Revista de Saúde Pública
ISSN 0034-8910 versão impressa

Rev Saúde Pública 2003; 37(6)

Hypertension and salt intake in an urban population

Maria del Carmen Bisi Molina[a], Roberto de Sá Cunha[b], Fernando Luis Herkenhoff[b] and José Geraldo Mill[b]

[a]Departamento de Enfermagem do Centro Biomédico da Universidade Federal do Espírito Santo. Vitória, ES, Brasil. [b]Departamento de Ciências Fisiológicas do Centro Biomédico da Universidade Federal do Espírito Santo. Vitória, ES, Brasil

---

ABSTRACT

Objective

To evaluate the salt intake and urinary Na^+/K^+ ratio in a randomized sample from an ethnically mixed urban population.

Methods

A randomized residential sample of 2,268 individuals aged 25-64 in Vitória, ES, was selected, of whom 1,663 (73.3%) reported to the University Hospital for standardized tests. Salt, Na^+ and K^+ intake was estimated from 12-hour urine excretion (7 p.m. to 7 a.m.) and from the monthly salt consumption at home reported in the interview. Clinic arterial pressure was measured twice under standard conditions by two trained investigators, using mercury sphygmomanometry. The Student t and Tukey tests were utilized for statistical analysis.

Results

Urinary Na^+ excretion was higher in men and individuals of lower socioeconomic level (P<0.000). No difference between ethnic groups was observed. K^+ excretion was unrelated to socioeconomic level and ethnicity, but was significantly higher among men (25±18 vs. 22±18 mEq/12h; P=0.002). Positive linear correlation was observed between urinary Na^+ excretion and systolic (r=0.15) and diastolic (r=0.19) arterial pressure. Hypertensive individuals showed higher urinary Na^+ excretion and Na^+/K^+ ratio than normotensive individuals. Reported salt intake was around 50% of the intake estimated from 12-hour urine collection (around 45% of 24-hour urinary excretion).

Conclusions

Salt intake is strongly influenced by socioeconomic level and may partially explain the higher prevalence of hypertension in lower socioeconomic classes.

Keywords

Sodium chloride, analysis. Sodium. Potassium. Hypertension, epidemiology. Prevalence. Socioeconomic factors.

INTRODUCTION

Arterial hypertension is considered to be a public health problem because of its magnitude and risk and the difficulties in its control. It is also recognized as one of the most important risk factors for the development of cerebrovascular events and myocardial infarct.[14]

Several population studies have given evidence of the importance of controlling hypertension for the reduction of cardiovascular morbidity and mortality. Thus, the high rates of cardiovascular morbidity and mortality in recently industrialized countries appear to be significantly dependent on the high prevalence of arterial hypertension in such countries.[21] Although there are no studies with good national-level representativeness available regarding arterial hypertension in Brazil, localized research has shown high prevalence, within the range of 20 to 45% of the adult population.[8]

In most cases, the cause of the hypertension is unknown. However, there are several factors that could be associated with raising the arterial pressure, such as sedentary lifestyles, stress, smoking, aging, family history, race, gender, weight and dietary factors.

Despite the strong relationship confirmed between arterial hypertension and nutritional factors, the mechanisms of how such factors act to raise arterial pressure remain unclear. However, the effects of a healthy diet (rich in fruit and vegetables and low on fats) on the behavior of pressure levels are well known.[17] Among the nutritional factors studied that are associated with the high prevalence of arterial hypertension are high alcohol and sodium consumption and excess weight.[11] The consumption of potassium, calcium and magnesium have also been associated with such hypertension recently, which would attenuate the progressive increase in blood pressure levels with age.[13]

Assessment of sodium in the diet is extremely complex, since its daily consumption varies substantially. The daily sodium intake may be underestimated, since the differences in salt addition between people are not taken into consideration.[7] In addition to this, another problem encountered in dietary assessment is the food composition table utilized, which may vary greatly from one country to another and not take into consideration regional preparations and manufactured products on the domestic market.

Considering that more than 95% of the sodium intake is excreted in the urine and that dietary assessments present many operational problems, 24-hour urine excretion has been utilized as a marker for daily sodium consumption, despite the great variability between individuals. Thus, there needs to be caution regarding clinical and physiological interpretations based on a single evaluation. This problem can, however, be overcome in population-based studies, given that the urinary excretion of sodium is considered to be a good indicator for salt consumption on a given day.[9]

The majority of studies aiming to find an association between sodium consumption and arterial hypertension have utilized 24-hour urinary excretion of sodium as a daily marker, and in many such studies a consistent relationship has been found. Evidence of an association between sodium consumption and hypertension has also been reported by the INTERSALT Group,[11] especially with regard to assessments of the differences in the prevalence of arterial hypertension that is associated with the level of industrialization of the populations studied. Western populations and those with high salt consumption appear to have the highest percentages of hypertension, while rural or primitive populations that do not make use of added salt present lower prevalence or no cases of arterial hypertension.[11] However, overweight and sedentary lifestyles present in these populations may be significant confounding variables. Other studies have been conducted along these lines in several populations, with the objective of proving the hypothesis that high salt intake in the diet increases blood pressure levels, independent of age and other factors, which today is well established.

In addition to the operational difficulties in assessing sodium consumption, the questions relating to sensitivity to sodium appear to be difficult to resolve when studied in human beings. In effect, some individuals excrete larger quantities of sodium without an increase in arterial pressure while it is the opposite for others.[6] The physiological response to increased sodium intake results in the reduction of the activity of the renin-angiotensin-aldosterone system and an increase in the release of atrial natriuretic peptide. These systems interact with each other and with other systems, as well as acting in the reduction of sympathetic activity directed towards the kidneys. The genetic differences responsible for these different responses of the human body are not yet well known. It would appear to be difficult to establish, *a priori*, who would be in the first or second group when large numbers of individuals in the population are studied, especially when such populations are racially heterogeneous. With regard to this question, some studies have now given evidence that Negro individuals have greater sensitivity to sodium than whites do.[20]

Despite these observations, the majority of studies have reported a causal relationship between increased dietary sodium, evaluated via urine excretion, and arterial hypertension in different populations.[4] However, 24-hour urine collection is very difficult to implement in the general population, notably among age groups in which manual labor activities are more frequent. In a previous study,[15] a method was tested for estimating 24-hour Na^+ consumption by means of nighttime urine collection at home, covering the period from 7 p.m. to 7 a.m. of the next day. The validation of this method on a small-scale sample has allowed its extension in the present study, to cover a representative sample of the adult urban population of Vitória, ES. Thus, the objective of the work was to assess sodium and potassium consumption and the sodium/potassium ratio in different socioeconomic classes and according to race and sex, and the relationship between such consumption and high arterial pressure.

METHOD

The study design was based on cross-sectional research methodology and was developed by means of surveying and analyzing socioeconomic and health data in a probabilistic sample of residents from the municipality of Vitória, ES. The sampling plan had the objective of ensuring that the research would be socioeconomically, geographically and demographically representative of the residents of this municipality. The resident population aged 25 to 64 years in the city of Vitória was studied. According to the census carried out by Fundação IBGE in the year 1996, the resident population of Vitória was 265,874 inhabitants. The sampling was performed in four stages: by district, IBGE census sector, drawing lots to choose homes, and drawing lots to choose the individual from each home. The survey was conducted with just one resident of the home that was drawn, within the age group of the study. The draw was carried out by means of a randomization mechanism. A selection of 2,268 residential homes located in Vitória was made and these were visited. The individual selected at each of these homes was given explanations of the purposes of the research and invited to participate in the study, after obtaining his or her consent. The project received approval from the Ethics Committee of the Biomedical Center of Universidade Federal do Espírito Santo (UFES).

The data collection was carried out by interviewers and trained technicians in the years 1999 and 2000, by means of questionnaires applied during visits to 2,200 individuals in the selected homes. During the home visit, the participant received guidance and materials for the 12-hour urine collection covering the period from 7 p.m. to 7 a.m. of the next day.

The selected individuals were asked to attend the Cardiovascular Investigation Clinic of the University Hospital for tests to be performed on the following day. Of the total sample, 1,663 individuals attended. As well as handing in the 12-hour urine collected during the preceding night, arterial pressure was measured, a questionnaire was completed regarding dietary and lifestyle habits, blood was collected and other tests were performed with the aim of determining the cardiovascular risk. The quantification of sodium and potassium in mmol/L was done by means of flame spectrophotometry, using commercial kits. The values found in the urine samples were converted into 12-hour urine electrolyte quantities. The daily quantity of sodium was estimated by means of the equation $Na^{+}24h = 1.7Na^{+}12h + 49.8$ ($r = 0.88$, $p < 0.01$), which was derived from the validation study on 50 normotensive individuals.[15]

The salt consumption was initially estimated from calculation of the 24-hour sodium excretion, assuming that all the sodium intake had been in the form of NaCl. The consumption was also estimated from the quantity of salt consumed very month in the home (according to information collected via the questionnaire). These data were corrected for the number of people who had meals in the home. The Na/K ratio was calculated from the quantities of these electrolytes in the 12-hour urine and was utilized as a marker for the dietary quality.

The arterial pressure measurement was done by trained researchers using a bench-mounted mercury column sphygmomanometer (Esotec). The arterial pressure was measured in the non-dominant arm with the individual seated and having rested for at least five minutes after emptying the bladder. Two measurements were obtained from each individual, done by two different investigators and with a minimum interval of 10 minutes between the measurements. The average of the two measurements was utilized in the determination of the basal arterial pressure. Among the individuals examined, 435 declared that they had taken some antihypertensive medication during the preceding 15 days. The pressure and urinary sodium and potassium excretion data include these individuals. The mean arterial pressure (MAP) was calculated via the equation (SAP+2DAP)/3, where SAP = systolic arterial pressure and DAP = diastolic arterial pressure. For classifying individuals into six pressure stages, the JOINT VI proposal[18] was utilized. For classifying individuals as hypertensive or normotensive, the proposal of the Brazilian Consensus for Arterial Hypertension[5] was utilized. In this, individuals with

SAP of greater than or equal to 140 mmHg and/or DAP of greater than or equal to 90 mmHg, or furthermore those using antihypertensive medications, are identified as hypertensive.

The individuals were classified into five socioeconomic classes, on the basis of data on the education level of the head of the family and the type and quantity of domestic equipment in the home (Fundação IBGE).[10]

The comparison of averages between the sexes was done by means of the Student t test for independent samples. For the other variables (socioeconomic class, race and pressure stages), one-way variance analysis (ANOVA) was utilized, followed by the Tukey test. The degree of association between variables was found by means of the Pearson correlation coefficient (r). The simple and partial aged-controlled correlations between SAP, DAP and MAP and the 12-hour urinary Na and K excretion and the urinary Na/K ratio were also calculated. For analysis of the data, the SPSS program for Windows (version 10.0.1) was utilized.

RESULTS

The sample studied consisted of 764 men (45.9%) and 899 women (54.1%). These percentages are close to the distribution by sex for the 143,539 inhabitants of Vitória (46.2 and 53.8%) within the 25-64 year age group, according to the 2000 census.[10]

With regard to socioeconomic class, 10.9% were in class A, 27.5% in B, 29.4% in C, 28.4% in D and 3.8% in E.

Table 1 presents the averages and standard deviations of the variables studied and the urine volume, according to sex, socioeconomic class and race. Significant differences were found in Na^+12h and Na/K between the sexes and socioeconomic classes ($P<0.05$). The Na/K ratio and urine volume were lower among individuals of Negro race ($P<0.05$). No significant difference between Na^+12h and race was found (F=1.13).

Table 1 – Average and standard deviation of the measurements and nutritional indicators of the sample studied, according to sex, socioeconomic class and race.

Characteristics	Na^+ (mEq)	K^+ (mEq)	Na^+/K^+	Daily salt (g)	Urine volume (L)
Sex					
Men	107 (58)	25 (18)	5.1 (3.6)	6.7 (4.3)	0.85 (0.5)
Women	93 (57)	22 (16)	4.8 (2.8)	6.9 (4.5)	0.86 (0.4)
P	0.000	0.002	0.029	0.730	0.699
Socioeconomic class					
A	90 (48)	26 (16)	3.9 (1.8)	5.1 (2.9)	0.90 (0.49)
B	90 (49)	24 (14)	4.2 (3.8)	6.1 (4.1)	0.86 (0.47)
C	103 (59)	23 (16)	5.0 (2.6)	7.1 (4.6)	0.87 (0.44)
D	107 (66)	23 (19)	5.8 (4.5)	7.5 (4.7)	0.82 (0.44)
E	102 (62)	21 (16)	5.6 (3.0)	8.1 (5.2)	0.75 (0.43)
P	0.000	0.202	0.000	0.000	0.095
Race					
White	98 (57)	25 (17)	4.6 (3.7)	6.3 (4.2)	0.89 (0.48)
Negro	102 (59)	21 (15)	5.6 (3.1)	7.1 (4.6)	0.75 (0.41)
Mulatto	102 (59)	23 (17)	5.1 (2.9)	7.1 (4.4)	0.84 (0.44)
Mestizo	91 (48)	23 (13)	4.5 (2.3)	6.9 (4.9)	0.84 (0.46)
P	0.335	0.094	0.004	0.009	0,009
Total	99 (58)	24 (17)	4.9 (3.2)	6.8 ± 4.5	0.85 (0.46)

Na^+ 12h: 12-hour urinary sodium excretion; K^+ 12h: 12-hour urinary potassium excretion; Na^+/K^+: ratio of 12-hour urinary sodium excretion to 12-hour urinary potassium excretion; daily salt: daily salt intake divided by number of persons.

The figures represent averages with standard deviations.

Taking into consideration that no difference in urine volume was found between the sexes and socioeconomic classes, it can be inferred that the quality of the measurements was satisfactory and that study of the elements Na^+ and K^+ in 12-hour urine provides reliable markers for the consumption of these electrolytes. Ten individuals (0.6%) of the sample attended the clinic but did not hand in the 12-hour urine collection. It is probable that some of the individuals originally selected in the household sampling did not some for the tests in the clinic because they had not done the urine collection over the preceding night. Among those who did hand in the urine, 0.4% reported that they had not done the collection in accordance with the protocol and were excluded from the sample.

With regard to the consumption variables, which are indicated as average and standard deviation in Table 2, only the quantity of sodium excreted in the 12-hour urine increased progressively with the arterial pressure class. Individuals in the “excellent” arterial pressure class (SAP <120 and DAP <80) presented the lowest 12-hour urinary sodium excretion (86±57 mEq), and this value was significantly lower than what was found in the “normal” (94±48 mEq, $P<0.05$), “high normal” (102±54 mEq, $P<0.001$), stage 1 (109±61 mEq), stage 2 (110±63 mEq, $P<0.001$) and stage 3 (120±65 mEq, $P<0.05$) arterial pressure classes. The sodium/potassium ratio was also lowest in the “excellent” arterial pressure class (4.5±2.7) and significantly different from the stages 1 (5.2±2.9, $P<0.05$) and 3 (5.9±3.2, $P<0.05$). No significant differences were found in the 12-hour urinary potassium excretion and daily salt consumption between the arterial pressure stages. The salt consumption estimated from the 12-hour urinary sodium excretion followed the same trend as the 12-hour sodium values.

Table 2 – Averages and standard deviations for the consumption variables, according to the arterial pressure stages.

Arterial pressure stages*	Consumption variables				
	Na^+ 12h	K^+ 12h	Na^+/K^+	**Daily salt**	Estimated salt
	(mEq)	(mEq)		(g)	(g)
Excellent	86 (57)	22 (18)	4.5 (2.7)	6.5 (4.0)	11.2 (5.6)
Normal	94 (48)***	23 (17)	4.8 (4.3)*	6.4 (4.0)	12.0 (4.8)***
High normal	102 (54)***	24 (15)	5.0 (3.1)*	6.9 (4.5)	12.7 (5.3)***
Stage 1	109 (61)***	24 (14)	5.2 (2.9)*	7.2 (4.5)	13.4 (6.0)***
Stage 2	110 (63)***	26 (20)	4.9 (2.7)*	7.3 (3.7)	13.5 (6.2)***
Stage 3	120 (65)***	24 (16)	5.9 (3.2)*	7.2 (4.5)	14.4 (6.4)***
P	0.000	0.171	0.001	0.134	0.000

SAP: systolic arterial pressure; DAP: diastolic arterial pressure

*Excellent: SAP<120 and DAP<80; normal: SAP<130 and PAD<85; high normal: SAP between 130 and 139 or DAP between 85 and 89; stage 1: SAP between 140 and 159 or DAP between 90 and 99; stage 2: SAP between 160 and 179 or DAP between 100 and 109; stage 3: SAP≥180 or DAP≥110; Na^+ 12h, 12-hour urinary sodium excretion; K^+ 12h, 12-hour urinary potassium excretion; Na^+/K^+, sodium/potassium ratio; daily salt, daily quantity of salt consumed per person; estimated salt, estimated consumption of salt from 12-hour urinary sodium excretion.

The data are presented as averages (with standard deviation).

*$P<0.05$, vs. excellent pressure stage.

***$P<0.001$

Table 3 presents the averages and standard deviations for the hemodynamic measurements and variable studied, according to the classification of the individuals as hypertensive or normotensive. All the measurements for the individuals classified as hypertensive differ from those of the group classified as normotensive. When only two groups were utilized for classifying the individuals, measurements that previously did not differ from one group to another, such as daily salt consumption, became statistically different in this situation (hypertensive: 7.2±5.0 g, normotensive: 6.6±4.0 g, $P<0.05$).

Table 3 – Averages and standard deviations of the hemodynamic measurements and consumption variables for the sample studied, according to the classification of individuals as hypertensive or normotensive.

Measurements and indicators*	Normotensive	Hypertensive	***P* value**
	(N=953)	(N=703)	
Age (years)	42 (10)	49 (10) ***	0.000
SAP (mmHg)	115 (11)	145.5 (20) ***	0.000
DAP (mmHg)	76 (8)	96 (13) ***	0.000
MAP (mmHg)	89 (8)	112 (99) ***	0.000
Daily salt (g)	6.6 (4.0)	7.2 (5.0) **	0.007
Estimated salt (g)	11.7 (5.3)	13.5 (6.1) ***	0.000
Na^+ 24h (mmol)	91 (54)	110 (61) ***	0.000
K^+ 24h (mmol)	23 (15)	25 (18) **	0.006
Na^+/K^+	4.7 (3.3)	5.2 (3.1) **	0.002

*SAP: systolic arterial pressure; DAP: diastolic arterial pressure; MAP: mean arterial pressure; Na^+ 12h, 12-hour urinary sodium excretion; K^+ 12h, 12-hour urinary potassium excretion; Na^+/K^+, sodium/potassium ratio; daily salt, daily quantity of salt consumed per person; estimated salt, estimated consumption of salt from 12-hour urinary sodium excretion.

The data are presented as averages (with standard deviation).

**$P<0.01$, vs. normotensive.

***$P<0.001$.

Table 4 presents the results from the correlation analysis, before and after age-control, between the hemodynamic measurements and the variables studied. It was observed that only the variables Na^+12h and Na/K continued to have a correlation with SAP, DAP and MAP.

Table 4 – Partial correlation between the hemodynamic measurements and nutritional variables, before and after age-control.

Variables	Hemodynamic measurements		
	SAP	DAP	MAP
Na^+ 12h			
before	0.15***	0.19***	0.18***
after	0.14***	0.19***	0.18***
K^+ 12h			
before	0.06*	0.05*	0.07**
after	0.03	0.04	0.03
Na^+/K^+			
before	0.07*	0.12***	0.10***
after	0.10***	0.14***	0,13***
Daily salt			
before	0.05	0.06*	0.06*
after	0.04	0.05	0.05

SAP: systolic arterial pressure; DAP: diastolic arterial pressure; MAP: mean arterial pressure; Na^+ 12h, 12-hour urinary sodium excretion; K^+ 12h, 12-hour urinary potassium excretion; Na^+/K^+, sodium/potassium ratio; daily salt, daily quantity of salt consumed per person. The hemodynamic measurements were correlated with the consumption variables before and after age-control.

*P<0.05; **P<0.01; ***P<0.001.

Positive linear correlations were observed between urinary sodium excretion and SAP (r=0.15, P<0.001) and DAP (r=0.19, P<0.001), as shown in the Figure.

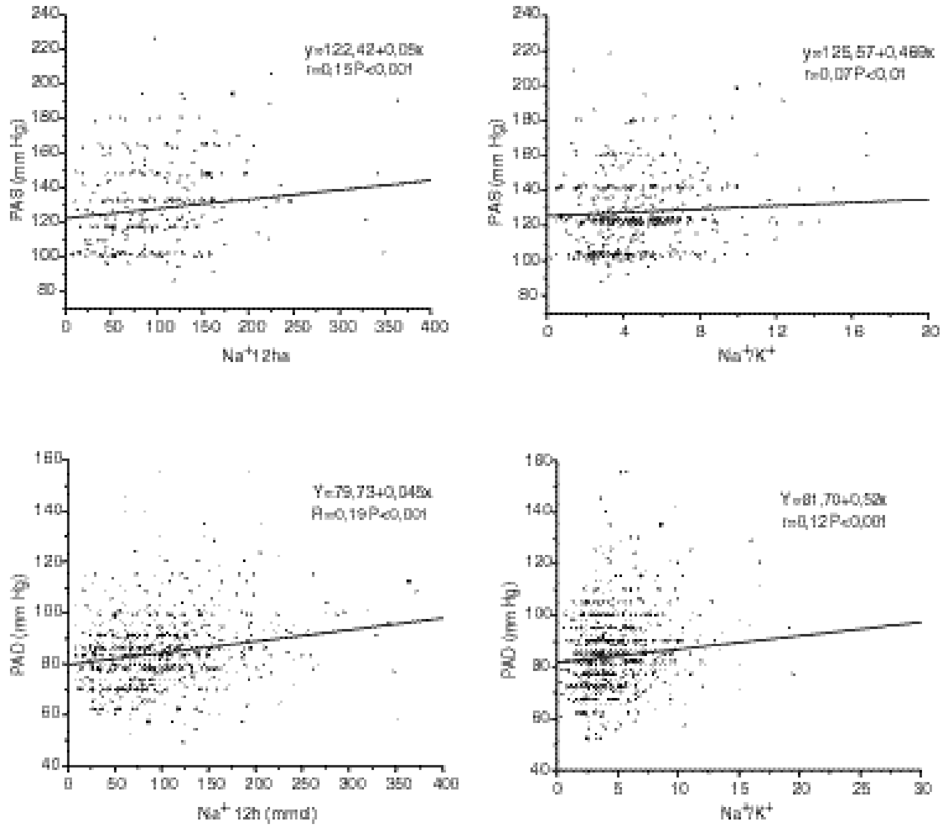

Figure – Linear regression of systolic arterial pressure (SAP) and diastolic arterial pressure (DAP) as a function of urinary sodium excretion and the sodium/potassium ratio.

DISCUSSION

Differing from other population studies performed in Brazil, a large proportion of the individuals in higher social classes welcomed the interviewers into their homes and agreed to participate in the study. This was probably due to publicity through the media that was given before and during the fieldwork. However, one limitation of the study was the low return from individuals of class E. There was also a lower proportion of younger individuals attending the clinic for tests to be performed, and the average age for the group studied was around 45 years. The percentage of young individuals within the sample was lower than found within the general population of Vitória, which may be considered to be a limitation.

The daily salt consumption estimated from the 12-hour urine excretion among the participants in the study was high (12.6±5.8 g) in comparison with the current recommendation of 6 g from the American Heart Association.[16] The percentage of individuals classified as hypertensive also reached high levels, thereby indicating hypertension prevalence of 37.8% among the population of Vitória.[15]

The quantity of daily added salt reported was 6.8±4.5 g, thus corresponding to 52.3% of the consumption estimated from urinary sodium excretion. However, the added-salt method does not take into account the salt intake from natural foods and manufactured products. Although the estimated consumption of added salt was lower in class E than in classes C and D, class E presented higher added-salt consumption than for the other classes, probably due to lower use of manufactured foods and overall quantity of food eaten. This fact may, however, be relative, since class E is less represented in the sample. Another matter that can be highlighted is that the lower socioeconomic classes probably have easier recollection of what quantities of food were consumed in the home.

High salt consumption is today utilized as a predictor for cardiovascular diseases. In Western countries, salt consumption is high, not only in food preparation but also in food conservation. Other substances like monosodium glutamate are also greatly utilized in this. Salt appears to have great acceptance among the young and has become indispensable in dough-based foods. Despite the few studies on changes in dietary standards in Brazil, the study by Barreto & Cyrillo,[2] in the city of São Paulo, showed that there has been a reduction of 35% in domestic expenditure on fruit and vegetables in the family budget. The opposite situation has been found for expenditure on manufactured foods. It appears that this modification is not only related to market prices but also marketing and the dynamics of life, which have an important role in consumer decisions.

The study made by Tian et al[19] in a Chinese population utilizing the dietary method (three 24-hour records) identified consumption of approximately 6 g of sodium among the urban population, with 53% probably coming from added salt, 17% from manufactured foods, 16% from soybean-based sauces and 6% from monosodium glutamate. Cereal and vegetables were the greatest sources of potassium in the food. That study also suggested the need for reducing sodium intake, especially in relation to salt added in the preparation of meals. This can be achieved by means of population-based strategies aimed at the control of arterial hypertension within all social classes.

A diet that is poorer in fruit and vegetables and based on manufactured foods that are richer in fats and salt appears to be a predictor for health problems, particularly those due to pressure levels. It is within this context that the sodium/potassium ratio has been utilized a marker for dietary quality, given that a more adequate diet in relation to sodium and potassium may be related to greater consumption of fruit and vegetables and lower consumption of manufactured foods such as processed and canned foods. Some studies have demonstrated that this ratio is more important than separate measurements of sodium and potassium.[13] The study made by Kaufmann et al[12] in Africa showed that this ratio was associated with the systolic and diastolic arterial pressures and that increased prevalence of hypertension was associated both with economic and dietary changes. In the present study, salt consumption and the Na/K ratio had a positive association with increased pressure levels. Individuals in class A, women, whites and mixed-race individuals presented lower Na/K ratios, independent of any increases in potassium, and it can be inferred that these groups present diets that are more adequate than for other groups. This association appears to be resultant from the socioeconomic class. High sodium consumption may also be related to greater intake of prepared foods with ready seasoning, which are very accessible for the less favored socioeconomic classes. This relationship was also higher among Negroes. However, their salt intake estimated from sodium excretion did not differ statistically from that of other groups. This result may be related to greater sensitivity to sodium present among individuals of Negro race, which may be linked to the lower urinary sodium excretion found in this group.

It would be possible to demonstrate more satisfactory results if, in relation to this question, it could be proven which parts of the population are in fact utilizing greater quantities of salt in food preparation or greater quantities of manufactured foods. Given that there are large difficulties in estimating the quantities of salt added in food preparation, daily usage of salt may be an indicator for such consumption. In the present study, differences in daily salt consumption were observed, with individuals in class A and whites presenting the lowest daily consumption.

Results from meta-analyses are consistent in demonstrating that sodium reduction has a small but significant effect on arterial pressure,[4] especially among elderly individuals and those who present higher arterial pressure.[1] Cappuccio[3] emphasized the need for moderate salt reduction in the diet and increase in foods rich in potassium, not only as a first step in the treatment of individuals with hypertension, but also especially as a preventive measure for reducing the prevalence of arterial hypertension and its complications within the population.

A more balanced and healthier dietary pattern must be encouraged so as to promote changes in the population's anthropometric profile over the long term that are more consistent. There is now epidemiological evidence that improvement in the diet has a great potential for preventing today's illnesses.

REFERENCES

1. Alderman MH. Salt, blood pressure, and human health. *Hypertension* 2000;36:890-3.

2. Barretto SAJ, Cyrillo DC. Análise da composição dos gastos com alimentação no município de São Paulo (Brasil) na década de 1990. *Rev Saúde Pública* 2001;35:52-9.

3. Cappuccio FP. Dietary changes and their effect on blood pressure: what lesson should we learn? *J Hum Hypertens* 1997;11:765-6.

4. Chobanian AV, Hill M. National heart, lung, and blood Institute Workshop on sodium and blood pressure. *Hypertension* 2000;35:858-63.

5. Consenso Brasileiro de Hipertensão Arterial - III Consenso Brasileiro de Hipertensão Arterial – 1998. Available at URL: http://departamentos.cardiol.br/dha/publicacoes/consenso3/consen.asp [2000, Sep 20].

6. Cowley AW. Genetic and nongenetic determinants of salt sensibility and blood pressure. *Am J Clin Nutr* 1997;6(Suppl):587S-93S.

7. Espeland MA, Kumanyika S, Wilson AC, Reboussin DM, Easter L, Self M et al. Statistical issues in analyzing 24-hours dietary recall and 24-hours urine collection data for sodium and potassium intakes. *Am J Epidemiol* 2001;153:996-1006.

8. Freitas OC, Carvalho FR, Neves JM, Veludo PK, Parreira RS, Gonçalves RM et al. Prevalence of Hypertension in the urban population of Catanduva, in the state of São Paulo, Brazil. *Arq Bras Cardiol* 2001;77:16-21.

9. Frost CD, Law MR, Wald NJ. By how much does dietary salt reduction lower blood pressure? II- Analysis of observational data within populations. *BMJ* 1991;302:815-8.

10. Fundação Instituto Brasileiro de Geografia e Estatística. *Pesquisa por amostra de domicílios 2000: microdados*. Rio de Janeiro; 2001.

11. Intersalt Cooperative Research Group. An international study of electrolyte excretion and blood pressure: results for 24-hour urinary sodium and potassium excretion. *BMJ* 1988;297:319-28.

12. Kaufmann EE, Owoaje SA, James SA, Rotini CN, Cooper RS. Determinants of hypertension in West Africa: contribution of anthropometric and dietary factors to urban-rural and socioeconomic gradients. *Am J Epidemiol* 1992;143:1203-18.

13. Kotchen TA, Kotchen JM. Dietary sodium and blood pressure: interactions with other nutrients. *Am J Clin Nutr* 1997;65(Suppl):708S-11S.

14. MacMahon S, Peto R, Cutler J. Blood pressure, stroke and coronary heart disease: effects of prolonged differences in blood pressure-evidence from nine prospective observational studies corrected for dilution bias. *Lancet* 1995;335:765-74.

15. Molina, MCB. Hipertensão arterial e fatores nutricionais: um estudo de base populacional no município de Vitória/ES [Doctoral thesis]. Vitória: Universidade Federal do Espírito Santo; 2002.

16. Pearson TA, Blair SN, Daniels SR, Eckel RH, Fair JM, Fortmann SP et al. AHA Guidelines for primary prevention of cardiovascular disease and stroke: 2002 update. *Circulation* 2002;106:388-91.

17. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. *N Engl J Med* 2001;344:3-10.

18. The sixth report of the Joint National on Prevention, Detection, and Treatment of High Blood Pressure (JOINT VI). *Arch Int Med* 1997;157:2413-46.

19. Tian HG, Hu G, Dong QN, Yang XL, Nan Y, Pietinen P et al. Dietary sodium and potassium, socioeconomic status and blood pressure in a Chinese population. *Appetite* 1996;26:235-46.

20. Weinberger MH. Salt sensibility of blood pressure in humans. *Hypertension* 1996;27:481-90.

21. Yusuf S, Reddy S, Ounpuu S, Anand S. Global burden of cardiovascular diseases: part I: general considerations, the epidemiological transition, risk factors, and impact of urbanization. *Circulation* 2001;27:2746-53.

Address to correspondence

Maria del Carmen Bisi Molina
Departamento de Enfermagem, Centro Biomédico da Universidade Federal do Espírito Santo
Av. Marechal Campos s/nº
29040-090 Vitória, ES
E-mail: mdcarmen@escelsa.com.br

Source of funding:
Supported by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq – grant no. 521148/97-6) and Facitec (Fundo de Apoio à Ciência e à Tecnologia) /Vitória City Authority
Based on doctoral thesis presented within the postgraduate program in Physiological Sciences of Universidade Federal do Espírito Santo, 2002.
Received on 5/8/2002. Reviewed on 6/6/2003. Approved on 10/6/2003.