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ARTICLE

Factors associated with salt intake in the Brazilian adult population: National Health Survey

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Abstract *This paper aims to identify the factors associated with high salt intake in the Brazilian adult population. This is a cross-sectional study with 8,083 adults participating in the National Health Survey (PNS, 2014/15). Salt intake was based on the estimation of 24-hour urinary sodium calculated from the sodium/creatinine ratio in spot urine samples. The highest quartile of the distribution was considered high salt intake. The relationship between high salt consumption and sociodemographic factors, lifestyles, morbidity, and self-rated health status was analyzed by calculating the crude prevalence ratios and the prevalence ratios adjusted for age and gender. Approximately 28.1% had an estimated salt intake higher than 10.56 g/day. Overweight (Adjusted Prevalence Ratio; 95%CI - PRadj 1.23; 1.09-1.39), obesity (PRadj 1.61; 1.43-1.83), and diabetes (PRadj 1.36; 1.17-1.58) were positively associated with high salt intake. Female gender (PRadj 0.73; 0.66-0.80), high schooling level (PRadj 0.88; 0.79-0.99), living in the North and chronic kidney disease (PRadj 0.71; 0.56-0.90) were protective factors. Salt consumption is elevated nationwide and in all population subgroups, requiring coordinated actions.*

Key words *Dietary Sodium, Feeding Behavior, Health Surveys, Urine*

Introduction

Despite the current, almost omnipresence of salt in food, its introduction into the diet is relatively recent in human history. It probably started with the discovery of its food preservation properties. Since their ancestors, humans evolved for millions of years with a diet of less than 0.1 g/day of sodium (0.25 g/day of NaCl), an amount naturally present in food[1]. Salt addition only became part of the diet in the last 5,000 to 10,000 years[2]. Thus, excessive salt intake and, consequently, sodium are significant challenges to physiological systems, given the continuous need to eliminate diet sodium ingested through the kidneys[3].

Excessive salt consumption is the main dietary risk factor for NCDs, mainly because of its relationship with cardiovascular outcomes mediated by arterial hypertension (AH), such as stroke, myocardial infarction, hypertensive cardiomyopathy, and chronic kidney disease[2,4]. Moreover, other outcomes, such as stomach cancer, osteoporosis, and obesity, are also associated with excessive sodium intake[4]. Overall, it is estimated that excessive sodium consumption is associated with about 3 million deaths and the loss of 70 million DALYs (Disability-Adjusted Life Years)[5].

In global terms, it is estimated that more than 95% of the population consume excess sodium (on average 3.9 g/day, ranging from 2.2 g to 5.5 g/day), while the recommended level of the WHO is up to 2 g/day, equivalent to 5 g of table salt[6].

The first salt/sodium intake estimates of the Brazilian population were obtained in 2002-2003, through indirect methods, based on home food purchase[7], and in 2008-2009, through 24-hour food records[8]. Home purchase-based estimates tend to overestimate intake, while recalls may underestimate it. However, they are essential for identifying dietary sodium sources[9]. In this sense, sodium's primary dietary source for Brazilians is added salt, including salt used in food preparation (74%) and sodium in processed foods (19%)[10].

In 2013, the first direct assessment of salt consumption in the population was carried out in the National Health Survey (PNS). Therefore, the sodium/creatinine ratio was obtained in a spot urine sample. Mean daily consumption of 9.34 g of salt was estimated. More than 95% of the adult population had excessive salt intake (>5 g/day), regardless of gender, age group, schooling, skin color, and geographic region[11]. The study also showed significant inter-individual variability, with daily consumption estimates from 1 to around 25 g/day.

The factors that affect individual salt intake are still little known in the Brazilian population. Despite the widespread recognition of the harmful effects of excessive salt intake, especially regarding its effects on blood pressure, little is known about adequate intake levels in Brazil and other Latin American countries[12]. Also, in Brazil, self-perceived salt consumption is very distorted, and, in the PNS, only 14.2% highly rated their intake[13].

Reducing salt consumption is one of the goals of the Strategic Action Plan for Coping with NCDs in Brazil (2011-2022)[14] and, globally, the WHO has set a goal of 30% reduction in salt intake by 2025 in all the countries. Thus, this study aimed to identify the factors associated with salt consumption in the adult Brazilian population, which can contribute to the planning of actions to achieve these goals.

Methods

This is an analytical cross-sectional study based on data from the PNS laboratory tests collected in 2014/15. PNS is a nationwide, home-based survey conducted by the Brazilian Institute of Geography and Statistics, in partnership with the Ministry of Health. The survey used a three-stage probabilistic sample. Interviews were conducted with adult residents (>18 years) of 64,348 residential homes. Additional methodological details have been previously described[15,16].

A random subsample of 8,952 individuals with blood and urine collection was separated from the PNS sample, and 869 samples with insufficient material, losses, and others were excluded from this analysis[15]. Thus, the current analysis refers to 8,083 participants. The study adopted post-stratification weights according to gender, age, education, and region, to establish estimates for the Brazilian adult population[15].

Urine samples were collected at home at different times of the day. A 5 mL aliquot was transferred to a sterile flask in a thermal bag and stored in a refrigerator until it was sent to the central laboratory in São Paulo. The urinary sodium was measured with a selective electrode, and creatinine was gauged by the Jaffe's kinetic method without deproteinization[15].

The 24-hour urinary sodium excretion was estimated using Tanaka et al.[17], which was validated for the Brazilian population in a pilot study of the PNS[18]. Using this equation requires estimating the urinary excretion (Ur) of creatinine

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(Cr) expected for 24 hours (CrPr24h, in mg), from age (years), weight (kg), and height (cm) of the individual, obtained in the home visit, as follows:

$$CrPr\ 24h,\ mg = [(14{,}89\ x\ peso,\ kg) + (16{,}14\ x\ estatura,\ cm) - (2{,}04\ x\ idade,\ anos)] - 2.244{,}5$$

Given CrPr24h, the sodium/creatinine ratio in urine in 24 hours (Na Ur 24h, mEq) is estimated by the following equation:

$$Na\ Ur24h,\ mEq = \left(\frac{Na\ UR\ casual,\ mEq/L\ x\ 10}{CrUr\ casual,\ mg/dL}\right) \text{ x } CrPr24h,\ mg$$

The estimated sodium excretion in 24 h (mEq) is given by the equation:

$$Na\ Ur24h,\ mEq = 2{,}98\ x\ NaUr^{0{,}398}$$

Salt consumption was estimated by considering all sodium excreted in the urine as being ingested as NaCl:

$$Consumo\ estimado\ de\ sal,\ g/dia = Na\ 24h,\ mEq\ x\ 58{,}5$$

For the current study, the estimated mean salt intake in the Brazilian population was 9.34 g/day (95% confidence interval - 95%CI: 9.27-9.41)[11]. Urinary excretion was distributed in quartiles, and, in this analysis, we chose to consider "high consumption" individuals located in the highest quartile, equivalent to the 75th percentile or above (≥P75); that is, those with daily salt intake ≥10.56 g, which corresponds to the daily urinary excretion of 4.15 g of sodium. The following blocks of variables of interest were included in the analysis: a) sociodemographic variables gender (male and female), age group (18-29, 30-44, 45-59, and 60 or more years), education (illiterate to incomplete elementary school, complete elementary school to incomplete high school, complete high school and over), skin color (white, black, brown, and other) and the country's macro-region (North, Northeast, Southeast, South, and Midwest); b) variables lifestyle, fatty red meat consumption (yes or no), soft drinks consumption 5 or more days a week (yes or no), alcohol beverages consumption 1 or more times a month (yes or no), and tobacco use (yes or no); c) variables related to morbidities, adiposity according to the Body Mass Index - BMI (underweight or normal, overweight, obesity[19]), diabetes (glycated hemoglobin - HbA1c ≥6.5% or use of a hypoglycemic agent[20,21], yes or no), high blood pressure (>140-90mm Hg[22], yes or no), high total cholesterol (total cholesterol ≥200 mg/dL[23], yes or no), Chronic Kidney Disease - CKD (Glomerular Filtration Rate - GFR <60 mL/min/1.73 m²[24], yes or no, without adjustment factor for black race), anemia (hemoglobin - Hb <12 g/dL[25], yes or no); d) self-assessed health status (very good and good, fair, poor and very poor). Prevalence and 95% confidence intervals (95%CI) were calculated, and bivariate analyses were performed using the chi-square test. Crude (PR) and adjusted (PRadj) prevalence ratios were also calculated according to age and gender using the Poisson regression method with robust variance and respective 95%CI.

The analyses were performed with statistical program Data Analysis and Statistical Software (Stata), version 14, using the survey command to analyze data from surveys with a complex sample.

The National Research Ethics Commission (CONEP) of the National Health Council, Ministry of Health, approved the 2013 PNS. Research participants signed an informed consent form (ICF) before data collection.

Results

Figure 1 shows that the consumption curve follows an approximately normal distribution (Figure 1A), with a higher intake in males (Figure 1B). As shown in Table 1, 28.14% (95%CI: 26.79-29.52%) of the participants were in the highest consumption quartile (≥10.56 g of salt/day). Prevalence data with the respective 95%CI showed that this highest consumption was found in the male population (32.84%; 95%CI: 30.68-35.07), in overweight patients (28.89%; 95%CI: 26.67-31.21) and obesity (35.84%; 95%CI: 32.92-38.87), in those who reported fatty red meat consumption (30.41%; 95%CI: 27.84-33.12), patients with diabetes (34.30%; 95%CI: 29.88-39.01) and who consumed alcoholic beverages once or more times per month (31.00%; 95%CI: 28.11-34.04). High salt consumption was lower in older adults (24.8%; 95%CI: 22.21-27.6), in the population of the North region (20.64%; 95%CI: 18.85-22.56), in CKD patients (18.96%; 95%CI: 15.04-23.61). There was no association between the distribution of quartiles and salt intake for different levels of education, skin color,

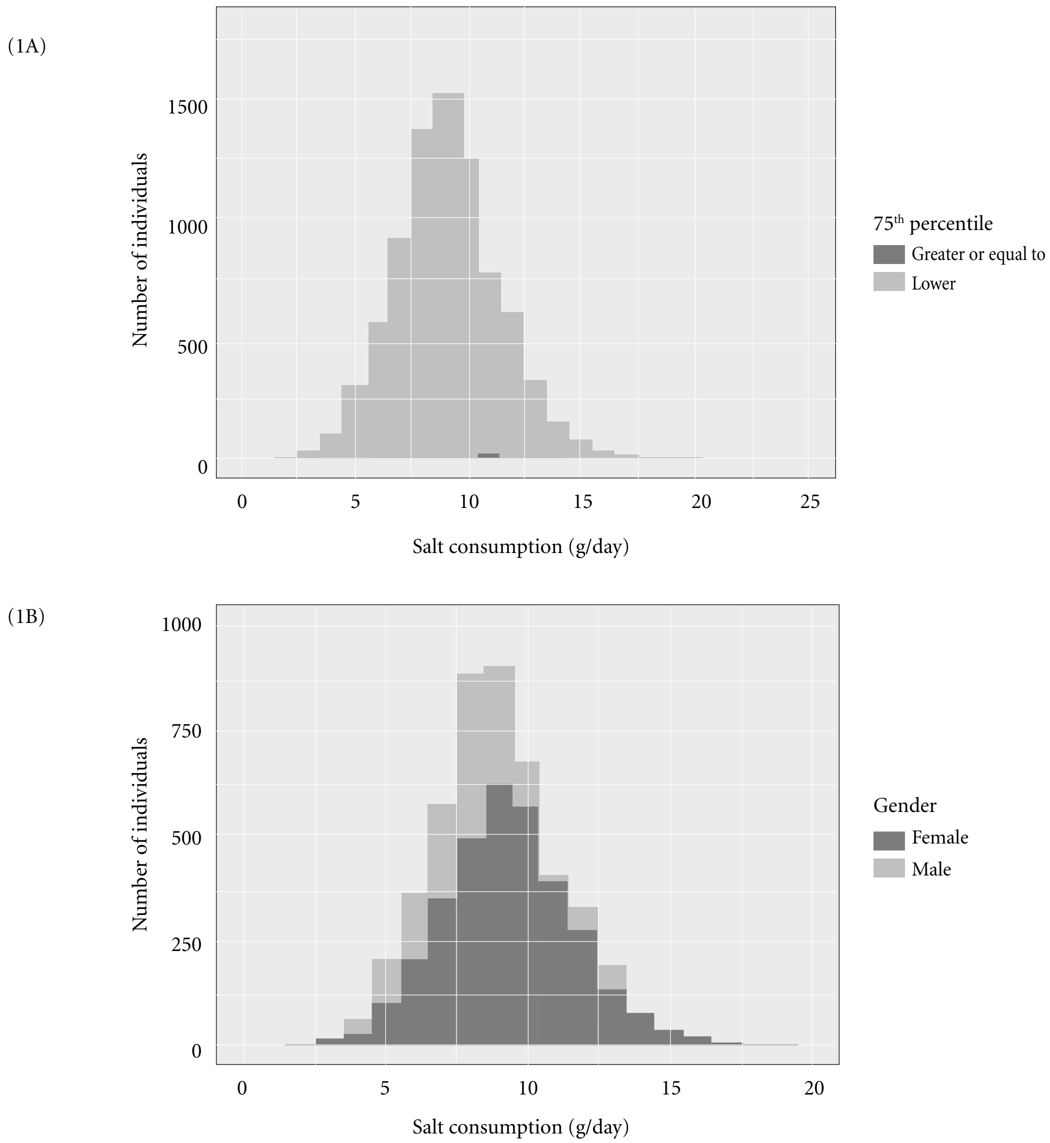

Figure 1. Distribution of estimated salt intake (g/day) in the Brazilian population, PNS 2014-2015 (1A) and distribution of estimated salt intake (g/day) in men and women in the Brazilian population, PNS, 2014-2015 (1B).

Source: Elaborated by authors.

consumption of soft drinks, tobacco use, high blood pressure measured during the home visit where urine was collected, high cholesterol, anemia, and self-assessment of health status.

Table 2 presents the crude and adjusted PR of the relationship between high salt intake and the factors studied. The PRadj by gender and age (PRadj; 95% CI) showed that the highest salt consumption (≥P75) was associated with male, overweight (PRadj 1.23; 95%CI: 1.09-1.39), obesity (PRadj 1.61; 95%CI: 1.43-1.83) and diabetes (PRadj 1.36; 95%CI: 1.17-1.58). Female (PRadj 0.73; 95%CI: 0.66-0.80), higher schooling (0.88; 95%CI: 0.79-0.99), living in the North, and CKD

Table 1. Estimated salt intake (g/day) in the Brazilian population, according to sociodemographic characteristics, lifestyle, and comorbidities. PNS, 2014-2015.

Variables	Estimated salt intake (g/day)				p*
	Less than P75 (<10.56 g/day)		Greater or equal to P75 (≥10.56 g/day)		
	%	95%CI	%	95%CI	
Total	71.86	[70.48 - 73.21]	28.14	[26.79 - 29.52]	
Gender					
Male	67.16	[64.93 - 69.32]	32.84	[30.68 - 35.07]	0.00
Female	76.12	[74.43 - 77.73]	23.88	[22.27 - 25.57]	
Age group					
18-29 years	72.16	[68.97 - 75.15]	27.84	[24.85 - 31.03]	0.04
30-44 years	69.41	[66.86 - 71.84]	30.59	[28.16 - 33.14]	
45-59 years	72.20	[69.65 - 74.62]	27.80	[25.38 - 30.35]	
60 years and over	75.20	[72.40 - 77.79]	24.80	[22.21 - 27.60]	
Schooling					
Illiterate	70.98	[68.92 - 72.95]	29.02	[27.05 - 31.08]	0.13
Elementary school	69.77	[66.02 - 73.27]	30.23	[26.73 - 33.98]	
High school and over	73.34	[71.19 - 75.40]	26.66	[24.60 - 28.81]	
Skin color					
White	72.18	[70.05 - 74.22]	27.82	[25.78 - 29.95]	0.80
Black	70.10	[65.10 - 74.65]	29.90	[25.35 - 34.90]	
Brown	71.82	[69.85 - 73.71]	28.18	[26.29 - 30.15]	
Other	74.97	[62.20 - 84.51]	25.03	[15.49 - 37.80]	
Region					
North	79.36	[77.44 - 81.15]	20.64	[18.85 - 22.56]	0.00
Northeast	74.48	[72.70 - 76.17]	25.52	[23.83 - 27.30]	
Southeast	68.41	[65.72 - 70.99]	31.59	[29.01 - 34.28]	
South	73.56	[70.49 - 76.42]	26.44	[23.58 - 29.51]	
Midwest	72.66	[69.39 - 75.72]	27.34	[24.28 - 30.61]	
Fatty red meat consumption					
No	72.80	[71.11 - 74.42]	27.20	[25.58 - 28.89]	0.04
Yes	69.59	[66.88 - 72.16]	30.41	[27.84 - 33.12]	

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(GFR <60 ml/min/1.73 m²) (PRadj 0.71; 95%CI: 0.56-0.90) were identified as protective factors, that is, lower salt intake.

Discussion

The study analyzed PNS data and identified the demographic, behavioral, and clinical factors associated with high salt consumption (≥10.56 g/day), corresponding to the P75 of this parameter's distribution in the adult Brazilian population. Higher intake was associated with male or overweight, obesity, or diabetes, while lower consumption was associated with higher education, living in the North, and CKD.

For the first time, PNS allowed estimating salt consumption in the Brazilian population through urine analysis[11]. Data point to widespread high intake in the population since only 3.4% of them showed consumption recommended by the WHO (<5 g daily), which converges with results from other studies in Brazil and other countries[11,26-29].

The gold standard for estimating salt consumption is 24-hour urine collection. However, this method is challenging to perform in population studies due to the great possibility of collection errors, which significantly reduces the measurement's precision and, consequently, the method's reliability. Thus, there is a trend in the literature to adopt spot collection to obtain the

Table 1. Estimated salt intake (g/day) in the Brazilian population, according to sociodemographic characteristics, lifestyle, and comorbidities. PNS, 2014-2015.

Variables	Estimated salt intake (g/day)				p*
	Less than P75 (<10.56 g/day)		Greater or equal to P75 (≥10.56 g/day)		
	%	95%CI	%	95%CI	
Soft drinks consumption 5 days/week and over					
No	72.09	[70.55 - 73.58]	27.91	[26.42 - 29.45]	0.52
Yes	70.96	[67.78 - 73.95]	29.04	[26.05 - 32.22]	
Alcoholic beverage consumption once a month and over					
No	72.80	[71.25 - 74.30]	27.20	[25.70 - 28.75]	0.02
Yes	69.00	[65.96 - 71.89]	31.00	[28.11 - 34.04]	
Tobacco use					
No	71.56	[70.07 - 73.01]	28.44	[26.99 - 29.93]	0.37
Yes	73.39	[69.58 - 76.88]	26.61	[23.12 - 30.42]	
Body mass index					
Underweight/normal weight	76.58	[74.45 - 78.59]	23.42	[21.41 - 25.55]	0.00
Overweight	71.11	[68.79 - 73.33]	28.89	[26.67 - 31.21]	
Obesity	64.16	[61.13 - 67.08]	35.84	[32.92 - 38.87]	
Diabetes (HbA1C≥6.5 or medication use)					
No	72.31	[70.83 - 73.74]	27.69	[26.26 - 29.17]	0.00
Yes	65.70	[60.99 - 70.12]	34.30	[29.88 - 39.01]	
Measured high blood pressure					
No	72.21	[70.74 - 73.62]	27.79	[26.38 - 29.26]	0.13
Yes	68.79	[64.32 - 72.93]	31.21	[27.07 - 35.68]	
High total cholesterol (≥200 mg/dL)					
No	71.34	[69.57 - 73.06]	28.66	[26.94 - 30.43]	0.46
Yes	72.43	[70.11 - 74.64]	27.57	[25.36 - 29.89]	
CKD (GFR <60 mL/min/1.73 m2)					
No	71.07	[69.60 - 72.50]	28.93	[27.50 - 30.40]	0.00
Yes	81.04	[76.39 - 84.96]	18.96	[15.04 - 23.61]	
Anemia (Hb <12 g/dL)					
No	71.52	[69.97 - 73.03]	28.48	[26.97 - 30.03]	0.54
Yes	72.81	[68.84 - 76.44]	27.19	[23.56 - 31.16]	
Self-assessed health status					
Very good/good	72.00	[70.22 - 73.72]	28.00	[26.28 - 29.78]	0.80
Fair	71.79	[69.35 - 74.10]	28.21	[25.90 - 30.65]	
Poor/very poor	70.17	[65.00 - 74.88]	29.83	[25.12 – 35.00]	

*Chi-square test p-value.
Source: Elaborated by authors.

sodium/creatinine ratio and estimate the mean population intake[30,31] using formulas. This strategy was adopted in the PNS and other countries[32], enabling greater adherence and speed in obtaining the data. Applying the Tanaka equation was because it showed better performance in a validation study[18], which was also found in other populations[32]. A validation study[18] showed that the Tanaka formula estimates salt consumption with an accuracy of 1 g/day, with good performance to estimate large groups' mean intake. However, accuracy is low at the extremes. Therefore, in clinical practice, the recommendation remains to measure salt intake by 24-hour urine collection or 12-hour nighttime collections, when collection errors tend to be smaller[31,33].

Studies point to an association between high salt consumption and arterial hypertension[34] and cardiovascular diseases[35]. However, in the current study, arterial hypertension was not associated

Table 2. Crude and adjusted Prevalence Ratio of high salt consumption (highest quartile), according to sociodemographic characteristics, lifestyle, and comorbidities in the Brazilian population. PNS, 2014-2015.

Variables	Estimated salt intake (g/day)							
	Greater or equal to P75 (≥10.56 g/day)		PR_{crude}	95%CI		$PR_{adjusted}$*	95%CI	
	%	95%CI						
Total	28.14	[26.79 - 29.52]						
Gender**								
Male	32.84	[30.68 - 35.07]	1.00			1.00		
Female	23.88	[22.27 - 25.57]	0.73	0.66	0.80	0.73	0.66	0.80
Age group***								
18-29 years	27.84	[24.85 - 31.03]	1.00			1.00		
30-44 years	30.59	[28.16 - 33.14]	1.10	0.96	1.26	1.11	0.97	1.27
45-59 years	27.80	[25.38 - 30.35]	1.00	0.87	1.15	1.01	0.87	1.16
60 years and over	24.80	[22.21 - 27.60]	0.89	0.76	1.04	0.91	0.78	1.06
Schooling								
Illiterate	29.02	[27.05 - 31.08]	1.00			1.00		
Elementary school	30.23	[26.73 - 33.98]	1.04	0.91	1.20	1.00	0.86	1.15
High school and over	26.66	[24.60 - 28.81]	0.92	0.83	1.02	0.88	0.79	0.99
Skin color								
White	27.82	[25.78 - 29.95]	1.00			1.00		
Black	29.90	[25.35 - 34.90]	1.08	0.90	1.28	1.07	0.90	1.27
Brown	28.18	[26.29 - 30.15]	1.01	0.92	1.12	1.00	0.90	1.11
Other	25.03	[15.49 - 37.80]	0.90	0.57	1.42	0.92	0.58	1.45
Region								
North	20.64	[18.85 - 22.56]	1.00			1.00		
Northeast	25.52	[23.83 - 27.30]	1.24	1.10	1.38	1.25	1.11	1.40
Southeast	31.59	[29.01 - 34.28]	1.53	1.35	1.73	1.55	1.37	1.76
South	26.44	[23.58 - 29.51]	1.28	1.11	1.48	1.30	1.12	1.50
Midwest	27.34	[24.28 - 30.61]	1.32	1.14	1.53	1.33	1.15	1.54

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with high salt intake. This may have occurred due to the study's cross-sectional design or because blood pressure was not considered a continuous variable in the analysis but regarding the proportion of individuals in quartiles. Also, high overall consumption in the Brazilian population can hinder the detection of an existing association. However, the evidence for the association of sodium consumption and hypertension is well established in the literature, and guidelines regarding the application of preventive actions remain, aiming at reducing consumption and events related to NCDs[36-38].

This study pointed to an association with lower salt consumption in individuals with CKD (GFR ≤60 ml/min/1.73 m²), calculated using the CKD-EPI formula (Chronic Kidney Disease Epidemiology Collaboration)[24]. It is noteworthy that in this condition, it is already established that the reduction of salt intake is necessary to avoid the appearance of edema and to reduce renal overload[39]. Thus, this data suggests adherence, at least in part of the individuals, to the recommendation to reduce salt intake in these conditions. On the contrary, there was no difference in salt consumption in individuals with high blood pressure at home. One of the essential recommendations in hypertensive patients is the reduction of salt in the diet to reduce the pressure and increase the pharmacological response to antihypertensive drugs. This finding can be explained because, in cross-sectional studies, hypertensive individuals have higher urinary sodium excretion than normotensive individuals[40]. This data indicates low adherence to this dietary recommendation among people with high blood pressure.

Table 2. Crude and adjusted Prevalence Ratio of high salt consumption (highest quartile), according to sociodemographic characteristics, lifestyle, and comorbidities in the Brazilian population. PNS, 2014-2015.

Variables	Estimated salt intake (g/day)							
	Greater or equal to P75 (≥10.56 g/day)		PR_{crude}	95%CI		$PR_{adjusted}$*	95%CI	
	%	95%CI						
Fatty red meat consumption								
No	27.20	[25.58 - 28.89]	1.00			1.00		
Yes	30.41	[27.84 - 33.12]	1.12	1.01	1.24	1.04	0.93	1.16
Soft drinks consumption 5 days/week and over								
No	27.91	[26.42 - 29.45]				1.00		
Yes	29.04	[26.05 - 32.22]	1.04	0.92	1.17	1.02	0.91	1.15
Alcoholic beverage consumption once a month and over								
No	27.20	[25.70 - 28.75]	1.00			1.00		
Yes	31.00	[28.11 - 34.04]	1.14	1.02	1.27	1.03	0.91	1.15
Tobacco use								
No	28.44	[26.99 - 29.93]	1.00			1.00		
Yes	26.61	[23.12 - 30.42]	0.94	0.81	1.08	1.12	0.97	1.29
Body mass index								
Underweight/normal weight	23.42	[21.41 - 25.55]	1.00			1.00		
Overweight	28.89	[26.67 - 31.21]	1.23	1.10	1.39	1.23	1.09	1.39
Obesity	35.84	[32.92 - 38.87]	1.53	1.36	1.73	1.61	1.43	1.83
Diabetes (HbA1C≥6.5 or medication use)								
No	27.69	[26.26 - 29.17]	1.00			1.00		
Yes	34.30	[29.88 - 39.01]	1.24	1.07	1.43	1.36	1.17	1.58
Measured high blood pressure								
No	27.79	[26.38 - 29.26]	1.00			1.00		
Yes	31.21	[27.07 - 35.68]	1.12	0.97	1.30	1.11	0.95	1.29
High total cholesterol (≥200 mg/dL)								
No	28.66	[26.94 - 30.43]	1.00			1.00		
Yes	27.57	[25.36 - 29.89]	0.96	0.87	1.07	0.99	0.89	1.09
CKD (GFR <60 mL/min/1.73 m2)								
No	28.93	[27.50 - 30.40]	1.00			1.00		
Yes	18.96	[15.04 - 23.61]	0.66	0.52	0.83	0.71	0.56	0.90
Anemia (Hb <12 g/dL)								
No	28.48	[26.97 - 30.03]	1.00			1.00		
Yes	27.19	[23.56 - 31.16]	0.95	0.82	1.11	0.97	0.84	1.13
Self-assessed health status								
Very good/good	28.00	[26.28 - 29.78]	1.00			1.00		
Fair	28.21	[25.90 - 30.65]	1.01	0.91	1.12	1.06	0.95	1.18
Poor/very poor	29.83	[25.12 - 35.00]	1.07	0.89	1.27	1.17	0.98	1.40

*PR adjusted for age and gender; **PR adjusted for age; ***PR adjusted for gender.
Source: Elaborated by authors.

The high salt consumption detected in this study had already been observed in the 2002-2003 POF[7]. POF analyses showed that the primary source of sodium comes from the salt added in food preparation[7,8]. A progressive reduction in the annual household purchase of salt (refined or coarse) was observed in Brazil, from 2.98 to 2.47 kg per capita[7]. However, this fact may not have affected individual consumption due to the increased intake of processed and ultra-processed foods[41], which contain high salt levels, besides the increased participation of food outside the home in the population's dietary behavior[41,42]. Thus, it can be considered that there has been no substantial reduction in salt consumption in the Brazilian population since the 2002-2003 POF. However, the variation in consumption can only be determined in serial studies and using the same methods to measure the consumption of this nutrient[31].

Self-reported research, such as "Surveillance of Risk and Protection Factors for Chronic Diseases by Telephone Survey" (VIGITEL), showed that men have unhealthier dietary indicators than women and lower perception of high salt consumption[13]. Also, higher salt intake among younger people has been described in the previous analyses[11]. However, when adjusting for schooling, these differences disappeared, showing that the exceptionally high salt consumption is distributed in all age groups in the general Brazilian population.

The literature points out worse diet quality indicators in individuals with lower education[11,43], and schooling is a proxy for socioeconomic status. Higher education results in greater access to information, preventive exams, and earlier medical diagnoses, which would result in better health indicators, corroborating other data found in the PNS[38].

The lower salt intake in the North region must be analyzed and compared with POF data, but it can be explained by the lower consumption of ultra-processed foods in this region (11.4% of calories, while the national average is 18.4%), with a high proportion of rural and riverside population sustaining a more traditional food style[44].

This study revealed a direct association between body fat accumulation and higher salt consumption. In this sense, studies show the association between high sodium intake and obesity by increasing consumption of sugar-added drinks, which also contain sodium in their composition[45]. However, there may also be a relationship between sodium intake and obesity regardless of the energy consumed, due to still little known physiological and metabolic mechanisms[2,46].

Another finding of the study was the association between diabetes and high salt consumption. Studies show that reducing sodium intake can attenuate insulin resistance (IR) and induce changes in serum lipoproteins and inflammation markers similar to those found in the metabolic syndrome (MS)[47]. Meta-analysis indicates beneficial effects of moderate sodium restriction in the diet in diabetes control[48]. Therefore, the opposite of what was found in the current study was expected, which requires further investigation. It is necessary to question the industry's call for patients with diabetes to prefer foods with *diet* or *light* labels, which have a higher amount of sodium in their composition, and guide the reformulation of ultra-processed foods[49,50]. Thus, soft drinks, sweeteners, and others widely consumed by people with diabetes could contribute to these patients' high sodium consumption and explain the data found here. Recent evidence indicates a possible higher sodium intake in diabetic individuals in some countries, particularly when they are also hypertensive[51]. Still, studies point to people's growing consumption of non-caloric sweeteners worldwide and that people with diabetes are the largest consumers of artificial sweeteners[52]. They also evidence that the high intake of sugar-added drinks, which also contribute to sodium intake through sweeteners based on this mineral, is associated with a higher risk of stroke[53].

This study points to high salt consumption in general in the Brazilian population and indicates that intake reduction programs should be aimed at the entire population. Among the initiatives, noteworthy are the 2011 National Plan for Coping with NCDs[14,54], the WHO Global NCD Action Plan[55], which contains sodium content reduction targets, and the "Brazilian Population Food Guide", which contains information and guidance on the choice, preparation, and consumption of food (including the use of small amounts of culinary ingredients, such as salt, sugar, oils, and fats) and strengthens the narrative of valuing the consumption of fresh food of regional origin, alerting for the risks associated with the consumption of ultra-processed foods, resulting from high levels of sodium, fats, and sugars[56]. From this perspective, the implementation of voluntary agreements (terms of commitment) with segments of the productive sector in the industrial food chain reduced the sodium content in most processed foods evaluated[41]. However, the data analyzed here indicate that we are far from reaching the voluntary goals of reducing sodium intake. Thus, it seems necessary to move forward in food regulation and control measures, such as frontal nutritional labeling with a warning, regulation of the sale and advertising of ultra-processed foods, and taxation of unhealthy foods and drinks[43].

Among the main limitations of this study is that the standard gold method was not used to estimate sodium consumption. However, a lower-cost and easier-to-use method was adopted in population surveys, already validated for the Brazilian population in a previous study[18]. We underscore that due to the Brazilian population's excessive salt intake, the reference category for consumption used also contains individuals who consume over the daily 5 g recommended by the WHO[6]. This fact may have influenced the results presented here, reducing the strength of the association between high sodium consumption and the factors studied. However, it is noteworthy that, even so, statistically significant results were observed, which reinforces the value of the findings.

This study points out that salt intake is high nationwide and in all subgroups of the population, requiring coordinated coping actions, such as improving access to healthy food, implementing health education actions, and regulating and monitoring agreements signed with the food industry.

Collaborations

DC Malta, JG Mill, RTI Bernal participated in the conception, design, and data analysis and interpretation. DC Malta wrote the first version of the paper. RTI Bernal performed statistical analysis. EAF Nilson, IE Machado, PC Jaime, LSM Cardoso, CL Szwarcwald performed data analysis and critical review of the manuscript. All authors approved the version to be published.

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