



Original article

Contribution of ultra-processed foods consumption in sodium ingestion of atherosclerotic disease patients, residents in the southern region of Brazil



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SUMMARY

Background and objective: Recent studies have related the consumption of ultra-processed foods with the development of cardiovascular diseases and have considered this relation with excessive sodium intake. While Brazilian studies have analysed that this consumption may have no direct relationship with the processing, but rather with the addition of salt. The purpose of this study is to investigate the contribution of the consumption of processed products in the daily intake of sodium ingestion by atherosclerotic disease patients.

Methods: A sub study, conducted with data from 630 cardiopathic patients who take part in “Effect of Brazilian Cardioprotective Food Program study on the reduction of events and risk factors in secondary prevention of cardiovascular disease part”. Food was classified as: unprocessed or minimally processed foods, processed culinary ingredients, processed foods, ultra-processed food and beverages. Twenty-four-hour food recall (R24h) was collected from patients, and the estimation of total calories and sodium intake were calculated, as well as the percentage of sodium contribution according to the categories already mentioned. For the adequacy ratio analysis, the daily values of sodium intake were used to compared to the recommendations of the World Health Organization (<2000 mg / day).

Results: The average sodium intake was 1970.87 mg for women and 2642.86 mg for men, being higher for males' patients aged 60–79. It was observed that 64% of the studied population demonstrated sodium intake > 2000 mg. When considered levels > 3001 mg, a higher incidence of consumption was observed in the male group. Only 21.1% were intaking sodium within the recommended amount. Industrialized foods contributed to 33% of the mineral intake.

Conclusion: These findings have demonstrated that the majority of the studied patients exceeded the dietary sodium recommendation. It has also indicated that patient's male, have presented increased consumption of the mineral. Consequently, warning for the necessity of greater investments in the nutritional re-education of these patients.

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1. Introduction

For years salt has been known and appreciated by the population and, throughout history, has been seen as precious. Its main source is sodium chloride – NaCl (table salt), of which sodium constitutes 40% of the weight. It can be found intrinsically, being predominantly present in foods of animal origin, or extrinsic, by means of the addition of common salt and industrial treatment [1–3]. Agreeing with the Centers for Disease Control and Prevention (CDC) [4], over 40% of daily sodium intake comes from major sources such as breads, processed and cured meats, sandwiches, pizza, ready-made soups, cheese, snacks, indicating the possibility of its intaking to be related to the increase in the consumption of ultra-processed foods [5,6].

The recommendation of daily sodium intake for American population was established by the Guidelines for Americans [6] and corresponds to less than 2300 mg/day. For the Brazilian population, WHO [7] recommended the intake were below 2000 mg/day, equivalent to 5 g of salt/day, being 3 g extrinsic and 2 g intrinsic [8].

According to the VII Brazilian Hypertension Guideline (2016), the excessive sodium intake has been related to increased pressure levels, cardiovascular and renal events [9]. Therefore, excessive consumption of sodium can lead to health damage, associated with stroke, ventricular hypertrophy due to elevated cardiac output and renal diseases [10,11].

The Brazilian Food Guide [12] classifies food in four categories according to the extent of processing. Since this definition is still recent, there are few studies which investigate the association between ultra-processed foods consumption and morbidity and mortality. Brazilian studies have related the consumption of these foods with the development of metabolic syndrome, as well as the presence of obesity among other comorbidities [5,13,14].

Taking into account the possibility of increased sodium intake due to the presence of processed products, the necessity of evaluating the contribution of these foods consumption in the daily sodium intake was stated to patients with evidence of manifested atherosclerotic disease, attended at an outpatient care, volunteers in the “Effect of Brazilian Cardioprotective Food Program research, in the Southern Region of Brazil” [15], which was designed for people with risk factors or cardiovascular events who suffered acute myocardial infarction, stroke or peripheral vascular disease, not including congestive heart failure and arrhythmias. The guidelines are based on three food groups, according to the colors of the Brazilian flag, and only unprocessed and minimally processed foods are considered. Consumption should be based on the proportion of each color, representing energy density, saturated fat, cholesterol and sodium density. Green group should be the basis of the feed, yellow consumption moderate and blue consumed in smaller quantity. Ultra-processed foods are excluded from the diet and classified into the red group [16].

2. Material and methods

An observational, retrospective and cross-sectional substudy, conducted with data from cardiopathic patients who take in “Effect of Brazilian Cardioprotective Food Program study on the reduction of events and risk factors in secondary prevention for cardiovascular disease: A Randomized Clinical Assay” [15] coordinated by the Heart Hospital (São Paulo, Brazil), in partnership with the Ministry of Health, based on the Support Program to Institutional Development of the Unified Health System, during five years (2013–2017). Participants signed the Free and Informed Consent Term and the study was approved by the Research Ethics Committee of the referred institution, under the number 312,262. The sampling was composed of patients from eleven collaborating centers in the

South region (Rio Grande do Sul, Santa Catarina and Paraná). Preferably baseline data were used, and in its absence, data from medical appointment of the last 15 days were used.

The sampling size was composed of 633 individuals. Three outliers were identified in the data set, using Grubbs Test, 1% level of significance was considered [17]. The data was submitted to a normality test, and 630 adult patients, 45 years old or older, of both sexes and presenting evidence of atherosclerotic disease (coronary artery disease, cerebrovascular disease or peripheral arterial disease) remained in the sampling.

Exclusion criteria were: psychiatric or neurocognitive condition that prevented from obtaining reliable clinical data; life expectancy less than 6 months (metastatic neoplasia or other factor defined by the criteria of the study researches, for example); pregnancy or lactation; diagnosis of hepatic failure with previous history of encephalopathy or generalized edema; diagnosis of renal failure with dialysis indication; diagnosis of congestive heart failure; organ transplantation; gastropasty; use of a wheelchair or difficulty in oral feeding.

The food intake evaluation was performed using the Nuti-quant® diet analysis software, which database is Brazilian Food Composition Table [18]. A photo album with portion sizes of the standardized foods was prepared by the core research coordinating center and provided to participants as a guide to the 24-h food recall (R24h) recording.

Foods were grouped according to the extent of processing, and the classification elaborated by the Epidemiological Research in Nutrition and Health Center, University of São Paulo, published in the magazine *World Nutrition* [19], known as “NOVA”. This system categorizes foods into four groups: unprocessed or minimally processed foods, processed culinary ingredients, processed foods, ultra-processed food and beverages.

From the R24h the foods were classified into four groups according to NOVA and the estimated total of calories and sodium intake (intrinsic and extrinsic), as well as the percentage of sodium contribution were quantified according to categories. To analyze the adequacy ratio, the sodium values ingested per day were compared to the WHO recommendation [7].

Intake variability was calculated considering the repetition of the R24h on a subsample of the population using simple, proportional and without replacement random subsampling technique. Thus, starting from the total sample, the estimation of its sample standard deviation was done using 5% of significance level and standard error of $E = 2$ and the reference calculation, described by Miot [20], was applied in order to estimate the sample size, for description of quantitative variables, assuming infinite population.

Then, the random function (which returns a random number between zero and one) of Excel 2016® software, was used to select the sample elements randomly and proportionally according to the age range (<60, 60–79, ≥ 80 years old).

The prevalence of inadequacy was estimated according to the age range (<60, 60–79, ≥ 80 years old) and according to the WHO recommendation of sodium intake (<2000 mg/day), as proposed by the Institute of Medicine (IOM) from The United States, using ANOVA variance analysis along with a classification factor.

To perform normality tests, categorization of parametric and non-parametric variables, descriptive analysis, and averages comparison tests, the Statistical Package for Social Sciences (SPSS) software version 22.0 was applied. Parametric variables analyzed by descriptive statistics were represented by average and standard deviation, while non-parametric variables were represented by median, minimum and maximum values. T-test for independent samples and the Mann–Whitney test were applied to compare the averages and medians of the three periods, with significance level of $p < 0.05$.

Table 1
Estimates of sodium (mg) consumption of patients with heart disease in southern Brazil, according to sex and age group.

Age group	Female (mg)	Male (mg)	P Value*
<60	2331,82 (560,85–7262,91)	2711,1 (799,70–7959,23)	0,086
60–79	1867,55 (290,17–5956,56)	2609,28 (550,24–8248,19)	0*
≥80	1484,1 (304,56–4346,13)	2332,67 ± 1067,16	0,081
Total	1970,87 (290,17–7262,91)	2642,86 (550,24–8248,19)	0*

NOTE: * significant difference by Kruskal Wallis test or Mann Whitney p value < 0.05.

Values expressed as median (minimum–maximum value) or Mean ± Standard Deviation. Descriptive statistics (SPSS software).

3. Results

From the 630 patients analyzed, 59.1% (n = 372) were males and 40.9% (n = 258) females, being 23.6% (n = 149) less than 60 years old, 70% (n = 441) between 60 and 79 years old, and 6.4% (n = 40) 80 or more years old. Regarding total sodium intake, the patients' intake varied from 1970.87 mg (290.17 mg–7262.91 mg) to 2642.86 mg (550.24 mg–8248.19 mg) among women and men respectively, being significantly different between them (p < 0.05). Males consumption was also higher when compared to 60–79 years old females patients (p < 0.05). The highest prevalence of consumption occurred among the group in age equal to or less than 60 years old, regardless of sex, with an intake higher than the recommended value (Table 1).

In general, it is noticed that the majority of the patients (64%) had the sodium intake higher than expected (2000 mg). The frequency of sodium intake equal or below 2000 mg, which is recommended, was 21.1% (n = 133) for women and 15.3% (n = 96) for men (p < 0.05). There was similarity between the groups whose estimate of sodium intake was between 2001 and 3000 mg (p > 0.05). A higher incidence of sodium consumption in the male population when compared to the female one, taking into account levels between 3001–4000 mg (Table 2).

As for the contribution of food consumption to the sodium intake of studied patients, according to the degree of processing, the influence was 67, 12 and 21% of unprocessed or minimally processed, processed and ultra-processed foods, respectively. When analyzed statistically, the groups presented a strong level of significance (p < 0.05) (Fig. 1).

Based on the value of sodium intake adjusted by intrapersonal variability, presented in Table 2, a prevalent inadequacy, in the studied population, was observed among groups stratified by age (<60 years, 60–79 years and <80 years), that is, sodium intake over 2000 mg/day, 99, 92, and 52% concomitantly.

4. Discussion

It is possible to observe, in the majority of the patients studied, that the dietary sodium recommendation for healthy population is

Table 2
Sodium intake (mg) according to the daily amount and by sex.

Sodium (mg)	Female % (n)	Male % (n)	Total % (n)
≤2000	21,1 (133)	15,3 (96)*	36,4 (229)
2001–3000	11,7 (74)	22 (138) ^{ns}	33,7 (212)
3001–4000	4 (25)	12,8 (81)*	16,8 (106)
4001–5000	2,5 (16)	4,5 (28) ^{ns}	7 (44)
>5000	1,5 (10)	4,6 (29) ^{ns}	6,1 (39)

Abbreviations: ns: not significant by Kruskal Wallis or Mann Whitney test (p < 0.05)
NOTE: * level of significance p value by Kruskal Wallis test or Mann Whitney test (<0.05).

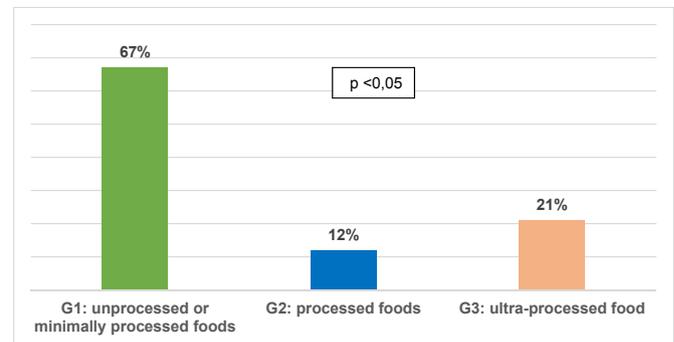


Fig. 1. Contribution of processed products in the sodium intake of cardiopathy patients in southern Brazil. Curitiba, PR, Brazil, 2017.

exceeded. The results also indicated that patients under 60 years old, for both sexes, and the male population, of all age, presented increased consumption of the mineral. Similar data were found in literature, observing that 89% of Americans had sodium intake higher than the established, and the higher proportion of inadequacy have been for adult males [21]. Authors indicated that male patients have presented higher intakes when compared to female ones. In addition, they verified a decrease in consumption among the elderly population in both sexes [22].

A decrease in sodium consumption was detected, as age increases, which may be associated with physiological changes taking place in senescence process, such as esophageal peristaltic reduction, anatomic gastric alteration, olfactory and taste modification, contributing to early satiety [23]. Boyce and Shone, 2017, in a research study, found that 75% of the elderly over 80 years presented greater impairment of the olfactory sense and that the gustatory perception may present disturbances due to alterations of the cellular membranes that involves the function of the receptor channels of ions [24]. Thus, these modifications may predispose preference to other foods, the main motivation being the sensory appeal, convenience and price. The main barriers may be necessity for special diets due to health condition and functional disability in preparing or purchasing food [25].

It was observed that practically two-third (64%) of the cardiopathic patients studied presented sodium intake above 2000 mg, and 6.1% of them had a consumption above 5000 mg, corresponding to 12.5 g/salt/day. Other studies, in which the consumption of the Brazilian population was about 4700 mg, equivalent to 12 g/salt/day or 3190 mg/day, 7.9 g/salt/day also reported this fact [26].

Concerning to the influence of processed foods on total sodium consumption, it was evidenced that processed and ultra-processed foods did not have the expected impact on mineral intake, contributing with 33%. Studies have revealed a lower participation of the processed food in the high consumption of sodium, and an attributed influence to the ingestion of foods such as, rice, beans, bread and by means of the addition of salt, and sodium reduction targets in processed foods have indicated a small reduction in the average consumption of the population, suggesting that those foods are seen as important sources of sodium due to the frequent consumption by the Brazilians [22,26,27].

The most noticeable foods in this research were preparations such as “feijoada”, bolognese pasta and “arroz carreteiro”, salt addition, breads and unprocessed animal meat (beef, chicken, fish). Allemandi et al., 2015 [28], when analyzing nutritional labels of processed products in Argentina, identified the food groups which presented the highest sodium content in 100 g of product. They

were: sauces, meat products (sausage, hamburger), dairy products (cheese), snacks, snacks and pre-prepared meals. A similar study monitored the sodium content in categories of processed foods that contributed to salt intake in the Australians' diet and the high-lighted foods were sauces and processed meats [29].

In our study, processed foods accounted for 12%, and ultra-processed for 21%, totalizing a contribution of 33% in nutrient/day intake, being consistent with the literature. Sarno et al., 2013 [10], reported that 1/5 of the mineral came from processed foods with salt addition, whose contribution exceeded 25% in households with higher incomes.

A study using data from the Brazilian Institute of Geography and Statistics from 2008 to 2009 [27] analyzed the consumption of sodium by the Brazilian population, brought up important observations about the excessive sodium intake, demonstrating there was no direct relationship with the industry, but rather, as how food is prepared and with salt addition. The main source of sodium was cooking salt addition, representing 59.7% of the nutrient consumed in the households, followed by 11.8% of the food offered by restaurants and 13.8% of processed foods, 6% of French bread, 4.7% of unprocessed foods and 4.1% of semi-processed foods. The contribution of ultra-processed food was 23.8% of total salt intake [27].

In 2010, authors noticed that for three decades the consumption of fresh or minimally processed foods has been replaced by ultra-processed ones, both in low and higher income population. An increase in processed foods and its directly proportional relationship to sodium consumption in Brazil was also observed [30].

There is shortage of Brazilian studies to evaluate sodium intake from food ready for consumption or processed products [5,10]. However, it is assumed that meals made outside the home, along with the contribution of processed food, tend to present higher sodium content in the diet [27,31].

The results of this study suggest that sodium content in the diet of patients with cardiovascular disease exceeds the recommended limits, not only resulting from ultra-processed foods by itself, but also from the high consumption of preparations based on sauce and processed meats, breads and foods of unprocessed animal origin, as well as the addition of salt. Further studies are recommended, including control of urinary sodium excretion and salt addition in preparations to explore new results.

5. Conclusion

The results of the study indicated that sodium intake at the recommended level for a healthy population (<2000 mg) was not achieved for the majority of patients with heart disease (65%). An excessive consumption of salt was detected, especially for males, which is a worrying factor, since these patients, due to their clinical characteristics, require restricted diets for sodium.

Although ultra-processed foods have had less influence on the ingested sodium content, they should still be monitored due to the negative impact on the health and nutritional status of the population. Even though public health policies have been striving for the processed products reformulation to reduce this mineral, there is still a lot to be done in order to Brazilian population reaches the average consumption of 2000 mg/day

The collected data do not have enough information about the salt added to the food. Most of the collaborating centers considered the salt already in the culinary preparation, and it was not possible to separately quantify it, and to consider the fourth group as "processed cooking ingredients". Therefore, it was decided to include the added salt in the group of unprocessed or minimally processed foods for greater precision of the results. However, we

can highlight the fact that it is the first national study to provide information relevant to food orientation in vulnerable groups, to understand the food behavior of Brazilian population, as well as to identify the foods that influenced the excessive consumption of sodium.

Conflicts of interest

The authors declare that they have no conflicts of interest related to this article.

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