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Estimation of salt intake in the Brazilian population: results from the 2013 National Health Survey

Estimativa do consumo de sal pela população brasileira: resultado da Pesquisa Nacional de Saúde 2013

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ABSTRACT: ***Objective:*** To estimate the salt intake in the Brazilian population according to their urinary sodium excretion. ***Methods:*** The National Health Survey (2013) aimed to gather data on the health of adults (≥ 18 years) through a random selection of households. In each household, one adult was selected to have their biological data collected (anthropometry, blood pressure, and blood and urine tests). The urine sample was sent to a central laboratory to determine sodium (ion-selective electrode) and creatinine (Jaffé method) concentrations. Sodium excretion was estimated with the Tanaka equation. ***Results:*** Urinary sodium and creatinine concentrations were measured in 8,083 individuals (58% women). The mean salt intake was estimated at 9.34 g/day (95% confidence interval – 95%CI 9.27 – 9.41) and was higher in males (9.63 g/day; 95%CI 9.52 – 9.74) than in females (9.08 g/day; 95%CI 8.99 – 9.17). We found no significant differences regarding age group, ethnicity, or schooling. Salt intake was higher in the Southeast and South regions and lower in the Northeast and North. Only 2.4% (95%CI 2.0 – 2.8) of the sample consumed less than 5 g/day, and 58.2% (95%CI 56.7 – 59.6) of participants had an estimated intake of 8 to 12 g/day. ***Conclusion:*** The mean salt intake in the Brazilian population is approximately twice the recommended by the World Health Organization (5 g/day). Given the association of high salt intake with hypertension and decreased renal function, these data indicate the need to adopt comprehensive public policies to reduce the consumption in the Brazilian population.

Keywords: Urine. Sodium. Diet. Arterial pressure. Brazil.

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RESUMO: ***Objetivo:*** Estimar o consumo de sal na população brasileira pela excreção urinária de sódio. ***Métodos:*** A Pesquisa Nacional de Saúde (2013) teve como objetivo obter dados de saúde de adultos (≥ 18 anos) por meio de seleção aleatória de domicílios. Em cada domicílio foi selecionado um adulto para coleta de dados biológicos (antropometria, pressão arterial, sangue e urina). A urina foi enviada para um laboratório central, para medida da concentração de sódio (eletrodo sensível) e creatinina (método de Jaffé). A estimativa da excreção de sódio foi feita com a equação de Tanaka. ***Resultados:*** A dosagem urinária de sódio e de creatinina foi obtida em 8.083 indivíduos (58% mulheres). O consumo médio de sal foi estimado em 9,34 g/dia (intervalo de confiança de 95% — IC95% 9,27 – 9,41), sendo maior em homens (9,63 g/dia; IC95% 9,52 – 9,74) do que em mulheres (9,08 g/dia; IC95% 8,99 – 9,17). Não foram observadas diferenças importantes em relação à faixa etária, cor da pele nem escolaridade. O maior consumo foi detectado nas regiões Sudeste e Sul e o menor no Nordeste e Norte. Apenas 2,4% (IC95% 2,0 – 2,8) da amostra apresentou consumo inferior a 5 g/dia, e 58,2% (IC95% 56,7 – 59,6) dos participantes tiveram consumo estimado de 8 a 12 g/dia. ***Conclusão:*** O consumo médio de sal da população brasileira é, aproximadamente, o dobro da recomendação da Organização Mundial da Saúde (5 g/dia). Tendo em vista a associação da alta ingestão de sal com hipertensão arterial e decréscimo da função renal, os dados apontam para a necessidade de adoção de políticas públicas abrangentes para redução desse consumo na população brasileira.

Palavras-chave: Urina. Sódio. Dieta. Pressão arterial. Brasil.

INTRODUCTION

Chronic non-communicable diseases (NCDs) are responsible for approximately 70% of global mortality and, among them, deaths from cardiovascular diseases (CVDs) are the most common[1]. Arterial hypertension (AH) is the most important risk factor for cardiovascular morbidity and mortality[2-5]. The prevalence of AH is quite high, affecting 28% of Brazilian adults[6], and its onset depends on genetic predisposition and lifestyle-related factors[7]. Thus, low levels of education and income, sedentary lifestyle, weight gain, and insulin resistance are factors associated with the increase in blood pressure with age and, consequently, higher blood pressure levels in adults[2,8,9]. Children have lower blood pressure levels than adults. Body growth is associated with the progressive increase in blood pressure, which should stabilize in adulthood. In some individuals, however, blood pressure continues increasing and eventually they develop hypertension. Data from the Intersalt study suggest that sodium intake is a key factor for the rise in blood pressure during adulthood[5,9,10].

Table salt has been used for millennia as a food preservative. Over time, the primitive diet, high in potassium and low in sodium, was progressively replaced by the current one, which presents an inversion of this relationship. Sodium is an important dietary component for the maintenance of blood volume and blood pressure[11]. However, a diet high in sodium and low in potassium increases blood pressure levels and facilitates the onset of AH. Therefore, low sodium and high potassium intake are recommended to prevent the development of AH in genetically susceptible individuals; however, the current dietary pattern of the population is very far from reaching the suggested daily intake of sodium and potassium (2 and 3 g, respectively)[12]. Estimates indicate that up to 10% of deaths from CVDs can be attributed to sodium intake exceeding 2 g/day[12-14].

The mechanism that allows high sodium intake to increase blood pressure is still little known, but the greater consumption of this nutrient leads to water retention to maintain osmotic balance, with extracellular volume expansion[11]. In the long term, sodium also accumulates inside the smooth muscle cells of arterioles, causing increased peripheral vascular resistance and persistence of high blood pressure levels[11]. In addition to AH, excessive salt intake also predisposes to other comorbidities, including chronic kidney disease, ventricular hypertrophy, cerebrovascular accident, and even obesity[15-18].

The World Health Organization (WHO) recommends daily consumption of up to 2 g of sodium, equivalent to 5 g of table salt[12]. The Global Burden of Diseases Nutrition and Chronic Diseases Expert Group (NutriCoDE) estimated the mean sodium intake in the global population. They collected data from 66 countries and, using a hierarchical Bayesian model, calculated a mean sodium intake of 3.95 g/day, with a variation of 2.18 to 5.51 g/day[19]. Based on these data, we can estimate that more than 95% of the world's population consumes excess salt[20].

More robust studies on salt intake in Brazil are still scarce, and most estimates were based on questionnaires, which can lead to inaccurate measurements due to the low perceived salt intake by the population[21]. In Vitória, Espírito Santo, using the 12-hour urine collection, salt intake was estimated at 12.6 g/day, with a standard deviation of 5.6 g/day[22]. Data from the National Household Budget Survey (HBS, 2008–2009) revealed a mean sodium intake of 4.7 g/day, equivalent to 12 g/day of salt[23]. Also in Vitória, salt intake was estimated at 11.4 g/day with the 24-hour urine collection[24]. Thus, regardless of the method, region, and period, all data indicate that salt intake is more than twice the recommended by WHO.

The Strategic Action Plan for Tackling Chronic NCDs in Brazil (2011–2022) defined reducing salt intake as one of its goals[25]. In 2013, WHO set a target to reduce by 30% the mean salt intake[26]. The Ministry of Health included questions about salt intake in the 2013 National Health Survey (NHS) and also planned a casual urine collection to estimate the consumption of this nutrient so as to monitor this variable in Brazil[27]. The objective of this study was to estimate the salt intake in the Brazilian adult population according to their urinary sodium concentration.

METHODS

We used data from the 2013 NHS collected by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* – IBGE) in partnership with the Ministry of Health. NHS is a household survey with a representative sample of the Brazilian population that covers all states in the country. It aims at characterizing the health status and lifestyle of the adult population[28].

NHS has a complex three-stage sampling process: census tracts, households, and individuals. Census tracts, or set of tracts, comprise the primary sampling units; households are the secondary units; and residents aged 18 years or older represent the tertiary sampling units. In each census tract, 10 to 14 households were selected, and in each household, an adult ≥ 18 years was chosen by drawing[28,29].

The questionnaire administered in the household was divided into three parts to collect different types of information. The first involved questions about the household; the second, about socioeconomic characteristics and use of health services by all residents of the household; the third was a self-report of the health status and lifestyle of the individual randomly selected[29]. This individual also had his or her weight, height, waist circumference, and blood pressure measured[30]. A subsample of these individuals also had their blood and urine collected.

A total of 6,069 census tracts and 81,254 households were selected, of which 69,994 were eligible for the study, composing the sample of interviewees. Interviews were conducted in 64,348 households, with 60,202 complete individual interviews. After the household interviews, the information of the participants selected for the subsample was transferred to the laboratory for later collection of biological material. The goal was to include 15 thousand individuals from cities with better infrastructure for the collection, using probability proportional to the inverse of the distance between the city where the primary sampling unit was located and the nearest city with at least 80 thousand inhabitants. However, only 8,952 individuals had their material collected for analysis (blood and urine) due to operational issues. The main reasons for these losses were: the laboratory agent did not locate the household, the individual refused to have his or her material collected, unawareness of the project, and unavailability to receive the researcher.

Out of the 8,952 urine samples, 8,083 were analyzed, with the losses (10.0%) resulting from incomplete tests or insufficient material. Due to sample losses, we adopted a post-stratification method, which included variables such as gender, age, ethnicity, and region, aiming at reducing non-representativeness bias. Another publication[30] described the details about the sampling process, data collection, and weighting.

The selected resident had his or her urine sample collected at home with no time constraints and no prior food restriction. The urine sample could be the first in the morning or any other, as long as the participant went at least 2 hours without urinating. The project provided the materials for collection. The participant was instructed to wash his or her hands, clean the genital area with water and soap, discard the first stream, collect the urine in a wide mouth container, and then pour the urine collected into a narrow capped tube. A 5 mL aliquot of the sample was transferred to a sterile vial, put in a thermal bag, and stored in a refrigerator until it was sent to the central laboratory, located in São Paulo.

The urinary sodium concentration was determined by the ion-selective electrode method, and creatinine (Cr) levels, by the Jaffé method[31,32].

The 24-h urinary sodium excretion was estimated by the equation of Tanaka et al.[33], which was validated for the Brazilian population in a substudy in Vitória[34]. To use this equation, initially, the Cr excretion predicted for 24 h (CrPr24h) is estimated based on age, weight, and height, as in Equation 1:

$$\text{CrPr24h} = \{(14.89 \times \text{weight, kg}) + [(16.14 \times \text{height, cm}) \times (2.04 \times \text{age, years})] - 2{,}244.5\} \quad (1)$$

After determining the CrPr24h, Equation 2 calculates the urinary sodium excretion in 24 hours (NaUr, mEq):

$$\text{NaUr (mEq)} = [\text{Na casual urine, mEq/L}/(\text{Cr casual urine, mg/dL} \times 10)] \times \text{CrPr24h} \quad (2)$$

Lastly, an exponential equation (Equation 3) estimates the sodium excretion in 24 h (mEq):

$$\text{Na24h (mEq)} = 21.98 \times \text{NaUr}^{0.398} \quad (3)$$

Salt intake was calculated considering all sodium excreted in the urine, ingested as NaCl (Equation 4):

$$\text{Estimated salt intake (g/day)} = \text{Na24 h (mEq)} \times 58.5 \quad (4)$$

The estimated salt intake was described according to gender (male and female), age group (18 to 29; 30 to 44; 45 to 59; and 60 or older), schooling (illiterate up to incomplete elementary school; complete elementary school up to incomplete high school; and complete high school and higher), ethnicity (white, black, multiracial, and other), and region of Brazil (North, Northeast, Midwest, Southeast, and South). We analyzed the data with the software Stata (Stata Corp. 2015 Statistical Software Release 14, College Station, TX, USA), using the set of commands for surveys with a complex sample. Continuous data were expressed as mean and standard deviation and 95% confidence interval (CI).

The National Research Ethics Committee (*Comissão Nacional de Ética em Pesquisa* – CONEP) of the National Health Council, Ministry of Health, approved the 2013 NHS (Report No. 328,159 of June 26, 2013).

RESULTS

Table 1 presents the estimated salt intake according to sociodemographic characteristics. The mean salt intake was 9.34 g/day (95%CI 9.27 – 9.41) and was higher in males (9.63 g/day;

95%CI 9.52 – 9.74; N=3,391) than in females (9.08 g/day; 95%CI 8.99 – 9.17; N=4,692). The age group 30 to 44 years had the highest consumption (9.56 g/day; 95%CI 9.44 – 9.68), while the group ≥ 60 years had the lowest (9.01 g/day; 95%CI 8.86 – 9.17). Ethnicity and schooling did not show a significant difference in salt intake. As to the regions of Brazil, we found lower intake in the North Region (8.78 g/day; 95%CI 8.68 – 8.88) and

Table 1. Mean daily salt intake (g/day) among the Brazilian adult population according to sociodemographic variables. 2013 National Health Survey (NHS), Brazil.

Total (n=8,083)	Mean	SE	Lower CI	Upper CI
	9.34	0.04	9.27	9.41
Gender				
Male	9.63	0.06	9.52	9.74
Female	9.08	0.05	8.99	9.17
Age group (years)				
18 to 29	9.36	0.08	9.20	9.53
30 to 44	9.56	0.06	9.44	9.68
45 to 59	9.28	0.06	9.16	9.41
60 or older	9.01	0.08	8.86	9.17
Schooling (years)*				
Range A	9.34	0.05	9.23	9.44
Range B	9.52	0.10	9.32	9.72
Range C	9.28	0.05	9.18	9.39
Ethnicity				
White	9.35	0.05	9.24	9.46
Black	9.36	0.14	9.08	9.64
Multiracial	9.33	0.05	9.23	9.43
Other	9.28	0.34	8.62	9.94
Region				
North	8.78	0.05	8.68	8.88
Northeast	9.19	0.05	9.10	9.28
Southeast	9.50	0.07	9.36	9.64
South	9.40	0.08	9.25	9.55
Midwest	9.33	0.08	9.17	9.50

SE: standard error; CI: confidence interval; N: number of individuals; *range A: illiterate up to incomplete elementary school; range B: complete elementary school up to incomplete high school; range C: complete high school or higher.

higher in the Southeast (9.50 g/day; 95%CI 9.36 – 9.64) and South (9.40 g/day; 95%CI 9.25 – 9.55).

Table 2 shows the ranges of salt intake according to sociodemographic characteristics. Only 2.39% of the sample consumed < 5 g/day, that is, within the range recommended by WHO. The

Table 2. Ranges of estimated salt intake according to sociodemographic characteristics. 2013 National Health Survey (NHS), Brazil*.

	< 5 g/day (n=241)		5 to < 8 g/day (n=2,279)		8 to < 12 g/day (n=4,702)		≥ 12 g/day (n=861)		p
	%	95%CI	%	95%CI	%	95%CI	%	95%CI	
Total	2.4	2.0 – 2.8	26.3	25.0 – 27.6	58.2	56.7 – 59.6	13.1	12.1 – 14.2	
Gender									
Male	1.9	1.4 – 2.5	22.2	20.4 – 24.1	60.2	57.9 – 62.4	15.7	14.0 – 17.6	< 0.001
Female	2.8	2.3 – 3.5	30.0	28.3 – 31.8	56.4	54.5 – 58.3	10.8	9.6 – 12.1	
Age (years)									
18 to 29	1.7	1.0 – 2.8	26.3	23.4 – 29.3	59.6	56.2 – 62.9	12.4	10.2 – 15.0	< 0.001
30 to 44	1.9	1.3 – 2.7	23.5	21.5 – 25.8	59.4	56.9 – 62.0	15.2	13.2 – 17.3	
45 to 59	2.6	1.9 – 3.5	26.3	24.0 – 28.8	58.8	56.1 – 61.4	12.3	10.5 – 14.4	
60 or older	4.0	3.1 – 5.3	31.1	28.4 – 33.9	53.1	50.1 – 56.1	11.8	9.9 – 14	
Schooling (years)**									
Range A	3.0	2.4 – 3.7	26.9	25.1 – 28.7	55.8	53.6 – 57.9	14.4	12.8 – 16.2	< 0.001
Range B	2.4	1.5 – 3.8	23.9	20.9 – 27.3	58.6	54.8 – 62.3	15.1	12.3 – 18.3	
Range C	1.9	1.4 – 2.6	26.6	24.6 – 28.8	60.1	57.8 – 62.4	11.4	9.9 – 13.0	
Ethnicity									
White	1.8	1.3 – 2.5	25.9	23.9 – 28	59.5	57.2 – 61.8	12.8	11.3 – 14.5	< 0.001
Black	3.0	1.8 – 5.0	29.9	25.6 – 34.6	51.3	46.3 – 56.3	15.8	12.1 – 20.5	
Multiracial	2.9	2.3 – 3.6	25.9	24.2 – 27.7	58.3	56.2 – 60.2	13.0	11.5 – 14.5	
Other	3.2	1.4 – 7.1	28.3	16.9 – 43.3	57.2	43.1 – 70.2	11.4	5.0 – 23.8	
Region									
North	4.0	3.2 – 4.9	32.9	30.8 – 35.1	55.4	53.1 – 57.6	7.7	6.6 – 9.1	< 0.001
Northeast	2.7	2.1 – 3.4	27.3	25.6 – 29.1	59.1	57.2 – 61.0	11.0	9.8 – 12.3	
Southeast	2.1	1.5 – 3.1	25.6	23.2 – 28.1	56.6	53.7 – 59.3	15.8	13.8 – 18.0	
South	1.8	1.2 – 2.8	24.5	21.7 – 27.5	60.7	57.4 – 64.0	12.9	10.8 – 15.4	
Midwest	2.6	1.7 – 3.9	24.3	21.4 – 27.5	62.5	59.0 – 65.9	10.6	8.6 – 13.1	

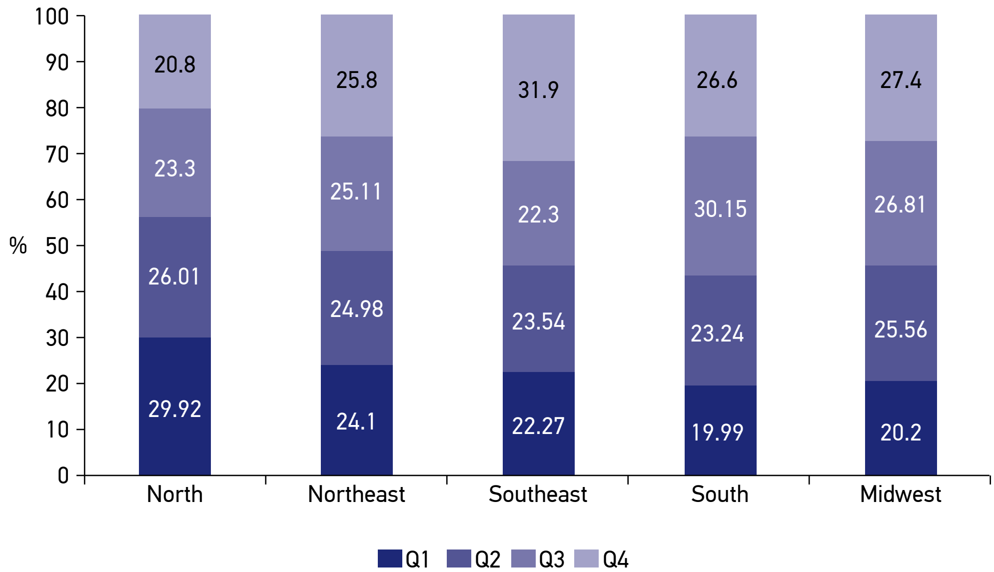
*Data in g/day; n: number of individuals; 95%CI: 95% confidence interval; **same ranges described in Table 1.

consumption within this range was greater among women, older individuals, and in Northern Brazil. Considering the moderately high intake (5 to 8 g/day), only 30% of individuals reached its upper limit. Most participants consumed 8 to 12 g/day. Very high intake (≥ 12 g/day) was more frequent in men (15.7%; 95%CI 14.0 – 17.6) than in women (10.8%; 95%CI 9.6 – 12.1). In the group with higher schooling, a smaller proportion of individuals consumed ≥ 12 g/day (11.35%; 95%CI 9.90 – 12.98). With respect to regions, the percentage of individuals with very high intake was lower in the North and Midwest regions. Figure 1 demonstrates how the intake quartiles are distributed among the regions. The lowest quartile (less intake) was more representative in the North region, while the highest (more intake) was prevalent in the Southeast (31.9% of individuals).

According to Table 2, 71.3% of the total population presented high salt intake (≥ 8 g/day), being more frequent in men (74.2%; 95%CI 73.9 – 77.8) than in women (67.2%; 95%CI 66.9 – 67.5). Regarding age group, the consumption decreased in individuals aged 60 years and older in both genders, especially among women ($p<0.001$). Schooling and ethnicity showed no differences. As to regions, high intake predominated ($p<0.001$) in the South (79.9%), Midwest (77.7%), and Southeast (77.5%), and was lower in the North (66.1%). High salt intake in females presented no differences among regions.

DISCUSSION

This was the first nationwide study that estimated salt intake in the Brazilian population according to urine analysis. Data indicate that nearly three-quarters of the population



Q1, Q2, Q3, Q4: quartiles.

Figure 1. Distribution of salt intake quartiles among the Brazilian great regions. 2013 National Health Survey (NHS), Brazil.

consumes a high amount of salt (> 8 g/day), being higher among men and younger people. Consumption had little variation among regions, with lower values in the North and higher in the South and Southeast.

Although 24-h urinary sodium excretion is the gold standard to estimate salt intake[35], this procedure is complex and difficult to adopt in epidemiological studies, as it presents important operational issues, requiring the individual to stay in a reserved place, suitable to collect and store urine. In this scenario, population studies with 24-h collection can be weakened by an increased refusal rate and collection errors[13,14].

Several studies have sought alternatives to simplify the collection, reduce costs, and minimize errors[35-37]. A pilot study performed in Vitória to validate equations that estimate 24-h urinary sodium excretion measured the sodium/creatinine ratio in casual urine[34]. In this investigation, the 24-h collection was combined with casual collection on the same day and in the same individuals. Salt intake was determined in the 24-h urine, and, based on data collected from the casual urine, two equations were tested to estimate salt intake[33,38]. The sodium/creatinine ratio was measured in the casual urine collected at any time of the day. The Tanaka formula was able to predict the consumption with accuracy of 1 g/day in individuals who ingested 9 to 12 g/day, that is, in the intake range of the population mean[34]. The study, in addition to validating the Tanaka equation, also defined the methodology used in the 2013 NHS across the country. This methodology facilitated the procedures for sample collection, reduced costs, and enabled its application in nationwide studies. We emphasize that requiring casual urine, and not 24-h collection, allowed a greater adherence and promptness in data gathering. Thus, Brazil has innovated and revealed a path for other countries, demonstrating that simpler techniques can also be adopted to aid in the monitoring of sodium intake[26,27].

The study confirmed previous estimates that indicated that salt intake in Brazil was high compared not only with the WHO recommendation (5 g/day) but also with other countries[5,9,13,15]. Given the association of high salt intake with AH[10] and CVDs[14], the data presented reinforce the need to implement preventive actions aimed at reducing its consumption and the events related to chronic NCDs[39-41].

Reducing sodium intake leads to a drop in mean blood pressure levels and, consequently, in the prevalence of AH[13,15,40] and incidence of cardiovascular events. Evidence from a meta-analysis of prospective studies showed that high sodium intake was associated with an increased mortality rate for coronary artery disease (relative risk – RR = 1.32; 95%CI 1.13 – 2.10) and cerebrovascular accident (RR = 1.63; 95%CI 1.27 – 2.10)[13]. Furthermore, dietary sodium was also related to non-fatal cardiovascular events, chronic kidney disease, and gastric cancer. On the other hand, reducing salt intake by 2.3 g/day was associated with a 3.8 mmHg (95%CI 3.08 – 4.55) drop in systolic blood pressure. Decreasing salt intake to values lower than 5 g/day showed no positive or adverse effects regarding renal function and levels of catecholamines and lipids in the blood[13,15].

Data from the 2013 NHS also revealed that the perceived high salt intake is low[21], as only 14.2% (95%CI 13.6 – 14.7) of adults declared their consumption as high, the inverse of what the urine levels evidenced. This perception was slightly higher in men (16.1%), individuals aged 18 to 29 years (17.3%), residents of urban areas (14.8%), and in the South Region (18.2%)[21]. We can speculate that this finding results not only from these individuals effectively consuming more salt but also because they are better informed about how this practice can be detrimental to their health and more aware of their lifestyle habits.

The high sodium intake detected in this study had already been identified in the 2002-2003 HBS[42]. The second edition of HBS (2008–2009) analyzed the reported food consumption in non-consecutive days in a sample of 21,003 individuals aged 20 to 59 years and revealed that excessive salt intake was more frequent in men than in women (89.3% vs. 70%)[23]. The Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (*Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico* – VIGITEL) showed that men have less healthy dietary indicators than women[43]. Studies that used questionnaires for data collection[21] had already reported a greater prevalence of high salt intake among younger individuals. Molina et al. identified higher salt intake – estimated based on 12-h urinary excretion – in individuals of lower socioeconomic status[22], data consistent with those from VIGITEL, which found worse indicators of dietary quality in subjects with lower education[43].

According to HBS, the main source of sodium is the salt added to food preparations[42]. The reduction in the annual per capita household acquisition of salt (fine or coarse) – from 2.98 to 2.47 kg[42] – between 2002–2003 and 2008–2009 does not indicate decrease in sodium intake, as the consumption of processed and ultra-processed foods increased in these periods, and these products usually have higher sodium content[44]. Moreover, the participation of out-of-home eating in total food consumption also increased during this time interval[23,45].

This study indicates that high salt intake is widespread in the Brazilian population, covering all age groups and levels of schooling. Therefore, programs that promote a reduction in salt intake should be developed to reach all these subcategories, and not only specific groups, such as patients with hypertension or kidney diseases. We underline that the 2011–2022 Strategic Action Plan for Tackling Chronic NCDs established initiatives to improve access to healthy foods in all life stages[25]. The "Dietary Guidelines for the Brazilian Population," released in 2014, provided information and recommendations about food choice, preparation, and intake, valuing the consumption of fresh foods of regional origin, and warning for the risks of consuming ultra-processed products, given their high sodium, fat, and sugar content[46].

Establishing voluntary agreements (consent decree) with segments of the productive sector involved in the industrial food chain was also an effective initiative, which has produced satisfactory results in other countries, such as England and Portugal. The assessment of these agreements showed a reduction in the sodium content of most processed foods evaluated[45].

Health, educational, and nutrition policies aimed at children and adolescents are also crucial in this area, given the growth in obesity and, consequently, blood pressure in this segment of the population. The Health at School Program (*Programa Saúde na Escola* – PSE) has encouraged actions that prevent obesity in childhood and adolescence by improving the dietary quality of foods provided in schools, stipulating a minimum offer of 30% of fresh foods[46,47].

In addition to educational actions, regulation and control measures for foods are also necessary, such as a national review of the standard nutrition labeling of packaged foods, so the consumers can understand and identify critical levels of components, like sodium, in processed foods; for instance, a recent experience in Chile included warnings in nutrition labels and placed them in the frontal part of the product[47].

CONCLUSION

Lowering salt intake is one of the interventions with better cost-effectiveness to reduce the chronic NCD burden, especially CVDs, mainly by decreasing the mean blood pressure levels in the population. Considering that hypertension is, directly and indirectly, responsible for approximately nine million deaths each year worldwide, reducing salt intake can potentially save millions of lives.

The Global Action Plan for the Prevention and Control of NCDs from WHO has defined targets to decrease salt intake, showing the importance of monitoring its consumption in population surveys. Thus, the data collected by NHS will serve as a baseline for the continued surveillance of this variable in the population.

The present study indicates that salt intake is high across the country and in all subgroups of the population, requiring coordinated actions to tackle this issue, such as improving access to healthy foods, promoting health education actions, and regulating and monitoring the agreements entered into with the food industry.

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REFERENCES

1. World Health Organization. Global status report on noncommunicable diseases 2014 [Internet]. World Health Organization; 2014 [acessado em 20 jan. 2018]. Disponível em: http://apps.who.int/iris/bitstream/10665/148114/1/9789241564854_eng.pdf?ua=1
2. Lewington S, Clarke R, Qizilbash N, Peto R, Collins R, Prospective Studies Collaboration. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. Lancet 2002; 360(9349): 1903-13. https://doi.org/10.1016/s0140-6736(02)11911-8
3. Graudal NA, Hubeck-Graudal T, Jurgens G. Effects of low sodium diet versus high sodium diet on blood pressure, renin, aldosterone, catecholamines, cholesterol, and triglyceride. Cochrane Database Syst Rev [Internet]. 2011 [acessado em 18 jan. 2018]; 9(11): CD004022. Disponível em: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD004022.pub3/full https://doi.org/10.1002/14651858.CD004022.pub3
4. O'Donnell MJ, Xavier D, Liu L, Zhang H, Chin SL, Rao-Melacini P, et al. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. Lancet 2010; 376(9735): 112-23. https://doi.org/10.1016/S0140-6736(10)60834-3
5. Brown IJ, Dyer AR, Chan Q, Cogswell ME, Ueshima H, Stamler J, et al. Estimating 24-h urinary sodium excretion from casual urinary sodium concentrations in western populations: The Intersalt Study. Am J Epidemiol [Internet] 2013 [acessado em 18 jan. 2018]; 177(11): 1180-92. Disponível em: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3664342/ https://doi.org/10.1093/aje/kwt066
6. Picon RV, Fuchs FD, Moreira LB, Riegel G, Fuchs SC. Trends in prevalence of hypertension in Brazil: a systematic review with meta-analysis. PloS One [Internet] 2012 [acessado em 21 jan. 2018]; 7(10): e48255. Disponível em: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3485225/ https://dx.doi.org/10.1371%2Fjournal.pone.0048255
7. Waken RJ, de Las Fuentes L, Rao DC. A review of the genetics of hypertension with a focus on gene-environment interactions. Curr Hypertens Rep 2017; 19(3): 23. https://dx.doi.org/10.1007/s11906-017-0718-1
8. Malta DC, Bernal RTI, Andrade SSCA, Silva MMA, Velasquez-Melendez G. Prevalência e fatores associados com hipertensão arterial autorreferida em adultos brasileiros. Rev Saúde Pública [Internet] 2017 [acessado em 21 jan. 2018]; 51(Supl. 1): 11s. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-89102017000200313&lng=en http://dx.doi.org/10.1590/s1518-8787.2017051000006
9. Elliott P, Marmot M, Dyer A, Joossens J, Kesteloot H, Stamler R, et al. The INTERSALT study: main results, conclusions and some implications. Clin Exp Hypertens A 1989; 11(5-6): 1025-34.
10. Henry JP. Stress, salt and hypertension. Soc Sci Med 1988; 26(3): 293-302. https://doi.org/10.1016/0277-9536(88)90393-0
11. Rust P, Ekmekcioglu C. Impact of salt intake on the pathogenesis and treatment of hypertension. Adv Exp Med Biol 2017; 956: 61-84. https://doi.org/10.1007/5584_2016_147
12. World Health Organization. Guideline: Sodium intake for adults and children [Internet]. Genebra: World Health Organization; 2012 [acessado em 15 jan. 2018]; 86(6): 2012. Disponível em: https://apps.who.int/iris/bitstream/handle/10665/77985/9789241504836_eng.pdf?sequence=1
13. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden disease and injury attributable to 67 risk factor clusters in 21 regions, 1990-2010: a systematic review for the Global Burden of Disease Study 2010. Lancet 2012; 380(9859): 2224-60.
14. Oparil S. Low sodium intake - Cardiovascular health benefit or risk? N Engl J Med [Internet]. 2014 [acessado em 21 jan. 2018]; 371: 677-9. Disponível em: http://www.nejm.org/doi/full/10.1056/NEJMe1407695
15. He FJ, Li J, MacGregor GA. Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomized trials. BMJ 2013; 346: f1325. https://doi.org/10.1136/bmj.f1325
16. Kim YC, Koo HS, Kim S, Chin HJ. Estimation of daily salt intake through a 24- hour urine collection in Pohang, Korea. J Korean Med Sci 2014; 29(Supl. 2): S87-90. https://doi.org/10.3346/jkms.2014.29.S2.S87
17. Ma Y, Fe FJ, McGregor GA. High Salt Intake. Independent Risk Factor for Obesity? Hypertension 2015; 66(4): 843-9. https://doi.org/10.1161/HYPERTENSIONAHA.115.05948
18. Choi Y, Lee JE, Chang Y, Kim MK, Sung E, Shin H, Ryu S. Dietary sodium and potassium intake in relation to non-alcoholic fatty liver disease. Br J Nutr 2016; 116(8): 1447-56. https://doi.org/10.1017/S0007114516003391
19. Micha R, Shulkin ML, Peñalvo JL, Khatibzadeh S, Singh GM, Rao M, et al. Etiologic effects and optimal intakes of foods and nutrients for risk of cardiovascular diseases and diabetes: Systematic reviews and meta-analyses from the Nutrition and Chronic Diseases Expert Group (NutriCoDE). PLos One 2017; 12(4): e0175149. https://doi.org/10.1371/journal.pone.0175149

20. Powles J, Fahimi S, Micha R, Khatibzadeh S, Shi P, Ezzati M, et al. Global, regional and national sodium intakes in 1990 and 2010: a systematic analysis of 24 h urinary sodium excretion and dietary surveys worldwide. BMJ Open [Internet] 2013 [acessado em 19 jan. 2018]; 3(12): e003733. Disponível em: http://bmjopen.bmj.com/content/3/12/e003733 https://doi.org/10.1136/bmjopen-2013-003733
21. Oliveira MM, Malta DC, Santos MAS, Oliveira TP, Nilson EAF, Claro RM. Consumo elevado de sal autorreferido em adultos: dados da Pesquisa Nacional de Saúde, 2013. Epidemiol Serv Saúde [Internet] 2015 [acessado em 16 jan. 2018]; 24(2): 249-56. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S2237-96222015000200249&lng=en http://dx.doi.org/10.5123/S1679-49742015000200007
22. Molina MCB, Cunha RS, Herkenhoff LF, Mill JG. Hipertensão arterial e consumo de sal em população urbana. Rev Saúde Pública [Internet] 2003 [acessado em 19 jan. 2018]; 37(6): 743-50. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-89102003000600009 http://dx.doi.org/10.1590/S0034-89102003000600009
23. Instituto Brasileiro de Geografia e Estatística. Coordenação de Trabalho e Rendimento. Pesquisa de Orçamentos Familiares 2008-2009: análise do consumo alimentar pessoal no Brasil [Internet]. Rio de Janeiro: IBGE; 2011 [acessado em 16 jan. 2018]: 1-150. Disponível em: https://biblioteca.ibge.gov.br/visualizacao/livros/liv50063.pdf
24. Rodrigues SL, Souza Júnior PR, Pimentel EB, Baldo MP, Malta DC, Mill JG, et al. Relationship between salt consumption measured by 24-h urine collection and blood pressure in the adult population of Vitória (Brazil). Braz J Med Biol Res 2015; 48(8): 728-35. http://dx.doi.org/10.1590/1414-431X20154455
25. Malta DC, Morais Neto OL, Silva Junior JB. Apresentação do plano de ações estratégicas para o enfrentamento das doenças crônicas não transmissíveis no Brasil, 2011 a 2022. Epidemiol Serv Saúde [Internet] 2011 [acessado em 21 jan. 2018]; 20(4): 425-38. Disponível em: http://scielo.iec.gov.br/scielo.php?script=sci_arttext&pid=S1679-49742011000400002&lng=pt http://dx.doi.org/10.5123/S1679-49742011000400002
26. World Health Organization. Global Action Plan for the Prevention and Control of NCDs 2013-2020 [Internet]. Genebra: World Health Organization; 2013 [acessado em 19 jan. 2018]. Disponível em: http://www.who.int/nmh/events/ncd_action_plan/en/
27. Malta DC, Silva Jr. JB. O plano de ações estratégicas para o enfrentamento das doenças crônicas não transmissíveis no Brasil e a definição das metas globais para o enfrentamento dessas doenças até 2025: uma revisão. Epidemiol Serv Saúde 2013; 22(1): 151-64. http://dx.doi.org/10.5123/S1679-49742013000100016
28. Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional de Saúde 2013: Percepção do estado de saúde, estilos de vida e doenças crônicas Brasil, Grandes Regiões e Unidades da Federação [Internet]. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística. 2014 [acessado em 5 jan. 2018]. Disponível em: http://www.ibge.gov.br/home/estatistica/populacao/pns/2013/
29. Szwarcwald CL, Malta DC, Pereira CA, Vieira MLFP, Conde WL, Souza Júnior PRB, et al. Pesquisa Nacional de Saúde no Brasil: concepção e metodologia de aplicação. Ciênc Saúde Coletiva [Internet] 2014 [acessado em 5 jan. 2018]; 19(2): 333-42. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-81232014000200333&lng=en http://dx.doi.org/10.1590/1413-81232014192.14072012
30. Szwarcwald CL, Malta DC, Souza Junior PRB, Almeida WS, Damacena GN, Pereira CA Exames laboratoriais da Pesquisa Nacional de Saúde: Metodologia de amostragem, coleta e análise dos dados. Rev Bras Epidemiol 2019. (no prelo).
31. Fernandes JCB, Kubota LT, Oliveira Neto G. Eletrodos íon-seletivos: histórico, mecanismo de resposta, seletividade e revisão de conceitos. Quím Nova 2001; 24(1): 120-30. Disponível em: http://www.scielo.br/pdf/qn/v24n1/4459.pdf
32. Perrone RD, Madias NE, Levey AS. Serum creatinine as an index of renal function: new insights into old concepts. Clin Chem 1992; 38(10): 1933-53. Disponível em: https://www.ncbi.nlm.nih.gov/pubmed/1394976
33. Tanaka T, Okamura T, Miura K, Kadowaki T, Ueshima H, Nakagawa H, et al. A simple method to estimate populational 24-h urinary sodium and potassium excretion using a casual urine specimen. J Hum Hypertens [Internet] 2002 [acessado em 19 jan. 2018]; 16(2): 97-103. Disponível em: https://www.nature.com/articles/1001307
34. Mill JG, Rodrigues SL, Baldo MP, Malta DC, Szwarcwald CL. Estudo de validação das equações de Tanaka e de Kawasaki para estimar a excreção diária de sódio através da coleta da urina casual. Rev Bras Epidemiol [Internet] 2015 [acessado em 16 jan. 2018]; 18(Supl. 2): 224-37. Disponível em: http://www.scielo.br/pdf/rbepid/v18s2/1980-5497-rbepid-18-s2-00224.pdf http://dx.doi.org/10.1590/1980-5497201500060020
35. Bentley B. A review of methods to measure dietary sodium intake. J Cardiovasc Nurs 2006; 21(1): 63-7.
36. Mill JG, Silva ABT, Baldo MP, Molina MCB, Rodrigues SL. Correlation between sodium and potassium excretion in 24- and 12-h urine samples. Braz J Med Biol Res [Internet] 2012 [acessado em 19 jan. 2018]; 45(9): 799-805. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-879X2012000900002 http://dx.doi.org/10.1590/S0100-879X2012007500114

37. Ji C, Sykes L, Paul C, Dary O, Legetic B, Campbell NRC, et al. Systematic review of studies comparing 24-hour and spot urine collections for estimating population salt intake. Rev Panam Salud Publica [Internet] 2012 [acessado em 21 jan. 2018]; 32(4): 307-15. Disponível em: https://scielosp.org/scielo.php?script=sci_arttext&pid=S1020-49892012001000010&lng=en&nrm=iso&tlng=en
38. Kawasaki T, Itoh K, Uezono K, Sasaki H. A simple method for estimating 24 h urinary sodium and potassium excretion from second morning voiding urine specimen in adults. Clin Exp Pharmacol Physiol 1993; 20(1): 7-14.
39. Malta DC, Oliveira TP, Santos MAS, Andrade SSCA, Silva MMA. Avanços do Plano de Ações Estratégicas para o Enfrentamento das Doenças Crônicas não Transmissíveis no Brasil, 2011-2015. Epidemiol Serv Saúde [Internet] 2016 [acessado em 18 jan. 2018]; 25(2): 373-90. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S2237-96222016000200373&lng=en http://dx.doi.org/10.5123/s1679-49742016000200016
40. Mente A, O'Donnell MJ, Rangarajan S, McQueen MJ, Poirier P, Wielgosz A, et al. Association of urinary sodium and potassium excretion with blood pressure. New Engl J Med 2014; 371(7): 601-11. http://dx.doi.org/10.1056/NEJMoa1311989
41. GBD 2017 Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2018; 392(10159): 1923-94. http://dx.doi.org/10.1016/S0140-6736(18)32225-6
42. Sarno F, Claro RM, Levy RB, Bandoni DH, Ferreira SRG, Monteiro CA. Estimativa de consumo de sódio pela população brasileira, 2002-2003. Rev Saúde Pública [Internet] 2009 [acessado em 19 jan. 2018]; 43(2): 219-25. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-89102009000200002 http://dx.doi.org/10.1590/S0034-89102009005000002
43. Brasil. Ministério da Saúde. Vigitel Brasil 2015 Saúde Suplementar: vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico [Internet]. Brasília: Ministério da Saúde; 2017 [acessado em 08 mai. 2018]. 170 p. Disponível em: http://www.ans.gov.br/images/stories/Materiais_para_pesquisa/Materiais_por_assunto/2015_vigitel.pdf
44. Instituto Brasileiro de Geografia e Estatística. Aquisição alimentar domiciliar *per capita* [Internet]. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2010 [acessado em 19 jan. 2018]. Disponível em: https://biblioteca.ibge.gov.br/visualizacao/livros/liv47307.pdf
45. Nilson EAF, Spaniol AM, Gonçalves VSS, Moura I, Silva SA, L'Abbé M, et al. Sodium Reduction in Processed Foods in Brazil: Analysis of Food Categories and Voluntary Targets from 2011 to 2017. Nutrients [Internet] 2017 [acessado em 21 jan. 2018]; 9(7): 742. Disponível em: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5537856/ http://doi.org/10.3390/nu9070742
46. Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Guia alimentar para a população brasileira [Internet]. 2ª ed. Brasília: Ministério da Saúde; 2014 [acessado em 19 jan. 2018]. Disponível em: http://bvsms.saude.gov.br/bvs/publicacoes/guia_alimentar_populacao_brasileira_2ed.pdf
47. Jaime PC, Stopa SR, Oliveira TP, Vieira ML, Szwarcwald CL, Malta DC. Prevalência e distribuição sociodemográfica de marcadores de alimentação saudável, Pesquisa Nacional de Saúde, Brasil 2013. Epidemiol Serv Saúde [Internet] 2015 [acessdao em 21 jan. 2018]; 24(2): 267-76. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S2237-96222015000200267&lng=en http://dx.doi.org/10.5123/S1679-49742015000200009

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