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Abstract

Purpose – The purpose of this paper is to compare the sodium content displayed on the labels of conventional processed food products (C) and of those with nutrition claims suggesting the absence or reduced levels of nutrients (AR).

Design/methodology/approach – Cross-sectional study analyzing the ingredients list, nutrition facts and nutrition claims on food labels. Subjects: all processed food products with added salt or additives containing sodium that were for sale in a large supermarket in Brazil from October to December 2011.

Findings – All 3,449 products were analyzed and categorized into 66 groups according to Brazilian legislation. The median of sodium content in the AR was 42.7 percent higher than in the C ($p = 0.007$). In 33.3 percent of the groups there was difference in sodium content between AR and C ($p < 0.05$) and in 68.2 percent of these the sodium content was higher in AR. The variation range of sodium in products from the same group reached 2,905.0 mg in C and 1,712.0 mg in AR. Even when the median of sodium was lower in the AR, the minimum sodium values were lower in the C.

Originality/value – Comparisons of sodium content of conventional and AR processed food are scarce in the literature, especially covering all food for sale in a large supermarket. To the best of the knowledge, this is the first census making this comparisons in Latin America.

Keywords Nutrition labelling, Salt, Food marketing, Low-nutrient food, Nutrient content claims

Paper type Research paper

1. Introduction

The increased consumption of processed food products in addition to a more sedentary lifestyle are examples of factors associated with an increase in chronic non-communicable diseases (NCDs), such as diabetes, obesity and systemic hypertension (World Health Organization and Food and Agriculture Organization, 2003; Monteiro *et al.*, 2011; Popkin *et al.*, 2012). The increased consumption of processed food reflects in the increased consumption of salt and sodium in many countries worldwide (Anderson *et al.*, 2010; Sarno *et al.*, 2013).

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The current recommendation of sodium intake for healthy individuals establishes a maximum of 2,000 mg a day, what is equivalent to 5 g of salt (World Health Organization and Food and Agriculture Organization, 2003). However, the daily quantity of sodium available for consumption at homes was estimated in 3,479 mg in the USA (US Department of Agriculture, 2012), 4,700 mg in Brazil (Sarno *et al.*, 2013) and 5,400 mg in the UK (Mhurchu *et al.*, 2010).

The increase in the amount of sodium in the diet above the recommended limit causes the elevation of blood pressure and has been associated with adverse health outcomes (Johnson *et al.*, 2015). Such causal relationship was confirmed, although there is a tendency to affirm that poor diets in sodium are associated with cardiovascular risks, based on studies that ignore the bias of reverse causality (Neal *et al.*, 2013). In other words, diets with poor sodium content may be caused by the existence of previously diagnosed cardiovascular risks, and not the opposite.

Considering the health hazards related to a high consumption of sodium (Fiocco *et al.*, 2012; Frisoli *et al.*, 2012; Song *et al.*, 2013; Johnson *et al.*, 2015; Hendriksen *et al.*, 2015), the World Health Organization (WHO) published in 2004 the *Global Strategy on Diet, Physical Activity and Health* which recommends, among other things, a reduction in sodium intake, mainly from processed foods (World Health Organization, 2004). More recently, the WHO published the Global Action Plan to prevent and control NCDs recommending a reduction of 30 percent in sodium intake till the year of 2025 (World Health Organization, 2013).

In the case of some processed food products, nutrition claims suggest an absence or reduced levels of nutrients (AR), such as "low calorie," "no sugar," "less fat" or "light." In Brazil and in the European Union (EU), "reduced/less" and "light" claims are synonymous. In general, they can be disclosed in food products with at least 25 percent (Brazil) or 30 percent (EU) less calories or nutrients when compared with their conventional version. In the USA, "reduced/less" claims have the same parameter as in Brazil (reduction of at least 25 percent), but "light" is a different claim and it can usually be disclosed in food products with at least 50 percent less calories or nutrients (fat and sodium) when compared with their conventional version. The nutrient profiling system to guide the use of specific nutrition or health-related claims is described in Brazilian legislation, similarly to the USA and to countries belonging to the EU (European Parliament and of the Council, 2006; Food and Drug Administration, 2013).

In the USA, the EU and Brazil, legislation lists the nutritional conditions that food products ought to comply with to be able to use nutrition claims, but it does not describe the procedures for the authorization of use of these claims (Boer and Bast, 2015). In Brazil, the National Agency of Sanitary Surveillance, for instance, only indicates that the company willing to use a comparative nutrition claim suggesting the reduction of some nutrient should have documentation about the identity and the composition of the food product used as reference (Brazil Ministry of Health, 2012).

The consumption of AR processed food has grown over the years and has become a market trend (Piernas *et al.*, 2013). According to Brazilian legislation, AR products include food for people with specific metabolic and physiological conditions, and they are recommended for diets aimed at weight control and the restriction or control of nutrient intake. They should be consumed, preferably, under the guidance of a nutritionist/dietitian or a doctor. Claims in the food label suggesting nutrient reduction are not mandatory in the Brazilian food industry (Brazil Ministry of Health, 1998b, 2012).

The hypothesis that the sodium content of AR food products is higher than that of the corresponding conventional products is raised because of ingredient substitutions

that alter energy and nutrient content. Moreover, in the preparation of AR food products, additives are often used to enhance the flavor or improve food texture (Weisz, 2010). Salt is one of the additives adopted due to its low cost and wide functionality (Albarracin *et al.*, 2011). Therefore, we question the consumption of AR food by individuals with obesity or diabetes, particularly those with associated high-blood pressure.

The aim of this study was to register and compare the sodium content declared on the labels of conventional and AR processed food products marketed in Brazil.

2. Methods

2.1 Data collection

In this cross-sectional study, the sodium labeling of processed food products sold in a supermarket in the city of Florianopolis, Southern Brazil, was investigated. The supermarket was selected because it belongs to one of the ten largest supermarket chains in Brazil, with 26 stores in the Southern region, six of which are located in Florianopolis. The products sold in this store are similar to those sold in other large supermarket chains throughout the country. The data were collected from October to December 2011. The supermarket manager authorized the research.

The instrument was conceived based on the instrument used in a similar study about trans-fat (Silveira *et al.*, 2013). The collection of label information was carried out using the following analysis variables: product identification (product name and brand), nutrient claims (diet, light, low/no/reduced/free sugar/fat/sodium), sodium ingredients (appearance and position of salt on the list and sodium-containing food additives appearing on the list) and sodium in serving size information (sodium in the nutritional information, serving size in grams and sodium amount in mg per serving).

Before data collection, the instrument was pre-tested so that adaptations could be made. It took place in a day in the month of October 2011, in a supermarket of Florianópolis, SC, different from the one where data collection took place. Information about 15 food products was collected. The three researchers responsible for the conception of the instrument participated in the pre-test.

The data collection team, composed of 12 researchers, was trained and participated in the instrument's pilot test. In the training, the explanation about the analysis of the food product labels and the clarification of doubts about the information to be collected were given. The pieces of information were recorded in the instrument. As well, the collected data were double checked.

The pilot test consisted of filling out the data collection instrument (individually and without assistance) based on the information reported on the labels of five foods. Afterwards, there was a conference of notes by the responsible researchers.

The instrument was printed in white dual-sided A4 page, and it was supported by a wooden clipboard. The pieces of information were collected individually with a blue or black pen.

2.2 Inclusion criteria for food products in the study

This study included all food products covered under Brazilian nutrient labeling legislation (Brazil Ministry of Health, 2003a, b) that had the following characteristics: first, appearance of sodium on the ingredients list; second, classified as processed foods; and finally, available in a conventional version and in another version with claim (s) regarding the absence or reduction of nutrient content.

The collected food products were assembled into 66 groups, according to the classification proposed in the Brazilian legislation about food labeling (Brazil Ministry of Health, 2003b). Similar food products were considered the ones that presented the same product name, as collected in the product identification. For instance, "breads," "cheeses," "cookies" and "meat hamburgers." To assess the true variability in the sodium content for each type of specific product, products that did not include sodium among their ingredients were only included in the sample when other products with similar characteristics contained this ingredient. Information on the packaging of identical products of different sizes was recorded separately because their ingredients lists also differed, as observed in a previous study about trans-fat (Silveira *et al.*, 2013).

We did not collect information of foods that were fractionated, labeled and marketed by the supermarket itself since such food products are not required to be labeled in Brazil (Brazil Ministry of Health, 2003b).

2.3 Data processing and statistical analysis

The data collected were entered into two separate databases and later checked for errors and validated in EpiData® 3.1 (EpiData Association, Odense, Denmark). The products were distributed into 66 groups predefined by Brazilian nutrient labeling legislation to describe serving sizes for packaged foods (Brazil Ministry of Health, 2003a). A quantity equivalence of sodium in mg per 100 g or 100 ml was determined for all the products based on serving size information.

Two types of processed food were chosen. The first had nutrition claims on their labels, such as diet, light and low or no fat and/or sugars and the second was conventional food, similar to the first but with no nutrition claims. Food products were considered to be similar when they belonged to the same food group, according to their classification in the Brazilian food labeling legislation (Brazil Ministry of Health, 2003a).

The processed foods with nutrition claims regarding the absence or reduction of nutrients were considered together (AR) for later comparison with the corresponding conventional food products. Due to the asymmetric distributions of sodium present in most food groups, the data were described using the median, as well as the minimum and maximum values.

The Mann-Whitney test was conducted to determine whether there were differences between the median values for the sodium content in 100 g or 100 ml of an AR food product and of its conventional version. The processed foods were first analyzed together and then in food groups (defined according to Brazilian legislation) (Brazil Ministry of Health, 2003a).

The χ^2 test was used to identify differences between the AR and conventional food products regarding the frequency in which salt was listed as the first ingredient. The Wilcoxon test for paired data were used to analyze the difference between the minimum sodium contents observed for each one of the 66 groups of the AR and 66 groups of the conventional food products.

The Stata® version 11.0 statistical program (StataCorp, CollegeStation, TX, USA) was used for the statistical analysis and $p < 0.05$ was considered indicative of statistical significance.

3. Results

The resulting database of the census consisted of 4,538 processed foods, of which 1,089 were excluded, as shown in Figure 1. These exclusions were due to lack of information

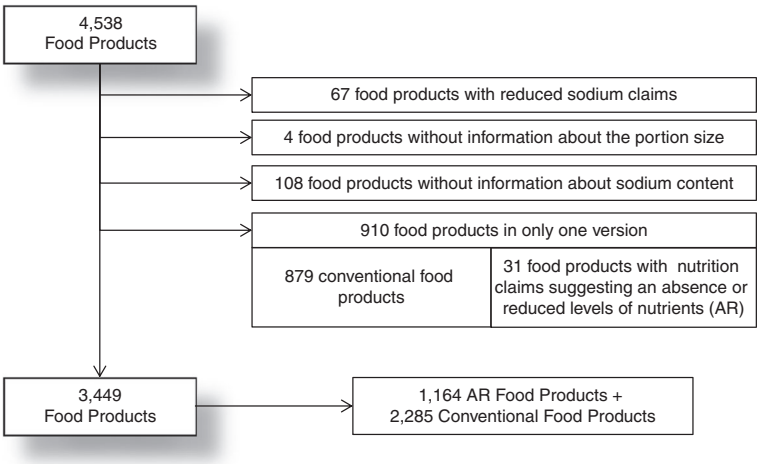

Figure 1.
Flow chart describing the selection of the food products

on the weight of the portion ($n = 4$) or the sodium content ($n = 108$) (information not presented in the packaging), presence of claims as regards sodium reduction ($n = 67$), or because only AR ($n = 31$) or conventional ($n = 879$) versions were available ($n = 910$), precluding a comparison.

Thus, the database analyzed consisted of 3,449 processed foods, classified as AR ($n = 1{,}164$) and conventional ($n = 2{,}285$). The processed foods were then divided according to the groups defined by Brazilian legislation (Brazil Ministry of Health, 2003a), as described in Table I.

Table I also shows a comparison of the levels of sodium in AR and conventional food products. In general, the median for the sodium content in the AR foods was 42.7 percent higher than the value observed for conventional food ($p = 0.007$).

Of the 66 food groups, 39 (59.1 percent, 15 of them with $p < 0.05$) showed higher sodium levels in the AR version, while for 25 (37.9 percent) the levels of sodium were lower in the AR version (seven with $p < 0.05$). Only the gelatines and chewing gum groups (3.0 percent) showed no difference in the sodium content in the AR and conventional versions.

Higher levels of sodium in the AR food products compared to the conventional versions ($p < 0.05$) were observed, in descending order, in the following groups: concentrated broths (meat, chicken, vegetable and others) and soup powders (+434.4 mg/100 g); powdered drinks (+272.5 mg/100 g); powdered shakes (+201.6 mg/100 g); gelatins (+160.8 mg/100 g); soft drinks (+135.3 mg/100 g); dairy desserts (+131.3 mg/100 g); fruit spreads and butters (+100 mg/100 g); powdered cocoa drinks (+62.0 mg/100 g); complete seasoning (+48.7 mg/100 g); powdered milks (+36.2 mg/100 g); dairy drinks, yogurt and fermented milk (+35.0 mg/100 g); candies (+31.3 mg/100 g); crackers (+25.1 mg/100 g); cookies (+21.6 mg/100 g) and processed snacks (14.7 mg/100 g).

Lower levels of sodium in the AR food products compared to the conventional versions ($p < 0.05$) were observed, in ascending order, in the following subgroups: toast (croutons) (−14.8 mg/100 g); farofas[1] (−33.1 mg/100 g); chocolate (−48.3 mg/100 g); juices and coconut water (−49.7 mg/100 g); cake mix (−65.2 mg/100 g); breakfast cereals (including granolas) (−68.1 mg/100 g) and popsicles/ice cream in single portions (−88.1 mg/100 g).

Table I.
Comparison of the sodium levels in food products with nutrition claims regarding the absence or reduction of nutrients (AR) and conventional food products according to the food groups defined by Brazilian legislation

Food groups	*N* Total	Sodium (mg)/100 g or 100 ml: Absence or reduced levels of nutrients (AR) *n*	Median	Min	Max	Conventional *n*	Median	Min	Max	% Diff. Median[a]	*p*[b]
Bread products, cereals, legumes, roots, tubers and their derivatives											
Powdered shakes	70	40	367.1	0.0	714.3	30	121.7	0.0	500.0	201.6	0.003
Flan and dessert mixes	43	5	366.7	73.2	616.7	38	127.0	0.0	1,009.1	188.7	0.081
Cakes without topping and frosting	25	12	341.7	150.0	388.3	13	250.0	141.7	451.7	36.7	0.703
Granola bar	50	31	135.0	48.0	533.3	19	104.5	0.0	611.1	29.2	0.582
Salted crackers	92	49	780.0	460.0	1,500.0	43	628.6	78.4	1,328.1	24.1	0.006
Instant pasta or dehydrated pasta with or without seasoning	80	16	1,808.9	235.0	2,172.7	64	1,612.9	0.0	2,904.7	12.2	0.866
Bread	81	57	468.0	254.0	824.0	24	444.0	248.0	592.0	5.4	0.405
Popcorn	30	20	960.0	0.0	1,712.0	10	928.0	36.0	928.0	3.4	0.269
Soy-based hamburger	13	6	582.1	280.0	582.1	7	563.9	558.9	698.2	3.2	0.883
Fresh pasta with and without filling	53	2	570.0	466.0	674.0	51	581.0	0.0	1,110.0	−1.9	0.640
Pizza dough	9	2	486.6	360.8	612.5	7	550.0	350.0	915.0	−11.5	0.770
Bread mix	13	7	630.0	170.0	1,045.8	6	715.9	585.3	995.0	−12.0	0.567
Toast	24	14	605.0	256.7	846.7	10	710.0	536.7	1,026.7	−14.8	0.016
Frozen pre-fried potatoes/mashed potato	9	4	236.5	60.0	450.6	5	335.3	23.5	388.2	−29.5	0.624
Ready-to-consume manioc flour (farofa)	13	10	577.1	337.1	922.9	3	862.9	791.4	908.6	−33.1	0.042
Frozen filled or not filled cheese bread	6	1	420.0	420.0	420.0	5	634.0	302.0	774.0	−33.8	0.770
Cake mix	49	8	188.2	0.0	935.1	41	540.5	20.9	967.6	−65.2	0.015
Breakfast cereal	69	35	125.0	0.0	656.7	34	391.7	0.0	792.5	−68.1	0.012
Fresh and canned vegetables											
Pickled cucumber	15	1	520.0	520.0	520.0	14	510.0	266.0	1,570.0	2.0	0.464
Traditional tomato sauce	16	1	283.3	283.3	283.3	15	476.7	0.0	1,530.0	−40.6	0.446
Fruits, juices, nectars and fruit drinks											
Canned peaches with syrup	5	1	30.0	30.0	30.0	4	3.6	0.0	7.1	733.3	0.136
Juices and coconut water	145	40	3.8	0.0	21.0	105	7.5	0.0	62.0	−49.7	0.025

(*continued*)

Table I.

Food groups	N Total	Sodium (mg)/100 g or 100 ml: Absence or reduced levels of nutrients (AR) n	Median	Min	Max	Conventional n	Median	Min	Max	% Diff. Median[a]	p[b]
Dairy products											
Dairy desserts	44	9	145.0	65.0	361.5	35	62.7	0.0	250.0	131.3	0.004
Cheeses	135	40	546.0	120.0	1,576.7	95	413.3	0.0	1,833.3	32.1	0.138
Powdered milks	13	4	497.5	470.0	520.0	9	365.4	269.2	857.7	36.2	0.028
Dairy drinks, yogurt and fermented milk	137	48	53.3	27.0	85.0	89	39.5	5.9	198.6	35.0	<0.001
Grated cheeses	22	2	973.3	546.7	1,400.0	20	740.0	50.0	1,660.0	31.5	0.772
Milk	31	14	67.8	65.0	105.0	17	65.0	50.0	105.0	4.3	0.257
Yogurt drinks	71	14	44.8	33.0	250.0	57	45.6	26.7	90.5	−1.8	0.256
Meats and eggs											
Meatballs	6	3	650.0	190.5	680.0	3	471.3	471.3	747.5	37.9	0.825
Tuna pickled with or without sauces	15	7	375.0	151.7	630.0	8	344.2	210.0	540.0	8.9	0.908
Poultry meat preparations with flour or breading	26	9	705.4	400.0	730.0	17	680.0	480.0	931.5	3.7	0.224
Sausages, all kinds	41	5	1,030.4	934.0	1,190.0	36	1,056.0	770.0	1,428.0	−2.4	0.842
Meat hamburgers	15	2	715.0	590.0	840.0	13	765.0	625.0	1,328.8	−6.5	0.395
Meat preparations – seasoned, smoked and cooked	12	1	1,260.0	1,260.0	1,260.0	11	1,410.0	1,020.0	1,652.5	−10.6	0.245
Meats cooked or pre-cooked	39	6	346.0	84.8	1,258.0	33	775.0	100.0	1,483.0	−55.4	0.185
Oils, fats and seeds											
Cream	14	1	60.0	60.0	60.0	13	38.0	0.0	133.0	57.9	0.531
Mayonnaise	33	32	1,058.3	708.3	1,233.3	1	741.5	741.7	741.7	42.7	0.125
Margarine/vegetable fat	30	26	600.0	0.0	1,000.0	4	460.0	0.0	520.0	30.4	0.273
Salad dressings	30	18	1,119.2	769.2	1,838.5	12	1,896.2	383.3	6,000.0	−41.0	0.498
Shredded coconut	9	1	25.0	25.0	25.0	8	67.3	51.7	91.7	−62.9	0.113
Processed nuts	28	14	265.4	86.7	3,108.0	14	736.7	233.3	1,526.7	−64.0	0.062
Sugar and processed foods rich in carbohydrates and fats											
Jellies	82	33	0.0	0.0	230.0	49	0.0	0.0	26.5	0.0	0.960
Peanut candy	15	5	113.6	0.0	204.6	10	6.8	0.0	233.3	1,570.6	0.411

(*continued*)

Table I.

Food groups	*N* Total	Sodium (mg)/100 g or 100 ml: Absence or reduced levels of nutrients (AR) *n*	Median	Min	Max	Conventional *n*	Median	Min	Max	% Diff. Median[a]	*p*[b]
Powdered drinks	68	23	1,650.0	450.0	4,450.0	45	442.9	0.0	833.3	272.5	<0.001
Gelatines	54	16	3,000.0	1,285.7	3,464.3	38	1,150.5	0.0	1,282.1	160.8	<0.001
Fruit spreads and butters	67	13	100.0	2.0	365.0	54	50.0	0.0	466.7	100.0	0.027
Powdered cocoa drinks	45	9	392.9	0.0	1,057.1	36	242.5	44.0	520.0	62.0	0.036
Ice cream	99	31	73.3	0.0	98.3	68	58.3	18.3	128.3	25.7	0.059
Soft drinks	226	115	20.0	0.0	95.0	111	8.5	0.1	95.0	135.3	<0.001
Chocolate candies	23	2	76.8	56.0	97.5	21	50.8	0.0	104.0	51.1	0.380
Candies	47	10	65.0	47.0	65.0	37	49.5	0.0	135.0	31.3	0.016
Condensed milk	6	1	130.0	130.0	130.0	5	100.0	0.0	105.0	30.0	0.138
Cookies	317	122	235.0	0.0	613.3	195	193.3	0.0	900.0	21.6	0.018
Snack/processed snack	77	27	688.0	396.0	2,004.0	50	600.0	216.0	1,264.0	14.7	0.006
Chewing gum	19	12	0.0	0.0	466.7	7	0.0	0.0	0.0	0.0	0.266
Panetone	36	1	132.5	132.5	132.5	35	152.5	120.0	222.5	−13.1	0.134
Cakes and similar products	48	31	185.0	100.0	416.7	17	230.0	107.0	330.0	−19.6	0.315
Chocolate	239	24	41.4	0.0	240.0	215	80.0	0.0	400.0	−48.3	0.020
Ice cream in individual portion and popsicle	18	6	5.7	5.2	54.0	12	47.6	6.2	78.4	−88.1	0.011
Açaí	7	2	18.9	16.2	21.7	5	18.3	2.0	23.3	3.3	0.696
Sauces, ready-to-consume seasonings, broths, soups and prepared dishes											
Concentrated broths (meat, chicken, vegetable and others) and soup powders	79	22	19,266.7	4,500.0	26,955.6	57	3,605.3	2,600.0	23,726.3	434.4	<0.001
Complete seasonings	28	6	25,950.0	17,768.4	33,800.0	22	17,450.0	11,060.0	26,160.0	48.7	0.005
Prepared and semi-prepared dishes not included in other table items	136	25	497.5	90.0	786.2	111	470.2	8.0	1,172.0	5.8	0.908
Sauces based on dairy or broth products	13	7	536.0	310.0	796.0	6	653.3	355.0	1,118.3	−18.0	0.668
Ketchup and mustard	39	3	683.3	0	691.7	36	741.7	100.0	2,975.0	−7.9	0.072
Total	3,449	1,164	240.0	0.0	33,800.0	2,285	168.2	0.0	26,160.0	42.7	0.007

Notes: [a]Percentage difference between medians = [(MedianAR/MedianC)−1]×100; [b]Mann-Whitney test
Sources: Brazil Ministry of Health (2003a, b)

In the case of 1,997 (57.9 percent) AR and conventional processed food products salt was mentioned on the ingredients list, in nine different ways: salt, refined salt, sodium chloride, low-sodium salt, sea salt, iodized salt, iodized common salt, light salt and non-iodized salt. Salt was the term most frequently used on the ingredient list, both for AR ($n = 627$) and conventional ($n = 1{,}199$) food products. The presence of the denominations "low-sodium salt" (AR = 8; conventional = 1) and "light salt" (AR = 1; conventional = 1) were not accompanied by claims of "sodium reduction" or "light in sodium" on the label.

On the ingredients lists of the 1,997 processed food items containing salt, 22.6 percent ($n = 452$) mentioned salt as one of the top three ingredients. Of these, salt appeared as the first ingredient in 12.6 percent ($n = 57$). This frequency was higher in the case of the AR products (18.4 percent) compared with conventional foods (10.1 percent) ($p = 0.015$).

Through an analysis of the minimum and maximum values, it was observed that the variation of sodium content reached 1,712.0 mg in the AR food products (popcorns) and 2,905.0 mg in conventional food products (Instant pasta or dehydrated pasta with or without seasoning). When we analyzed the difference between the minimum sodium contents in the AR and conventional products of the 66 groups, it was found that the conventional products exhibited lower minimum levels of sodium than the AR products in 36 subgroups (54.5 percent), the same minimum levels in nine subgroups (13.6 percent) and higher minimum levels in 21 subgroups (31.8 percent) ($p = 0.02$). Even among the 25 food groups which presented lower median values for sodium content in the AR version, it was observed that for ten subgroups (40 percent) the minimum values for sodium content were lower in the conventional version.

4. Discussion

The main finding of this study is that food products with nutrition claims suggesting an absence or reduced levels of nutrients marketed in Brazil have higher median sodium contents than the corresponding conventional products. This result is similar to those of other studies in which only some groups of food products, such as soft drinks, were compared (Ferrari and Soares, 2003; Guimarães *et al.*, 2009).

Nearly half of the food groups analyzed in this study that presented higher sodium contents in the AR versions were commercialized in powder form, and thus they need to be diluted for consumption (powdered shakes, milk, drink, gelatine, cocoa drinks and concentrated broths (meat, chicken, vegetable and others) and soup powders). Consequently, depending on the dilution, the finished product may have higher or lower sodium contents compared with conventional products. Improper dilution can exacerbate the problems associated with the high levels of sodium present in these foods. For example, to prepare a serving of 250 ml of soup (Brazil Ministry of Health, 2003a), the labels, on average, recommend using 14 g of powder. This dilution, recommended by the manufacturer, would result in an average consumption of 631 mg of sodium per serving, which is 32 percent of the sodium intake recommended for an entire day (2,000 mg) (World Health Organization and Food and Agriculture Organization, 2003). If the dilution is carried out using the same amount of powder but with less water, the sodium content can be raised even further.

Some food groups with higher sodium content in the AR version, such as soft drinks, gelatines, candies, fruit pastes and butter, are among the foods most consumed by people with diabetes mellitus in Brazil. Data obtained in studies by Castro and Franco (2002) showed that 61.7 percent of diabetics consume soft drinks, 44.7 percent

gelatines, 21.3 percent puddings and flans, 15.9 percent chocolate, 17.7 percent candies and chewing gums and 8.5 percent jellies/jam. According to the analyses conducted with the labels, the majority of the cited products present null sodium as a minimum level in their conventional versions as shown by Table I. However, the same does not happen with AR products. Such results demonstrate the need for caution in relation to consumption of the AR version of these products, considering the increasing association between diabetes and high-blood pressure in Brazil (Freitas and Garcia, 2012).

Brazilian and foreign dietary guidelines (Brazil Ministry of Health, 2014; US Department of Agriculture, 2015) recommend the intake of dairy products with reduced fat content. However, in the present study, dairy desserts, powdered milks and dairy drinks, yogurt and fermented milk showed higher median of sodium content in the AR version.

In Brazil, dairy products participate 9.2 percent in the sodium consumption and the average sodium intake among those who consume milk and milk products exceeds 3,300 mg (IBGE, 2011; Martins, 2014). Dairy products were also among the main sources of sodium consumed by Australian preschoolers (19 percent) and among the major contributors to sodium purchases in the UK (12 percent) (Mhurchu *et al.*, 2010; O'Halloran *et al.*, 2016). In the USA, the sodium intake from dairy products reaches 7.0 percent (Auestad *et al.*, 2015). Thus, the intake of AR dairy products, mainly by patients with high-blood pressure, can be associated with health risks (Frisoli *et al.*, 2012), despite the reduced fat content.

The high-sodium content of AR food products becomes more problematic when considering studies which suggest that the fat reduction claims related to some processed foods can lead to their consumption in larger quantities, especially by overweight consumers (Wansink and Chandon, 2006). Studies highlight that the presence of a fat reduction claims can also reduce the perception of the content of other components which, in excess, can be harmful, like sodium (Keller *et al.*, 1997; Colby *et al.*, 2010). Another study showed that the least discerning shoppers are the most likely to consider health claims when shopping at supermarkets, but more evidences is needed regarding how nutrition and health claims might influence purchasing behavior (Petrovici *et al.*, 2012).

Colby *et al.* (2010) researched the use of nutrition marketing on labels of food with high-saturated fat, sodium and sugar content and investigated the labels of 56,900 pre-packed food products sold in six supermarkets in the USA. Colby *et al.* (2010) found that among the products containing $\geqslant$20 percent of sodium content in their composition, 19 percent had claims of the absence or reduction of fat or trans-fat.

It is important to consider that certain types of food analyzed may be consumed together in the same meal or snack, for instance, bread, cheese, mayonnaise or margarine. Thus, with regard to nutrition advice for patients it is important to highlight that a meal based on AR products may have higher sodium content than one based on conventional products. For example, using the serving size suggested by Brazilian legislation (Brazil Ministry of Health, 2003a) and based on the median sodium content observed for the subgroups of this study, we estimated the sodium content of a sandwich consisting of two slices of bread (50 g), a portion of mayonnaise (12 g) and a slice of cheese (30 g) consumed with a portion of non-alcoholic drink (200 ml) such as a soft drink or a soya drink. This snack prepared with conventional products would have a sodium content of approximate 451.90 mg while with the use of AR products the sodium content would be 25 percent higher (564.80 mg), representing 28 percent of the daily sodium intake recommended by WHO.

Cookies and processed snacks presented higher median of sodium content in the AR versions. In Brazil, the average sodium intake among people that consume these products reaches 3,500 mg and the participation of these products in the sodium intake reaches 7.3 percent. The same fact may be observed for the complete seasonings that have a participation of 24.2 percent in the sodium intake of Brazilians. They also presented higher sodium content in the AR version (IBGE, 2011; Martins, 2014). Among Australian preschoolers, snack foods contribute with 1.2 percent in the daily ingestion of sodium, and sweet biscuits, with 1.5 percent (O'Halloran *et al.*, 2016).

The groups toast, farofa (a typically Brazilian toasted manioc flour mixture), chocolate, juices and coconut water, cake mix, breakfast cereals and popsicle/ice cream in single portions presented lower sodium content in the AR version. However, these products do not have a significant percentage share in the sodium intake of the Brazilian population (IBGE, 2011; Martins, 2014), neither are they among the main contributors to sodium purchases in the UK (Mhurchu *et al.*, 2010).

On the labels of processed foods sold in Brazil the ingredients must be listed in descending order of quantity, as recommended worldwide by the Codex General Standard for the Labeling of Pre-packaged Food (Food and Agriculture Organization and World Health Organization, 2005). Thus, the first ingredient on the list is that which is present in the product in the largest amount. It was observed that the frequency of salt as the first ingredient was higher in AR food products, indicating that in these foods salt is used as the main ingredient more often than in C products.

It should be noted that the requirement of the Brazilian Ministry of Health refers only to the minimum amounts of sodium per serving (Brazil Ministry of Health, 1998a) in diet food recommended for people on a weight loss or weight maintenance diet, through the partial or full replacement of meals. Thus, by not restricting the maximum amount of sodium, the legislation may favor the industrial use of a higher content of salt or other ingredients which contain high amounts of sodium, enhancing the final sodium content of diet products.

It was also observed that the minimum amounts of sodium present in 66 food groups tend to be lower in the conventional version. This demonstrates that conventional processed foods offer more options for consumers who want to reduce sodium intake. This reinforces the importance of consumers reading the nutrient values on the labels, especially those who need to consume AR products, which offer less choice in relation to products with reduced sodium content.

In this study a large variation was found in the sodium content of similar processed foods. This indicates that the higher sodium contents could be reduced, since similar products with lower sodium contents are already available. Moreover, as the data obtained in an experimental study in Ireland (Mitchell *et al.*, 2013) with 60 participants indicates, reductions of up to 48 percent in the sodium content of vegetable soup did not affect the consumer preference. The results of another study (Ferrante *et al.*, 2011) carried out in Argentina suggest that reductions of 30 percent in the salt content of bread was not perceived by consumers. This information may help the industry to reduce the sodium content of processed food, minimizing the possibility of rejection of the product and increasing the benefits related to consumer health.

Taking into account the high levels of sodium currently found in processed food (Anderson *et al.*, 2010) and the damage to health caused by an excess of this nutrient (Fiocco *et al.*, 2012; Frisoli *et al.*, 2012; Song *et al.*, 2013; Johnson *et al.*, 2015; Hendriksen *et al.*, 2015), it is important to highlight the need for a review of the AR or conventional food formulations in order to reduce the content of this mineral (Mhurchu *et al.*, 2010;

Webster *et al.*, 2014; Kloss *et al.*, 2015; Downs *et al.*, 2015; O'Halloran *et al.*, 2016). Strategies such as the signing of an agreement between the Brazilian Government and the food industry aimed at the reduction of the sodium contents of processed food products could be considered as the first step (Martins, 2014).

A possible limitation of the present study is the use of the food label to determine the sodium content of the products without performing chemical analysis. However, it was considered that consumers have access only to the information reported on the packaging and thus the accuracy of such information should be ensured by the manufacturer and tested for compliance with the legislation (Brazil Ministry of Health, 2003a). Another potential limitation of the study was the inclusion of products sold in a single store, but since the store is a large supermarket in an urban area which offers a wide variety of food products and belongs to a large chain, most of the products sold there are sold by other chains and stores throughout the country, so this factor is unlikely to affect the external validity of the study. Finally, considering the products as groups predefined by Brazilian food and nutrition labeling legislation can also be considered a limitation. However, although this prevented the specific analysis of each type of food product, the predefined groups were considered because this is the official categorization under current labeling Brazilian legislation (Brazil Ministry of Health, 2003a), which regulates the presentation format of nutrition information available at the time of purchase.

As the focus of the present study was to compare the sodium content of food products with and without nutrition claims, they were grouped in AR and the comparison did not identify which claim contributed more, or less, to the increase of sodium content in food products. Some nutrition claims were presented simultaneously in the same products, so an analysis conducted separately would reduce the number of food products in each group, thus, diminishing the power of the statistical analysis.

On the other hand, the study also had many strong points. First, it was based on a census conducted in a selected supermarket covering all products available for sale, which ensures greater representation of information. Second, the double entry of the data collected allowed greater precision and reliability of the information analyzed. Third, given the scarcity of studies comparing the sodium contents of conventional and AR food products, the results reported herein highlight the possibility of using this type of data to support discussions and actions aimed at reducing the sodium content of AR food products.

5. Conclusions

In this study, it was found that food products with nutrition claims suggesting the absence or reduced levels of nutrients (AR) have higher sodium levels than the corresponding conventional food products and that salt was present more frequently as the first ingredient listed. Furthermore, the majority of groups that presented a higher median of sodium content in the AR food products have a significant contribution in the sodium presented in the diet, as dairy products, cookies, crackers, complete seasonings and processed snacks. Thus, there is a need to reduce the supply of sodium in AR foods sold in Brazil, in order to avoid health risks to consumers.

The large variation observed between the minimum and maximum levels of sodium in the same group of food products highlights the feasibility of reducing the higher sodium levels, since similar products with reduced levels are already marketed.

We propose a review of the Brazilian legislation related to food labeling for AR food products, in order to limit the use of salt and sodium containing food additives in

high amounts. At the same time it is important that surveillance by the appropriate government agency is carried out to ensure adequate levels of sodium content in AR and conventional processed foods.

Considering that some of the AR food products are aimed at people with specific metabolic and physiological conditions, it is important to be careful when recommending these foods, so as to avoid indiscriminate consumption, though in few specific cases they may be presented as an alternative.

Note

1. Farofa is a toasted manioc flour mixture but maize flour is sometimes used and flavors vary.

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