Impact of Light Salt Substitution for Regular Salt on Blood Pressure of Hypertensive Patients

Carolina Lôbo de Almeida Barros, Ana Luiza Lima Sousa, Brunella Mendonça Chinem, Rafaela Bernardes Rodrigues, Thiago Souza Veiga Jardim, Sérgio Baiocchi Carneiro, Weimar Kunz Sebba Barroso de Souza, Paulo César Brandão Veiga Jardim

Liga de Hipertensão Arterial da Faculdade de Medicina da Universidade Federal de Goiás, Goiânia, GO - Brazil

Abstract

Background: **Studies have shown sodium restriction to have a beneficial effect on blood pressure (BP) of hypertensive patients.**

Objective: **To evaluate the impact of light salt substitution for regular salt on BP of hypertensive patients.**

Methods: **Uncontrolled hypertensive patients of both sexes, 20 to 65 years-old, on stable doses of antihypertensive drugs were randomized into Intervention Group (IG – receiving light salt) and Control Group (CG – receiving regular salt). Systolic BP (SBP) and diastolic BP (DBP) were analyzed by using casual BP measurements and Home Blood Pressure Monitoring (HBPM), and sodium and potassium excretion was assessed on 24-hour urine samples. The patients received 3 g of salt for daily consumption for 4 weeks.**

Results: **The study evaluated 35 patients (65.7% women), 19 allocated to the IG and 16 to the CG. The mean age was 55.5 ± 7.4 years. Most participants had completed the Brazilian middle school (up to the 8th grade; n = 28; 80.0%), had a family income of up to US$ 600 (n = 17; 48.6%) and practiced regular physical activity (n = 19; 54.3%). Two patients (5.7%) were smokers and 40.0% consumed alcohol regularly (n = 14). The IG showed a significant reduction in both SBP and DBP on the casual measurements and HBPM ($p < 0.05$) and in sodium excretion ($p = 0.016$). The CG showed a significant reduction only in casual SBP ($p = 0.032$).**

Conclusions: **The light salt substitution for regular salt significantly reduced BP of hypertensive patients. (Arq Bras Cardiol. 2015; 104(2):128-135)**

Keywords: **Hypertension; Sodium; Blood Pressure; Diet.**

Introduction

Excessive salt intake has been identified as an important risk factor for cardiovascular disease (CVD). Sodium restriction has a favorable influence on blood pressure (BP) control, thus being a potentially powerful tool for systemic arterial hypertension (SAH) prevention and control[1].

Several studies have claimed that a reduction in sodium-rich foods consumption causes a significant decrease in BP of hypertensive patients[2-4]. *Intersalt* was one of the first studies to evaluate sodium intake from 24-hour urine samples, demonstrating a positive association between high sodium consumption and BP increase[5].

High sodium excretion is related to a higher risk of death due to CVD. On the other hand, higher potassium excretion implies reduced heart attack risk[6]. Chang et al[7] have detected that mortality due to CVD decreased significantly in individuals who consumed salt with lower sodium and higher potassium levels.

Research studies assessing the effect of the reduction in sodium consumption on BP have been treated with great importance by the scientific community. For this reason, it is important to perform new experimental studies in order to find complementary and more current results on the association between those variables[8].

Therefore, evaluating the impact of a low-sodium salt consumption on BP may contribute to better control it. The present study aimed at evaluating whether light salt substitution for regular salt could reduce the BP of hypertensive patients.

Methods

This was a single-blind randomized controlled trial.

Sample characterization

Sample size was calculated for comparison of means, with a statistical power of 90%, two-tailed hypothesis test, standard deviation of 12.7 mmHg and an expected difference of 13.1

Mailing Address: Carolina Lôbo de Almeida Barros •
Rua T37 n. 3832 St. Bueno. Postal Code 74.230-022, Goiânia, GO - Brazil.
E-mail: carolinabarrosnutri@gmail.com
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mmHg in systolic blood pressue (SBP)[3], with a significance level of 5%. The necessary sample size was of 20 individuals in each group.

Hypertensive individuals of both sexes, aged between 20 and 65 years, were recruited and regularly followed up at a multiprofessional service for hypertension care. Patients were dwellers of the metropolitan region of Goiânia, Brazil, on stable doses of antihypertensive drugs for at least 30 days, with uncontrolled hypertension (BP ≥ 140 x 90 mmHg)[9] in their last visit.

Patients with acute or subacute (up to 3 months before the beginning) and unstable chronic diseases were excluded, as were those having their meals prepared with a salt different from that provided in this study more than once a week.

Sample selection and randomization

Initially, patients were identified from medical charts, according to the inclusion and exclusion criteria. Then, they were invited to visit a nutrition office to receive the necessary information about this research and to provide their written informed consent, when agreeing to participate in this study. The project was approved by the Research Ethics Committee from the General Hospital of the Federal University of Goiás (protocol number 193/2011) and was conducted in accordance with the Declaration of Helsinki.

The studied population was assigned to two homogeneous groups [Intervention Group (IG) and Control Group (CG)], according to the order of their visit with the nutritionist: the first patient was included in IG and the second in CG, and so forth. The IG participants received light salt, whereas CG participants received placebo (regular salt), for four weeks (28 days). All participants from both groups remained on regular follow-up.

Study design

The variables collected in the inclusion visit were sex, age, schooling level (complete middle school; complete high school; and complete college), family income (up to US$ 600; from US$ 600 to US$ 1200; and US$ 1200 or more), regular physical activity practice (at least 30 minutes, three times a week), smoking habit and alcoholism (alcoholic beverage intake frequency equal to or higher than once a month.

The variables collected prior to and following the intervention included weight, height, body mass index (BMI), 24-hour urine sodium and potassium (mEq/day), casual BP and home blood pressure monitoring (HBPM).

Patients were recruited from May to October 2012. Two visits were scheduled during this study, the first corresponding to the participants' selection and randomization and the second, 28 days after the first, during the post-intervention return. In the initial week of study, patients had their casual BP measured, and underwent HBPM for four days and 24-hour urine sample collection. Then, they started to consume the prescribed salt and carried it on for 28 days. During the last week of the study, patients returned to their second visits, had their casual BP measured, and underwent HBPM and 24-hour urine sample collection, following the same procedures used before the intervention.

Casual BP was measured by the same researcher, at least three times and at 1-minute intervals, until the differences between the measurements were lower than 4 mmHg[9]. For the purpose of analysis, the mean of the last two values was considered.

HBPM was accomplished according to the III Brazilian Guidelines for HBPM[10]. Twenty-four measurements were performed, being three in the morning and three in the afternoon for four days. The examinations with a recovery percentage higher than 70% were considered adequate.

All the SBP and DBP measurements were obtained by using a semi-automatic digital device (OMRON 705 CPINT, Illinois, USA), and patients were duly guided on how to use the device for HBPM.

The process of 24-hour urine sample collection initiated with the second urine elimination of the first day and finished at the first elimination of the following day, approximately at the same time. Urine was analyzed at the General Hospital's laboratory of the Federal University of Goiás using the ion-selective membrane technique[11] to quantify sodium and potassium levels in human urine.

Intervention

All patients were instructed to consume only the provided salt throughout this study. In addition, they were instructed to reduce sodium-rich food consumption during the study period, being particularly warned about industrialized foods[12,13].

The patients received the salt after the first BP evaluation and urine collection. The daily recommendation adopted was 3 g of salt per person, proposed by the VI Brazilian Guidelines on Hypertension[9]. To calculate the amount of salt consumed per patient, the number of people usually sharing the same meals was considered. Ten percent of the amount of salt per patient was added, anticipating a higher consumption due to family routine changes on weekends (greater number of people).

Every patient received 28 small plastic bags containing the daily amount of salt, with a tag showing the initials of the patient's name, date of use and the amount of salt. The salt provided showed no identification of its composition. Therefore, participants were not aware of the type of salt they were receiving. The researcher was the only person who knew that information, characterizing the study as a simple-blind investigation.

The light salt composition (per gram) was as follows: 130 mg of sodium, 346 mg of potassium and 44 mcg of iodine. The regular salt contained (per gram) 390 mg of sodium and 25 mcg of iodine.

Statistical analysis

The data were analyzed using the SPSS software, version 20.0 (SPSS Inc, Chicago, USA). Qualitative variables were

presented as mean and standard deviation, according to their absolute and relative frequencies. Shapiro-Wilks W test was used to verify data normality. In the presence of normal distribution, independent data, as well as paired data, were compared by using Student *t* test; Wilcoxon's test was used when paired data were skewed.

The 5% significance level was adopted for all tests.

Results

Of the 1800 medical registrations at our service, 265 corresponded to patients with uncontrolled BP, of whom, only 56 were eligible. This could be explained by the fact that our service provides care to an elderly population with a high incidence of chronic diseases, which were exclusion criteria of this study.

Of the 56 eligible patients, 38 agreed to participate and were selected for the study from May to October 2012 (19 in each group). The calculated sample (40 individuals) was not reached, because most of the patients reported personal problems or difficulties as a justification for not participating. In addition, after beginning the research and due to patients' personal reasons (illness in family or lack of time), there was a follow-up loss of three CG individuals prior to the intervention, which resulted in a final sample of 35 patients (19 in IG and 16 in CG) (Figure 1).

At the beginning of the study, the groups were homogeneous in regard to socio-demographic variables. The mean age was 55.5 ± 7.4 years, and 65.7% of the sample corresponded to women. The majority had completed the Brazilian middle school, that is, up to the 8th grade (n = 28; 80.0%), had a family income of up to US$ 600 (n = 17; 48.6%) and practiced regular physical activity (n = 19; 54.3%). Two patients (5.7%) were smokers and 40.0% consumed alcohol regularly (n = 14).

Regarding the clinical variables, both groups were also homogeneous at the beginning of the study (Table 1). The recovery percentage of BP measurements was 100%.

After intervention

Seven days from the end of the research, one CG patient asked for more salt. At the end of the study, casual BP measurements (SBP and DBP) and 24-hour sodium excretion significantly differed between IC and CG. However, no significant differences in BMI values, HBPM and potassium urine excretion were observed between the groups (Table 2).

The intragroup analysis demonstrated that the mean BP measurements of IG patients were significantly reduced after using light salt. Likewise, sodium excretion was significantly decreased in that group. No change was observed in 24-hour urine potassium excretion (Table 3).

Concerning the CG individuals, the only significant difference after using regular salt was a SBP reduction, because the other variables (casual DBP, SBP and DBP by HBPM and urine sodium and potassium values) remained similar (Table 4).

Adverse effects

This clinical trial detected an adverse effect among IG patients. Due to its peculiar taste, light salt had low acceptance by 89.5% of IG individuals, who claimed there were taste changes in the prepared foods. Nevertheless, patients agreed to use that salt throughout the study period. The above mentioned adverse effect was considered mild and study interruption was not necessary.

Discussion

This study sought to reduce the dietary sodium intake of CG patients to less than the 5 g of salt per day (2 g of sodium) proposed by the World Health Organization[14], considering that the 3 g provided corresponded to the consumption of 1.2 g of sodium from regular salt.

On the other hand, light salt (with approximately 67% less sodium than the regular one) promoted a mean intake of 390 mg of sodium per day. This sodium restriction was capable of promoting the BP and sodium excretion control observed in the IG, suggesting that, at least in the short-term, the use of light salt has proven to be an efficient strategy for SAH treatment.

Despite demonstrating a significant BP reduction after decreasing salt intake, the mean sodium excretion values in the present study were higher than 125 mEq (IG) and 180 mEq (CG), indicating that the provided sodium amount (1.2 g from regular salt and 390 mg from light salt) may not have corresponded to that consumed by the patients. This shows the difficulty of changing a lifestyle, because salt consumption is a strong habit around the world. Ortega et al[15] have found a dietary salt intake of 9 g/day on Spanish adults between 18 and 60 years, with 168 mmol/d sodium excretion on 24-hour urine. It reflects ingestion above the recommended 5 g per day, just as in the present study.

Unfortunately, the design of this study could not follow patients on their routine to check if there was a complete adhesion regarding their sodium intake, although they had been strongly instructed about how to use the given salt and how to avoid all sodium-rich food. It seems they may have eaten less sodium than usual, but not exactly as recommended, justifying sodium excretion above expected. Besides, 24-hour excretion values showed only the previous-day sodium and potassium intake, which could have been atypical as compared to that of other days, even with all the recommendations. The same argument may apply to the unchanged potassium excretion of IG, in addition to the fact that the light salt potassium content is low to cause a significant difference in urine excretion, which could vary more with a higher than usual potassium-rich food ingestion.

Resistance to lifestyle changes to control SAH is common among hypertensive patients[16]. In addition, another limiting aspect that impairs adhesion to SAH control was detected among IG patients, because 89.5% reported identifying a bitter taste in their foods. Although the same patients reported that the 28-day period of diet was acceptable, they were reluctant to comply with the suggestion of maintaining light salt after the conclusion

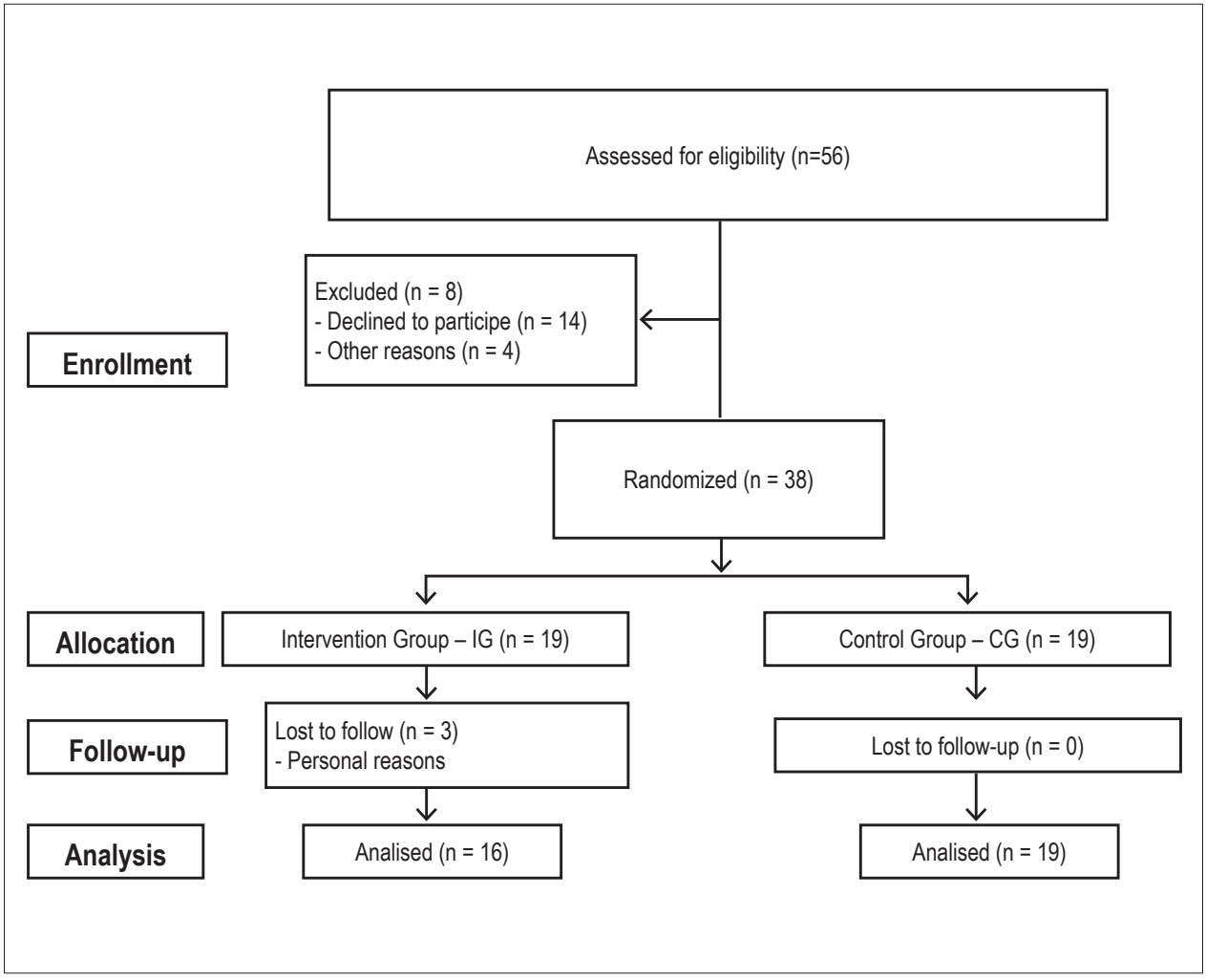

Figure 1 - *Flow diagram of patients' randomization.*

Table 1 - Mean values of the evaluated variables before intervention, according to groups. Goiânia city, Goiás state, Brazil, 2012 (n = 35)

	CG (n= 16)	IG (n= 19)	p*
	Mean ± SD	Mean ± SD	
BMI	31.00 ± 5.97	29.38 ± 5,55	0.411
Casual BP:			
SBP	143.44 ± 13.99	142.95 ± 14.86	0.921
DBP	91.19 ± 9.10	89.79 ± 9.10	0.654
HBPM:			
SBP	131.63 ± 14.36	134.47 ± 17.00	0.600
DBP	79.38 ± 11.65	77.95 ± 10.23	0.702
Sodium	213.56 ± 89.99	205.87 ± 131.50	0.844
Potassium	54.41 ± 17.01	74.53 ± 76.14	0.309

*CG: control group; IG: intervention group; BMI: body mass index (kg/m²); BP: blood pressure; DBP: diastolic blood pressure (mmHg); HBPM: home blood pressure monitoring; Potassium: 24-hour urine potassium (mEq/day); SBP: systolic blood pressure (mmHg); SD: standard deviation; Sodium: 24-hour urine sodium (mEq/day). *Student t test for independent samples.*

Table 2 - Mean values of the evaluated variables after intervention, according to groups. Goiânia city, Goiás state, Brazil, 2012 (n = 35)

	CG	IG	IG x CG	p*
	Mean ± SD	Mean ± SD	Difference	
BMI	31.19 ± 6.14	29.44 ± 5.50	(1.75)	0.379
Casual BP:				
SBP	137.19 ± 20.22	127.11 ± 15.64	(12.47)	0.034
DBP	82.75 ± 12.12	75.95 ± 9.47	(7.58)	0,046
HBPM:				
SBP	131.06 ± 15.53	127.47 ± 15.33	(4.78)	0.365
DBP	80.13 ± 11.75	73.42 ± 10.78	(7.19)	0.074
Sodium	182.59 ± 76.74	127.11 ± 57.39	(55.59)	0.023
Potassium	55.33 ± 18.43	48.05 ± 19.29	(7.03)	0.296

*CG: control group; IG: intervention group; BMI: body mass index (kg/m²); BP: blood pressure; DBP: diastolic blood pressure (mmHg); HBPM: home blood pressure monitoring; Potassium: 24-hour urine potassium (mEq/day); SBP: systolic blood pressure (mmHg); SD: standard deviation; Sodium: 24-hour urine sodium (mEq/day). *Student t test for independent samples.*

Table 3 - Mean values of casual BP and HBPM in the IG (light salt) before and after intervention. Goiânia city, Goiás state, Brazil, 2012 (n = 19)

	IG (before)	IG (after)	Before x After	p
	Mean ± SD	Mean ± SD	Difference	
Casual BP:				
SBP	142.95 ± 14.86	127.11 ± 15.64	(-15.84)	0.002*
DBP	89.79 ± 9.10	75.95 ± 9.47	(-13.84)	0.000**
HBPM:				
SBP	134.47 ± 17.00	127.47 ± 15.33	(-7.00)	0.012**
DBP	77.95 ± 10.23	73.42 ± 10.78	(-4.53)	0.003**
Sodium	205.87 ± 131.50	127.11 ± 57.39	(-78.76)	0.016 **
Potassium	74.53 ± 76.14	48.05 ± 19.29	(-9.40)	0.157**

*IG: intervention group; BMI: body mass index (kg/m²); BP: blood pressure; DBP: diastolic blood pressure (mmHg); HBPM: home blood pressure monitoring; Potassium: 24-hour urine potassium (mEq/day); SBP: systolic blood pressure (mmHg); SD: standard deviation; Sodium: 24-hour urine sodium (mEq/day). * Wilcoxon's test. **Student t test for matched samples.*

Table 4 - Mean values of casual BP and HBPM in the CG (regular salt) before and after intervention. Goiânia city, Goiás state, Brazil, 2012 (n = 16)

	CG (before)	CG (after)	Before x After	p
	Mean ± SD	Mean ± SD	Difference	
Casual BP:				
SBP	143.44 ± 13.99	137.19 ± 20.22	(-6.25)	0.032**
DBP	91.19 ± 9.10	82.75 ± 12.12	(-8.44)	0.055*
HBPM:				
SBP	131.63 ± 14.36	131.06 ± 15.53	(-0.57)	0.858**
DBP	79.38 ± 11.65	80.13 ± 11.75	(+0.75)	0.587**
Sodium	213.56 ± 89.99	182.59 ± 76.74	(-30.97)	0.175**
Potassium	54.41 ± 17.01	55.33 ± 18.43	(+0.92)	0.796**

*CG: control group; BMI: body mass index (kg/m²); BP: blood pressure; DBP: diastolic blood pressure (mmHg); HBPM: home blood pressure monitoring; Potassium: 24-hour urine potassium (mEq/day); SBP: systolic blood pressure (mmHg); SD: standard deviation; Sodium: 24-hour urine sodium (mEq/day). * Wilcoxon's test. **Student t test for matched samples.*

of the study, even after acknowledging the better control of their BP.

The possible explanation for the taste change of light salt is the potassium added to its composition. In spite of this negative effect, the scientific community often discusses not only the beneficial effect on BP of reducing sodium intake, but also the positive impact that potassium intake may have on SAH control[17,18].

Similarly to the present study, Lotaif et al[17] used a salt with lower sodium content and added potassium in order to verify its effect on BP. Patients were separated into a control group (regular salt) and an intervention group (light salt), and had their BP assessed by using Ambulatory Blood Pressure Monitoring (ABPM), as well as their blood and urine sodium and potassium levels assessed. The intervention group showed BP reduction. On the other hand, sodium levels showed no change in any of the groups, whereas the intervention group showed a significant increase only in plasma potassium levels. The authors attributed BP control to potassium supplementation and not to the reduction in sodium intake.

The literature, however, still lacks conclusive studies on the need for medical supplementation of potassium to control BP, being a balanced diet, rich in fruits and vegetables, the best way to obtain that mineral[14].

In accordance with the results of the study by Lotaif et al[17], the potassium excretion values obtained at the beginning and end of this study were similar. It indicates that, in the present study, salt intake from light salt may not have influenced the total balance ingested by patients, since the daily potassium need for adult individuals, which contributes to BP control, is 4.7 g[19].

Therefore, the potassium content consumed by the IG may not have accounted for the BP reduction of those patients, because the additional amount ingested from light salt was only 1038 mg. This fact reinforces the hypothesis that the BP control of this study was due to sodium reduction, much more effective with the use of light salt and, additionally, confirmed with the significant reduction in sodium excretion of IG patients.

Such reduction in sodium intake is an important factor considering the reduction in CVD mortality, as shown in the study with individuals from five kitchens of a retirement home in northern Taiwan, who were separated into two groups. The first group was given a potassium-enriched lower sodium salt, and the other group, only regular salt. A significant reduction in CVD mortality was observed in the experimental group[7].

A systematic review has shown randomized trials of dietary counseling methods on sodium intake reduction to treat hypertension and identified a significant reduction in BP and sodium excretion when sodium intake was restricted[20].

Sodium intake reduction has also been proven to be efficient in the SAH control of 169 individuals, separated into two groups, one with low sodium intake and the other with placebo, submitted to a double-blind crossover study[21]. In the present study, the decrease in BP reached 15.84 x 13.84 mmHg (IG) and 6.25 x 8.44 mmHg (CG), although the reduction was significant only in IG.

Another meta-analysis allowed the conclusion that, when compared to the current recommendations, a reduction in salt consumption to 3 g per day may have much better results and, thus, that should be used as the daily intake goal around the world[4]. Such conclusion reinforces this study's findings to obtain more favorable results on BP control.

The sodium excretion values found in the present study suggest that the patients may have consumed amounts higher than 3 g of the provided salt, as already mentioned. Nevertheless, BP control at the end of the intervention demonstrated that the intake prior to the study was probably excessive as compared to that during the study. Therefore, the reduction in salt consumption had beneficial effects on SAH, as seen in this study's results.

These data reinforce the relevance of the present study, once dietary sodium restriction has been constantly referred to as a factor contributing to SAH control, and, consequently, to reduce mortality due to CVD[2-4].

Therefore, changes in eating habits, such as decreasing the consumption of addicted salt and processed food, which represents more than 75% of sodium intake of the North American's diet[22], proposed in this study, are a valuable tool for SAH control and reduction in the risk of mortality due to CVD, which is the major cause of death in the world.

The significant reduction in casual SBP in the CG, with no changes in HBPM values, may have occurred due to attenuation of the white-coat effect in the study.

One limitation of this study was the change in food taste attributed to light salt by a large number of IG patients. This fact did not interfere with the use of light salt during this study, but it may be a limiting factor regarding long-term adhesion. Finally, salt sensitivity, which varies among individuals, may have influenced the patients' BP levels.

Conclusion

In conclusion, potassium-enriched light salt substitution for regular salt was efficient in reducing hypertensive patients' BP in this study. Thus, the long-term implementation of that change could be interesting to reduce population hypertension and even mortality due to CVD. Health care professionals could use these results to explain to their patients how sodium intake can raise BP and encourage them to reduce it by using light salt. Furthermore, hospitals could control BP of hypertensive patients by using that type of salt in their diet during hospitalization and light salt's industry could create strategies so that its flavor is not a limiting factor for its use, since the benefits of its consumption were evident.

Author contributions

Conception and design of the research: Barros CLA, Sousa ALL, Jardim TSV, Jardim PCBV; Acquisition of data: Barros CLA, Chinem BM, Rodrigues RB; Analysis and interpretation of the data: Barros CLA, Sousa ALL, Chinem BM, Rodrigues RB, Jardim TSV, Souza WKSB, Jardim PCBV; Statistical analysis: Barros CLA, Sousa ALL, Jardim PCBV; Obtaining Financing: Barros CLA, Jardim PCBV; Writing of the manuscript: Barros CLA, Sousa ALL, Jardim PCBV; Critical revision of the

manuscript for intellectual content: Barros CLA, Sousa ALL, Chinem BM, Rodrigues RB, Jardim TSV, Carneiro SB, Souza WKSB, Jardim PCBV.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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