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Sodium intake in individuals with metabolic syndrome: a study based on sodium content of diet and source foods

Consumo de sódio em indivíduos com síndrome metabólica: um estudo baseado no teor de sódio da dieta e alimentos-fonte

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Abstract

Objective: The study aimed at evaluating the energy intake and identifying the sodium intake and its main sources in individuals with metabolic syndrome. *Methods:* This is a cross-sectional study with 88 individuals with metabolic syndrome diagnosis from both sexes, adults and elderly, treated at the Endocrinology Outpatient Clinic of the Onofre Lopes University Hospital, in Natal-RN, Brazil. The consumption of energy, sodium and respective source foods were assessed using two 24-hour dietary recalls, which were analyzed in Virtual Nutri Plus®. *Results and discussion:* The studied population was predominantly female (72.7%), and the mean age was 49.0 (11.3) years. The most frequent comorbidities were dyslipidemia (92.0%) and arterial hypertension (76.1%). The mean energy intake was 1,664.35 (630.8) kcal/d and the mean sodium intake was 2,792.8 (866.2) mg/d, with 82.2% of the individuals presenting an intake higher than the recommended intake. Significant statistical differences were found for energy intake between the sexes ($p < 0.001$), but not for sodium intake ($p = 0.107$). The use of the added salt was quite expressive in the analysis of the food consumption of this population (310 repetitions, corresponding to an average of 635.5mg of sodium). Industrialized foods presented the highest amount of sodium among the foods consumed, although few patients consuming these products were registered. *Conclusion:* An inadequate sodium intake was found in a significant percentage of the population, and it may have a negative impact on the health of these individuals, especially those living with arterial hypertension, evidencing the need for a broader nutritional education action directed specifically to this population.

Keywords: Metabolic syndrome. Diet, Sodium-Restricted. Hypertension. Food consumption.

Resumo

Objetivo: Avaliar a ingestão energética e identificar o consumo de sódio e suas principais fontes em indivíduos com síndrome metabólica. *Metodologia:* Estudo tipo transversal realizado com 88 indivíduos com diagnóstico de síndrome metabólica, de ambos os sexos, adultos e idosos atendidos no Ambulatório de Endocrinologia do Hospital Universitário Onofre Lopes, Natal, RN. O consumo de energia, sódio e respectivos alimentos-fonte foram avaliados por meio de dois recordatórios de 24 horas, cuja análise foi realizada no Virtual Nutri Plus®. *Resultados e discussão:* A população estudada era predominantemente feminina (72,7%), com média de idade de 49,0 (11,3) anos. As comorbidades mais frequentes foram dislipidemia (92,0%) e hipertensão arterial (76,1%). Observou-se ingestão energética média de 1.664,4 (630,8) kcal/d e consumo médio de sódio de 2.792,8 (866,2) mg/d, registrando-se 82,2% dos indivíduos com ingestão acima do recomendado. Diferenças estatísticas significativas foram encontradas para ingestão energética entre os sexos ($p<0,001$), mas não para consumo de sódio ($p=0,107$). A utilização do sal de adição foi bastante expressiva na análise do consumo alimentar dessa população (310 repetições, correspondendo a uma média de 635,5mg de sódio). Alimentos industrializados foram os que apresentaram maior quantidade de sódio entre os alimentos consumidos, apesar de registrarmos poucos indivíduos fazendo uso desses produtos. *Conclusão:* A ingestão inadequada de sódio foi registrada em um percentual expressivo da população, podendo ter impacto negativo na saúde desses indivíduos, especialmente aqueles que convivem com hipertensão, evidenciando a necessidade de uma ação de educação nutricional mais ampla direcionada especificamente para essa população.

Palavras-chave: Síndrome metabólica. Dieta hipossódica. Hipertensão. Consumo de alimentos.

Introduction

Metabolic syndrome is a group of metabolic risk factors, including central obesity, insulin resistance, atherogenic dyslipidemia and arterial hypertension. According to Vidigal et al.,[1] the general prevalence of metabolic syndrome in Brazil, using such criteria, is around 28.9%. The occurrence of this syndrome is related to an excessive energy intake, physical inactivity, obesity and genetic and metabolic susceptibility.[2]

Among the components of the metabolic syndrome, it is known that arterial hypertension is, on its own, an important risk factor for cardiovascular diseases.[3] Arterial hypertension is a multifactorial clinical condition characterized by a sustained increase of pressure levels, >130 and/or 80 mmHg.[4] Frequently associated to metabolic disturbances, functional and/or structural changes of key organs, it may be aggravated by the presence of other risk factors, such as dyslipidemia, abdominal obesity, insulin resistance and diabetes *mellitus* – characteristic conditions in individuals with metabolic syndrome. The nondrug therapy for arterial hypertension involves some nutritional measures, with diets that emphasize the consumption of fruits, vegetables and low-fat content dairies, integral cereals, lean meats, oil seeds, and reduction of the intake of saturated fats, sweets, sugary drinks and other industrialized products.[5]

In the dietary field, the effect of a long-term excessive energy intake is already known to be related to obesity and metabolic syndrome. The quality of the diet also influences the complex hormonal and neurological mechanisms associated with weight gain and metabolic complications.[6,7] Furthermore, it is a consensus that an excessive sodium content intake is related to higher arterial pressure and to cardiovascular complications.[8,9] The suggested mechanisms to explain this relationship are: (1) volumetric expansion; (2) changes to the kidney function, causing disturbances on the sodium balance; (3) dysfunction of the renin-angiotensin- aldosterone system and associated receptors; (4) central stimulation of the activity of the sympathetic nervous system; and (5) possible inflammatory processes.[10]

The guideline regarding the need to reduce the salt intake in all manners is a standard as a primary prevention and as a nondrug therapy for arterial hypertension and metabolic syndrome. Therefore, the current Brazilian guidelines suggest that the daily intake of sodium should not exceed 2,000mg, corresponding to approximately 5,000mg of sodium chloride, commonly referred to as cooking salt.[5,11,12] American organizations, however, already indicate an ideal intake of <1,500mg/day of sodium to prevent and treat arterial hypertension, a value which corresponds to 3,750mg of sodium chloride.[4]

In addition to cooking salt, other sodium sources in food are dairy products, meats, seafood, eggs and mainly processed and ultra-processed foods, such as cold cuts, canned foods and ready-to-eat foods. In relation to specific foods, some that stand out are ready-made spices, instant noodles, rolls, tomato extract, powder milk, canned vegetables and corn flour cookies, which present the highest amount of sodium per portion of 100g. Furthermore, processes foods also contain sodium as monosodium glutamate, bicarbonate, phosphate, carbonate and sodium benzoate.[13]

Data from the Family Budget Survey (POF)[14] conducted by Instituto Brasileiro de Geografia e Estatística (IBGE, Brazilian Institute of Geography and Statistics) in 2008-2009 showed that the daily sodium amount available on Brazilian households was 4,700mg, for a daily intake of 2,000kcal, corresponding to approximately 12g of salt, more than double the maximal intake value (UL) recommended for sodium, considering that most of this amount originates from added salt, although an increase in the fraction coming from processed foods with added also was also observed.[15]

In the literature, dietetic analyses indicate the prevalence of high sodium intake by individuals with metabolic syndrome. Raisenen et al.[16] observed a significant difference between the sodium intake of individuals with and without metabolic syndrome, in which individuals diagnosed with the syndrome consumed approximately 3,644.3mg sodium/day, and this value was around 6% higher when compared to individuals who had not been diagnosed with the disease. On the other hand, Kim et al.[17] did not observe differences in the sodium intake of patients with and without the diagnosis of metabolic syndrome, both with an average intake of 5,709.8mg of sodium a day.

Within this context, the relationship between food intake and sodium intake in individuals with metabolic syndrome must be further analyzed. Considering the physio-pathological mechanisms, it is suggested that individuals who live with arterial hypertension are more vulnerable. Therefore, the aim of this study is to analyze the energy intake and identify the sodium intake and its main sources on individuals with metabolic syndrome, in the search for better understanding the eating patterns of this population, in order to acknowledge deficiencies or excesses and assist in the improvement and efficiency of nutritional therapies and public policies directed toward reducing the sodium intake.

Methodology

Characterization of the population and study design

This is a transversal study, constituting an excerpt of a database from a larger project entitled "Avaliação do status de zinco em indivíduos com síndrome metabólica" ("Evaluation of the zinc status in individuals with metabolic syndrome"), approved by the Research Ethics Committee of Onofre Lopes University Hospital (CEP - HUOL) under CAAE number 38566914.5.0000.5292. The participation of the individuals counted on a voluntary and informed consent by signing the Clear and Informed Consent Term (TCLE).

The sample was constituted by 88 adult and elder individuals from both sexes who had been diagnosed with metabolic syndrome, selected at the Endocrinology Outpatient Clinic of the Onofre Lopes University Hospital, from March 2015 to February 2016. A total of 857 patient charts were consulted, from which, 119 were included within the criterion of metabolic syndrome diagnosis. From those, 26 individuals did not show up to the appointment, and five refused to participate in the research, totaling the final sample of the study.

The exclusion criteria were the following: (1) individuals with type 1 DM, type 2 DM who had used insulin and/or glucocorticoids over the course of the three previous months; (2) changes to the kidney functions (glomerular filtration rate estimated by the *Modification of Diet in Renal Disease* (MDRD) calculator <60 ml/minute); (3) hepatic alterations (values three times above the reference range for transaminases); (4) decompensated heart failure, with a history of cardiovascular disease or cardiovascular event; (5) people with memory-related or mental health problems; (6) pregnancy or lactation; and (7) use of vitamin-mineral supplements. The participants completed a form containing personal and health-related information, and then received clinical care, in which biochemical examinations were requested, and the first 24-hour recall being applied. When the patients returned for the examination results to be delivered, the second recall was applied.

Metabolic syndrome diagnosis

The metabolic syndrome diagnosis considered what is suggested by the *National Cholesterol Education Program Adult Treatment Panel* III (NCEP-ATP III),[18] corresponding to the presence of, at least, three of the following changes: (1) waist perimeter >102cm for men, and >88cm for women; (2) concentrations of triglycerides >150 mg/dL; (3) concentrations of high-density lipoprotein (HDL-c) <40mg/dL for men, and <50mg/dL for women; (4) systolic arterial pressure >130 mmHg and/or diastolic arterial pressure >85 mmHg and/or use of anti-hypertensive drugs, and (5) plasmatic glucose concentrations >100 mg/dL and/or use of hypoglycemic drugs. The fasting glycaemia cutoff was changed to >100mg/dL, meeting the value suggested by the American Diabetes Association.[19]

Anthropometric evaluation

Regarding the anthropometric evaluation, the body mass was measured using a 150-kg digital scale with precision of 0.1 kg (Tanita®, model MEA-03140, Arlington Heights, IL, USA); the height was measured with the help of a portable stadiometer (Sanny® model, São Paulo, SP, Brazil). Such measurements were used to calculate the body mass index (BMI), classified according to the cutoffs recommended by the Food and Nutritional Surveillance System[20] for adults and elderly people.

The waist perimeter was measured twice using an inextensible tape measure, using as the parameter the distance between the iliac crest and the lower back edge. The arterial pressure was evaluated during the appointment, using the mercury column device (Unitec® model, São Paulo, SP, Brazil), according to the 7th Brazilian Arterial Hypertension Guideline.[5]

Biochemical evaluation

The blood samples were collected after fasting for 12 hours during the night and analyzed at the Clinical Analysis Laboratory of the Onofre Lopes University Hospital. The triglyceride and fasting glycaemia concentrations was conducted by the enzymatic method, and the HDL-c concentration was analyzed by an indirect colorimetric test. Kits from Wiener-Lab (CMD 800ixl Equipment) were used for all methods.

Food and dietetic intake evaluation

Data to evaluate the food and dietetic intake was obtained with the application of the 24-hour recall in duplicates, with an interval of 30 to 45 days, by qualified professionals. A photographic record book was used to assist in the quantification of the home measurements of consumed foods. Subsequently, the dietetic information was standardized in grams and milliliters to analyze the diet in the Virtual Nutri Plus 2.0® software and was then exported to Excel®. The foods that were not found on the database of the *software* were added from nutritional tables and information contained on the product labels. The preparations were determined through the elaboration of datasheets.

The sodium intake adequacy was based on the cooking salt intake recommendation of up to 5g/day (2,000mg of sodium) established by the 7th Brazilian Arterial Hypertension Guideline.[5] The material exported to Excel® was used to classify the foods as to their average amount consumed in g/mg and their corresponding home measurement, to the gross average sodium value and the number of times that they were mentioned (repetitions), considering both recalls for each individual. Definitions from the *Guia Alimentar para a População Brasileira*[21] (Dietary Guidelines for the Brazilian Population) were used to classify the foods *in natura,* minimally processes, processed, ultra-processed foods, oils, fats and sugars.

The energy intake adequacy followed the 20kcal to 25kcal/kg weight recommendation from the 1st Brazilian Guideline for the Diagnosis and Treatment of Metabolic Syndrome.[11] The ideal weight was calculated from the highest BMI value corresponding to eutrophy, according to the age, in order to establish the adequate energy recommendation.

Statistical analysis

The analyses of the variables were made in the IMB SPSS® v. 20.0 software, using a standard mean and deviation for the quantitative variables that showed symmetric distribution; median (interquartile interval) for quantitative variables that showed asymmetric distribution and relative frequencies (percentages) and absolute frequencies for categorical variables.

The Kolmogorov-Smirnov test was applied to verify the distribution symmetry of the data. Since sodium showed an asymmetric distribution, it was turned into a natural logarithm and tested again. The ANOVA test was used to adjust the sodium intake data according to the interpersonal and intrapersonal variability. The sodium was adjusted according to the energy through simple linear regression.

The variables were compared in relation to the sex, and Student's *t* test was used to compare the normal distribution variables ($p<0.05$). The Mann-Whitney test was used to compare asymmetric distribution variables ($p<0.05$).

Results and Discussion

From the 88 individuals that represent the study sample, a prevalence of the female sex was observed (n = 64; 72.7%), with an average age of 49.0 (11.3) years and BMI of 33.5 (6.6) kg/m^2, indicating obesity.

In the literature, the characterization of individuals with metabolic syndrome in relation to their sex shows divergent results. Similarly to what was found in this study, Fonseca et al.,[22] when evaluating the prevalence of metabolic syndrome in individuals who received care in a Family Health Strategy unit, observed that most individuals were females and were over 40 years old, possibly because women search for more medical assistance than men, above all at more advanced ages.[23] The same was shown by Pinho et al.,[24] but it was not observed in the study by Felipe-de-Melo et al.[25] The presence of metabolic syndrome in individuals over 50 years of age, as observed in our study, may be explained by the greater accumulation of risk factors and a reduction on the efficiency of metabolic functions with time.[26]

Regarding the anthropometric nutritional status, our study observed a greater metabolic syndrome percentage in individuals with higher BMIs, especially in relation to the to the obesity classification (IMC > 30 kg/m^2), since the other authors confirm that obesity is strictly related to the diagnosis and is a risk factor for metabolic syndrome.[24,25]

The most common comorbidities in this population were dyslipidemia (n = 81; 92.0%) and arterial hypertension (n = 67; 76.1%) (table 1), for both sexes. A similar result was observed by por

Pimenta et al.,[27] according to the same diagnosis criteria. The association between the comorbidities found shows a trend of a characteristic grouping of risk factors in metabolic syndrome, especially in relation to individuals who already live with some non-contagious chronic disease.[28]

Specifically, in relation to arterial hypertension, it is observed in the literature that this is one of the most frequent components in individuals with metabolic syndrome,[22,29] a fact that was also confirmed in our study, both for males and females. Rosa et al.[30] realized a significant association between obesity, dyslipidemia and the presence of a greater number of components of metabolic syndrome in a population of elders with arterial hypertension. Similarly, Scherer & Vieira[31] showed an association between obesity and cardiovascular risk factors (arterial hypertension, diabetes *mellitus,* metabolic syndrome, central obesity and dyslipidemia) in overweight elder individuals.

Contextualizing this mechanism, it is believed that central obesity is able to trigger the renin-angiotensin-aldosterone system, when aggravated by the action of insulin under hyperglycemia and hyperinsulinemia conditions, which are characteristic of a metabolic syndrome. The triggering of this mechanism leads to a disturbance on the transportation of electrolytes, sodium retention, glomerular hyperfiltration, increase of the cardiac output, vasoconstriction of the arteries and inflammatory responses. Dietetic and metabolic factors, endothelial and vascular dysfunctions and neuroendocrine unbalances are also identified in the arterial hypertension etiology in individuals with metabolic syndrome.[32,33]

In relation to dietetic consumption, the results indicate an average energy intake of 1,664.3 (630.8) kcal/d and an average sodium intake of 2,792.8 (866.2) mg/d. A significantly higher energy intake was also found for males in relation to females ($P<0.001$), however, no significant differences were detected regarding the sodium intake between the sexes ($p=0.107$) (table 2). A sodium intake above the intake recommendation (2,000mg/day) was observed in 82.2% of the individuals with metabolic syndrome. This percentage was higher for males (95.5%) than for females (83.4%). It was observed that ten individuals had an average sodium intake below 2,000mg, one male and nine females, although it is interesting to observe that none of the individuals reached the intake recommendation of <1,500mg/day from the American organizations. From the individuals with an average daily sodium intake below 2,000mg/day, only three showed no arterial hypertension (figure 1).

Table 1. General, anthropometric and biochemical characteristics of individuals with metabolic syndrome who received care at the Endocrinology Outpatient Clinic of the Onofre Lopes University Hospital, Natal-RN, 2018.

Variables	Total (n=88)	Male (n=24)	Female (n=64)	P value
Age (years)[a]	49(11.3)	47.9(10.6)	51.0(11.6)	
Comorbidities				
Dyslipidemia[b]	81(92.0)	22(91.7)	59(92.2)	1.000
Arterial hypertension[b]	67(76.1)	15(62.5)	52(81.2)	0.092
Overweight/obesity[b]	58(65.9)	13(54.2)	45(70.3)	0.207
Type 2 Diabetes[b]	43(48.9)	11(45.8)	32(50.0)	0.813
Metabolic syndrome components				
Systolic arterial pressure (mmHg)[a]	134.9(18.3)	129.3(17.5)	128.6(18.8)	0.830
Diastolic arterial pressure (mmHg)[a]	88.5(11.5)	85.7(12.8)	83.8(12.0)	0.511
Fasting glycaemia(mg/dL)[a]	119.7(47.7)	119.9(51.9)	105.1(39.1)	0.057
HDL-c (mg/dL)[a]	45.0(9.3)	39.5(13.5)	45.5(7.2)	0.346
Waist perimeter (cm)[a]	105.1(12.6)	104.3(14.8)	101.5(11.5)	0.243
Triglycerides (mg/dL)[c]	156.0(126.9-215.5)	186.0(70.0-1604.0)	146.0(66.0-651.0)	0.073

[a]: Data shown as mean (±standard deviation); [b]: data shown as numeric value (percentage); [c]: data show as median (interquartile interval).

Table 2. Energy and sodium intake in individuals with metabolic syndrome who received care in the Endocrinology Outpatient Clinic of the Onofre Lopes University Hospital, Natal-RN, 2018.

Variable	Total Mean(SD*)	Males (n=24)					Females (n=64)					P value
		RI**	Mean (SD)	Intervals in percentiles			RI	Mean (SD)	Intervals in percentiles			
				25th	50th	75th			25th	50th	75th	
Energy (kcal)	1,664.4 (630.8)	1,429.8 – 2,144.7	2,116.6 (583.0)	1,697.6	2,016.3	2,561.4	1,191.1 – 1,488.9	1,481.3 (471.9)	1,181.6	1,371.9	1,689.3	<0.001
Sodium (mg)	2,792.8 (866.2)	2,000.0	2,977.7 (578.2)	2,439.9	2,947.0	3,507.2	2,000.0	2,723.5 (677.8)	2,323.0	2,676.3	2,931.9	0.107

*SD = standard deviation; **RI: Recommended ingestion.

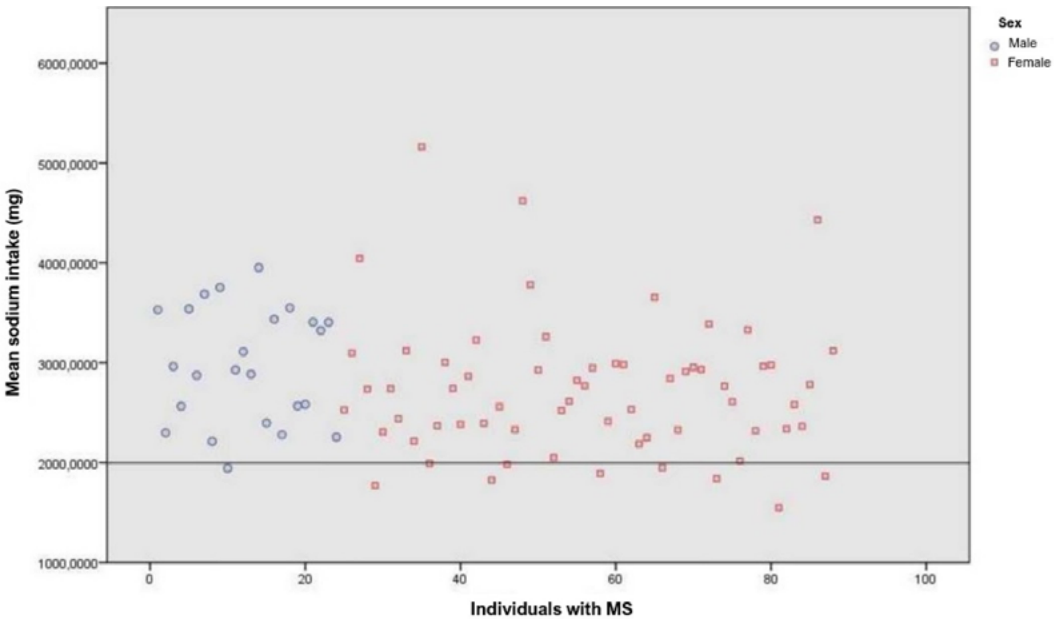

Figure 1. Individual distribution of the mean sodium intake of individuals with metabolic syndrome who received care in the Endocrinology Outpatient Clinic of the Onofre Lopes University Hospital, Natal-RN, 2018.

Considering the role of sodium for the physiopathology of arterial hypertension, the food intake data analysis showed an excessive sodium intake by the individuals with metabolic syndrome (2792.8mg/day), corresponding to approximately 7,000mg of salt. Despite a lower average energy intake, a significant statistical difference is observed for energy intake between males and females. Such data confirms that the average sodium intake was similar for the sexes, even with females having a comparatively lower energy intake, suggesting a proportionally higher sodium intake by females in relation to males.

In our study, a greater gross sodium intake was observed for females (1964.6mg), and approximately 70% of the individuals showed an intake above the recommended value (2,000 mg/day). Similar studies in individuals with metabolic syndrome show an energy intake of 1,736 kcal/day[34] and sodium intake of 2,994 mg/day.[35] Also corroborating out findings, Da Cunha et al.,[29] in a similar population and using information from two 24-hour recalls, found a low energy intake (1,523.1 kcal/d) in individuals with metabolic syndrome, with higher energy intake in males ($p = 0.003$). Thus, the average energy intake and the excessive sodium intake by individuals with metabolic syndrome observed in this study are similar to the data found in the literature.

As shown by Teramoto et al.,[36] the high sodium intake may be associated to an increase in the arterial pressure, making the individuals who live with arterial hypertension within the metabolic syndrome group more vulnerable to the effects of excessive sodium intake.

Evaluating the data related to the consumed foods the following was observed: 118 *in natura* or minimally processed foods, 100 processed or ultra-processed foods and eight types of oils, fats, salt and sugar. The analyses also show that processed and ultra-processed foods, or preparations that use these types of foods, have the highest sodium content among the foods consumed by the population of this study. On the other hand, when analyzing the amount of times that each food appears in the recall, it is observed that refined salt appears in the first place, with the greatest number of repetitions (310 times) in the analyzed recalls, with an average sodium content corresponding to 635.5 mg/d (table 3). Since the sodium intake is the result of different eating behaviors, resulting from the different intake sources of this mineral, there is a recurrence of salt *per capita* as the largest salt intake source, especially in relation to salt addition during the preparation of the foods.[37]

Table 3. Main foods consumed, according to the sodium content, by individuals with metabolic syndrome who received care in the Endocrinology Outpatient Clinic of the Onofre Lopes University Hospital, Natal-RN, 2018.

Foods	Number of repetition	mg/g Mean (SD*)	Home measurement	Sodium content (mg) Mean (SD)
Fried pastel	7	83.9 (44.3)	2 ½ units	1,753.9 (926.5)
Instant noodles with industrialized seasoning	2	83.8 (1.8)	1 shallow scoop	1,556.7 (1271.5)
Sun dried meat	33	71.9 (64.9)	1 large piece	1,396.7 (1261.8)
Feijoada	1	337.5(0.0)	1 ½ medium scoop	1,285.3 (0.0)
Industrialized pizza	1	300.0 (0.0)	3 medium slices	1,220.1 (0.0)
Industrialized powder seasoning	7	3.98 (6.7)	$^2/_3$ of a cube	1,207.3 (1369.6)
Chicken *coxinha*	4	86.9 (40.3)	1 ½ unit	1,130.6 (525.5)
Soups in general	21	309.8 (180.5)	2 large scoop	744.16 (773.6)
Sausage	12	64.0(49.3)	2 medium units	717.25 (551.8)
Ground beef-stuffed pancake	2	182.0(0.0)	2 medium units	708.0 (0.0)
Canned tuna	3	184.7 (65.0)	1 ½ can	695.2 (244.7)
Breaded chicken	1	185.0 (0.0)	1 large steak	667.9 (0.0)
Refined salt	310	1.6 (1.2)	1 ½ coffee spoon	635.5 (477.7)

*SD = standard deviation

Thus, the salt addition in preparations is the ingredient that most contributes for the sodium diet intake, as also established by Sarno et al.[15] It is important to point out that, although few individuals have mentioned the use of industrialized products, the amount of sodium available on these foods is still concerning. Souza et al.[38] indicate that the goals to reduce the sodium in processed foods effective in Brazil shall have a small impact in the average sodium intake of the Brazilian population and the necessary reduction on the intake of this mineral shall hardly be reached. It should also be pointed out that, in addition to presenting a high sodium content, ultra-processed foods are also associated to na excessive energy content, high free sugar content, *trans* and saturated fats and low fiber content, related to an increase in the incidence of non-contagious chronic diseases.[39]

It is documented that changes to the food intake is an important nondrug therapy method that may be used to prevent and reduce non-contagious chronic diseases. On the other hand, eating habits that include high sodium concentrations, high glycemic load and high empty calorie concentrations is associated to a sedentary lifestyle and favors the increase of obesity and non-contagious chronic diseases. The excessive sodium intake recorded for our population is concerning, since it is one of the most important risk factors for arterial hypertension, since it increases the arterial pressure a mortality due to cardiovascular diseases. Consequently, a nutritionally adequate food intake is a protection factor against cardiovascular diseases in individuals with metabolic syndrome, considering their associated metabolic disorders.[15,23]

The main limitations of this study are intrinsic to the food intake data collection and analysis: reporting lower usual intake values due to memory biases; difficulty by the individuals to quantify the salt used in the preparations; possible lack of information on nutritional composition tables and on the dietetic analysis *software*. In order to minimize such limitations, the 24-hour recalls were applied by trained professionals; a photographic record book was used to facilitate the quantification of home measurements; the data related to home measurements and grammage was standardized before the *software analysis;* the sodium intake data was adjusted according to the inter- and intrapersonal variability and the energy, and food replacements for the Virtual Nutri Plus 2.0® analyses were made, respecting the characteristics of the food and the sodium amount present.

A positive contribution of this study is a detailed analysis of the sodium intake and its main sources in individuals with metabolic syndrome, helping to understand the eating habits of this population and providing important information to potentialize the action of nutritionists who work with this group. Although the self-reported diet intake may underestimate the daily sodium intake, this is an interesting tool to evaluate the perception of the individuals as to quantities, the eating model and to identify the deficiencies in the dietetic knowledge in individuals with metabolic syndrome. These results alert to some care that must be taken with this group, especially individuals who live with arterial hypertension, since they are the ones who are most vulnerable to this inadequacy.

Conclusion

An inadequate sodium intake was recorded in an expressive percentage of the population, regardless of the sex, although the energy intake was below the needs for most individuals. The food that contributed the most for the sodium intake was cooking salt. Industrialized products were not expressive components in the diet of this population, but these were the foods that presented the highest amount of sodium.

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Contributors

de Carvalho GM, Freitas EPF, Lima JG, Lima SCVC and Sena-Evangelista KCM participated in the conception of the study. de Carvalho GM, Sena-Evangelista KCM and Freitas EPF participated in the statistical analysis, writing, edition and review of the final version of the article. de Carvalho GM, Freitas EPF and Soares JS participated in the data collection. Carvalho GM, Soares JS, Freitas EPF, Lima JG, Lima SCVC and Sena- Evangelista KCM participated in the final review of the article.

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