

## Dietary sources of sodium among Brazilian population: data from Latin American Nutrition and Health Study (ELANS)

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### ABSTRACT

**Introduction:** The average daily intake of sodium in Brazil is 4.11 g/d, which is higher than that in most countries worldwide.

**Objective:** This study aimed to investigate the main food sources of sodium in a representative sample of Brazilian population, considering sex, age group, and Brazilian macro-regions.

**Methods:** 2,000 individuals aged 15–65 years were included in the Brazilian Nutrition and Health Study (EBANS). EBANS is part of the Latin American Study of Nutrition and Health (ELANS), a multicenter cross-sectional study of a nationally representative sample of urban populations from eight Latin American countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru, and Venezuela).

**Results:** The top 10 dietary food sources of sodium were beef and main dishes without processed meat (21.55%), white bread, approximately 50g (known as French bread in Brazil) (12.38%), rice (11.23%), processed meat products (8.38%), pasta (with or without sauce) (4.74%), beans (3.41%), salt (3.39%), butter or margarine (2.63%), crackers (white or whole) (2.59%), and milk (2.26%), accounting for

72.57% of the total contribution. Independent of sex, age group, or Brazilian macro-regions, the main contributors to sodium intake were beef and main dishes without processed meat, followed by French bread.

**Discussion:** It is important to emphasize that the main described foods among Brazilians, are part of cultural and regional aspects that influence choices and food consumption and greatest contributors to sodium intake.

**Conclusions:** These results highlight the need for implementation of public health policies to control the use of sodium in food industry and to aware the community about the addition of salt in food preparation and their food choices.

### KEYWORDS

Cross-sectional Study; Diet; Brazil; Food Intake; Dietary Sodium.

### INTRODUCTION

It is already established that Brazilians have high sodium consumption<sup>1-3</sup>. According to data from the National Health Survey (NHS)<sup>4</sup>, approximately one in six Brazilian adults perceived that they have high consumption of salt. The frequency of this condition was higher among men than in women, showing an inverse relation between age groups<sup>4</sup>. This perception responds to the average daily intake of sodium in Brazil, that is, 4.11 g/d by general population, 4.31 g/d by men, and 3.92 by women<sup>2</sup>.

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Considering these alarming data around the world and not only in Brazil, the World Health Organization (WHO)<sup>5,6</sup> brought new recommendations by means of "Global Action Plan for the Prevention and Control of Non-communicable Diseases (2013–2020)": reducing dietary sodium to less than 2,000 mg per person or 5 grams of salt and reducing the level of salt/sodium added to food (prepared or processed) by 2020, which decreases the risk of developing high blood pressure, the main risk factor for cardiovascular disease and renal failure<sup>1,7,8</sup>.

At the individual level, dietary guidelines for the Brazilian population presents qualitative orientations regarding moderate sodium intake<sup>9</sup>. In addition, at the population level, the Brazilian Association of Food Industries, following these recommendations, created a voluntary agreement, which accounts for over 70% of processed food market based on sodium, for specific categories of foods: breads, cakes, cookies and biscuits, pasta, dairy spreads, breakfast cereals, and mayonnaise. The reduction targets from sodium content for these foods had been improving, with a progressive reduction in recent years (from 2011 to 2017)<sup>10</sup>.

To help in the elaboration of public policies, as well as to stimulate the reduction of consumption and the level of sodium of foods, it is important to know the main sources of sodium in distinct population groups. It is important to highlight that the strategies used to reduce sodium in foods differ from those aimed at reducing sodium intake<sup>5,6,10</sup>. Thus, the present study aimed to investigate the main food sources of sodium in a representative sample of Brazilian population, considering sex, age group, and Brazilian macro-regions.

## METHODS

The present study is part of the Latin American Study of Nutrition and Health (*Estudio Latinoamericano de Nutrición y Salud*, ELANS), conducted in eight Latin American countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru, and Venezuela. Each country also has its regional study and for this study were included only data from the Brazilian Nutrition and Health Study (*Estudo Brasileiro de Nutrição e Saúde*, EBANS), collected from November 2014 to August 2015.

EBANS is a household-based cross-sectional population-based survey. Individuals were stratified by geographical location (only urban areas), sex, age, and socioeconomic level. The sampling design procedures were performed using a random complex, multistage sampling, and the sample size was calculated using a confidence level of 95% and a maximum error of 3.49% at a 5% significance level and survey design effect of 1.75. The total sample was composed of 2,000 individuals, aged 15–65 years, both sexes, living in private households in Brazil's macro-regions (North, Northeast, Midwest, Southeast, and South), considering major cities of Brazil and other relevant cities in terms of population weight.

Pregnant and lactating women (in the first 6 months postpartum), individuals with major physical or mental impairments that affect food intake or physical activity (e.g., musculoskeletal disease, recent surgery, severe asthma, dementia, and major depression), individuals outside of the age range, adolescents without assent or consent of a parent or legal guardian, and individuals living in institutions and unable to read were excluded from the study.

Foods and beverages (n=1317), reported in the 24-hour dietary recall (24HR), were classified into 347 food groups based on nutritional similarity. The total sodium intake comprised the sodium intrinsic in food (naturally present) and added for flavor during preparation, according to the standardization of the Nutrition Data System for Research (NDSR) database (e.g., rice cooked with salt, sautéed vegetables etc.). Therefore, in order to estimate consumption and sources of this nutrient, the amount of sodium was revised based on the Brazilian food composition table<sup>11</sup> and according to nutrition information available on food labels.

It should be highlighted that a single 24HR for a large population yields an unbiased estimate of the population-level dietary patterns<sup>12</sup>. In the next step, if the food group was consumed fewer than ten times, it was grouped with other food items according to the similarity of sodium content (e.g., beef group, including all types of beef, independent of the fat percentage). The final groups that compose Tables 1-3 are beef and main dishes with not processed meat (red or white); white bread, approximately 50g (known as French bread in Brazil); rice, plain, white or brown, cooked in salted water; processed meat products; pasta, with or without sauce; beans, dried, cooked; salt; butter or margarine, salted; crackers, white or whole, salted; milk, plain or not; mixed dishes, *farofa*, couscous, and mayonnaise salad; savory snacks, fried or baked; breads, white or whole; soups and broths; pizza; cheese, processed.

To determine the contribution of each food group to the nutrient intake of the Brazilian population, the method proposed by Block et al. (1958)<sup>13</sup> was applied, considering the sampling design. After that, the foods groups were sequenced in rank order of contribution for Brazilian population. Food groups included in the list of top 10 food sources of sodium were presented according to overall EBANS, sex (female and male), age group (15–19 years old, 20–34 years old, 35–49 years old, and 50–65 years old), and Brazilian macro-region (South, Southeast, Midwest, North, and Northeast), respecting the sample design.

All statistical analyses were performed using SPSS Complex Samples (version 22.0 for Windows, SPSS, Inc., Chicago, IL, USA) to incorporate sample weights and adjust for clusters and strata of the complex sample design.

This study was conducted in accordance with ethical principles for research involving humans, complying with Resolution CNS 196/96. The overarching ELANS protocol (60953716.4.0000.5505) was approved by Federal University

of São Paulo, Brazil. EBANS was approved by the Research Ethics Committee of the "Instituto Pensi - Hospital Infantil Sabará" (31670314.8.0000.5567).

## RESULTS

Data of the top 10 dietary food sources of sodium in Brazilian diet were presented according total population, sex, age group, and Brazilian macro-region (Tables 1–3). The major contributors to sodium intake in EBANS were beef and main dishes without processed meat (21.55%), white bread, approximately 50g (known as French bread in Brazil) (12.38%), rice (11.23%), processed meat products (8.38%), pasta (with or without sauce) (4.74%), beans (3.41%), salt (3.39%), butter or margarine (2.63%), crackers (white or whole) (2.59%), and milk (2.26%), which together accounted for 72.57% of the total contribution. First four foods (1st: beef and main dishes without processed meat; 2nd: French bread, 3rd: rice (with exception of those Southwest and Midwest, in which this order of the second and third positions were inverted); and 4th: processed meat products, appeared in the same rank position for both sexes, all age groups, and Brazilian macro-regions. Thus, the contribution of meals to sodium consumption was higher than processed foods.

Beef and main dishes without processed meat are in the first position and contributed most to sodium intake in Brazilian diet. The percentage ranged from 19.94% (South) to 26.57% (North) for the macro-regions, and from 19.16% (adolescents) to 23.03% (35–49 years) for age groups. For both sexes, the contribution was similar (men: 20.05% and women: 20.94%). Although this food group was the primary contributor to sodium intake, it did not present the highest average consumption (mg/g). This finding was only observed among individuals living in the Northern region of the country and among men.

Table 1 shows the top 10 contributors to sodium intake according to sex. When evaluating data separately, the 10th contributor to sodium intake differ from the whole sample. Fried or baked savory snacks among men, and breads (white or whole) among women, were found to be the 10th contributor to sodium intake instead of milk. The contribution and consumption of added salt were lower in men (7th position; 2.48% and 276.82 mg/d) than in women (6th position; 4.52% and 326.28 mg/d). In women, breads and crackers (white or whole) make a bigger contribution in the ranking, along with French bread, they represent almost 15% of the total contribution.

**Table 1.** Top 10 dietary sources of sodium by contribution and consumption in participants of EBANS Study according to total population and sex.

EBANS				Male				Female			
Food group	%	mg/d		Food group	%	mg/d		Food group	%	mg/d	
		Mean	SE			Mean	SE			Mean	SE
Beef and Main dishes	21.55	709.48	13.77	Beef and Main dishes	22.05	807.29	18.03	Beef and Main dishes	20.94	612.3	18.18
White Bread	12.38	573.36	9.77	White Bread	13	639.09	14.85	White Bread	11.62	501.54	10.07
Rice	11.23	410.8	7.29	Rice	12.45	499.25	11.32	Rice	9.72	320.4	8.19
Processed Meat	8.38	762.24	29.24	Processed Meat	8.3	786.39	35.81	Processed Meat	8.48	734.79	48.98
Pasta	4.74	548.44	28.1	Pasta	4.5	588.78	43.78	Pasta	5.05	509.75	35.44
Beans	3.41	134.46	2.9	Beans	3.84	161.72	4.9	Salt	4.52	326.28	18.48
Salt	3.39	304.2	14.07	Salt	2.48	276.82	19.02	Crackers	3.06	317.8	19.41
Butter/Margarine	2.63	151.27	5.45	Butter/Margarine	2.32	151.58	6.01	Butter/Margarine	3.01	150.97	8.76
Crackers	2.59	367.27	15	Crackers	2.21	443.96	20.91	Beans	2.88	105.07	2.82
Milk	2.26	135.82	3.21	Savory snacks	2.18	503.37	28.04	Breads	2.66	314.51	17.59

#: Percentual of contribution.

With regard to age groups, contributors to sodium intake in adolescents included fried or baked savory snacks and pizzas, differing from the other age ranges (Table 2). For this reason, adolescents had the highest consumption of sodium (1388.17 mg/d). Although the percentage of French bread as the 2nd contributor increases with age (11.75%–13.18%), the average consumption decreased with age (647.35 mg/d–515.41 mg/d). For young adults (20–34 years old), such it is observed in women, breads and crackers (white or whole) along with French bread represented almost 15% of the total contribution. Among middle-aged adults (35–49 years old), the average consumption was high for soups and broths, which appeared in the 10th position and was only observed in this group.

Table 3 shows the results according to Brazilian macro-regions. The consumption of pizza and mixed dishes, which include typical Brazilians recipes, such as *farofa*, couscous, and mayonnaise salad, was observed only among Brazilians living in the South and represented the sources with the highest sodium consumption (1255.59 mg/d and 696.45 mg/d, respectively). In the North and Northeast, soups and broths appeared as con-

tributors to sodium intake while in the Southeast, fried or baked savory snacks. The average consumption of sodium and the specific contributors to sodium consumption in the Midwest were similar to those identified in the whole sample.

Considering the percentage of tolerable upper intake level (UL), processed meats resulted in the highest percentage of sodium in EBANS (33.14% of UL). The same result was also observed in pizzas, which represented values above 50% (adolescents: 60.36%; South: 54.59%), followed by soups and broths, which yield values between 30% and 50% (35–49 years: 48.46%; Northeast: 40.05%; North: 33.67%), processed meat products (30% and 37%; with exception of the South (23.17%); and beef and main dishes with processed meat (red or white) (26%–37%).

## DISCUSSION

The main important contributors to sodium intake in EBANS were beef and main dishes without processed meat, French bread, rice, processed meat products, pasta (with or without

**Table 2.** Top 10 dietary sources of sodium by contribution and consumption in participants of EBANS Study according to age groups.

15 to 19 years old				20 to 34 years old				35 to 49 years old				50 to 65 years old			
Food group	%	mg/d		Food group	%	mg/d		Food group	%	mg/d		Food group	%	mg/d	
		Mean	SE			Mean	SE			Mean	SE			Mean	SE
Beef and Main dishes	19.16	740.26	45.32	Beef and Main dishes	21.29	720.33	20.63	Beef and Main dishes	23.03	726.65	22.28	Beef and Main dishes	21.47	644.1	25.38
White Bread	11.75	647.35	29.93	White Bread	12.19	620.39	15.13	White Bread	12.45	534.26	16.66	White Bread	13.18	515.41	18.44
Rice	10.65	441.37	19.41	Rice	10.87	412.53	10.71	Rice	11.97	422.37	16.33	Rice	11.24	371.48	15.49
Processed Meat	8.9	732.09	45.18	Processed Meat	8.95	766.45	54.86	Processed Meat	7.43	747.56	50.34	Processed Meat	8.33	801.6	66.75
Pasta	5.03	600.8	68.04	Pasta	4.58	539.04	37.34	Pasta	5.01	534.95	41.68	Pasta	4.44	554.96	88.48
Beans	3.48	154.17	9.48	Salt	3.38	351.05	27.37	Beans	3.59	136.69	4.96	Salt	4.43	291.54	40.26
Savory snacks	3.34	562.66	51.78	Beans	3.34	140	4.44	Salt	3.32	272.9	16.53	Beans	3.22	110.14	3.45
Crackers	3.08	544.14	57.28	Breads	2.61	394.26	25.87	Butter or Margarine	2.97	155.69	11.85	Cheese	2.62	273.69	22.12
Pizza	2.88	1388.17	132.2	Butter/Margarine	2.58	159.96	9.44	Crackers	2.84	354.68	33.63	Milk	2.48	118.74	6.69
Milk	2.67	173.27	8.12	Crackers	2.39	380.47	21.88	Soups	2.28	1114.48	194.29	Butter/Margarine	2.48	125.06	5.59

#: Percentual of contribution.

**Table 3-A.** Top 10 dietary sources of sodium by contribution and consumption in participants of EBANS Study according macro-regions.

South				Southeast				Midwest			
Food group	%	mg/d		Food group	%	mg/d		Food group	%	mg/d	
		Mean	SE			Mean	SE			Mean	SE
Beef and Main dishes	19.94	628.58	45.12	Beef and Main dishes	21.21	722.97	19.27	Beef and Main dishes	22.44	750.19	39.71
White Bread	12.92	564.51	25.26	Rice	11.84	427.05	10.01	Rice	14.13	505.58	29.55
Rice	8.3	305.51	16.28	White Bread	11.68	539.1	8.43	White Bread	9.51	505.1	25.32
Processed Meat	7.78	533.03	71.12	Processed Meat	8.33	775.01	36.44	Processed Meat	8.39	845.93	100.17
Pasta	7.46	644.55	105.86	Pasta	4.28	576.15	40.51	Salt	5.82	480.53	105.67
Salt	3.49	232.13	33.83	Salt	3.85	297.36	9.99	Pasta	3.84	462.27	62.62
Breads	3.48	321.62	34.41	Beans	3.4	128.8	2.67	Beans	3.16	122.11	6.93
Mixed dishes	3.08	696.45	60.79	Milk	2.48	139.58	3.3	Crackers	2.67	417.83	69.73
Pizza	3	1255.59	147.42	Butter/Margarine	2.44	149.62	6.35	Butter/Margarine	2.5	166.52	32.15
Milk	2.83	137.89	11.32	Savory snacks	2.43	532.3	22.48	Milk	2.49	154.9	13.31

‰: Percentual of contribution.

sauce), beans, salt, butter or margarine, crackers (white or whole), and milk. After analyzing the dietary sources of sodium, some particularities were observed in relation to the consumption of some foods and food groups that are included in the usual Brazilian diet<sup>14</sup>. The same finding was observed in other countries, where it is possible to note a similarity in the diet. For example, in Mexican population, processed meat was the main contributor to daily sodium intake, followed by bread products (savory bread and sweet bakery)<sup>15</sup>. In the United States of America and Australia, the primary food sources of sodium were cereal-based products, followed by meat and poultry (mainly processed meats)<sup>16,17</sup>. In Europe, the major food sources of sodium among the United Kingdom and French population were similar: breads, soups, and meats<sup>16,18</sup>. It is important to emphasize that the main described foods among these studies, as such in Brazil, are part of cultural and regional aspects that influence choices and food consumption and greatest contributors to sodium intake (e.g., tacos, canned peppers, and tamacos for the Mexican population; soy sauce, soups, salted fish and seafood for the Japanese population)<sup>15,16</sup>.

Brazilians have a high sodium intake and obtain sodium from meat; bread (mainly of French bread), and a combination of rice and beans. Traditional Brazilian dietary pattern in-

cludes the consumption of rice and beans, that is usually consumed together with meats<sup>19,20</sup>, what highlight the importance of these foods as contributors to sodium intake in our population. While traditional foods like rice and beans have low sodium density (<500 mg/d), foods like beef and main dishes without processed meat and processed meat products (>700 mg/d), soup (>900 mg/d), and pizza (>1,100 mg/d) have high sodium density. These foods were similar to those analyzed by the Brazilian National Dietary Survey (2008–2009)<sup>21</sup>. Taking into consideration the WHO' recommendation of <2,000 mg/d, the mean population consumption of only one food is greater than the half indicated<sup>5,6</sup>.

This present study identified that beef and main dishes without processed meat were the largest contributors to sodium intake, and processed meat products as one of the main food sources in all evaluated categories. Although the portion size consumed, processed meat is well-known for presenting high sodium amounts in its nutritional composition. In many countries, meat product manufacturers have marketed low-salt alternatives or have progressively reduced salt content. Biotechnological considerations have made this possible by using formulations and procedures that involve modifying low-salt meat products to maintain the characteristic flavor<sup>22</sup>.

**Table 3-B.** Top 10 dietary sources of sodium by contribution and consumption in participants of EBANS Study according to Brazilian macro-regions.

North				Northeast			
Food group	%	mg/d		Food group	%	mg/d	
		Mean	SE			Mean	SE
Beef and Main dishes	26.57	839.5	58.33	Beef and Main dishes	21.09	645.4	26.48
White Bread	11.04	587.69	68.4	White Bread	16.12	696.6	32.71
Rice	9.39	376.29	14.86	Rice	9.99	372.1	16.97
Processed Meat	8.43	811.26	125.73	Processed Meat	8.79	809.4	85.71
Crackers	4.99	553.07	30.31	Pasta	5.7	493.6	54.55
Butter or Margarine	4.38	213.55	34.35	Beans	3.71	151.6	7.52
Beans	3.88	191.49	34.17	Crackers	2.98	402.1	30.88
Pasta	3.8	496.92	114.72	Butter/ Margarine	2.95	146.2	9.62
Breads	3.53	527.49	110.62	Soups	2.8	921.1	146.69
Soups	2.45	774.44	111.16	Cheese	1.74	260.1	22.95

#: Percentual of contribution.

French bread was the second contributor in Brazil, and along with breads and crackers (white or whole), they represent almost 15% of the total contribution. As already mentioned, breads are an important contributor to sodium intake not only in Brazil, but also in other countries<sup>15-18</sup>. It was easier to identify the breakfast pattern of Brazilians as they usually consume foods that are major sources of sodium, such as French bread, butter or margarine, crackers (white or whole) and milk; these foods are the most frequently consumed by the total population in the breakfast<sup>23</sup>. As processed meats, high amounts of salt are usually included in breads to improve their characteristics, including shelf-life, volume, sensory, and flavor characteristics. Manufacturers have marketed low-salt alternatives using biotechnological processes in bread production<sup>24</sup>. In Brazil, the sodium content in breads has been reduced in recent years, as also observed in Australia and New Zealand<sup>25</sup>, which may potentially help and can be a strategy to reduce the consumption of this micronutrient but may not be decisive or compensatory<sup>26</sup>.

Stratified population analyzes were essential to identify and understand the differences between groups. In this way, the major and the second contributors, apart from beef and main dishes without processed meat and French bread, were not different in all categories evaluated, but some other contributors differed by sex, age group, and Brazilian macro-regions. Different from the results of the analysis on foods included in the "traditional" meal pattern, a high consumption of sodium

derived from pizza (adolescents and South); soup (North and Northeast); fried or baked savory snacks (adolescents, males, and Southeast); mixed sources, which includes typical Brazilian recipes, as well as *farofa*, couscous, and mayonnaise salad (South); and cheese (Northeast) were unidentified in the general population.

For age groups, the analysis conducted among adolescents showed that foods like pizzas and fried or baked savory snacks appeared as contributors to sodium intake of this age group alone. The average consumption of sodium from pizzas was the highest (1,388.17 mg/d) in relation to all other foods, due to its high sodium content, and was the 9th major contributor to sodium intake. Adolescents have a high frequency of substituting main meals (lunch and dinner) to snacks, such as fried or baked savory snacks and pizzas, which were the main snacks consumed<sup>27</sup>. Studies have demonstrated a high percentage of adolescents with sodium consumption above the limits of UL<sup>28</sup>, as they consume healthier foods than healthy foods<sup>29</sup>.

Globally, the average sodium intake in men was 10% higher than that in women in all regions evaluated<sup>2</sup>. In the present study, it was observed that the average consumption of sodium from all food sources were higher in men than in women, except for added salt. Men frequently consumed fried or baked savory snacks (which ranked 10th), while women frequently consumed either white or whole breads (in the

same position). The Brazilian surveillance system of risk factors for chronic non-communicable diseases conducted in 2006 indicated that men add more salt to ready meals than women<sup>30</sup>.

Although there are cultural and regional differences in each macro-regions of the country, some similarities were observed among sodium sources and few differences were identified in the South (pizza and mixed sources, which include typical Brazilian recipes, such as *farofa*, couscous, and mayonnaise salad), in North and Northeast (soup), in Northeast (cheese), and in Southeast (fried or baked savory snacks).

A matter of concern is that the tolerable UL for sodium could contribute a significant proportion just from a single food. It was observed that pizzas had a UL of above 50%, followed by soups and broths, 30%–50%; processed meat products, 30%–37%; and beef and main dishes with processed meat (red or white), 26%–37%. Therefore, special attention to excessive sodium intake is due, among other reasons, to the evidence that its high levels in the organism are associated with blood pressure elevations and consequently involve alterations in renal function, fluid volume, fluid regulatory hormones, vasculature, cardiac function, and autonomic nervous system and may lead to high risk of cardiovascular events<sup>7,8</sup>.

This study had some limitations. A 24-hour urine collection was not performed, which would help substantiate the accuracy of these data obtained through a 24HR, and the use of a single 24HR will not help estimate the habitual intake of sodium.

## CONCLUSION

In conclusion, the EBANS showed the top food sources of sodium and their expressive consumption in Brazilian population. The major sources of sodium differed according to sex, age groups, and Brazilian macro-regions as result of different meal pattern, food preferences, cultural and regional in each group. These results highlight the need for implementation of public health policies to control the use of sodium in food industry and to aware the community about the addition of salt in food preparation and their food choices.

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