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Prevalence of excess sodium intake and main food sources in adults from the 2017-2018 Brazilian National Dietary Survey

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Abstract

An excessive dietary intake of sodium has been related to high blood pressure, a central but modifiable risk factor for cardiovascular disease and other ill health conditions. In the present work, we aimed to update estimates of sodium intake in a representative sample of Brazilian adults from the 2017-2018 Brazilian National Dietary Survey. Based on 24-hour recall, we calculated total daily sodium consumption, the prevalence of excess intake, and the main food sources. Overall, the median dietary sodium intake was 2432 mg/d. The prevalence of adults exceeding the recommended limit considering the Tolerable Upper Limit and the Chronic Disease Risk Reduction cut-off points was 61% and 56%, respectively. Higher median sodium intake and proportion of individuals above the limits was found in: men, individuals in the 20-29 age category, residents of the South region, in the third tertile of *per capita* family income, that had an educational level above high school, whose reported not follow a specific diet, declared the habit of adding extra salt to already prepared meals, and individuals classified as in food security status. The main source of salt intake came from salt added during cooking. The top dietary sources of sodium were white bread and toast (12.3%), beans (11.6%), white rice (10.6%), and beef (7.7%). Given the established health benefits of dietary salt reduction, it would be advisable to continue and even improve the current national initiatives of awareness and educational campaigns to decrease overall salt intake across the Brazilian population.

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List of abbreviations

24HR: 24-hour recall

BMI: Body mass index

BNDS: Brazilian National Dietary Survey

CDRR: Chronic Disease Risk Reduction

CVD: Cardiovascular diseases

DALY: Disability-adjusted life years

EBIA: Brazilian Food Insecurity Scale

FAO: Food and Agriculture Organization

HBS: Household Budget Survey

HTN: Hypertension

IBGE: Brazilian Institute of Geography and Statistics

MSM: Multiple Source Method

NASEM: National Academies of Sciences, Engineering, and Medicine

NCD: Non-communicable diseases

PNS: National Health Survey

UL: Tolerable Upper Limit

USDA: United States Department of Agriculture

WHO: World Health Organization

1. Introduction

Numerous studies provided ample evidence that excessive dietary sodium intake is the top risk factor for cardiovascular diseases (CVD), such as heart failure, stroke, and hypertension, which are the major causes of death and disability in the world[1][2]. Globally, a quarter of all diet-related deaths and disability-adjusted life years (DALYs) were attributable to a high intake of sodium (being responsible for 2 million [95%CI 0.5-4] deaths and 45 [95%CI 1395] million DALYs in 2019)[3]. Reducing salt intake in populations is considered the most cost-effective intervention or even cost-saving approach to decrease the burden of non-communicable diseases (NCD), endorsed by the World Health Organization (WHO) as the primary strategy to prevent CVD[2][4].

Based on these findings, the National Academies of Sciences, Engineering, and Medicine (NASEM) established the Chronic Disease Risk Reduction (CDRR) intake, a chronic-disease-specific recommendation for dietary sodium of 2,300 mg/day[5]. Although the 2019 sodium CDRR intake is equivalent in number to the Tolerable Upper Limit (UL) released in 2005, the UL was intended to provide guidance on safe intake levels, not to serve as an intake goal[6]. Limiting sodium intake to recommended parameters is expected to reduce chronic disease risk among healthy persons, primarily by lowering blood pressure[5].

Brazil has committed to achieving the global target of reducing population salt intake by 30% by 2025[7]. In 2011, the Ministry of Health launched the 2011-2022 Strategic Action Plan for Tackling NCD. One of the targets was to reduce the average salt consumption by promoting intersectoral actions, such as voluntary agreements with the food industry, health promotion in school and work settings, healthy food regulations, and healthcare services[8]. Despite long-standing recommendations to limit sodium[9] and efforts from government programs[8], the current health policies have not effectively reduced dietary sodium in the Brazilian population. Previous publication from the Brazilian National Dietary Survey shows that the prevalence of excess dietary sodium intake has not changed over the past decade, ranging from 54.4% in 2008 to 53.5% in 2018[10]. And was observed a decrease in the proportion of food products that had a sodium content within the established goals[11]. In addition, accurate measurement of sodium intake presents enormous challenges due to the extensive distribution of sodium in foods, preparation methods, and the widespread use of sodium compounds in food processing. Since the market changes continuously, food sources of sodium can also change, highlighting the need to monitor data on salt consumption at the population level and provide essential information to policymakers and all interested stakeholders, on the implementation, progress, limits, and effects of a sodium reduction policy[12].

Nevertheless, particularly in an ethnically diverse country like Brazil, a better understanding of dietary patterns, and actual sodium intake is crucial to patient counseling and program planning. Thus, this study aimed to (i) describe the prevalence of excess sodium intake in the context of the CDRR and UL intake goals, (ii) and provide information on the current sources of dietary sodium in a representative Brazilian population using intake data from the 20172018 BNDS.

2. Methods and Materials

2.1. Study design and population

The general data were obtained from the 2017-2018 Brazilian National Dietary Survey (BNDS) and the Household Budget Survey (HBS). The HBS is a survey carried out by the Brazilian Institute of Geography and Statistics (IBGE, Instituto Brasileiro de Geografia e Estatística), the official agency of Brazilian Populational Statistics, and designed to collect data on consumption expenditure, life conditions, as well as nutritional information in a representative sample of Brazilians. In summary, the 2017-2018 HBS used two-stage cluster sampling: In the first stage, the census tracts (primary sample units) were randomly selected from each stratum of census tracts. In the second stage, permanent private households (second sample units) were randomly selected without replacement within census tracts. More details about the sampling plan are obtained elsewhere[10].

Of the 57,920 households sampled, a subsample of 20,112 households (~35% of the total sample) was randomly selected for data collection on individual food intake (see Supplementary Fig.1). Thus, the final sample included 28,153 adults (20-59y, both sexes, non-pregnant, non-lactating) with sociodemographic, life condition and dietary data collected[13]. The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, the Brazilian Resolution Number 196/96 on research involving human subjects, and under Brazilian Law #5534 from 14 November 1968, which guarantees the confidentiality of the information collected by all national census and surveys.

2.2. Sociodemographic and anthropometric information

Individuals' information on age, sex, geographic region (North, Northeast, Southeast, South, Midwest), household area (urban/rural), self-reported ethnicity, dietary habits, *per capita* family income, and educational level (years of schooling) was collected by a structured questionnaire administered by trained interviewers in the household.

Self-reported ethnicity categorization was based on Brazilian law #12711 from 29 August 2012, which provides for admission into public universities and institutions, and was categorized as White or Asian, and Black, Mixed-race, or Native. *Per capita* family income was estimated by summing all monetary and non-monetary income reported by family members divided by the number of family members, and minimum wage was 954.00 Brazilian Real (BRL) in 2018 (equivalent to USD 298.53, 1 USD = 3.1957 BRL on 15 January 2018).

Anthropometric data (body weight and height) were measured in triplicate using digital scales and portable wall-mounted stadiometers following standardized procedures. Body mass index (BMI) was calculated by dividing weight by height squared (kg)/[height(m)]^2. Individuals were classified according to their BMI into two groups: without overweight (BMI <25 kg/m^2) and with overweight (BMI ≥25 kg/m^2)[14].

Food security status was measured by the Brazilian Food Insecurity Scale (EBIA, Escala Brasileira de Insegurança Alimentar), an adapted scale from that proposed by the United States Department of Agriculture (USDA) and validated to the Brazilian population[15][16]. The higher number of affirmative responses indicates greater food insecurity. The final score is categorized as food security (score 0 or no affirmative responses), mild food insecurity (1-5 points for households with members aged <18y, and 1-3 points for households without members aged <18y), moderate food insecurity (6-9 and

4-5 points for households with members aged <18y and households without members aged <18y, respectively), and severe food insecurity (10-14 and 6-8 points, respectively)[15].

2.3. Dietary data

Dietary data were collected by two non-consecutive food records (24HR) throughout all days of the week and seasons of the year. Both 24HR were collected by face-to-face interviews at participants' homes following procedures described in the USDA Automated Multiple Pass Method[17].

Individuals were instructed by interviewers to inform all consumed foods and beverages in household measures and report the meal time, place of consumption (i.e., at home or away from home), cooking methods, and added seasonings. The dietary data were entered into the software developed by IBGE that automatically converted the household measures into standard weight and volume measures, such as grams and milliliters. Quality control of the 24HR was conducted during and after the interview to identify and correct misreporting in real time.

The energy and nutrient content of each food item reported in 24HR was obtained by the Brazilian Food Composition Table (TBCA-USP), version 7.0, developed by the Food Research Center (FoRC) at the University of São Paulo (USP), available at http://www.fcf.usp.br/tbca, in accordance with standards and guidelines for generation, compilation and use of food composition data of FAO/INFOODS (Food and Agriculture Organization/International Network of Food Data System).

Sodium intake was adjusted for within-person variation through the web-based statistical modeling technique Multiple Source Method (MSM), version 1.0.1, updated in 2020. The MSM was developed within the European Food Consumption and Validation Project as a suitable technique for estimating the usual nutrient and food intakes (including those episodically consumed) based on two or more short-term dietary methods per individual, such as the 24HR[18][19]. The effects of day-of-the-week (weekday vs. weekend) and atypical day of dietary intake (no vs. yes) were considered as adjustments in the models.

2.4. Food grouping

The 1508 different foods reported in both 24HR were classified into 54 mutually exclusive food groups. Foods were combined based on the frequency of consumption, similarity of the nutrient profile, dietary habits, and culinary usage in the Brazilian population. The total sodium intake comprised the sodium naturally present in food and added during preparation (e.g., rice cooked with salt, sautéed vegetables, etc.). A detailed description of foods included in each food grouping is described in Supplementary Table 1.

2.5. Statistical analyses

This report was prepared following the Strengthening the Reporting of Observational Studies in Epidemiology-Nutritional

Epidemiology (STROBE-Nut) statement specified for nutritional epidemiologic studies[20]. Descriptive analyses of mean, percentage, and 95% confidence intervals (95% CI) were performed using Stata® software (version 14.0, 2011, Stata Corp LP) considering the complex sampling design and significance level of 5%. Differences in socioeconomic, demographic, anthropometric, and lifestyle variables were tested by Theil– Sen median test for complex sampling design. The post hoc Dunn test was used to identify the significance between groups. The population prevalence exceeding dietary sodium intake was estimated according to the NASEM parameters UL (UL=2,300 mg/d) and CDRR (reduce intakes if above 2,300 mg/day) for adults ≥19 years old[5].

The organizational contribution of each food group to the sodium intake was determined using the method proposed by Block *et al.*[21]. This method estimates the corresponding percentage of foods or food groups consumed by the population from the total nutrient intake. Individuals who reported intake of a certain food group in at least one 24HR were classified as “consumers” regardless of the amount reported. The prevalence of consumers and sodium density were calculated for food groups contributing to >1% of total sodium intake.

3. Results

Sociodemographic, lifestyle, and diet characteristics of all included participants, their sodium consumption, and the prevalence of excess sodium intake are shown in Table 1. The sample is predominantly composed of adults living in urban areas (86.3%), in the Southeast region (42.8%), having *per capita* family >1 minimum wage (40.4%), with schooling above high school (60.2%). Most of the population reported being black, mixed race, or native (56.7%) and presented excess body weight (55.6%). Regarding diet characteristics, most participants reported not being on a diet (86.9%) and not having the habit of adding extra salt to already prepared dishes (85.5%). The EBIA classification indicates that a significant portion of the population in some degree of food insecurity (40.5%). Similar proportions were found for variables sex and age group.

Overall median sodium consumption of Brazilian adults was 2432 mg per day (95%CI: 19023074). As to the regions of Brazil, we found lower intake in the North Region (2223 mg/day; 95%CI: 1702-2880) and higher in the South (2485 mg/day; 95%CI: 1941-3166). Sodium consumption declined with advancing age. The median intake was 2595 mg/day (95%CI: 2029-3261) for individuals aged 20-29 years and 2449 mg/day (95%CI: 1912-3126) for individuals aged 30-39 years. For individuals aged 40-49 years and 50-59 years, sodium intake was 2382 mg/day (95%CI: 1889-3025) and 2306 mg/day (95%CI: 1799-2912), respectively ($P < 0.01$ for all comparisons). Median sodium consumption was greater in males (2769 mg/day; 95%CI: 2176-3431; the highest consumption found), also among those with *per capita* family income above one minimum wage (2471 mg/day; 95%CI: 1927-3115), that had an educational level above high school (2461 mg/day; 95%CI: 1934-3105), that reported not follow a specific diet (2491 mg/day; 95%CI: 1954-3129), declared the habit of adding extra salt to already prepared meals (2529mg/day; 95%CI: 1979-3195), and individuals classified as in food security status (2466 mg/day; 95%CI: 1939-3109). Household area, self-reported ethnicity, and BMI status did not significantly differ in sodium intake.

The percentage of Brazilian adults whose sodium intake exceeded the recommended limit considering the UL and CDRR

cut-off points was 61.0% and 56.1%, respectively. The lowest prevalences of excessive sodium consumption were found in individuals who reported following a specific diet (UL:45.6%; CDRR: 38.9%) and females (UL:48.0%; CDRR: 42.2%), whereas the highest prevalences of excessive consumption were found among males (UL:71.6%; CDRR: 70.1%) and individuals aged 20-29 years (UL: 65.9%, CDRR: 62.5%). The 25 food groups that collectively accounted for over 90% of the dietary total sodium intake and their prevalence of consumers are presented in Table 2. White bread and toast were the main sources of sodium intake (12.3%), emphasizing French Bread, which contributed to 9.3% of sodium intake – followed by Beans (11.6%), White rice (10.6%), Beef (7.7%) and Poultry meat (5.5%). These top five food groups accounted for 47.6% of total sodium intake, and they are also foods widely consumed by the population, with more than 50% of individuals reporting their consumption. Conversely, the traditional food items that presented high sodium density, such as Cured meats (1781mg/100g) and Sausages (1460mg/100g), did not emerge as major sodium contributors.
In the overall population, the top 10 food groups with the highest proportion of consumers were: Water (86%), Coffee (85%), White rice (83%), Sugar and honey (78%), Beans (72%), White bread and toast (61%), Leafy and non-leafy vegetables (57%), Beef (56%), Juices (48%), and Poultry meat (48%). The complete table with all food groups and their prevalence of consumers can be found in Supplementary Table 1.

4. Discussion

This study demonstrated that most Brazilian adults consume dietary sodium above UL and CDRR recommendations and could benefit from sodium reduction to lower their cardiovascular disease risk. The main food sources of dietary sodium were traditional foods widely consumed by the population, such as white bread and toast, beans, white rice, beef, and poultry meat.
Epidemiologic studies reveal a rapidly growing prevalence of HTN in Brazil. According to the 2013 National Health Survey (PNS), conducted in partnership with the Ministry of Health and IBGE, the prevalence of self-reported hypertension in Brazil was 21.4%; more recently, the PNS 2019 recorded this proportion at 23.9%[22]. Simulation studies carried out in Latin America have estimated that reducing sodium consumption as recommended by the WHO could reduce about 47,000 deaths from cardiovascular diseases, the equivalent of 85 million dollars in health care[23]. With the increasing prevalence of HTN, these updated data on dietary contributors that influence high blood pressure are essential to developing individualized and population-wide strategies.
Overall dietary sodium intake was notably higher than the NASEM parameters UL and CDRR. Among the total sample and most subgroups evaluated, sodium intake remained persistently above recommendations, surpassing the prevalence observed in HBS's previous editions[10]. We found substantial differences in the proportion of adults estimated to meet sodium intake recommendations. In general, UL parameters resulted in higher percentages of individuals exceeding sodium intake than CDRR. Increased cardiovascular disease risk due to excess intake was found mainly in men and individuals in the age category 20-29 years old, which is consistent with previous Brazilian studies that described these subgroups as the greatest consumers of salt[24][25] and having worse diet quality[26][27]. On the other hand, women and older individuals are recognized as having more health concerns, seeking out medical assistance regularly, and following

prescribed treatment more accurately than men and young people[28][29], which can partially explain the lower estimates expressed by this subgroup.

The prevalence difference among Brazilian macro-regions reflects the well-known country's social and economic inequalities. The FAO defines food insecurity as "when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life"[30]. In our study, individuals facing moderate or severe food insecurity presented lower sodium consumption. According to the literature, this scenario can also occur for several other micronutrients[31][32]. In agreement, the lowest sodium consumption was found in the North region, which has the higher proportion of the population facing moderate and severe food insecurity (29.3%), whereas the South region showed a higher percentual of individuals exceeding sodium intake and fewer households in moderate or severe food insecurity (4.9%) (Supplementary Table 2).

The detailed dietary data in the current study allowed us to identify the key dietary sources of sodium in Brazilian adults. Food groups that most contributed to total sodium intake were White bread and toast, followed by Beans and White rice. These are typical Brazilian foods that are not generally considered primary dietary sodium sources. However, the frequency of their consumption renders them important contributors to total sodium intake for the study population. For example, 100 grams of Beans presented 302 mg of sodium, whereas boiled white rice had 289 mg of sodium. These amounts are considered low compared to other food groups available to the population, such as Sausages and hot dogs (1460mg per 100g) and Pizza and calzones (847mg per 100g). These high-sodium foods are eaten by fewer people than the main foods; however, for those eating high-sodium foods, the consumption can reach 50% of the recommended intake just from a single portion.

The present study indicates discretionary salt as the leading source of sodium following previous data from 2008-2009 BNHS, which estimates that nearly three-quarters (74.4%) of total sodium intake came from table salt and salt-based condiments in the Brazilian population[33]. These findings are in agreement with a systematic review that included 80 studies from 34 different countries[34], its main results demonstrate that in developing countries, the predominant source of sodium is salt added as part of the traditional recipes, and the food components "bread and bakery products", "cereal and grain products", "meat", and "dairy products" appeared to be the main global contributors to sodium daily intake.

Recognizing that bread products are relevant sources of dietary sodium in the western diet, some countries in Latin America have set voluntary or regulated targets and timelines for reducing sodium content in bread, among other food products. In Argentina, where this food group accounts for almost 25% of total salt in the diet[35], over 90% of the farinaceous products had sodium content below the mandatory targets[36]. Costa Rica has reported gradual changes in meeting the national targets, with 69% of bread meeting the recommendations[37]. Moreover, a study performed in fourteen countries of Latin America and the Caribbean met an 82% general compliance with the regional targets[38]. Reducing the population's sodium intake has been on the health agenda in Brazil for many years and requires a combination of strategies to address all dietary sources of sodium[39]. In particular, the proportion of dietary salt obtained from cooking is an important consideration, as interventions targeted to the more frequent pattern of salt consumption are prone to be most effective. For instance, reformulation strategies are likely to be more effective in countries where a large proportion of dietary salt comes from packaged foods and food prepared outside the home, whereas salt substitution may be more effective in countries with extensive use of discretionary salt[34]. According to the 2018 Brazilian Ministry of

Health official monitoring report, the food categories “Loaf bread” and “Commercial buns” showed more than 95% adequacy of sodium content. When considering all food categories included in the voluntary agreement, the reported adequacy was 87%[11].

Since sodium intake in Brazil remains high despite the positive progress described, findings from the present study reinforce the need to also support campaigns focused on homemade preparations and bakery foods (which are broadly consumed by the population and the major contributors of sodium) to have a greater impact on sodium intake and improve CVD outcomes more effectively. Some common policies already in progress include intersectoral efforts in the education and communication fields, such as the elaboration of the dietary guidelines for the Brazilian population, which presents qualitative orientations regarding moderate sodium intake in strategic environments[40]. And even though packaged food products are not the main source of sodium in the population’s diet, a need was identified to reduce sodium in processed foods as well. So, in the field of labeling, frontal food labeling has great potential to inform consumers about excess critical nutrients such as sodium, fats, and sugars to guide healthier food choices[39].

Given the current status of salt intake in the country, other strategies must be reinforced to promote healthy diets and environments. It becomes essential to support massive campaigns that encourage the reduction of sodium consumption, especially regarding the addition of table salt and condiments during cooking, concerning specific cultural cooking practices. In contrast, the addition of herbs and spices can highlight the salty taste and improve the taste and nutritional characteristics of foods, favoring the acceptance of these foods with reduced salt content. Besides, it is necessary to propose policies more appropriate to regional realities, which favor the optimization of investments in Brazil’s Unified Health System and decrease inequalities among states.

Our study included the most recent available data on a large nationally representative sample of Brazilians and provided up-to-date evidence on sodium intake and its food sources. In addition, to our knowledge, no prior studies have analyzed adherence rates to evolving CDRR recommendations for sodium consumption in the Brazilian sample.

However, the present study was not without limitations. The ranking of food categories by the contribution to sodium consumption depended on methods used to categorize specific foods, portion sizes, and consumption frequency. Also, we estimate intake with 24HR; this information does not come from a direct biomarker such as 24h urine (reference method). Compared to the previously published estimate of mean salt intake measured from 24-hour urine samples using a Brazilian population sample[24], the mean salt intake estimated using 24HR was lower. The 24HR tends to underestimate the intake of nutrients due to the lack of precision and memory of the participant since this method is complex, requires much work for both participants and field workers, and participants tend to change the consumption report in the dietary recall interview. Nevertheless, it is a useful tool for identifying sources of sodium in diets and a reasonable approach to estimating sodium intake in large epidemiologic studies[41].

The population information reported in this study is essential to approaching sodium consumption in Brazil. As this country experiences the effects of a nutrition transition towards pre-prepared and processed foods, ongoing monitoring of dietary sources, estimated salt intake, and data on the knowledge and behaviors on salt intake will be essential to monitor changes and refocus interventions throughout the lifespan of a national action plan for salt reduction.

5. Conclusion

National programs and interventions to reduce sodium intake and promote healthy food options remain essential. Sodium intake in Brazil is high, and this research confirms it comes mainly from salt added by consumers during the preparation and cooking of meals. Urgent action is needed to implement a program to achieve the WHO salt reduction target of a 30% reduction by 2025. Therefore, improving the quality of nutritional composition of foods, as well as moderating consumption of certain food groups, are key goals for health authorities and achieving a balanced diet in the Brazilian population. The data presented can be used to shape and inform public health policies aimed at reducing the sodium content of the diet, which may help reduce the prevalence of hypertension-related diseases.

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Authors' contributions: All authors participated during manuscript preparation to take public responsibility for the article content. PVF was involved with statistical analyses, data interpretation, and manuscript writing. MMF and MAC contributed to statistical analyses, interpretation of data, and manuscript drafting. ILSI conceptualized the study, supervised the data management and statistical analyses, and provided comments and suggestions on all drafts. All authors have read and approved the submitted version.

Conflicts of interest: PVF, MMF, and MAC are researchers and collaborators at the Food Consumption Research Group in the School of Public Health of the University of São Paulo and performed consultancy for the manuscript development. MF is speaker honorarium and grants for research received from Abbott, CNPq, CPW, Danone, Fapesp, Fundação José Luis E. Setubal, Nestle, Novo Nordisk, RB and Sanofi. Member of the ILSI Brazil Scientific Advisory Committee, the board of Nutrition Department of Brazilian Society for Pediatrics, and Working Group Feeding Difficulties LASPGHAN.

Ethical statement: This investigation was performed in accordance with the Brazilian Law #5534 from 14 November 1968, which guarantees the confidentiality of the information collected by all national censuses. All ethical principles laid down in the Declaration of Helsinki and in the Brazilian Resolution Number 196/96 on research involving human subjects were followed. Ethical review and approval by Institutional Review Board were waived for this study because this investigation was performed based on a public database from a national census.

Data code and availability statements: Data used in the present study is made publicly available by the Brazilian Institute of Geography and Statistics (https://www.ibge.gov.br/estatisticas/sociais/saude/24786-pesquisa-de-orcamentos-familiares-2.html?=&t=microdados). The code used in this study is available upon request.

Tables

Table 1. Mean sodium intake and prevalence of excessive sodium consumption according to socioeconomic, demographic, and anthropometric characteristics of the Brazilian adult population. Household Brazilian Budget Survey, 2017-2018 [1]

Characteristics	Total Population			Sodium intake (mg/d)				p-value[3]	% Exceeding sodium intake according to	
	n	%	(95%CI)	mean	sd	median	IQR		UL	CDRR
Overall population	28,153	100	(-)	2569.1	969.6	2432.4	(1902.7, 3073.8)		61	56.1 (55.0, 57.2)
Geographic region										
North	4,132	8.2	(7.7, 8.7)	2364.4	953	2222.9[abcd]	(1701.6, 2880.0)		52.8	45.9 (42.8, 49.2)
Northeast	9,717	26.4	(25.6, 27.3)	2640.1	1018.2	2462.2[c]	(1901.1, 3151.9)		62.5	57.4 (54.8, 59.9)
Southeast	7,029	42.8	(41.7, 44.0)	2535.1	868.4	2431.1[bc]	(1927.4, 3026.3)		60.6	56.5 (54.3, 58.6)
South	3,699	14.6	(13.9, 15.4)	2657	1118.8	2485.5[ab]	(1940.6, 3166.2)		62.9	58.2 (56.7, 59.7)
Midwest	3,576	7.9	(7.5, 8.4)	2564.8	1000.8	2438.2[d]	(1882.4, 3082.6)	0.014	60.2	55.6 (52.5, 58.6)
Area										
Urban	21,863	86.3	(85.7, 86.9)	2571.6	961.7	2439.8	(1909.1, 3074.8)		61	56.4 (55.1, 57.6)
Rural	6,290	13.7	(13.1, 14.3)	2553.7	1018	2389.9	(1863.3, 3064.4)	0.06	59.9	54.6 (52.3, 56.8)
Age group, years										
20-29	6,665	25.1	(24.3, 26.0)	2731.3	1053.7	2595.5[a]	(2029.0, 3260.9)		65.9	62.5 (60.3, 64.6)
30-39	7,598	26.9	(26.0, 27.9)	2590.7	975.6	2448.8[a]	(1911.9, 3125.6)		61.8	57.3 (55.2, 59.3)
40-49	7,274	25.1	(24.2, 26.0)	2513.1	922.3	2382.5[a]	(1889.3, 3024.8)		59.1	53.6 (51.7, 55.5)
50-59	6,616	22.8	(22.0, 23.7)	2426.8	885.8	2306.2[a]	(1799.5, 2912.4)	<0.001	55.6	50.6 (48.6, 52.5)
Sex										
Male	13,338	49.8	(49.2, 50.4)	2881.5	1028.7	2769	(2176.5, 3431.4)		71.6	70.1 (68.7, 71.5)

Female	14,815	50.2	(49.6, 50.8)	2259.6	794	2171.8	(1717.8, 2668.8)	<0.001	48	42.2 (40.9, 43.7)
Self-reported ethnicity										
White or asian	10,496	43.3	(42.1, 44.5)	2588.5	971.5	2441.6	(1924.5, 3088.0)		61.8	56.4 (54.6, 58.2)
Black, mixed-race, or native	17,636	56.7	(55.5, 57.9)	2554.3	967.2	2425.7	(1893.2, 3058.9)	0.11	60.3	55.9 (54.6, 57.2)
Per capita family income [2]										
≤ 1 minimum wage	13,218	40.4	(39.1, 41.7)	2518.9	962.4	2374.4	(1872.5, 3016.0)		59.1	54.1 (52.5, 55.7)
>1 minimum wage	14,935	59.6	(58.3, 60.8)	2603.2	973	2471.8	(1926.6, 3115.1)	<0.001	62.2	57.5 (56.0, 59.0)
Education level										
≤ 9 years of schooling (below elementary school)	12,702	39.8	(38.7, 40.9)	2518.3	959.5	2384.3	(1847.9, 3029.6)		59.1	53.8 (52.2, 55.4)
> 9 years of schooling (above high school)	15,451	60.2	(59.1, 61.3)	2602.7	974.8	2461.5	(1934.4, 3105.7)	<0.001	62.2	57.6 (56.2, 59.0)
Body Mass Index										
Without overweight	12,676	44.4	(43.4, 45.4)	2563.2	963.9	2413.8	(1908.6, 3061.8)		60.6	55.4 (53.8, 56.9)
With overweight	15,477	55.6	(54.6, 56.5)	2573.9	974.1	2449.5	(1898.7, 3087.0)	0.47	61	56.7 (55.3, 58.1)
Followed a specific diet										
Yes	3,778	13.1	(12.4, 13.8)	2204.7	864.1	2081.3	(1602.0, 2644.5)		45.6	38.9 (36.3, 41.5)
No	24,375	86.9	(86.2, 87.6)	2624.1	972.8	2491.4	(1954.1, 3129.3)	<0.001	62.9	58.7 (57.5, 59.9)
Add extra salt at the table										
Yes	3,777	14.5	(13.7, 15.4)	2650.7	996.5	2528.7	(1979.4, 3194.6) (1888.5, 3055.7)		63.6	60.7 (57.8, 63.5)
No	24,376	85.5	(84.6, 86.3)	2555.2	964.3	2416.5		<0.001	60.2	55.4 (54.2, 56.5)
Food security status										
Food security	15,878	59.5	(58.1, 60.9)	2608.9	973.5	2466.1[a]	(1939.2, 3109.0)		62.5	57.7 (56.3, 59.2)
Mild food insecurity	7,836	27.1	(25.9, 28.3)	2544.1	961.2	2414.2[a]	(1892.0, 3036.4)		59.9	55.5 (53.2, 57.7)
Moderate or severe food insecurity	4,439	13.4	(12.6, 14.2)	2442.4	956.4	2304.0[a]	(1772.6, 2981.1)	<0.001	55.9	50.2 (47.5, 52.9)

Abbreviations: *UL, Upper Limit Intake; CDRR, Chronic Disease Risk Reduction*

[1] *All the analyses took into account the sampling survey design.*

[2] *1 minimum wage was approximately USD 298 in 2018.*

[3] *Median and interquartile ranges (IQR) are described, and differences were evaluated using Theil–Sen test. Post hoc Dunn's test was applied for comparing variables with three or more groups. Medians in the same variable with the same superscript letters*$^{(a–d)}$ *are significantly different (P < 0.01).*

Table 2. Description of the food groups contributing to >1% of total sodium intake, prevalence of consumers, and food group sodium density among Brazilian adults. Household Brazilian Budget Survey, 2017-2018.

Rank	Food groups	% total sodium intake[1]	% cumulative	% of consumers	Food group sodium density (mg/100g)
1	White bread and toast	12.3	12.3	61.0	578
	French bread	*9.51*		*43.7*	*681.9*
	Loaf bread	*0.29*		*3.8*	*548.5*
	Homemade bread	*0.14*		*1.5*	*430.8*
	Other White bread (except sweet rolls)	*2.17*		*16.0*	*653.8*
	Toast	*0.16*		*3.3*	*712*
2	Beans	11.6	23.9	72.4	302
3	White rice	10.6	34.4	83.4	289
4	Beef	7.7	42.1	55.7	350
5	Poultry meat	5.5	47.6	50.2	693
6	Sandwiches	5.2	52.8	22.5	346
7	Pasta	4.7	57.5	34.7	252
8	Cookies and crackers	2.8	60.3	31.9	688
9	Rice-based mixed dishes	2.8	63.1	12.7	440
10	Sausages and hot dogs	2.7	65.8	12.3	1460
11	Cured meats	2.3	68.0	3.4	1781
12	Butter and Margarine	2.1	70.2	47.0	810
13	Corn-based mixed dishes	2.1	72.3	13.8	261
14	Salty pastries	1.9	74.2	15.4	643
15	Pork meat	1.9	76.0	11.3	250
16	Roots and tubers	1.8	77.9	22.7	54
17	Beans-based mixed dishes	1.8	79.7	7.7	298
18	Fish and Seafood	1.7	81.4	12.2	201
19	Eggs and omelets	1.7	83.1	22.5	254
20	Pizza and calzones	1.6	84.6	5.9	847
21	Leafy and non-leafy vegetables	1.5	86.2	57.2	92
22	Water	1.5	87.7	85.4	3
23	Cheese	1.5	89.1	16.6	613
24	Meat-based mixed dishes	1.3	90.4	13.3	276
25	Soups and broth	1.0	91.5	11.4	365

[1] *This analysis included 54 food categories. Food groups are ranked in descending order by contribution to total sodium intake. The list of foods included in each food grouping is described in Supplementary Table 1.*

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