paste	31	19,596.2	14,064.1	0.0	3,700.0	26,840.0	32,540.0	35,380.0
Rice seasoning	14	20,075.7	3,825.9	12,220.0	19,540.0	19,730.0	20,340.0	31,260.0
Other types of seasoning	66	13,807.7	8,242.0	360.0	7,457.6	14,780.0	20,220.0	36 740.0
Yellow cheese	53	422.7	162.9	33.3	370.0	450.0	546.7	796.7
Cheese spread	85	570.0	149.7	183.3	483.3	532.0	626.7	1,100.0
Soup ²	43	289.1	300.8	89.0	216.0	269.2	290.4	2,111.6
Individual/instant soup ^b	12	312.5	47.5	245.0	282.5	311.7	339.6	411.2
Breaded foods	43	521.1	96.6	345.4	453.8	531.0	607.7	677.7
Hamburgers	39	495.0	312.2	38.0	96.2	570.5	737.5	1,211.7
Cooked sausage kept at room temperature	22	1,193.6	371.0	1.5	1,000.0	1,187.0	1,500.0	1,640.0
Refrigerated cooked sausage	13	1,136.6	237.5	780.0	1,000.0	1,066.0	1,342.0	1,500.0
Uncooked sausage	60	958.5	213.9	434.0	852.0	1,028.0	1,077.0	1,428.0
Refrigerated mortadella	21	1,443.5	884.2	160.0	1,232.5	1,320.0	1,415.0	5,000.0
Mortadella kept at room temperature	7	1,417.9	226.0	1,145.0	1,300.0	1,350.0	1,597.5	1,832.5
Hotdogs	32	943.9	286.4	344.0	700.0	880.0	1,110.0	1,478.0
Hams	45	1,329.9	810.0	531.7	892.5	1,160.0	1,560.0	5,600.0

^a. Target defined per portion of product. Sodium content (mg) per portion: mean = 936.3; SD = 186.7; p25 = 912; p50 = 963; p75 = 1,020. ^b. mg sodium/100 ml of ready-to-eat product. SD: standard deviation; min: minimum value; p: percentile; max: maximum value.

Source: Authors.

for 52.7% of the items that that failed to comply (183 of 347). Seven of these brands belonged to companies linked to the food associations that signed the voluntary agreements. Of the remaining 10, four were supermarket brands.

Only 35.9% of the foods met the limits proposed by the PAHO. The category with the largest proportion of items within the limit was 'moist cake mix' (100.0%), followed by 'sandwich cookies' (99.0%), 'sweet cookies' (94.6%), 'breakfast

cereal' (92.4%) and 'sandwich cakes' (91.3%). In almost a third of the categories (31.3%), none of the products were within the limits proposed by the PAHO Nutrient Profile Model, and in 16 categories (50.0%) the proportion of foods with appropriate sodium content was 50% or less.

Considering the overall sample, agreement between the two criteria was slight ($\kappa = 0.199$). Only five categories showed substantial agreement or above ($\kappa > 0.60$): 'chips/potato

sticks', 'sponge cake mix', 'cake without filling', 'sandwich cakes' and 'sweet cookies'. The large majority of the categories (23 of 32, or 71.9%) showed slight or poor agreement.

Discussion

Our findings show that around a quarter of the products belonging to the categories included in the voluntary agreements failed to meet the sodium reduction targets set to be achieved by 2017. An even larger proportion (64.1%) had a sodium content above the limit proposed by the PAHO

Table 2. Proportion of foods with sodium content equal to or below the limits set out in the voluntary sodium reduction agreements and PAHO Nutrient Profile Model and agreement between the two criteria, by food category.

Food category	n	% Compliance with voluntary agreements (95% CI)	% Compliance with PAHO (95% CI)	k (95% CI)
Instant noodles	80	96.3 (88.9 - 98.8)	0.0	0.000
Sliced bread	112	93.8 (87.4 - 97.0)	13.4 (8.2 - 21.1)	0.020 (0.002 - 0.038)
Mini bread rolls	9	100.0	33.3 (10.3 - 68.5)	0.000
Cake without filling	90	78.9 (69.2 - 86.1)	73.3 (63.2 - 81.5)	0.726 (0.560 - 0.893)
Sandwich cakes	46	91.3 (78.8 - 96.7)	91.3 (78.8 - 96.7)	0.726 (0.365 - 1.000)
Sponge cake mix	78	29.5 (20.4 - 40.6)	38.5 (28.3 - 49.7)	0.745 (0.592 - 0.898)
Moist cake mix	8	37.5 (11.5 - 73.5)	100.0	0.000
Salty corn snacks	48	60.4 (46.0 - 73.3)	10.4 (4.4 - 22.9)	0.142 (0.017 - 0.266)
Chips/potato sticks	81	80.2 (70.1 - 87.6)	80.2 (70.1 - 87.6)	0.922 (0.816 - 1.000)
Mayonnaise	21	95.2 (71.8 - 99.4)	4.8 (0.6 - 28.2)	0.005 (-0.009 - 0.019)
Sweet cookies	37	89.2 (74.2 - 95.9)	94.6 (80.5 - 98.7)	0.641 (0.189 - 1.000)
Savory cookies	45	64.4 (49.4 - 77.1)	6.7 (2.1 - 18.9)	0.076 (-0.012 - 0.164)
Sandwich cookies	103	84.5 (76.1 - 90.3)	99.0 (93.4 - 99.9)	0.101 (-0.083 - 0.286)
Breakfast cereal	157	97.5 (93.4 - 99.0)	92.4 (87.0 - 95.6)	0.350 (0.048 - 0.652)
Margarine	14	85.7 (55.9 - 96.6)	50.0 (25.2 - 74.8)	0.286 (-0.066 - 0.637)
Stock cube/powder	38	78.9 (63.0 - 89.2)	2.6 (0.4 - 16.8)	0.014 (-0.015 - 0.044)
Seasoning paste	31	93.5 (77.1 - 98.4)	16.1 (6.8 - 33.7)	0.026 (-0.016 - 0.068)
Rice seasoning	14	100.0	0.0	0.000
Other types of seasoning	66	89.4 (79.3 - 94.9)	0.0	0.000
Yellow cheese	53	66.0 (52.3 - 77.5)	18.9 (10.4 - 31.8)	0.214 (0.075 - 0.352)
Cheese spread	85	55.3 (44.6 - 65.5)	1.2 (0.2 - 8.0)	0.019 (-0.018 - 0.056)
Soup	43	90.7 (77.5 - 96.5)	2.3(0.3 - 15.1)	0.005 (-0.006 - 0.016)
Individual/instant soup	12	75.0 (43.4 - 92.2)	0.0	0.000
Breaded foods	43	95.3 (83.0 - 98.9)	0.0	0.000
Hamburgers	39	79.5 (63.8 - 89.5)	25.6 (14.3 - 41.7)	0.163 (0.030 - 0.297)
Refrigerated cooked sausage	22	81.8 (59.7 - 93.2)	4.5 (0.6 - 27.1)	0.021 (-0.024 - 0.066)
Uncooked sausage	13	61.5 (33.3 - 83.7)	0.0	0.000
Refrigerated mortadella	60	45.0 (32.9 - 57.8)	0.0	0.000
Mortadella kept at room temperature	21	23.8 (10.0 - 46.7)	4.8 (0.6 - 28.2)	0.276 (-0.164 - 0.716)
Refrigerated cooked sausage	7	71.4 (29.8 - 93.6)	0.0	0.000
Hotdogs	32	81.3 (63.7 - 91.4)	0.0	0.000
Hams	45	55.6 (40.8 - 69.4)	0.0	0.000
Total	1 553	77.7 (75.5 - 79.7)	35.9 (33.5 - 38.3)	0.199 (0.169 - 0.230)

CI: confidence interval; k: Cohen's kappa coefficient.

Source: Authors.

Nutrient Profile Model. Agreement between the two criteria for the classification of products with high sodium content was slight, despite the fact that both criteria are aimed at preventing NCDs.

Recent studies have pointed to a progressive reduction in the sodium content of foods sold in Brazil and, overall, a large proportion of products comply with the voluntary targets. In a study assessing 20 categories included in the first voluntary agreements, Nilson *et al.* found a significant reduction in the mean sodium content of foods in 13 categories between 2011 and 2017, ranging from 8 to 34%²¹. Another study including the same food categories reported that more than 85% of the products analyzed in each category met the sodium targets between 2011 and 2013²².

The difference between our results and those of these studies may be explained by methodological differences. For example, we included all the categories and products covered by the agreements and targets set to be achieved by 2017. Some of the categories in our study with a lower proportion of products that meet the targets, such as sausages, mortadellas and hams, were recently added to the agreements and were not assessed by Nilson *et al.*, who analyzed food categories in agreements signed in 2011²². However, comparisons of some of the same categories ('cake without filling', 'sponge cake mix', 'moist cake mix', 'salty corn snacks' and 'savory cookies', for example) show a lower level of compliance than that reported by Nilson *et al.* This difference may be at least partially explained by the fact that, unlike Nilson *et al.*, we included all of the relevant products found in the supermarkets, regardless of manufacturer, and not just those produced by ABIA member companies²². Our findings show that most of the brands that contributed most to the items that failed to meet the targets did not belong to companies that are members of the food associations that signed the agreements. Despite the expected spillover effects of these agreements on non-signatory companies, our findings show that these initiatives had less effect on this group than on ABIA member companies. Thus, the changes to the sodium content of foods on the market may not be as pronounced as previously shown by Nilson *et al.* Brazil, for example, was the country with the lowest proportion of products meeting the lower regional target among 14 Latin American and Caribbean Countries²³.

The comparison of the voluntary agreements and PAHO Nutrient Profile Model indicated that the two methods were discordant when classifying whether the sodium content of a product is

compatible with NCD prevention. The sodium reduction targets in the voluntary agreements were set based on mean values in each category after excluding outliers, leaving out a large proportion of the products that already met the targets. The Brazilian targets were set mainly focusing on products with high levels of sodium and are not capable of ensuring that products from different categories have appropriate nutrient profiles²⁴. Salt reduction targets in the United Kingdom, for example, cover a larger number of food categories (around 80) and are generally more rigorous, particularly for meat products such as sausages and hamburgers²⁵. Some of the included categories in the United Kingdom, such as pizzas and sandwiches, also contain high levels of sodium in Brazil²⁶, yet are not covered by the agreements. Deficiencies in monitoring is a factor that limits the effectiveness of voluntary agreements in the prevention and control of NCDs. A study that evaluated technical reports published by Brazil's National Health Surveillance Agency (ANVISA), which, together with the Ministry of Health, is responsible for monitoring reduction targets, showed that food categories lacked standardization and the number of samples and regions included in the process were insufficient²⁷.

Various countries have adopted measures to reduce population intake of sodium²⁸; however, estimates suggest that consumption exceeds recommended levels for the prevention of NCDs in all countries and regions²⁹. Some countries, such as the United Kingdom and Finland, have been successful in implementing voluntary programs with the food industry and have managed to reduce salt levels, population intake, blood pressure levels, and associated diseases over recent decades³⁰⁻³². Despite progress in Finland, which reduced population salt intake from 12 to around 9 g/day between 1979 and 2002, Laatikainen *et al.* estimate that, if the decrease in intake were to follow the same trend, it would take another 35 years for men and 26 years for women to achieve an intake of 5 g³¹. More recently, Argentina and South Africa introduced legislation limiting salt levels in a range of food categories. The advantages of mandatory reformulation include the possibility of imposing fiscal penalties, the fact that regulations apply to all manufacturers, and the stability of measures with changes of government²⁸. However, critics of reformulations aimed at reducing the intake of critical nutrients such as sodium suggest that the strategy has important limitations. These include the fact that it is not possible to ensure that reformulated ultra-pro-

cessed products have an appropriate nutrient profile and one of the policy rationales behind such measures is that reformulation is a means of reducing the consumption of these nutrients without changing dietary patterns, which can legitimate the consumption of these foods³³.

Other strategies can be employed to reduce population intake of sodium besides reformulation. These include the use of taxes and adequate nutrient labelling, including front-of-package warnings indicating that a product is high in one or more nutrients of concern. In 2014, Mexico created a tax on sugary drinks and non-essential high energy density foods such as salty snacks, candies and breakfast cereals. A study showed that one year after the introduction of the measure, purchases of the taxed products had fallen³⁴. In Hungary, a tax on unhealthy foods such as salty snacks was also effective in reducing the consumption of products in the food categories and promoting more healthy food choices, both due to price and increased awareness about the products³⁵. The use of front-of-package warnings is also mentioned by the report “Salt-smart Americas: a guide for country-level action” as a useful complement to the reformulation of foods with the aim of reducing population intake of sodium⁶. In Latin America, Chile, Uruguay, Peru and Mexico have adopted front-of-package warning labels. Studies in Brazil demonstrate that the presence of warnings indicating that a product is high in critical nutrients can help consumers make more healthy food choices^{36,37}.

The present study stands out because of the size and broad scope of the sample of packaged foods. However, it does have some limitations. The number of products found in some food categories was small and the possibility of losses of some foods cannot be ruled out. However, pre-

vious studies also found a small number of foods in certain categories^{21,22}, indicating limited product variety. Another limitation is the fact that we did not include other types of food outlets. However, supermarkets are the most commonly used outlet for food shopping in Brazil and provide around 60% of the calories purchased for household consumption³⁸. Furthermore, we used the information displayed by the manufacturers on the food labels, without performing laboratorial analyses to verify the stated content. Finally, we did not consider the market share of the products and were therefore unable to identify the sodium content of the most commonly consumed products in Brazil.

Considering that sodium intake in the country is more than twice the recommended threshold and the growing consumption of ultra-processed foods, more rigorous regulations need to be put in place in order to achieve Brazil’s population sodium intake reduction target. The deadline for the voluntary sodium reduction targets was 2020 and trends indicate that Brazil is far from achieving the desired population intake. We recommend that measures be expanded to cover more product categories, focusing especially on ultra-processed foods like pizzas and sandwiches, and the development of stricter targets as in other countries, ideally closer to the level proposed by the PAHO for the prevention of NCDs. Finally, it is important to highlight the limitations of voluntary agreements in comparison to mandatory regulations, meaning that priority should be given to the latter. Other measures such as high sodium content warning labels and education to raise public awareness of the use and consumption of salt should be implemented alongside these strategies in order to reduce population intake of sodium.

Collaborations

CZ Ricardo and BC Salvador proposed the study. CZ Ricardo conducted the data analysis, wrote the preliminary version, revised, edited, and approved the final version. GC Andrade, BC Salvador and LA Mais revised, edited, and approved the final version. AC Duran and APB Martins are the project coordinators and have reviewed, edited, and approved the final version sent for submission.

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