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The independent effect of central obesity on hypertension in adults living in Ribeirão Preto, SP, 2007. EPIDCV Project

O efeito independente da obesidade central sobre a hipertensão arterial em adultos residentes em Ribeirão Preto, SP, 2007. Projeto EPIDCV

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ABSTRACT: ***Objective:*** To identify the prevalence of hypertension and evaluate the independent effect of central obesity on this outcome in adults living in the municipality of Ribeirão Preto, São Paulo State, Brazil. ***Methods:*** Cross-sectional population-based epidemiological study using three stage cluster sampling. The variability introduced in the third stage was corrected by attributing probability weights, resulting in a weighted sample of 2,471 participants. Hypertension was defined according to the disease history, the use of anti-hypertensive drugs or the mean of three consecutive measures, in mm/Hg, ≥ 140 for systolic and ≥ 90 for diastolic blood pressure. Prevalence of hypertension was estimated according to anthropometric, sociodemographic, behavioral and dietetic variables, as well as biochemical dosages and medication use. Crude and adjusted prevalence ratios for central obesity indices were estimated using Poisson regression. All the estimates were calculated taking into account the sampling design effect. ***Results:*** The results showed high prevalence of hypertension: 32.8 (males) and 44.5% (females). In the final models, central obesity indexes were consistently associated with the outcome, in both genders. ***Conclusion:*** The results pointed out the need of planning health promotion and prevention, in order to control hypertension and central obesity aiming to reduce end-point events like coronary heart disease and stroke.

Keywords: Hypertension. Central Obesity. Cross-sectional Studies. Adults. Epidemiology. Public Health.

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RESUMO: ***Objetivo:*** Identificar a prevalência de hipertensão arterial e o efeito independente da obesidade central sobre este desfecho, em adultos residentes em Ribeirão Preto, SP. ***Métodos:*** Estudo epidemiológico transversal de base populacional, com amostragem desenvolvida em três estágios. A variabilidade introduzida no terceiro estágio foi corrigida pela atribuição de pesos, originando amostra ponderada de 2.471 participantes. A hipertensão foi definida segundo o histórico da doença, uso de medicação anti-hipertensiva ou médias de três medidas consecutivas, em mm/Hg, sendo ≥ 140 para a sistólica e ≥ 90 para a diastólica. Prevalências de hipertensão foram estimadas, segundo variáveis antropométricas, sociodemográficas, comportamentais, dietéticas, dosagens bioquímicas e uso de medicamentos. Razões de prevalências brutas e ajustadas para os indicadores de obesidade central foram obtidas utilizando-se regressão de Poisson. Todas as estimativas foram calculadas levando-se em consideração o efeito de desenho amostral. ***Resultados:*** Observou-se elevada prevalência de hipertensão: 32,8 (sexo masculino) e 44,5% (sexo feminino). Nos modelos finais, os indicadores de obesidade central permaneceram consistentemente associados ao desfecho, em ambos os sexos. ***Conclusão***: Os resultados do estudo impõem a necessidade de planejamento de medidas de promoção e prevenção em saúde, direcionadas para o controle da hipertensão arterial e da obesidade central, com vistas à redução de eventos finais como a doença isquêmica do coração e os acidentes vasculares cerebrais.

Palavras-chave: Hipertensão. Obesidade Central. Estudos Transversais. Adultos. Epidemiologia. Saúde Pública.

INTRODUCTION

Along the demographic, epidemiological and nutritional transitions, changes in the age structure, the pattern of morbidity and mortality and the inversion of undernutrition towards overweight , respectively, resulted in an increased prevalence of chronic outcomes such as high blood pressure (HBP), already considered a public health problem in developed and developing countries[1,2].

According to the World Health Organization (WHO), hypertension affects nearly one billion people and is responsible for nine million deaths per year worldwide, and is considered a major risk factor for cardiovascular disease. In 2008, about 40% of adults aged over 25 were diagnosed as hypertensive, registering prevalence of greater magnitude in regions of Africa (46%), while in the Americas, Europe, Asia and Oceania, the prevalence ranged between 35 and 40%[2].

Among the factors associated with hypertension, sociodemographic determinants, behavioral factors, cardiovascular risk factors and nutritional status have been described in the literature[3-5]. Evidences about the relevance of central obesity as a risk factor for hypertension adds up to these results[6-9].

Panagiotakos et al.[6], in a cohort study with a five years follow-up (ATTICA Study – 2001-2006), revealed that waist circumference and the waist/height and waist/hip ratios remained independently associated with the incidence of hypertension, even after adjustment for concurrent sociodemographic, behavioral, dietary and inflammatory factors.

Results from the National Health and Nutrition Examination Survey (NHANES 2007 – 2010)[7] revealed that, in 2010, participants who had altered waist circumference and body mass index (BMI) ≥ 30, when compared to those with normal values for both indexes showed adjusted odds ratios equal to 3.23 (95%CI 2.63 – 3.96).

Lately, along with the classical studies of association, has outgrown the interest in evaluating the precision of anthropometric indexes in the diagnosis of hypertension. Lee et al.[8], in a meta-analysis that included ten studies in which the authors applied Receiving Operating Characteristic Curves (ROC), concluded, based on the analysis of random effects, that, for both sexes, the waist circumference, the waist/height and waist/hip ratios, in relation to hypertension, showed areas under the curves of greater magnitude (0.67 to 0.73) when compared to the body mass index (0.64 to 0.69). Similar results were reported by Silva et al.[9] in a cross-sectional study carried out in Florianópolis, SC, Brazil, where the authors found that the waist/height ratio in both sexes showed areas under the ROC curves ≥ 0.70.

Notwithstanding the importance of systemic arterial hypertension, its participation in the triad of the major risk factors for ischemic heart disease[10] and its deleterious consequences for health as a whole, much of the knowledge about its prevalence, distribution and associated factors in Brazil focuses primarily on capital or metropolitan areas of the South and Southeast, with scarce or no epidemiological population-based studies carried out in the municipalities of the country.

Within this perspective, the present study aimed to estimate the prevalence of hypertension and investigate the independent effect of central obesity on this outcome in a representative sample of adults living in Ribeirão Preto, SP, Brazil, in 2007.

MATERIALS AND METHODS

STUDY DESIGN AND SAMPLING PROCESS

Cross-sectional population-based epidemiological study carried out in Ribeirão Preto, SP, Brazil, between 2007 and 2008, being part of the project entitled "Prevalence of cardiovascular diseases and the identification of associated factors among adults living in Ribeirão Preto, SP – EPIDCV Project". The sampling process was developed in three stages and the accuracy of the estimates, calculated on a sample of 1,205 individuals. The response rate was equivalent to 81.2%, satisfactory in cross-sectional studies[11] and, in all, 1,133 individuals of both sexes and with 30 years or more attended the study. Losses (18.8%) were due to address change (4.8%), deaths (0.5%) and refusals (13.5%), these last were considered as such after five attempts to contact for interview on alternate days and periods. The loss of equiprobability arising from multistage draw was corrected by assigning weights and use of specific commands, defining the census sectors as primary sampling unit (PSU) and the weighting variable (w12) as product of the sampling weights w1 and w2 which resulted in a weighted sample (nw) of 2,471 participants[12]. Further details about the sampling process and formulas for obtaining the fractions w1 and w2 are contained in previous publications[10].

DEPENDENT VARIABLE: SYSTEMIC ARTERIAL HYPERTENSION

Hypertension was defined according to prior history diagnosed by a physician, the use of antihypertensive medication or blood pressure ≥ 140 mm/Hg for systolic pressure and ≥ 90 mm/Hg for the diastolic pressure[13], considering, respectively, the three consecutive measurements average (portable sphygmomanometers Geratherm Medical AG, Geschwenda, Germany). The variable was generated as dichotomous (yes/no).

MAIN INDEPENDENT VARIABLES

1. Nutritional status (as measured by the body mass index and classified into three categories[14]: “euthrofic”, “overweight” and “obese”);
2. Central obesity, assessed by four indicators:
    - waist circumference, classified dichotomously adopting specific cutoff, according to sex, recommended by the International Diabetes Federation (IDF)[15];
    - waist-height ratio;
    - waist-hip ratio; and
    - conicity index[16], these last three according to theirs respectives tertiles.

The weight in kilograms was measured in portable electronic scales from Tanita (BF 680 model) and the height, in centimeters, in wall stadiometers (SECA, Hamburg, Germany), adopting the techniques recommended by Habicht and Butz[17]. The waist circumference and hip circumference (in cm) were measured with inelastic tape (SECA, Hamburg, Germany). Waist circumference was located on the minor curvature located between the costal margin and the iliac crest, whereas hip circumference had as a referral point the greatest protuberance of the buttocks (side view). The conicity index (C index) was calculated according to the following equation[16]:

$$\text{Index C} = \frac{\text{Waist circumference (m)}}{0.109\sqrt{\dfrac{\text{Body weight (kg)}}{\text{Height (m)}}}}$$

ADJUSTMENT VARIABLES

- Sociodemographic: sex (both sexes); age (classified into intervals of ten years); education (number of years of formal schooling); insertion in the labor market (the week before the interview) and individual income (referring to the month preceding the interview), classified, respectively, as no/yes, according to tertiles of the distribution, and marital status (defined according to the presence/absence of a partner, regardless of formal union).
- Behavioral: smoking time (classified according to tertiles of the distribution, being the first tertile the reference category); risk zones of alcohol addiction (classified into four categories according to the cutoff recommended by the Alcohol Use Disorder Identification Test Questionnaire – AUDIT[18]) and daily average of sitting time (obtained through the application of the short version of the International Physical Activity Questionnaire – IPAQ[19] and subsequently classified according to tertiles of the distribution).
- Dietary: total energy of diet (kcal/day); daily consumption of sodium and cholesterol (grams/day) estimated using a Food Frequency Questionnaire (FFQ) containing 128 items[20]. The calculation of the respective amounts of micronutrients and total calories was made in the NUTWin software, by using specific tables, considering the centesimal composition of each food, the type of preparation and their household measures. All nutrients were adjusted to the total energy of the diet using the residual method proposed by Willet[21].
- Biochemical dosages: ultrasensitive C-reactive protein – us-CRP (in mg/dL; classified as normal: ≤ 0.5 mg/dL, and altered: > 0.5 mg/dL) and plasma fibrinogen (in mg/dL; classified according to the cutoff corresponding to the tertiles of the distribution). The measurements were obtained after 12 hours fasting, in a Reference Laboratory with Certificate of Proficiency in Essays.
- Use of medicines: number of medicines taken during the fifteen days prior to the interviews (classified into four categories: "none", "1 – 2", "3 – 4" and "≥ 5").

PROCESSING OF DATA

Data were collected through structured interviews in the eligible households by a team of trained interviewers. Before final typing, proceeded from double data entry, the quality control of the information was assessed by replication of 12.5% of the interviews, applying the Kappa statistic for evaluation of reproducibility, which reached values greater than 0.80.

STATISTICAL ANALYSIS OF THE DATA

Specific prevalences of hypertension were calculated according to sex and age, with 95% confidence intervals. Prevalence of hypertension, stratified by sex, were also estimated in specific categories of the sociodemographic, behavioral, anthropometric, dietary, biochemical dosages and medicines taken variables. In the descriptive phase of the study, global associations between the above factors and the outcome were tested by "F" statistics, considering $\alpha = 0.05$[22]. In the analytical phase, it was used Poisson's regression to obtain prevalence ratios (PR)[23], estimated by point and by interval. Initially, the PR were estimated in univariate models containing each of the independent variables and the outcome, selecting for subsequent models variables with p -values ≤ 0.25 for the Wald's statistic. Subsequently, partial adjustment models, stratified by sex, were built, including, separately, each of the main variables, adjusted for the subset of variables in each group: sociodemographic, behavioral, dietary, biochemical dosages and medicines taken variables. At this stage (partial models), the variables that presented p-values < 0.10 for the Wald statistics were selected for the final models. In the final models, stratified by sex, remained the main variables adjusted for those variables provided by partial models which presented p-values <0.05 after simultaneously adjusted. Estimates were calculated taking into account the sampling design[12], using the survey module in Stata software (version 10.1).

ETHICAL CONSIDERATIONS

The EPIDCV project was approved by the Research Ethics Committee of the School of Nursing of Ribeirão Preto, *Universidade de São Paulo* and filed under the nº 0725/2006. All participants signed a consent form, as recommended by Resolution nº 196/96 of the National Health Council.

RESULTS

The Table 1 shows the characteristics of the sample according to sociodemographic variables. The design effect (deff) was equivalent to 1.34257.

In Table 2, the crude prevalences of hypertension in male and female corresponded, respectively, to 32.8 and 44.5%, with a linear gradient according to age in males, and in females, greater magnitude in all categories of age compared to males.

In Table 3, it can be observed that, in both sexes, the prevalence of hypertension was inversely related to education and was higher in subjects who were not included in the labor market. In both sexes, participants with more than 25 years of smoking time showed higher hypertension prevalence, compared to nonsmokers. In relation to risk zones of AUDIT (degrees of severity of addiction to alcohol), participants classified as Grade 3 (males) and Grade 2 (female), had higher prevalence of hypertension. The daily average of sitting timedid not show good discriminatory power for hypertension, in both sexes. In relation to sodium intake, women classified in the first two quarters of consumption had higher prevalence of hypertension, whereas among men, the highest prevalence were identified in those classified in the intermediate quarters. Among women, there was an inverse relationship between the consumption of cholesterol in diet and the prevalence of hypertension, although this relationship has not been observed in men.

In Table 4, for both sexes, the prevalence of hypertension increased according to exposure levels of anthropometric variables being indicative of linear gradient (variables with more than two categories), and in those with altered waist circumference the prevalence of hypertension corresponded to almost the double (male) or more than the double (female), in relation to the respective reference categories. Regarding biochemical dosages, in both sexes, the prevalence of hypertension had direct relation with the fibrinogen tertiles, indicating linear gradient. Still, in both sexes, the respective prevalence of hypertension was higher among those who had higher levels of us-CRP. Regarding the number of medicines taken in the 15 days preceding the interviews, the prevalence of hypertension in both sexes showed a direct relation with exposure levels and indication of linear gradient.

Table 1. Study population characteristics. Ribeirão Preto, SP, Brazil, 2007. EPIDCV Project.

	nw	%	95%CI
Sex			
Male	995.7	40.3	37.2 – 43.3
Female	1475.0	59.7	56.6 – 62.6
Age groups (years)			
30 – 39	661.3	26.7	23.4 – 30.4
40 – 49	765.7	30.9	28.3 – 33.8
50 – 59	507.3	20.5	18.2-23.0
≥ 60	536.6	21.7	18.8 – 24.8
Scholarity (years)			
0 – 3	343.8	14.0	11.5 – 17.0
4 – 7	739.8	30.2	26.6 – 34.1
8 – 11	821.5	33.5	30.3 – 37.0
≥ 12	540.8	22.1	17.0 – 28.1
Individual income (R$)			
Without income	848.9	34.3	31.6 – 37.2
1st tertile (50.00 – 700.00)	549.7	22.2	19.2 – 25.5
2nd tertile (700.01 – 1,400.00)	506.0	20.4	17.9 – 23.2
3rd tertile (1,400.00)	566.4	22.9	19.2 – 27.0
Marital status			
Without a partner	824.8	33.3	30.0 – 36.8
With a partner	1646.0	66.6	63.1 – 69.9
Working status			
No	847.8	34.3	31.5 – 37.1
Yes	1623.0	65.6	62.8 – 68.4

nw: weighted sample; 95%CI: confidence interval of 95%; R$: Brazilian currency (reais).

Table 2. Prevalence and confidence intervals for hypertension according gender and age. Ribeirão Preto, SP, Brazil, 2007. EPIDCV Project.

Age groups (years)	Male (nw = 995.7)		Female (nw = 1,475.0)	
	Hypertension		Hypertension	
	No % (95%CI)	Yes % (95%CI)	No % (95%CI)	Yes % (95%CI)
30 – 39	80.9 (73.6 – 86.6)	19.0 (13.3 – 26.3)	73.2 (64.7 – 80.3)	26.7 (19.6 – 35.2)
40 – 49	73.2 (64.7 – 80.3)	26.7 (19.6 – 35.2)	64.3 (58.0 – 70.2)	35.6 (29.8 – 41.9)
50 – 59	57.2 (45.8 – 68.0)	42.7 (32.0 – 54.1)	50.8 (41.6 – 59.9)	49.2 (40.1 – 58.3)
≥60	44.0 (34.6 – 53.8)	55.9 (46.1 – 65.3)	30.3 (22.1 – 40.0)	69.6 (59.9 – 77.8)
Total	67.2 (62.2 – 71.8)	32.8 (28.1 – 37.7)	55.4 (51.5 – 59.2)	44.5 (40.7 – 48.4)

nw: weighted sample; 95%CI: confidence interval of 95%.

In Table 5, the final models are presented, stratified by sex, highlighting the independent effect of central obesity indicators: waist circumference, waist/height and waist/hip ratios and the Conicity index that showed prevalence ratios statistically significant in both sexes ($p < 0.05$), except for waist circumference (male gender) corresponding prevalence ratios that did not reach statistical significance.

DISCUSSION

The main findings of the study revealed a high prevalence of hypertension in both sexes, especially among women, and directly related to exposure levels of all anthropometric indexes. All central obesity indexes remained in the final models, in both sexes.

Methodological rigour with which there were conducted all steps of the EPIDCV Project and the high response rate (> 80%) lends credibility to the results and strengthen its internal validity, not seeming, therefore, resulting from systematic bias. The losses resulting from changes of address or refusals (18.3%) did not seem associated with central obesity (main variables) or hypertension (outcome).

Passos et al.[24], in a systematic review that included 13 population-based studies carried out in Brazil between 1990 and 2003, observed prevalences of hypertension ≥ 25% in municipalities of the state of São Paulo, Brazil: Cotia – population aged between 20 – 88 years (44.4%); Catanduva – population ≥ 18 years (31.5%) and Bauru – population 41 – 79 years (29.8%). In contrast, the authors found that in Salvador, BA, Brazil, the prevalence of hypertension in adults > 20 years reached 41.4%. Pereira et al.[25] and Long et al.[26], from

Table 3. Prevalence and confidence intervals for hypertension according to gender, socio-demographic, behavioral and nutrition-related factors. Ribeirão Preto, SP, Brazil, 2007. EPIDCV Project.

	Male (nw = 995.7)		Female (nw = 1,475.0)	
	Hypertension		Hypertension	
	No % (95%CI)	Yes % (95%CI)	No % (95%CI)	Yes % (95%CI)
Schoolarship (years)[†]				
0 – 3	63.5 (51.7 – 73.9)	36.4 (26.0 – 48.2)	32.0 (22.5 – 43.4)	67.9 (56.5 – 77.4)
4 – 7	61.0 (51.6 – 69.6)	38.9 (30.3 – 48.3)	53.2 (46.1 – 60.2)	46.7 (39.7 – 53.8)
8 – 11	71.1 (63.9 – 77.4)	28.8 (22.5 – 36.0)	60.2 (52.6 – 67.2)	39.8 (32.7 – 47.3)
≥12	72.0 (61.5 – 80.6)	27.9 (19.3 – 38.4)	69.2 (57.9 – 78.6)	30.7 (21.3 – 42.0)
Marital status				
Without a partner	62.3 (52.5 – 71.2)	37.6 (28.7 – 47.4)	58.3 (52.1 – 64.3)	41.6 (35.6 – 47.8)
With a partner	68.9 (63.3 – 73.9)	31.1 (26.0 – 36.6)	53.6 (48.7 – 58.4)	46.3 (41.5 – 51.2)
Working status[†‡]				
No	41.6 (30.6 – 53.6)	58.3 (46.3 – 69.3)	45.5 (39.1 – 52.0)	54.4 (47.9 – 60.8)
Yes	72.6 (67.7 – 77.0)	27.3 (22.9 – 32.2)	63.7 (58.1 – 69.0)	36.2 (30.9 – 41.8)
Smoking time (years)[†]				
Not smoker	71.6 (64.7 – 77.7)	28.3 (22.2 – 35.2)	54.4 (49.3 – 59.5)	45.5 (40.4 – 50.6)
1st tertile (1 – 13)	74.4 (63.1 – 83.2)	25.5 (16.7 – 36.8)	56.5 (44.8 – 67.5)	43.4 (32.4 – 55.1)
2nd tertile (14 – 25)	57.5 (45.1 – 69.0)	42.4 (30.9 – 54.8)	62.1 (51.3 – 71.8)	37.8 (28.1 – 48.6)
3rd tertile (> 25)	60.1 (49.2 – 70.2)	39.8 (29.7 – 50.8)	52.2 (42.5 – 61.8)	47.7 (38.1 – 57.4)
AUDIT – degrees of dependence				
No dependence (0 – 7)	67.7 (61.7 – 73.3)	32.2 (26.7 – 38.2)	54.0 (49.8 – 58.2)	45.9 (41.7 – 50.1)
1st degree (8 – 15)	69.7 (60.6 – 77.5)	30.2 (22.4 – 39.3)	71.2 (58.8 – 81.0)	28.8 (18.9 – 41.1)
2nd degree (16 – 19)	60.6 (39.8 – 78.6)	39.0 (21.3 – 60.1)	43.5 (15.4 – 76.6)	56.4 (23.4 – 84.5)
3rd degree (20 – 40)	52.5 (33.7 – 70.5)	47.5 (29.4 – 66.2)	61.4 (31.5 – 84.6)	38.5 (15.4 – 68.4)

Continues...

Table 3. Continuation.

	Male (nw = 995.7)		Female (nw = 1,475.0)	
	Hypertension		Hypertension	
	No % (95%CI)	Yes % (95%CI)	No % (95%CI)	Yes % (95%CI)
Sitting time average (min/day)†				
1st tertile (≤ 180.00)	61.6 (52.4 – 70.1)	38.3 (29.8 – 47.5)	56.8 (51.2 – 62.3)	43.1 (37.6 – 48.7)
2nd tertile (180.00 – 308.60)	76.8 (68.5 – 83.4)	23.1 (16.5 – 31.4)	53.4 (45.5 – 61.1)	46.5 (38.8 – 54.4)
3rd tertile (>308.60)	64.6 (56.8 – 71.7)	35.4 (28.3 – 43.2)	55.5 (48.2 – 62.6)	44.4 (37.3 – 51.7)
Sodium in the diet (mg/day)				
1st quarter (≤ 3,104.40)	71.6 (56.5 – 83.0)	28.3 (16.9 – 43.4)	53.9 (47.1 – 60.5)	46.0 (39.4 – 52.8)
2nd quarter (3,104.41 – 4,682.70)	55.9 (43.2 – 67.8)	44.0 (32.1 – 56.7)	52.0 (45.9 – 58.0)	47.9 (41.9 – 54.0)
3rd quarter (4,682.71 – 6,571.30)	68.5 (58.7 – 76.9)	31.4 (23.0 – 41.2)	58.8 (51.6 – 65.6)	41.1 (34.3 – 48.3)
4th quarter (> 6,571.30)	71.2 (65.2 – 76.5)	28.7 (23.4 – 34.7)	60.6 (49.9 – 70.4)	39.3 (29.5 – 50.0)
Cholesterol in the diet (mg/day)‡				
1st quarter (≤ 133.52)	58.2 (46.2 – 69.3)	41.7 (30.6 – 53.7)	47.4 (40.1 – 54.8)	52.5 (45.1 – 59.8)
2nd quarter (133.53 – 203.73)	74.1 (64.3 – 81.9)	25.9 (18.0 – 35.6)	50.3 (43.8 – 56.9)	49.6 (43.0 – 56.2)
3rd quarter (203.74 – 300.91)	64.1 (53.8 – 73.3)	35.8 (26.6 – 46.1)	61.1 (53.7 – 67.9)	38.9 (32.0 – 46.2)
4th quarter (> 300.91)	69.1 (62.2 – 75.2)	30.8 (24.7 – 37.7)	68.6 (60.3 – 75.9)	31.3 (24.0 – 39.6)

nw: weighted sample; 95%CI: confidence interval of 95%. †p < 0.05 for F statistic (male gender). ‡p < 0.05 for F statistic (female gender).

cross-sectional studies carried out in Tubarão, SC, Brazil,[25] with participants ≥ 18 years and in Lages, SC, Brazil,[26] with participants between 20-59 years old, detected, respectively, prevalence of hypertension of 40 and 31.1% (male gender) and 33.6 and 38.1% (female gender). The above results, although not representative of the country as a whole, indicate that hypertension is already shaping up as a public health problem since the 1990s.

In the present study, the prevalence of hypertension was higher in women in all age groups when compared to males. This finding is consistent with the results of recent epidemiological studies carried out between 2006-2007 in Ribeirão Preto, SP, Brazil, in adults aged 30 years or more. Cross-sectional population-based study carried out in the city in 2006[27]

Table 4. Prevalence and confidence intervals for hypertension according to gender, anthropometric and inflammation-related factors and use of medicines. Ribeirão Preto, SP, Brazil, 2007. EPIDCV Project.

	Male (nw = 995.7)		Female (nw = 1,475.0)	
	Hypertension		Hypertension	
	No % (95%CI)	Yes % (95%CI)	No % (95%CI)	Yes % (95%CI)
Nutritional status†‡				
Euthrofic (BMI 18.50 – 24.99)	77.4 (70.2 – 83.2)	22.5 (16.7 – 29.7)	71.5 (66.4 – 76.1)	28.4 (23.8 – 33.5)
Pre-obese (BMI 25.00 – 29.99)	67.3 (60.1 – 73.7)	32.7 (26.2 – 39.8)	59.1 (52.0 – 65.7)	40.9 (34.2 – 47.9)
Obese (BMI ≥ 30.00)	50.9 (41.1 – 60.7)	49.0 (39.2 – 58.9)	32.1 (25.4 – 39.6)	67.8 (60.3 – 74.5)
Waist circumference (cm)*†‡				
Normal	77.6 (71.3 – 82.9)	22.3 (17.1 – 28.7)	75.8 (69.9 – 80.9)	24.1 (19.0 – 30.0)
Altered	56.9 (50.0 – 63.6)	43.0 (36.3 – 50.0)	47.1 (42.5 – 51.6)	52.8 (48.3 – 57.4)
Waist/height ratio†‡				
1st tertile (≤ 0.52)	86.9 (80.0 – 91.7)	13.0 (8.2 – 19.9)	77.0 (71.5 – 81.7)	22.9 (18.2 – 28.5)
2nd tertile (0.53 – 0.58)	65.6 (57.8 – 72.7)	34.3 (27.2 – 42.2)	57.1 (50.2 – 63.8)	42.8 (36.1 – 49.7)
3rd tertile (> 0.58)	48.0 (39.5 – 56.7)	51.9 (43.2 – 60.4)	32.1 (25.9 – 39.0)	67.8 (60.9 – 74.0)
Waist/hip ratio**†‡				
1st tertile	86.5 (79.8 – 91.2)	13.4 (8.7 – 20.1)	76.4 (69.8 – 81.8)	23.5 (18.1 – 30.1)
2nd tertile	64.2 (56.0 – 71.6)	35.7 (28.3 – 43.9)	54.2 (46.7 – 61.5)	45.7 (38.4 – 53.3)
3rd tertile	51.3 (42.8 – 59.6)	48.7 (40.3 – 57.1)	35.0 (28.7 – 41.8)	64.9 (58.1 – 71.2)
Conicity index †‡				
1st tertile (≤ 1.21)	91.9 (82.7 – 96.4)	8.0 (3.5 – 17.2)	74.0 (68.8 – 78.7)	25.9 (21.2 – 31.2)
2nd tertile (1.22 – 1.28)	78.2 (71.1 – 83.9)	21.7 (16.0 – 28.9(	46.2 (39.8 – 52.7)	53.7 (47.2 – 60.1)
3rd tertile (> 1.28)	51.2 (44.3 – 58.1)	48.7 (41.8 – 55.6)	30.2 (22.8 – 38.7)	69.7 (61.2 – 77.1)

Continue...

Table 4. Continuation.

	Male (nw = 995.7)		Female (nw = 1,475.0)	
	Hypertension		Hypertension	
	No % (95%CI)	Yes % (95%CI)	No % (95%CI)	Yes % (95%CI)
Ultrasensitive C-reactive protein (mg/dL)†‡				
Normal (≤ 0.5)	68.6 (63.6 – 73.2)	31.3 (26.7 – 36.3)	58.5 (54.3 – 62.5)	41.4 (37.4 – 45.6)
Altered (> 0.5)	48.2 (34.7 – 61.9)	51.7 (38.0 – 65.2)	38.1 (29.2 – 47.8)	61.8 (52.1 – 70.7)
Plasma fibrinogen (mg/dL)†‡				
1st tertile (≤ 311.30)	74.8 (68.1 – 80.6)	25.1 (19.3 – 31.8)	61.5 (53.4 – 68.9)	38.4 (31.0 – 46.5)
2nd tertile (311.31 – 345.30)	62.2 (51.7 – 71.6)	37.7 (28.3 – 48.2)	60.6 (54.9 – 66.1)	39.3 (33.8 – 45.0)
3rd tertile (> 345.30)	55.3 (45.6 – 64.7)	44.6 (35.2 – 54.3)	46.7 (40.4 – 53.0)	53.2 (46.9 – 59.5)
Number of medicines taken†‡				
None	84.0 (77.5 – 88.9)	15.9 (11.0 – 22.4)	76.6 (68.6 – 83.1)	23.3 (16.8 – 31.3)
1 – 2	69.0 (62.5 – 74.8)	30.9 (25.1 – 37.4)	66.8 (61.6 – 71.7)	33.1 (28.2 – 38.4)
3 – 4	41.9 (29.2 – 55.7)	58.0 (44.2 – 70.7)	47.3 (40.2 – 54.5)	52.6 (45.4 – 59.7)
≥ 5	30.8 (17.5 – 48.4)	69.1 (51.6 – 82.4)	23.7 (16.3 – 33.2)	76.2 (66.7 – 83.6)

nw: weighted sample; 95%CI: confidence interval of 95%; BMI: body mass index; *Cutoff: male ≥ 94 cm and female ≥ 80 cm according to Albert et al.[17], **Cutoffs for males: 1st tertile (≤ 0.89); 2nd tertile ((0.90 – 0.95); 3rd tertile (> 0.95); Female: 1st tertile (≤ 0.79); 2nd tertile (0.80 – 0.86); 3rd tertile (> 0.86).†p < 0.05 for the F statistic - (male gender); ‡p < 0.05 for the F statistic (female gender).

pointed out prevalence of obesity of greater magnitude in females than males in all age groups. Two other cross-sectional population-based studies conducted in Ribeirão Preto in the same period indicated, respectively, that women under 50 had higher daily sitting time average[28] and lower adherence to recommended consumption of fruit and vegetables[29]. These results, taken together, justify prevalence of greater magnitude of hypertension among women in the municipality, including the younger ones.

Projections of Kearney et al.[30] for the period 2000 to 2025 determine for the world as a whole, that the prevalence of hypertension will increase by 9% in males and 13% in females. Certainly, the cumulative effect of this and other chronic events, facing the population aging, on one hand, and the highest survival rates among women compared to men, on the other, may explain these differences.

In both sexes, inverse relation between the prevalence of hypertension and schoolarship, also observed by other authors[3,4], can be explained by greater access to health education

Table 5. Crude and adjusted prevalence ratios and confidence intervals for central obesity according to gender. Final Models. Ribeirão Preto, SP, Brazil, 2007. EPIDCV Project.

	Male sex			
	Crude PRs	95%CI	Adjusted PRs†	95%CI
Waist circumference*				
Normal	1.0	–	1.0	–
Altered	1.9	1.4 – 2.5	1.2	0.8 – 1.8
Waist/height ratio				
1st tertile (≤ 0.53)	1.0	–	1.0	–
2nd tertile (0.53 – 0.58)	2.6	1.6 – 4.3	2.2	1.2 – 3.7
3rd tertile (≥ 0.58)	3.9	2.5 – 6.3	2.8	1.5 – 5.3
Waist/hip ratio**				
1st tertile	1.0	–	1.0	–
2nd tertile	2.6	1.6 – 4.2	1.8	1.1 – 3.0
3rd tertile	3.6	2.3 – 5.6	2.0	1.2 – 3.3
Conicity index				
1st tertile (≤ 1.21)	1.0	–	1.0	–
2nd tertile (1.22 – 1.28)	2.6	1.1 – 6.1	2.0	0.9 – 4.6
3rd tertile (≥ 1.28)	6.0	2.6 – 13.4	3.0	1.3 – 7.0
	Female sex			
	Crude PRs	95%CI	Adjusted PRs‡	95%CI
Waist circumference*				
Normal	1.0	–	1.0	–
Altered	2.1	1.7 – 2.8	1.4	1.1 – 2.0
Waist-height ratio				
1st tertile (≤ 0.52)	1.0	–	1.0	–
2nd tertile (0.53 – 0.58)	1.8	1.4 – 2.4	1.5	1.1 – 2.1
3rd tertile (≥ 0.58)	2.9	2.3 – 3.7	1.7	1.1 – 2.7
Waist-hip ratio**				
1st tertile	1.0	–	1.0	–
2nd tertile	1.9	1.4 – 2.6	1.5	1.1 – 2.0
3rd tertile	2.7	2.1 – 3.7	1.6	1.2 – 2.1
Conicity index				
1st tertile (≤ 1.21)	1.0	–	1.0	–
2nd tertile (1.22 – 1.28)	2.1	1.6 – 2.6	1.5	1.2 – 1.9
3rd tertile (≥ 1.28)	2.7	2.1 – 3.4	1.4	1.1 – 1.9

95%CI: confidence interval of 95%; PR: prevalence ratios. *Cutoff: male ≥ 94 cm and female ≥ 80 cm according to Albert et al.[17]; **Cutoff for males: 1st tertile (≤ 0.89); 2nd tertile (0.90 – 0.95); 3rd tertile (> 0.95); Female: 1st tertile (≤ 0.79); 2nd tertile (0.80 – 0.86); 3rd tertile (> 0.86). †PR adjusted for: age groups, working condition, daily sitting time average, nutritional status and number of medicines taken. ‡PR adjusted for: age groups, schoolarship, marital status, cholesterol in diet, nutritional status and number of medicines taken.

among those in higher levels of education, which favors the adoption of habits related to healthy practices and protect against this outcome.

Several authors[31-33] have investigated associations between behavioral factors and hypertension and have proven deleterious effects arising from alcohol abuse[31], sedentary behavior[32] and excessive sodium intake[33]. In the present study, however, it was not possible to identify associations between these factors and hypertension. The reverse causality bias inherent to cross-sectional studies may have masked, at least in part, these associations, having been identified, for example, prevalence of hypertension of lower magnitude among men ranked in the top tertile of sitting time, and lower prevalence of the outcome among women classified in the last quarter of sodium and cholesterol consumption. Other examples of reverse causality bias were observed in both sexes for the variables "smoking time" and "AUDIT risk zones" one may suppose that, just because they are hypertensive, possible recommendations regarding changing habits such as smoking and alcohol consumption may have resulted in greater concentration of hypertensive in the levels of lower exposure of these variables. In the exploratory analysis of this study, another example of reverse causality was represented by physical activity. The short version of the International Physical Activity Questionnaire – IPAQ[19] allows, beyond the sitting time, calculating the physical activity patterns, according to intensity (mild, moderate and vigorous) and also according to the metabolic waste expressed in mets*min*week^{-1}. The presence of reverse causality between these two components of physical activity and hypertension, however, limited inferences about the association found, thus opting for "sitting time", less susceptible to this bias.

It is considered appropriate to highlight that although the us-CRP and plasma fibrinogen variables have presented global associations with the outcome, in both sexes, and the prevalence of hypertension have shown a dose-response relation to fibrinogen levels, results that are compatible with those of other authors[34,35], both variables did not remain in the final models. Variables with strong effect on blood pressure, such as central obesity anthropometric indexes, may have reduced the influence of these biochemical markers of inflammation on hypertension. These findings were corroborated by Lakoski et al.[34] in the cohort of the Multi-Ethnic Study of Atheroeclerosis (MESA), in which the authors found that the effect of proteins related to inflammation such as Interleukin 6, us-CRP and plasma fibrinogen on hypertension was attenuated after inclusion in the multivariate models of powerful predictors of hypertension, as opposed to global and central obesity indexes, which remained consistently associated with the outcome.

In the present study, central obesity indexes were independently associated with hypertension, having been observed a linear gradient for the respective adjusted prevalence ratios in both sexes (final models), evidencing also the effect of the Conicity index (CI) on hypertension, which has been little investigated in population-based studies. Epidemiological studies with cohort or cross-sectional design carried out in the United States[34], Brazil[36] and ten European countries[37] between 1993 and 2010 confirm the consistency of the association between measures of central obesity and hypertension.

It is appropriate to emphasize, moreover, the results reported by Barquera et al.[38] that, using structural equation modeling identified a mediator explicit effect of obesity in the relation between sitting time and hypertension. Thus, this study confirms the relevance of the findings presented, as well as the inclusion of sitting time as a confounding variable in the multivariate models. Results from ongoing studies with data from the EPIDCV Project and in which multilevel structural equation models were applied should certainly clarify direct, indirect and reciprocal potential effects of individual and/or aggregated level variables on chronic outcomes, among which includes hypertension.

Among the main limitations of the study, stands out the cross-sectional design that carries the bias of reverse causality, as already mentioned. Another important limitation that reduces the comparative ability of these results is the lack of analytical population-based epidemiological studies on chronic outcomes with primary data collection in representative samples of Brazilian populations, and it is rare in cross-sectional studies, corrections for the sampling design effect when using cluster sampling techniques.

In a meta-analysis paper recently published which included 40 Brazilian articles with cohort and cross-sectional designs, for the period 1980 – 2010, Picon et al.[39] investigated the prevalence and trends of hypertension between 1980 and 2000. Results of this meta-analysis, in which the authors used random-effects models, revealed absolute decline of 6% in the prevalence of hypertension between 1980 (36.7%) and 2000 (30.7%) when taken into consideration some cross-sectional studies with adjusted results for the sampling design effect. However, plausible explanations for this decline are not clear, because are scarce in the country time series studies on the evolution of risk factors or on the prevalence and control of hypertension, limiting inferences that could support intervention measures.

The results of EPIDCV Project indicated high prevalence of hypertension in both sexes, especially among women, reaffirming that the municipality is already between the fourth and the fifth stage of the epidemiological transition, and recent results concerning the local population indicated that nutritional transition is being led by women[27].

CONCLUSION

The study results impose the need to planning health promotion and prevention towards the control of hypertension and central obesity in order to reduce the final events, such as ischemic heart disease and stroke.

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