Hypertension Prevalence and Risk Factors in a Brazilian Urban Population

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Abstract

Background: **The available studies have not fully analyzed the several factors involved in the genesis of hypertension (HT), especially the association among blood pressure, urinary sodium excretion and renal dysfunction.**

Objective: **To assess the HT prevalence and risk factors in different age groups in a representative sample of an urban Brazilian population.**

Methods: **The studied population (1717 adult individuals) was evaluated by age groups: 18 to 39 years; 40 to 49; 50 to 59; 60 to 69 and > 70 years. Quantitative variable means and categorical variables of the hypertensive and normotensive groups were compared.**

Results: **The adjusted overall prevalence of HT was 25.23%. The prevalence increased with age and was higher in individuals with low educational level. Increased body mass index and abdominal waist were positively related to a higher prevalence of HT. There was a significant positive association between HT and urinary sodium excretion. Hypertensive individuals presented higher frequency of renal dysfunction, defined as measured creatinine clearance <60 ml/min/m². The prevalence of diabetes mellitus was 5.6% in the overall population and 14.5% in hypertensive individuals. Hypertension was a known condition to 74.4% of the hypertensive individuals. Among treated hypertensive individuals, 52.4% achieved controlled blood pressure and only 34.3% of the overall hypertensive patients (treated or not) had blood pressure controlled.**

Conclusion: **This population-based is unique by gathering different demographic, epidemiologic and risk factors involved in the genesis of hypertension in a single sample assessment with a population calculation, which might be extrapolated to other hypertensive populations. (Arq Bras Cardiol 2010; 94(4):488-494)**

Key words: **Hypertension; epidemiology and biostatistics; glomerular filtration rate; risk factors; age.**

Introduction

Cardiovascular disease (CVD) is the major cause of mortality in developed countries. In Brazil, CVD accounts for about 30% of the overall mortality and is responsible for 1.2 million hospitalizations with an approximate cost of 650 million dollars/year[1,2]. Hypertension is the most prevalent of all CVDs, affecting over 36 million adult Brazilians, is the major risk factor for cardio and cerebrovascular injury and is the third cause of disability[1,2]. Hypertension is likely to be involved in 50% of the deaths due to CVDs[3,4]. Blood pressure control is critical for the prevention of hypertension induced-organ injury, but the asymptomatic nature of this disease renders it underdiagnosed and consequently undertreated, despite its very high prevalence. In fact, The National Health and Nutrition Examination Survey (NHANES) observed that 28.7% of the assessed individuals were hypertensive, 68.9% knew their condition, 58.4% were treated, and only 31% achieved an effective blood pressure control[5].

In Brazil, the prevalence of hypertension and associated risk factors has been evaluated since the late 70s, with a wide variation among the different studies. This disparity probably results from the lack of methodological standardization and selection criteria of the screened individuals[6-9]. Other possible factor is the great heterogeneity found in different parts of the country, with coexisting developed and developing areas. Moreover, the available studies did not fully analyze the several factors involved in the genesis of hypertension, especially the association among the blood pressure, urinary sodium excretion and renal dysfunction.

The objective of this study was to assess the prevalence and risk factors for hypertension in different age groups in a representative sample of an urban Brazilian population.

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Methods

This project was approved by the Research Ethics Committee, São José do Rio Preto Medical School. All of the participants were informed and instructed about the test results and signed an informed consent before enrollment in the study.

In 2004 and 2005 a transversal study was carried out in a representative sample of the adult (≥ 18 years) urban population in São José do Rio Preto, State of São Paulo, Brazil. The sample was stratified by age according to Brazilian Institute for Geography and Statistics (IBGE) data. At the time of the survey, São José do Rio Preto had a population of about 370,000 inhabitants, a predominance of white individuals (82.8%) and a balanced distribution between men (48.4%) and women (51.6%)[10]. The evaluated age groups were 18 to 39 years; 40 to 49; 50 to 59; 60 to 69 and ≥ 70 years. The parameters used to calculate the strata sample sizes were number of inhabitants, expected prevalence of hypertension for each age group, maximum allowed 95% confidence interval semi amplitude of 3%[11].

The city was divided into the census sectors used by IBGE. In each sector, the number of individuals was studied according to the proportionality of the population. For each region, streets, homes and one adult who had been living for over six months in the house that met the inclusion and exclusion criteria was randomly chosen. After the first house at the street was chosen, interviewers went across the street and skipped two houses. In cases when the selected individual did not agree to participate, a next-door neighbor was chosen in the same way. The exclusion criteria were pregnancy, severe psychiatric diseases or mental disability and bedridden individuals.

The interviewers were previously trained and monitored by a field coordinator. The participants answered a questionnaire that included personal data, income and properties to assess the socioeconomic level, level of education, personal and family medical history, awareness of hypertension and medications being used. After that, the physicians checked the interviews and measured blood pressure (BP), heart rate (HR) and anthropometric data. The participants were instructed to fast and collect 12-hour urine for biochemical tests. On the day following the first visit the collected urine was picked up and a fasting blood sample was drawn.

The BP measurement technique was that standardized by the VII Joint National Committee[12]: 1) measurements were taken with a recently calibrated aneroid sphygmomanometer known to be accurate; 2) the cuff was placed so that the lower edge was 3 cm above the elbow crease and the bladder was centered over the brachial artery; 3) a standard bladder was used (12-13 cm long and 35 cm wide), but a larger and a smaller bladder were available for thicker and thinner arms, respectively; 4) the arm was bare and supported with the blood pressure cuff positioned at heart level; 5) the mean of three BP measurements taken in the sitting position after 5 to 10 minutes of rest was used; 6) phase I and V (disappearance) Korotkoff sounds were used to identify systolic and diastolic BP, respectively; 7) the pressure was increased rapidly to 30 mmHg above the level at which the radial pulse was extinguished; 8) a cuff deflation rate of 2 mmHg per beat was used; 9) a minimum of 1-minute intervals were recommended between readings to avoid venous congestion; 10) BP was measured in both arms to detect possible differences due to peripheral vascular disease; in this case, the higher value was taken as the reference one. Hypertension was defined as systolic BP ≥ 140mmHg and/or diastolic BP ≥ 90mmHg or current use of anti-hypertensive drugs. Individuals were classified as normotensive (N), unknown hypertensive condition, treated and controlled hypertensive condition and treated and not controlled hypertensive patients. For the individuals with borderline BP values, a new measurement was carried out on a different day at the same hour of the last day.

The socioeconomic level was classified into A, B, C, D or E (based on family income and assets, with A and B being the highest). The A and B levels were considered in accordance with family income above ten minimum wages, the C level between three and five and D/E levels below three minimum wages. Educational level was defined by the number of years of study, and the sample was divided into three groups: E_1 up to 7 years of instruction, E_2 8 to 10 years of instruction and E_3 ≥ 11 years of instruction, including university education[13].

The body mass index (BMI) was obtained by the weight/height ratio (kg/m^2). The examination was carried out with the bare-footed individuals wearing light clothes. A portable calibrated scale was used for weight measurement. Height and waist circumference (WC) were determined in centimeters using a measuring tape. The measurement of the WC was carried using the half of the distance between the anterior superior iliac crest and the last rib, at the end of expiration. The BMI classified individuals as normal (<25), overweight (25 to 29.9) and obese (≥30 kg/m^2) (table 1)[14,15]. The WC normal range was that recommended by the National Cholesterol Education Program - ATPIII[16] and the individuals were divided into three groups (Table 1).

Urinary sodium (mEq/l) was assessed by flame photometry. Sodium urinary excretion was calculated by multiplying sodium urinary concentrations in mEq/L by 12-hour urinary volume[17], and participants were divided into Na^+ I group with urinary sodium <100mEq/12h, Na^+ II group with urinary sodium >100 and <150mEq/12h and Na^+ III with urinary sodium ≥ 150mEq/12h. Twelve-hour urinary volume and

Table 1 - **Categorization of continuous variables**

Variable	Category		
	I	II	III
Body mass index (kg/m^2)	< 25	25 < 30	≥30
Abdominal waist (cm)	F : <80 M: <90	F: 80 < 88 M: 90 < 102	F: ≥88 M: ≥102
Glycemia (mg/dl)	<100	100 < 126	≥126
Urinary sodium (mEq/l)	<100	100 < 150	≥150
Creatinine clearance (ml/min/m^2)	<60	≥60	

F - female, M - male.

plasma and urinary creatinine concentrations were assessed to calculate creatinine clearance adjusted for body surface.

The diagnosis of diabetes mellitus (DM) was established by history, use of glucose-lowering drugs and serum glucose measurement[18]. The colorimetric method and the Dimension RXL device and Dade Behring reagent were used for glycemia and creatinine measurements. Table 1 shows the categorical range for biochemistry tests.

Statistical analysis

Statistical analysis was carried out by Minitab programs version 12.22 and R 2.4.1[19,20]. For each age group, quantitative variable means were calculated and the hypertensive and normotensive groups were compared by Student's t test. Categorical variables (obesity, gender, education, etc) and blood pressure control were estimated by Pearson's chi-square test, or by Fisher's exact test. Hypertension and normal BP associations with the same categorical variables, according to age group, were assessed by the likelihood ratio test for independent samples. As the samples were stratified according to the age group for the sake of the analysis, the whole population must be considered as a mixture of subpopulations, the age groups: 18 to 39 years, 40 to 49, 50 to 59, 60 to 69, ≥ 70, were respectively weighted by 0.5533; 0.1855; 0.1229; 0.0820 and 0.0573. Thus any proportion to be evaluated in the population is a convex combination of the strata proportions, of which estimators are independent of each other. The assessment of association structures of BP with any other population variable was carried out by the multinormal approximation with the above weights convex combinations of multinomial distributions for the frequencies of samples on the strata. Prevalence and *odds ratios (OR)* were analyzed by linear transformations of the natural logarithm of the combined relative frequencies[21].

Results

Five percent of the drafted individuals declined to participate in the study and a group of 1,717 adults aged 18 to 93 years (55.0 ± 14.7 years), with 838 males (48.8%, 55.1 ± 14.9 years) and 879 females (51.2%, 55.0 ± 14.4 years) were screened.

Of the overall sample, 762 individuals were hypertensive. The estimated and adjusted prevalence of hypertension for this population was 25.23% (95%CI [21.4, 30.0]). The hypertensive group age adjusted for the city population was 44.9 years (95%CI [43.9, 45.6]) for women and 42.4 (95%CI [40.8, 43.9]) for men. The normotensive group age adjusted for the population was 43.7 years (95%CI [43.2, 44.4]) for women and 50.0 (95%CI [49.4, 50.8]) for men.

The prevalence of hypertension increased progressively and significantly with age up to 69 yrs ($p<0.001$). No difference was observed between the groups 60 to 69 years and ≥ 70 years of age (see Table 2).

The prevalence of hypertension was similar in females (26.8%) and males (23.8%), except in the age group ≥ 70 years, with a higher prevalence among women (82.4%) as compared to men (57.1%, $p<0.05$).

The studied population included 79.6% of white and 20.4% of non-white individuals, with a prevalence of hypertension of 25.0% and 26.9%, respectively (Table 3).

As for the educational level, the following population distribution was observed: E_1 44.6% (95% CI, 41.0-48.2); E_2 16.1% (95% CI, 13.1-19.2) and E_3 39.3% (95% CI, 35.5-43.1). The prevalence of hypertension was higher in group E_1 when compared to the other two groups ($p<0.005$), and no difference was observed between groups E_2 and E_3 (table 3).

Socioeconomic levels were grouped into AB, C and DE. Social level estimates for the adult population were AB 19.8% (95% CI, 17.0-22.7); C 43.2% (95% CI, 39.4-47.0) and DE 37% (95% CI, 33.2-40.7). The estimated prevalence of hypertension was similar in all social levels, except for the DE level when compared to C (Table 3).

A positive family history for hypertension was observed in the hypertensive group when compared to the normotensive group for individuals ≥ 50 years ($p<0.05$), with positive familial history for hypertension in the age group from 60 to 69 years reaching a prevalence of 75.1% ($p=0.001$ compared to 23.9% in normotensive individuals).

The BMI was normal in 44.6% of the study population, 33.2% were overweight and 22.2% were obese, i.e., 55.4% had BMI above normal. A greater prevalence of hypertension was observed in all age groups for overweight and obese individuals when compared to those with a normal BMI ($p<0.001$) (table 3). The prevalence of hypertension increased progressively according to waist circumference increases in all age groups ($p<0.0005$).

Table 2 - **Prevalence of hypertension according to age groups (in years), and odds ratio (OR) related to the 18 to 39 yr-old group**

Age groups	Sample			Population		
	Normotensive	Hypertensive	% Hypertensive	Number of people 1	Expected number of hypertensive [95%CI]	OR [95%CI]
18 to 39	196	24	10.9 [7.1, 15.8]	145,938	15,900 [10,400; 23,100]	
40 to 49	301	94	23.8 [19.7, 28,3]	48,637	11,300 [9,600; 13,800]	2.54 [1.55, 4.32]
50 to 59	246	203	45.2 [40.5, 49.9]	32,416	14,700 [13,100; 16,200]	6.72 [4.19, 11.18]
60 to 69	128	247	65.9 [60.8, 70.7]	21,602	14,200 [13,100; 15,300]	15.67 [9.65, 26.44]
≥ 70	84	194	69.8 [64.0, 75.1]	15,133	10,600 [9,700; 11,400]	18.72 [11.25, 32.26]
Total	955	762	25.2 [22.7, 27.7]	263,768	66,700 [59,900; 73,100]	

1 = number of inhabitants for each age group.

Table 3 - Prevalence of hypertension adjusted to population, according to demographic and epidemiologic variables

Variable	Category	Sampled		Adjusted prevalence of Hypertension [95% CI]	P-value	OR 2 [95% CI]	H_0:OR=1 p-value
		Normotensive	Hypertensive				
Gender	Male[1]	484	354	23.8 [21.3, 26.6]	0.10	1.17 [0.87, 1.57]	0.10
	Female	471	408	26.8 [24.0, 30.0]			
Race	White[1]	807	641	25.0 [23.0, 27.1]	0.56	1.11 [0.79, 1.56]	0.56
	Non White	148	121	26.9 [24.7, 29.4]			
Educational level (years)	1. 0 up to 7	471	577	37.6 [33.6, 42.1]	1×2= 0.002		
	2. 8 up to 10	127	50	20.0 [13.3, 30.0]	1×3 <0.0005	3.80 [2.70, 5.36]	0.0005
	3. ≥ 11[1]	357	135	13.7 [11.0, 16.9]	2×3= 0.12	1.58 [0.88, 2.82]	0.13
Socioeconomic level	1. A/B[1]	230	146	23.8 [19.2, 29.5]	1×2= 1.0		
	2. C	410	309	23.8 [20.2, 28.0]	1×3= 0.26	0.80 [0.55, 1.15]	0.23
	3. D/E	315	307	28.1 [23.6, 33.4]	2×3= 0.19	1.25 [0.85, 1.83]	0.25
Family history of hypertension	No[1]	491	122	28.1 [23.1, 34.2]	0.14	1.33 [0.92, 1.92]	0.13
	Yes	197	404	22.8 [18.7, 27.7]			
Body mass index (kg/m^2)	1. Normal[1]	456	220	14.9 [14.5, 17.7]	1×2 <0.0005		
	2. Overweight	350	295	26.5 [23.2, 30.2]	1×3 <0.0005	2.06 [1.47, 2.89]	0.00001
	3. Obese	149	247	44.8 [39.6, 50.8]	2×3 <0.0005	4.65 [3.32, 6.53]	< 0.0005
Abdominal waist (cm)	I[1]	322	94	9.5 [6.8, 13.3]	1×2 <0.0005		
	II	306	206	24.7 [20.6, 29.6]	1×3 <0.0005	3.10 [1.98, 4.86]	<0.0005
	III	320	459	41.0 [36.1, 46.6]	2×3 <0.0005	6.60 [4.27, 10.20]	<0.0005

[1]Reference category for OR. [2]OR - odds ratio. CI - confidence interval. Abdominal waist (cm): I: Female (F) < 80, Male (M) < 90; II: F 80 < 88, M 90 < 102; III: F ≥ 88, M ≥ 102 cm.

The estimated prevalence of diabetes was 5.6% (95%CI, 4.5-6.7) in the overall population, 14.5% (95% CI, 12.7-17.4) in hypertensive and 2.5% (95% CI, 2.1-3.0) in normotensive individuals ($p<0.0005$). There was a clear association between diabetes and hypertension ($p<0.05$) in all age groups greater than 50 years. When the hypertensive and normotensive groups were compared for the presence of diabetes mellitus, an OR of 6.54 (95% CI, 3.73-11.42; $p<0.0005$) was observed.

The estimated prevalence of hypertension was 21.6% for the Na^+ I group (95% CI, 17.9-26.1), 28.8% for the Na^+ II group (95% CI, 22.8-36.3) and 32.8% for the Na^+ III group (95% CI, 25.5-42.2), with a greater prevalence of hypertension in the Na^+ II group when compared to the Na^+ I group ($p = 0.03$) and the Na^+ III group compared to the Na^+ I group ($p = 0.006$). There were no differences in hypertension prevalence between the Na^+ II and Na^+ III groups. The presence of the urinary sodium ≥ 150 mEq/l was more frequent in hypertensive than in normotensive individuals with a 76% greater risk of hypertension with this level of sodium excretion (Table 4).

Creatinine clearance (CrCl) was performed in 1,306 individuals. Values lower than 60 ml/min/m^2 were observed in 5.4% of the normotensive individuals and 20.8% of the hypertensive individuals (Table 4). When hypertensive and normotensive individuals were compared, it was observed that 295 (96.4%) of those with CrCl <60 ml/min/m^2 were ≥ 50 years of age.

Table 4 - Prevalence of reference values adjusted to population of biochemical tests in normotensive patients and hypertensive patients

	Reference values	Normotensive [95% CI]	Hypertensive [95% CI]	p-value
Glycemia	< 100 mg/dl	94.8 [90.1, 99.7]	83.0 [82.2, 83.7]*	<0.005
	100 - 125 mg/dl	3.4 [3.1, 3.8]	9.8 [9.6, 10.0] *	<0.005
	≥ 126 mg/dl	1.8 [1.6, 2.0]	7.2 [7.1, 7.4] *	<0.005
Urinary sodium (mEq/l)	< 100 mEq/l	55.1 [50.0, 60.7]	43.5 [42.7, 44.4]*	<0.005
	100 -149 mEq/l	25.8 [23.2, 28.5]	29.8 [29.2, 30.4]**	0.016
	≥150 mEq/l	19.1 [17.3, 21.2]	26.7 [26.1, 27.2]*	<0.005
Creatinine clearance	< 60 ml/min/m^2	5.4 [4.1, 7.2]	20.8 [17.2, 25.0]*	<0.005

*CI - confidence interval; *, ** = p-value (Normotensive x Hypertensive).*

Hypertension was a known condition to 74.4% (95% CI, 71.3-77.5) of the hypertensive individuals, and it was unknown to 25.6% (95% CI, 22.5-28.7). Among treated hypertensive individuals, 52.4% (95% CI, 48.2-56.6) had controlled blood pressure. Among all hypertensive individuals (treated or not), only 34.3% had controlled blood pressure.

Discussion

The prevalence of hypertension is higher in developed than in developing countries, but the large population mass in developing countries has significantly contributed to the overall number of hypertensive individuals worldwide. It is estimated that by 2025, 1.5 billion people will be hypertensive[22]. Currently, the estimated mean worldwide prevalence of hypertension is 26.4%, with a broad variation depending on the study population, reaching 21.0% in the USA and Canada, 33.5 to 39.7% in European countries, 15 to 21.7% in African and Asian countries and about 40% in Latin America[22-24].

The prevalence of hypertension in Brazil ranges from 24.8 to 44.4%[6-9]. In the present study, the prevalence of hypertension was evaluated according to age groups, determining a number of individuals proportional to the number of inhabitants for each age group and adjusting them for the adult population. This feature of the present study is distinct from most of the previous reports, which included an expressive number of women and elderly individuals. Moreover, few previous studies assessed simultaneously the most important risk factors for hypertension in the same population. The estimated prevalence of hypertension in the studied population was 25.3%, and a progressive increase was observed with age, reaching 70% in those older than 70 years. For comparison purposes, age groups were re-grouped using similar criteria to those adopted by NHANES 2003-2004[25] and χ^2 test was applied and similar results were obtained (Table 5). The clear increase in the prevalence of hypertension after 40 years of age and the potential for management of modifiable risk factors for hypertension urges the immediate adoption of preventive and educational measures, representing an important investment in public health.

The prevalence of hypertension was not different between genders, even when the population was stratified by the different age groups, except for women ≥ 70 years, which was also demonstrated by other authors[26].

There were no significant differences in the prevalence of hypertension among diverse ethnic groups in the studied population, although North-American studies reported a greater prevalence and severity of hypertension in blacks. It is possible that the large number of white individuals in the current population and the high level of ethnic miscegenation in Brazil might have influenced the obtained results[27].

Socioeconomic differences play an important role in health conditions influencing different factors such as access to the health system, degree of information, understanding of medical conditions and compliance to therapy[28]. Different studies showed higher CVD rates among lower socioeconomic level groups[29]. However, there was no significant difference in the prevalence of hypertension related to social levels in the present study, despite a tendency to higher prevalence in classes C and D/E. It is possible that this is a distinctive characteristic of developing countries.

Individuals with lower educational levels showed a higher prevalence of hypertension in all age groups. When the OR was compared, using the higher educational level as a reference, the risk for hypertension was 2.8-times higher for those with lower schooling, which was also observed by the NHANES, which has shown an OR of 1.14 (95% CI, 1.01 to 1.97) for hypertension prevalence in the group with a lower degree of schooling[25].

There was no significant difference between normotensive and hypertensive individuals regarding family history for age groups up to 49 years. However, after 50 years of age, there was a greater prevalence of positive family history in hypertensive individuals which might explain the differences observed[30, 31].

A linear association was found in all age groups between BMI and BP, as well as WC. Overweight and obesity are actual risk factors for hypertension, as individuals in these age groups had a 2-fold and 3.6-fold higher risk of having hypertension, respectively. There is also a proportional association between the prevalence of hypertension and the increase in waist circumference. In fact, waist circumference and BMI are considered good predictors of the risk of developing hypertension[32-34]. In the present study the risk for hypertension was more related to obesity defined by higher WC than higher BMI, as found by other authors[34].

The prevalence of DM was higher in hypertensive individuals, with an OR of 6.54, which carries an additional burden for cardiovascular disease. It is possible that the endothelial injury promoted by diabetes contributed to the development of hypertension in this population. The prevalence of diabetes in the North-American population is approximately 7%, and 30% of them are unaware of this condition. The prevalence of DM increases with age, reaching 20% in individuals ≥60 years[35], which was similar to the rate of 22% observed in this age group of the present study (data not informed).

Urinary sodium excretion had a positive and significant correlation with blood pressure levels in all age groups. These findings, infrequently described in hypertension prevalence studies, indicate a positive relationship among the salt consumption, urinary sodium excretion and the prevalence of hypertension[36,37].

Renal dysfunction, evaluated by creatinine clearance < 60/ml/min, was more prevalent among hypertensive individuals. In fact, hypertensive individuals had a 4.5-times greater risk of renal impairment, especially after 50 years of age. This finding suggests a possible association between hypertension and renal impairment regardless of age.

Table 5 - **Prevalence of hypertension in our study compared with NHANES data**

	NHANES	Current study	p-value
18-39 years	7.3%	10.9%	0.5
40-59 years	32.6%	35.2%	0.11
≥ 60 years	66.3%	67.3%	0.51

Population studies have shown different degrees of hypertension awareness by hypertensive individuals. In European countries, these levels range from 52.7% in Germany to 70% in Sweden. In North America, the awareness rate is 82.1% in the USA. Blood pressure control rates in the overall hypertensive population also vary. In Europe, rates range from 22.9% in Spain to 37.7% in England. In the present study, the degree of awareness of hypertension was high and similar to those found by the NHANES study. Among treated hypertensive individuals in this study, about half had blood pressure controlled and about 30%% of the overall hypertensive patients had blood pressure controlled. These data are also similar to those of NHANES 2003-2004, which showed that age-adjusted control rates were 63.9% for treated hypertensive individuals and 33.1% for the overall hypertensive patients[25]. These favorable results are probably due to adequate public information about the disease, investment in the training of health professionals, participation of multidisciplinary teams in the local health system, availability of free government-supplied anti-hypertensive drugs and more aggressive policies at the primary care level, as observed in other developing countries[38].

Some limitations of the present study should be mentioned. First of all, the guidelines of the American Diabetes Association recommend the confirmation of hyperglycemia through a second blood glucose measurement, which was not performed in this study. On the other hand, the epidemiological studies, among them NHANES, use almost exclusively a single blood glucose measurement for the diagnosis of DM. Second, salt consumption was based on a single sodium excretion measurement, which is also true for the glomerular filtration rate evaluation by a single creatinine clearance measurement. In this study, we did not assess the lipid profile, a fact that did not allow us to evaluate the dimensions of the metabolic changes associated to high blood pressure.

On the other hand, this population-based, age-stratified study, with a normotensive control group, is unique by gathering different demographic, epidemiologic and risk factors involved in the genesis of hypertension and of CVD in a single sample assessment with a population calculation, which might be extrapolated to other hypertensive populations.

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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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References

1. Ministério da Saúde. DATASUS. Information about health: mortality. [Accessed 2007 July 02]. Available at: http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sim/cnv/obtuf.def
2. Ministério da Saúde. DATASUS. Information about health: morbidity. [Accessed 2007 July 02]. Available at: http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sih/cnv/miuf.def
3. Bronner LL, Kanter DS, Manson JE. Primary prevention of stroke. N Engl J Med. 1995; 333: 1392-400.
4. He J, Whelton PK. Elevated systolic blood pressure and risk of cardiovascular and renal disease: overview of evidence from observational epidemiologic studies and randomized controlled trials. Am Heart J. 1999; 138: 211-9.
5. Hajjar I, Kotchen TA. Trends in prevalence, awareness, treatment, and control of hypertension in the United States, 1988-2000. JAMA. 2003; 290: 199-206.
6. Gus I, Harzheim E, Zaslavsky C, Medina C, Gus M. Prevalence, awareness, and control of systemic arterial hypertension in the state of Rio Grande do Sul. Arq Bras Cardiol. 2004; 83: 429-33.
7. Souza ARA, Costa A, Nakamura D, Mocheti LN, Filho PRS, Ovando LA. A study on systemic arterial hypertension in Campo Grande, MS, Brazil. Arq Bras Cardiol. 2007; 88: 441-6.
8. Castro RAA, Moncau JEC, Marcopito LF. Hypertension prevalence in the city of Formiga, MG (Brazil). Arq Bras Cardiol. 2007; 88: 301-6.
9. 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.
10. Brazilian Institute for Geography and Statistics (IBGE). Information about population census. [Accessed 2004 July 02]. Available at: http://www.ibge.gov.br/censo
11. Kish L. Survey sampling. New York: John Wiley & Sons; 1995.
12. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. National High Blood Pressure Education Program Coordinating Committee. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension. 2003; 42: 1206-52.
13. Krieger N, Williams DR, Moss NE. Measuring social class in U.S. public health research: concepts, methodologies, and guidelines. Annu Rev Publ Health. 1997; 18: 341-78.
14. Zhu S, Wang Z, Heshka S, Heo M, Faith MS, Heymsfield SB. Waist circumference and obesity-associated risk factors among whites in the third National Health and Nutrition Examination Survey: clinical action thresholds. Am J Clin Nutr. 2002; 76: 743-9.
15. Bray GA, Gray DS. Treatment of obesity: an overview. Diabetes Metab Rev. 1988; 4: 653-79.
16. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, et al. American Heart Association, National Heart, Lung, and Blood Institute. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Circulation. 2005; 112: 2735-52.

17. Bisi Molina MC, Cunha RS, Herkenhoff LF, Mill JG. Hypertension and salt intake in an urban population. Rev Saúde Pública. 2003; 37: 743-50.

18. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2007; 30 (Suppl 1): S42-S47.

19. Minitab Statistical Software, Minitab Inc. [Accessed 2006 Oct 01]. Available at: http://www.minitab.com

20. R 2.4.1 - A Language and Environment: the R Development Core Team. [Accessed 2006 Nov 10]. Available at: http://www.r-project.org

21. Bishop YMM, Fienberg SE, Holland PW. Discrete multivariate analysis: theory and practice. Cambridge: the MIT Press; 1975. p. 492-500.

22. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. Lancet. 2005; 365: 217-23.

23. Joffres MR, Hamet P, MacLean DR, L'italien GJ, Fodor G. Distribution of blood pressure and hypertension in Canada and the United States. Am J Hypertens. 2001; 14: 1099-105.

24. Ordúñez P, Silva LC, Rodriguez MP, Robles S. Prevalence estimates for hypertension in Latin America and Caribbean: are they useful for surveillance? Pan Am J Public Health. 2001; 10: 226-31.

25. Ong KL, Cheung BMY, Man YB, Lau CP, Lam KSL. Prevalence, awareness, treatment, and control of hypertension among United States adults 1999-2004. Hypertension. 2007; 49: 69-75.

26. Hajjar I, Kotchen JM, Kotchen TA. Hypertension: trends in prevalence, incidence, and control. Annu Rev Public Health. 2006; 27: 465-90.

27. Centers for Disease Control and Prevention (CDC). Racial/ethnic disparities in prevalence, treatment, and control of hypertension - United States, 1999-2002. MMWR Morb Mort Wkly Rep. 2005; 54: 7-9.

28. Kanjilal S, Gregg EW, Cheng Y, Zhang P, Nelson DE, Mensah G, et al. Socioeconomic status and trends in disparities in 4 major risk factors for cardiovascular disease among US Adults, 1971-2002. Arch Intern Med. 2006; 166: 2348-55.

29. Winkleby MA, Jatulis DE, Frank E, Fortmann SP. Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. Am J Public Health. 1992; 82: 816-20.

30. Hunt SC, Williams RR, Barlow GK. A comparison of positive family history definitions for defining risk of future disease. J Chronic Dis. 1986; 39: 809-21.

31. Muldoon MF, Terrell DF, Bunker CH, Manuck SB. Family history studies in hypertension research: review of the literature. Am J Hypertens. 1993; 6: 76-88.

32. Kaufman JS, Asuzu MC, Mufunda J, Forrester T, Wilks R, Luke A, et al. Relationship between blood pressure and body mass index in lean populations. Hypertension. 1997; 30: 1511-6.

33. Gallagher D, Visser M, Sepulveda D, Pierson RN, Harris T, Heymsfield SB. How useful is body mass index for comparison of body fatness across age, sex and ethnic groups. Am J Epidemiol. 1996; 143: 228-39.

34. Gus M, Fuchs SC, Moreira LB, Moraes RS, Wiehe M, Silva AF, et al. Association between different measurements of obesity and the incidence of hypertension. Am J Hypertens. 2004; 17: 50-3.

35. National Diabetes Statistics. Total prevalence of diabetes in the United States, all ages, 2005. [Acessed 2007 July 10]. Available at http://diabetes.niddk.nih.gov/dm/pubs/statistics/index.htm#7;

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

37. Law MR. Epidemiologic evidence on salt and blood pressure. Am J Hypertens. 1997; 10 (Suppl 1): S42-S45.

38. Ordunez-Garcia P, Munoz JL, Pedraza D, Espinosa-Brito A, Silva LC, Cooper RS. Success in control of hypertension in a low-resource setting: the Cuban experience. J Hypertens. 2006; 24: 845-9.