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High prevalence and poor control of hypertension in five venezuelan populations: the VEMSOLS study.

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Key words: hypertension; prevalence; Venezuela; obesity.

Abstract. The prevalence of hypertension in multiple regions of Venezuela is unknown. The objective of this study was to estimate the prevalence of hypertension in five populations from three regions. During 2006 to 2010, 1392 subjects aged 20 or older were selected by multistage stratified random sampling from all households in five municipalities from: Lara State (Western region), Merida State (Andean region), and Capital District (Capital region). Anthropometric measurements, blood pressure, and biochemical analysis were obtained from each participant. Mean age was 45.2 ± 0.4 years and 68% were females. The overall prevalence of hypertension was 31.3% (CI 95% 28.9 – 33.8), it was higher in men than women (38.1% [33.5 – 42.8] vs. 28.2% [25.4 – 31.2], respectively; p <0.001). The hypertensive participants were older, with higher body mass index (BMI), glucose, total cholesterol, LDL-c, and triglycerides; and lower values of HDL-c, than pre-hypertensive and normotensive participants (p < 0.05). In women, hypertension prevalence increased linearly for every decade of life and

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by category of BMI; whereas in men it increased until the fifth decade of life, and was similar in patients with overweight and obesity. The risk of hypertension increased with age, the presence of obesity, diabetes, overweight and family history of hypertension. Only 17.7% of the hypertensive subjects were both treated and controlled. In conclusion, about one third of the subjects evaluated had hypertension and about one fifth of them had their hypertension under control. In Venezuela, hypertension is a serious public health problem exacerbated by age and overweight.

Alta prevalencia y pobre control de la hipertensión en cinco poblaciones de Venezuela. Estudio VEMSOLS.

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Palabras clave: hipertensión arterial; prevalencia; Venezuela; obesidad.

Resumen. Se desconoce la prevalencia de hipertensión arterial (HTA) en múltiples regiones de Venezuela. El objetivo fue determinar la prevalencia de HTA en cinco poblaciones de tres regiones. Durante 2006 a 2010, 1392 sujetos de 20 o más años de edad fueron seleccionados mediante un muestreo aleatorio estratificado polietápico, de todas las casas en 5 municipios de: Estado Lara (región Oeste), Estado Mérida (región Andina) y Distrito Capital (región Capital). Se obtuvieron medidas antropométricas, presión arterial y análisis bioquímico. La media de edad fue 45,2 ± 0,4 años, y 68% fueron mujeres. La prevalencia de HTA fue 31,3% (IC 95%: 28,9 – 33,8), mayor en hombres que en mujeres (38,1% [33,5 – 42,8] vs 28,2% [25,4 – 31,2], respectivamente; p <0,001). Los sujetos hipertensos mostraron mayor edad, índice de masa corporal (IMC), glucemia, colesterol total, c-LDL y triglicéridos; y valores más bajos de c-HDL, que los sujetos pre-hipertensos y normotensos (p< 0,05). En las mujeres, la prevalencia de HTA aumentó linealmente en cada década de la vida y en cada categoría de IMC; en los hombres, se incrementó hasta la quinta década, siendo similar en sujetos con sobrepeso y obesidad. El riesgo de HTA se incrementó con la edad, presencia de sobrepeso/obesidad, diabetes, e historia familiar de HTA. Sólo 17,7% de los sujetos hipertensos se encontraban tratados y controlados. En conclusión, un tercio de los sujetos evaluados presentó HTA y alrededor de un quinto está bajo control. En Venezuela, la HTA es un grave problema de salud pública exacerbado por la edad y el sobrepeso.

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INTRODUCTION

Globally, hypertension is the most common cardiovascular disease risk factor and the leading disease burden (1). It has been estimated that hypertension have caused 9.4 million of deaths and 7% of disability-adjusted life years (DALYs) in 2010 (1). In 2008, worldwide,

the World Health Organization estimate that approximately 40% of adults aged 25 and above had been diagnosed with hypertension; the number of people with the condition rose from 600 million in 1980 to 1 billion in 2008, being highest in the African Region (46%), while the lowest prevalence (35%) in the Americas (2).

There is relatively little information regarding hypertension prevalence in Venezuela. Some studies with different methodologies have reported this prevalence but none includes more than one region of the country. The Cardiovascular Risk Factor Multiple Evaluation in Latin America (CARMELA) study (3) , designed to systematically compare cardiovascular risk factors in seven major Latin American cities, reported a prevalence of hypertension of 24.7% in Barquisimeto city, in the western region of Venezuela. The need to report the prevalence rates of several cardio-metabolic risk factors in multiple regions of Venezuela prompted the design of the Venezuelan Metabolic Syndrome, Obesity and Lifestyle Study (VEMSOLS). The objective in the present report was to estimate the prevalence of hypertension by age and gender, and determine the number of aware and controlled hypertensive subjects.

Population studied

Five municipalities were evaluated in three regions of Venezuela: 1) Palavecino municipality in Lara state (urban) from the Western region; 2) Ejido municipality (Mérida city) in Mérida state (urban) and 3) Rangel municipality (Páramo area) in Mérida state (rural), both from the Andes region; 4) Catia municipality in Vargas state (urban) and 5) Sucre municipality in the Capital District (urban), both from the Capital region. During the years 2006 to 2010, a total of 1392 subjects aged 20 or older who had lived in their houses for at least six months were selected according to a multistage stratified random sampling. Pregnant women and participants unable to stand up and/or communicate verbally were excluded from this study.

Clinical and biochemical data

Subjects were evaluated in their homes or in a nearby health center by a senior investigator of the study, and students of medicine previously trained according to a standardized protocol in sessions previous the journey recollection. Each home was visited twice. In the first visit, the participants received information about the study, including instructions regarding fasting for at least 12 hours for the second visit, and a written informed consent was obtained. Demographic and clinical information was obtained using a standardized questionnaire. Blood pressure was measured twice in the right arm supported to the heart level, in a sitting position, after five minutes of rest, with a aneroid sphygmomanometer, annually calibrated by the technicians of each center, with a proper cuff and bladder size according to the arm. The bladder length covered 80 percent of the subject's arm circumference Weight was measured with the fewest clothes possible, without shoes, using a calibrated scale. Height was measured using a metric tape on the wall. Body mass index was calculated (BMI: weight[kg]/height[m]^2).

In the second visit, blood samples were drawn after 12 hours of overnight fasting. Then, blood samples were centrifuged during 15 minutes at 3000 rpm within 30-40 minutes after collection, and transported on dry ice to the central laboratory where were they properly stored until analysis. Questionnaire information missing from participants who were absent during the first visit was also collected. Plasma glucose (4), total cholesterol (5), triglycerides (6), low density lipoprotein of cholesterol (LDL-c), and high density lipoprotein of cholesterol (HDL-c) (7), were determine by standard enzymatic colorimetric methods.

Categorization of variables

Hypertension was defined as systolic blood pressure (BP) ≥ 140 mmHg or diastolic BP ≥ 90 mmHg, or the use of antihypertensive medications. Individuals with a systolic BP of 120–139 mmHg or a diastolic BP of 80–89 mmHg were considered as pre-hypertensive (8). Isolated systolic hypertension was defined as systolic BP ≥ 140 mmHg and diastolic BP< 90 mmHg (9). Individuals were classified according BMI as normal weight (BMI < 25 kg/m^2), overweight (BMI ≥ 25 kg/m^2 and < 30 kg/m^2), or obese (BMI ≥ 30 kg/m^2) (10). Dyslipidemia was defined according the NCEP/ATPIII (11) and was categorized in three types: hypercholesterolemia (≥ 240 mg/dL of total cholesterol); low HDL-c (< 40 mg/L HDL-c in men and < 50 mg/dL HDL-c in women); hypertriglyceridemia (≥ 150 mg/dL of triglycerides). Diabetes was established if fasting plasma glucose was ≥ 126 mg/dL or by the use of antidiabetic medications (12).

Statistical analysis

All calculations were performed using the SPSS 20 program (IBM corp. Released 2011. Armonk, NY: USA). Results for continuous variables are presented as mean ± standard errors of the mean (SEM). Mean differences were assessed by analysis of variance (ANOVA), with Tukey adjustment for multiple comparisons. Mean differences between genders were assessed by the Student's t-test. Proportion of subjects with obesity, hypertension, dyslipidemia, and diabetes, were presented as prevalence rates and 95% confidence intervals (CI). To enable comparisons with other estimates, the prevalence of hypertension was directly standardized, by age and sex. Chi square tests were used to compare frequencies by gender. Logistic regression multiple was applied to estimate odds ratios for risk factors related to hypertension. A p-value < 0.05 was considered to be statistically significant.

RESULTS

Subject's characteristics

Overall, females constituted about two thirds of the population evaluated (Table I). All indicators of blood pressure were higher in men than in women: systolic BP 125.5 ± 0.9 mmHg versus 119.0 ± 0.5 mmHg, diastolic BP 80.6 ± 0.6 mmHg versus 75.8 ± 0.3 mmHg; and pulse pressure 44.9 ± 0.6mmHg, *vs* 43.1 ± 0.3 mmHg, respectively (p< 0.001). This difference disappears after postmenopausal age (Fig. 1). Blood pressure increased after the fifth decade of life in both genders.

Prevalence of hypertension

The overall prevalence of hypertension was 31.3% (CI 95% 28.9 – 33.8), higher in men than women (Table II). The prevalence of hypertension increased with age, being the lowest in the 20-29 age groups and the highest in the age group of 70 years or higher (p < 0.048). The age and sex standardized prevalence of hypertension was 30.0% (CI 95%: 29.0 – 34.1) in the total population, 34.4% (CI 95%: 31.5 – 36.6) in men, and 26.8% (CI 95%: 24.5 – 29.6) in women. In women, the prevalence of hypertension increased approximately by 50% in each decade. In men, the prevalence of hypertension increased until the fifth decade of life. The prevalence of isolated systolic hypertension was 6.2% (CI 95%: 4.9 – 7.4), similar between genders, and increased with age, in the 70 years of age group or older 22.2% [CI 95%: 18.3 – 26.2] in men and 31.6% [CI 95%: 28.6 – 34.5] in women; p < 0.001). The overall prevalence of pre-hypertension was 32.8% [CI 95%: 30.33 – 35.27], and it was higher in men that in women (35.3% [CI 95%: 30.8 – 39.8] and 31.7% [CI 95%: 28.7 – 34.6]; respectively, p < 0.001).

TABLE I
AVERAGE AGE AND BASIC ANTHROPOMETRIC CHARACTERISTICS IN A SAMPLE OF MEN AND WOMEN AGGREGATED FROM FIVE VENEZUELAN POPULATIONS: THE VEMSOLS STUDY.

	Men	Women	Total
Participants (n, %)	436 (31.3%)	956 (68.7%)	1392(100%)
Age (years)	46.2 ± 0.7	44.6 ± 0.4	45.2 ± 0.4
Weight (kilograms)	79.9 ± 0.7	67.7 ± 0.4*	71.6 ± 0.4
Height (meters)	1.69 ± 0.1	1.56 ± 0.1*	1.60 ± 0.1
BMI (kilograms/meters^2)	27.7 ± 0.2	27.5 ± 0.1	27.5 ± 0.1

Data are mean ± SEM. BMI: body mass index.*p < 0.001 for gender difference

TABLE II
PREVALENCE OF HYPERTENSION BY AGE IN A SAMPLE OF MEN AND WOMEN AGGREGATED FROM FIVE VENEZUELAN POPULATIONS: THE VEMSOLS STUDY.

	Men	**Women**	**Total**
Total prevalence	38.1 (33.5 – 42.8)	28.2 (25.4 – 31.2)*	31.3 (28.9 – 33.8)
20 to 29	15.5 (8.3 - 26.4)	9.3 (5.49 - 15.1)†	11.2 (7.6 – 16.1)
30 to 39	26.8 (17.9 - 37.9)	16.3 (11.7 – 22.1)	19.2 (14.9 – 24.2)
40 to 49	33.6 (24.9 – 43.5)	24.7 (19.3 – 30.8)	27.5 (22.8 – 32.6)
50 to 59	45.9 (34.4 – 57.8)	37.1 (30.4 – 44.3)	39.6 (33.7 – 45.7)
60 to 69	61.3 (49.3 – 72.1)	52.1 (42.7 – 61.4)	55.7 (48.4 - 62.8)
70 or older	63.0 (42.4 – 79.9)	78.9 (62.2 – 89.8)	72.3 (59.6 – 82.3)
ISH	6.4 (3.5 – 9.2)	6.1 (4.3 – 7-8)	6.2 (4.9 – 7.4)
Pre-hypertension	35.3 (30.8 – 39.8)	31.7 (28.7 – 34.6)*	32.8 (30.3 – 35.2)

Data are percent (95% CI). ISH: isolated systolic hypertension. *p<0.001 for overall gender difference; †P<0.05 for gender difference within this age category.

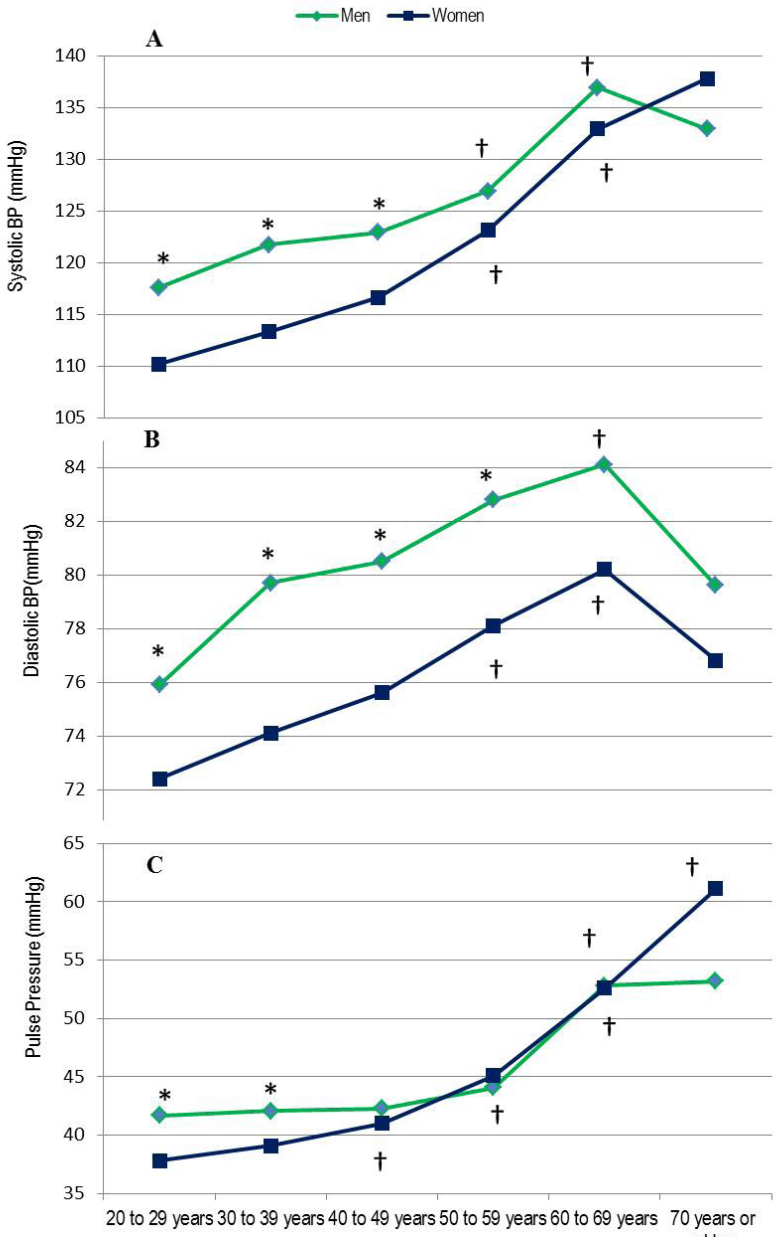

Fig. 1. Data are means. Blood pressure by sex and age . A: systolic blood pressure, B: diastolic blood pressure, and C: pulse pressure increased with age in both genders ($p < 0.01$), *Statistically significant BP difference between genders ($p < 0.05$). † Blood pressure increased compared with the previous decade of life.

Hypertension and cardiometabolic risk factors

On average, hypertensive participants were older and had higher values of body weight, BMI, glucose, total cholesterol, LDL-c, triglycerides, and lower values of HDL-c than pre-hypertensive and normotensive participants (Table III). The prevalence of hypertension according to different cardio-metabolic risk factors is shown in Table IV. All risk factors studied were more frequent in men. In women, the prevalence of hypertension increased with BMI. In men, the prevalence of hypertension was similar between the overweight and the obese groups; however, this prevalence doubled the normal weight group. About half of the patients with diabetes and one third of the patients with dyslipidemia had hypertension. The odds ratios calculated with logistic regression showed that for each additional year of age difference, the risk of hypertension increased by 6%. Obesity tripled the risk of hypertension, whereas overweight, diabetes, and family history of hypertension doubled this risk (Table V).

Awareness, treatment, and control among the hypertensive population

Sixty-seven percent of all participants with hypertension were aware of their condition, and in this group, 83.8% was currently in treatment. Hypertension treated and controlled, defined as a BP< 140/90 mmHg in hypertensive subjects, was 17.7% (Table VI).

TABLE III
CARDIOMETABOLIC RISK FACTORS IN PATIENTS ACCORDING TO BLOOD PRESSURE STATUS IN A SAMPLE OF MEN AND WOMEN AGGREGATED FROM FIVE VENEZUELAN POPULATIONS: THE VEMSOLS STUDY

	Normotensive	Pre-hypertensive	Hypertensive
	n =499	n =457	n =436
Age (years)*	39.6 ± 0.5[a]	43.8 ± 0.6[a]	52.7 ± 0.6[b]
Weight (kg)*	65.9 ± 0.5[a]	73.3 ± 0.7[b]	76.2 ± 0.8[c]
BMI (kg/m^2)*	25.7 ± 0.2[a]	27.8 ± 0.2[b]	29.4 ± 0.2[c]
Glucose (mg/dL)*	89.3 ± 1.7[a]	92.5 ± 1.7[a,b]	98.5 ± 2.0[b]
Total cholesterol (mg/dL)*	201.5 ± 2.1[a]	205.5 ± 2.3[a]	214.6 ± 2.3[b]
LDL-c (mg/dL)*	128.6 ± 1.9[a]	129.5 ± 2.1[a,b]	135.9 ± 2.2[b]
HDL-c (mg/dL)*	46.6 ± 0.5[a]	46.5 ± 0.5[a]	44.4 ± 0.5[b]
Triglycerides (mg/dL)*	137.9 ± 4.6[a]	148.6 ± 5.4[a]	178.7 ± 6.1[b]

Data are mean ± SEM. BMI: body mass index. LDL-c: low density lipoprotein cholesterol. HDL-c: high density lipoprotein cholesterol. *p<0.05 for differences according to blood pressure status. Different letters indicate significative differences with a p <0.05.

TABLE IV
PREVALENCE OF HYPERTENSION IN A SAMPLE OF MEN AND WOMEN AGGREGATED FROM FIVE VENEZUELAN POPULATIONS, ACCORDING TO CARDIO-METABOLIC STATUS: THE VEMSOLS STUDY

	Men	Women	Total
Obesity	47.5(38.3 – 56.8)	41.5(35.8 – 47.5)*	43.3(38.4 – 48.3)
Overweight	46.0(38.5 – 53.6)	29.3 (24.6 – 34.5)*	35.0(30.9 – 39.3)
Normalweight	20.0(13.9 – 27.8)	15.7(12.1 – 20.2)*	17.0(13.7 – 20.7)
Diabetes	56.2 (41.2 – 70.2)	47.8 (35.7 - 60.1)*	52.3 (41.9 – 60.5)
Hypercholesterolemia	44.1 (34.4 – 54.3)	34.0 (27.5 – 41.1)*	37.5 (32.0 – 43.2)
Hypoalphalipoproteinemia	43.2 (35.8 – 50.8)	30.2 (26.3 – 33.8)*	33.1 (29.8 – 36.5)
Hypertriglyceridemia	43.1 (36.4 - 50.1)	35.7 (30.5 – 41.1)*	38.6 (35.8 – 44.4)

Data are percentages (95% CI).*p<0.05 for gender difference.

TABLE V
ODDS RATIOS FOR HYPERTENSION IN A SAMPLE OF MEN AND WOMEN AGGREGATED FROM FIVE VENEZUELAN POPULATIONS ACCORDING TO DIFFERENT CARDIO-METABOLIC RISK FACTORS: THE VEMSOLS STUDY.

	OR	(95% CI)
Age	1.06	1.04 - 1.08
Positive family history	1.97	1.27 - 3.07
Diabetes	2.07	1.16 - 3.71
Overweight	2.25	1.36 - 3.70
Obesity	3.00	1.79 - 5.04

Multiple logistic regression. OR: Odds ratio.

DISCUSSION

The Venezuelan Metabolic Syndrome, Obesity and Lifestyle Study (VEMSOLS) is the first study that reports the prevalence of hypertension in a large segment of the Venezuelan population (five populations from three regions). Until now, this is the most representative study of hypertension in this country. The overall prevalence of hypertension found in the present study was 31.2%. This figure doubles the overall mean prevalence reported in the seven Latin America cities in the CARMELA study (16.3%) (3). The lower prevalence of hypertension re-

TABLE VI
NUMBER AND PERCENT OF AWARENESS, TREATMENT, AND CONTROL AMONG THE HYPERTENSIVE POPULATION

Participants	With hypertension	Unaware	Aware	Treated	Controlled
1392	436	144	292	245	43
100%	31.3%	33.0%	67.0%	83.8%	17.7%

Controlled: Blood pressure < 140/90 mmHg.

ported in the CARMELA study compared with the VEMSOLS could be explained in part by the fact that the CARMELA study only included participants between 25 and 64 years of age, excluding the older age group, which has the highest prevalence of hypertension(3).

A non-longitudinal study of hypertension or any other cardio-metabolic risk factor study has been performed in Venezuela (13). However, Barquisimeto city has been selected in at least three well-designed studies that allows us to estimate changes in the prevalence of hypertension over time. In 1994, in a sample of 15,000 subjects from Lara state mostly from Barquisimeto, a prevalence of 23.6% was reported (14). For 2008, a similar prevalence was reported for this city (24.7%) by the CARMELA study(3, 13), showing the highest prevalence of hypertension among seven Latin American cities studied, including Buenos Aires, Argentina (29.0%), and Santiago, Chile (23.8%)(15). In the present study, a prevalence of 28.3 % of hypertension was found (data not shown), in a population of Cabudare (Palavecino municipality), a city geographically annexed to Barquisimeto. Thus, it could be inferred that the prevalence in this region has been stable or slightly increased in the last 20 years, although these results cannot be extrapolated to the whole country. In one of the five population studied here, a rural population living 3000 meters above sea level (Páramo), a prevalence of hypertension of 25% was previously reported(16).

The Prospective Urban Rural Epidemiology (PURE) study (17) included 142,042 participants between the ages of 35 and 70 years, involving urban and rural communities from 17 countries on 5 continents. In the PURE study, 40.8% of the subjects had hypertension, similar to that reported by the WHO (2), which is higher than the present study (31.3%). But, after adjusting for age and gender, the prevalence of hypertension in the PURE study was 27.7%, which is similar to the similarly adjusted prevalence of the present report (30.0%).

In the VEMSOLS, present study, a different behavior in the prevalence of hypertension by gender was found. In men, the overall prevalence was higher than in women and it increased with age until the fifth decade of life. In women, the prevalence of hypertension in the third decade doubled the prevalence found in the second decade of life. The prevalence of hypertension increased 50% every decade until the seventh decade, in which eight in ten women had hypertension, a number even higher than that for men in this age group. These figures suggest the need to detect and treat high BP especially after menopause. This results was consistent with previous reports were prevalence of hypertension was higher in men than women (3,18). This result could be explained by the gender differences in the mechanisms that contribute to the vascular tone, involving mechanisms of endothelium-dependent vascular relaxation and the inhibition of the vascular smooth muscle contraction induced

by sex hormones (19). Higher BP in men may be related to high testosterone levels, whereas lower BP in women may be related to estrogen levels (20).

Regarding other cardio-metabolic risk factors, the prevalence of hypertension was similar in overweight and obese men, and both were higher than the prevalence in normal weight subjects. In women, the prevalence of hypertension increased with every category of BMI. When the individuals were categorized according blood pressure status (normotensive, pre-hypertensive and hypertensive), as the BP status deteriorated the prevalence of hypertension increased for all cardio-metabolic risk factors. Large-scale epidemiological studies in different countries support the association between obesity and hypertension. Obese patients have higher prevalence of hypertension than normal weight patients (21). The factors associated to obesity-related hypertension include the enhanced sympathetic tone, activation of the renin-angiotensin system, hyperinsulinemia, structural changes in the kidney, and higher levels of adipokines such as leptin (22). However, the relation reported here between excess body fat and hypertension was different in each gender. In a previous study, Wilsgaard et al (23), demonstrated gender differences in the impact of body weight on BP in two population surveys carried out with an 8-year interval in Norway. Baseline BMI and changes in BMI were independent predictors of systolic and diastolic BP changes in women. For a given BMI increase, obese women had a greater systolic and diastolic BP increase than lean women. In men, BP change was associated with a change in BMI, but the BP increase was independent of the baseline BMI. Another sex difference worth noting was that a given BMI increase in obese women induced a much greater systolic BP increase than in obese men (23).

The percentage of hypertensive patients aware of their condition in our study (67.4%) was similar to that reported in the CARMELA study (3) (64.4%) for Latin America, and higher than it was presented in the PURE study (40.8%) (17). In the PURE study, awareness and treatment rates of hypertension were similar in urban and rural communities of high-income countries and upper middle-income countries (based on information from the World Bank in 2006), but were significantly lower in rural areas versus urban areas in low-income countries. The average of controlled-hypertension individuals in our study (blood pressure < 140/90 mmHg) was 17.7%, lower than reported by the CARMELA study (24.0%) (3) and the PURE study (32.5%) (17). To the present, no local studies had evaluated the causes of this lack rate of control, the World Health Organization pointed that prevention and control of hypertension requires political will on the part of governments and policymakers (2).

In conclusion, the VEMSOLS pointed a major public health problem in Venezuela represented by a large number of people with hypertension. Additionally, a small proportion of these subjects remain controlled; and the problem may increase with the aging population. Three major actions need to be implemented. First, a population study representative of all the country in order to evaluate the national prevalence of hypertension and associated lifestyle factors. Second, develop screening programs to detect undiagnosed and untreated hypertension. Third, efficient health care policies must be implemented to increase the prevention and control of hypertension and ameliorate its burden on health systems.

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