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ORIGINAL ARTICLE

Prevalence of Metabolic Syndrome in Three Regions in Venezuela: The VEMSOLS Study

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Abstract

Background: No previous study has evaluated the prevalence of metabolic syndrome (MS) in more than one region in Venezuela.

Objective: To determine the prevalence of MS in three Venezuelan regions.

Methods: From 2006 to 2010, a total of 1,320 subjects aged ≥ 20 years were selected by multistage stratified random sampling from the regions of Lara State (western region), Mérida State (the Andean region), and Capital District (Capital Region). Anthropometric measurements, blood pressure, and biochemical analysis were obtained from each participant. MS was defined according to the harmonized Joint Interim Statement (2009) definition.

Results: Mean age was 44.8 ± 0.39 years and 68.5% of the participants were female. The overall prevalence of MS was 35.7% (95% confidence interval 32.2 – 39.2%), while the prevalence was 42.5% (95% CI 38.8 – 46.1%) among men and 32.6% (95% CI 29.1 – 36.0%) among women ($p < 0.001$). In women, the prevalence of MS increased at almost every decade of life, while in men, the prevalence was similar from the age of 30 years onwards. The most prevalent abnormalities were low HDL-c levels (58.6%, 95% CI 54.9 – 62.1%), abdominal obesity (52.0%, 95% CI 48.4 – 55.7%), and elevated triglycerides levels (39.7%, 95% CI 36.1 – 43.2%). The prevalence of MS increased with increasing body mass index categories.

Conclusion: In Venezuela, MS is a highly prevalent condition, which increases the risk of type 2 diabetes and cardiovascular disease in a large number of subjects. (Int J Cardiovasc Sci. 2018;31(6)603-609)

Keywords: Metabolic Syndrome/epidemiology; Obesity; Venezuela/epidemiology; Risk Factors; Cardiovascular Diseases; Diabetes Mellitus, Type 2.

Introduction

Metabolic syndrome (MS) is a cluster of cardiometabolic risk factors characterized by dysfunctional adipose tissue and insulin resistance,[1,2] clinically expressed by atherogenic dyslipidemia, abdominal obesity, increased blood pressure, and elevated blood glucose concentration. Subjects with MS have increased risk of cardiovascular diseases and type 2 diabetes (T2D).[3]

Although many controversial issues exist around MS,[4] assessing this syndrome is pathophysiologically and epidemiologically relevant[5] to determine regional differences in cardiometabolic diseases and risk. The International Diabetes Federation, American Heart Association, and National Heart, Lung and Blood Institute have standardized their criteria for the definition of MS. These updated diagnostic criteria maintained the components defined by the last National Cholesterol Education Program/Adult Treatment Panel III (NECP/ATP-III) modification in 2005,[6] and recommended the use of specific cutoff values of waist circumference for each ethnic group or population. A cutoff for abdominal

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obesity (waist circumference ≥ 94 cm in men and ≥ 90 cm in women) in the Latin American population has been proposed.[7] Considering that the level of fat mass linked to MS differs among regions, applying these abdominal obesity ethnic-specific cutoffs can improve the detection of cardiometabolic risk factors. Comparing with Caucasians and similar to Asian populations,[8] MS is present at lower levels of waist circumference in Latinos[7] and Venezuelans.[9]

Two major studies have reported the MS prevalence in Venezuela. Florez et al.,[10] evaluating 3,108 adults from the Zulia Region, found the prevalence of MS according to the NCEP/ATP-III[11] to be 31.2%, and the prevalence of atherogenic dyslipidemia (elevated triglycerides and low high-density lipoprotein cholesterol [HDL-c]) to be 24.1%. In Barquisimeto city, located in the western region of the country, the Cardiovascular Risk Factor Multiple Evaluation in Latin America (CARMELA) study,[12] which applied the NCEP/ATP-III definition[11] and included 1,848 adults, reported a prevalence of MS of 25.8%. The limitation of these studies was that they only included one Venezuelan region, prompting the design of the Venezuelan Metabolic Syndrome, Obesity and Lifestyle Study (VEMSOLS). This article presents the results of this study, specifically, the MS prevalence in five populations of three regions of Venezuela.

Methods

Design and subjects

An observational, cross-sectional study was designed to determine the prevalence of cardiometabolic risk factors in a subnational cohort in Venezuela. Five municipalities were evaluated in three regions in the country: Palavecino Municipality in Lara State (urban), located in the western region; Ejido Municipality (Mérida city), in Mérida State (urban) and Rangel Municipality (Páramo area) in Mérida State (rural), both located in the Andes region; and Catia La Mar Municipality in Vargas state (urban) and Sucre Municipality in Capital District (urban), both in the Capital Region. During the years 2006 and 2010, a total of 1,320 subjects aged ≥ 20 years who had lived in their homes for at least 6 months were selected by two-stage random sampling. The assessment included three different geographic regions in the country – the Andes, mountains in the south; Western, Llanos in the middle; and Capital District, coast in the north. Each region was stratified by municipalities, and one was randomly selected. Map and census of each location were required to delimit the streets or blocks, and to select the households to visit in each municipality. After selecting the sector to be surveyed at each location, the visits to the households started at house number 1 and moved up, skipping every two houses. Pregnant women and individuals unable to stand up and/or communicate verbally were excluded.

The sample size was calculated to detect a prevalence of hypercholesterolemia (the lowest prevalent condition reported in Venezuela) of 5.7%[12] with a standard deviation of 1.55%, which allows the calculation of a 95% confidence interval (95%CI). The minimum estimated number of subjects to be evaluated was 830. Overall, 1,320 subjects were evaluated (89.4% in the urban and 10.6% in the rural area).

Clinical and biochemical data

All subjects were evaluated in their homes or in a nearby health center by a trained health care team according to a standardized protocol. Each home was visited twice. In the first visit, the participants received information about the study 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 at the level of the heart, with the subject in the sitting position, after 5 minutes of rest, and obtained with a calibrated aneroid sphygmomanometer. Weight was measured with the use of a calibrated scale with the individuals wearing as few clothes as possible and without shoes. Height was measured using a metric tape attached to the wall. Waist circumference was measured at the iliac crest, in a horizontal plane with the floor at the end of expiration. Body mass index (BMI) was calculated with the formula weight (in kg) divided by the squared height (in m^2).

In the second visit, blood samples were drawn after 12 hours of overnight fasting, centrifuged during 15 minutes at 3000 rpm within 30-40 minutes from the collection, and transported in dry ice to the central laboratory where the samples were properly stored at -40°C until analysis. Questionnaire information from the participants absent during the first visit was collected during this second visit. Plasma glucose, triglycerides, and HDL-c were determined by standard enzymatic colorimetric methods. The study was conducted according to the Declaration of Helsinki. The only invasive procedure performed was venipuncture, and no complications occurred.

Categorization of variables

MS was defined according to the definition of the harmonized Joint Interim Statement (2009)[13] as the presence of at least three of the following: abdominal obesity (waist circumference ≥ 94 cm in men or ≥ 90 cm in women),[7] triglycerides ≥ 150 mg/dL, HDL-c < 40 mg/dL in men and < 50 mg/dL in women, blood pressure ≥ 130/85 mmHg or antihypertensive treatment, and fasting blood glucose ≥ 100 mg/dL or self-reported diabetes. Additionally, the definition of MS according to the NCEP/ATP-III[11] was also applied to compare with previous reports. In this definition, elevated fasting blood glucose was set at ≥ 110 mg/dL, and abdominal obesity as waist circumference > 102 cm in men and > 88 cm in women. Individuals were classified according to their BMI as having normal weight (BMI < 25 kg/m^2), overweight (BMI ≥ 25 kg/m^2 and < 30 kg/m^2), or obesity (BMI ≥ 30 kg/m^2).

Statistical analysis

All calculations were performed using the program SPSS 20 (IBM Corp., Armonk, NY, United States). Data of continuous variables are presented as mean ± standard deviation. Blood glucose values are presented as median and interquartile range (IR) due to a nonnormal distribution. Differences between mean values were assessed by analysis of variance (ANOVA), with Bonferroni or Tukey adjustment for multiple comparisons. Differences between median levels of blood glucose were evaluated with the Mann-Whitney U test. The proportion of subjects with MS and its components are presented as prevalence rates and 95%CIs. The chi-square test was applied to compare different frequencies by gender and nutritional state. A p value < 0.05 was considered to be statistically significant.

Results

Subjects characteristics

Two-thirds of the study subjects were female. Men had higher weight, height, waist circumference, blood pressure, and blood glucose values than women (Table 1). There were no differences between genders for age and BMI.

Prevalence of metabolic syndrome

More than one-third of the subjects had MS (35.7%), and the frequency of this condition was higher in men than women (Table 2). Low HDL-c and abdominal obesity were the most frequent abnormalities. Most MS components were increased in men, except for low HDL-c levels, which were more frequent in women.

Table 1 - Subjects' characteristics

	Men	Women	Total	p
Participants (n, %)	412 (31.2)	908 (68.8)	1,320 (100)	
Age (years)	45.8 ± 0.73	44.4 ± 0.46	44.8 ± 0.39	0.086
Weight (kilograms)	80.1 ± 0.80	67.9 ± 0.48	71.7 ± 0.44	0.0001
Height (meters)	1.69 ± 0.00	1.56 ± 0.00	1.60 ± 0.00	0.0001
BMI (kg/m^2)	27.7 ± 0.25	27.6 ± 0.17	27.6 ± 0.14	0.633
Waist circumference (cm)	96.4 ± 0.65	89.8 ± 91.9	91.9 ± 0.35	0.0001
Systolic blood pressure (mmHg)	125.6 ± 0.94	118.9 ± 0.60	121.0 ± 0.51	0.0001
Diastolic blood pressure (mmHg)	80.8 ± 0.68	75.9 ± 0.39	77.4 ± 0.35	0.0001
Blood glucose (mg/dL)	88 ± 22.0	85.0 ± 19.0	85.0 ± 19.0	0.0001
HDL-c (mg/dL)	43.2 ± 0.51	47.2 ± 0.36	45.9 ± 0.30	0.0001
Triglycerides (mg/dL)	175.3 ± 6.90	140.0 ± 2.81	151.0 ± 2.93	0.0001

Data are represented as mean ± standard deviation. Blood glucose values are represented as median values ± interquartile range. BMI: body mass index. HDL-c: high-density lipoprotein cholesterol. LDL-c: low-density lipoprotein cholesterol.

In men, the prevalence of MS was lower in the 20 – 29 years age group, but was similar in all other age groups, ranging from 39.5% to 60.9% (Figure 1). In women, the prevalence of MS increased at almost every decade of life, and was lower in the 20 – 29 years age group (9.0%) and higher in the ≥ 70 years group (71.9%). Comparing genders, the prevalence of MS was higher in men until the fifth decade of life. The prevalence of MS increased at every category of BMI in women but was similar between men with overweight and obesity (Figure 2). The prevalence of MS in men with overweight and obesity was higher than that in women. The prevalence of MS according to the ATP-III was 30.6% (95% CI 28.1 – 33.0%) and was similar between genders, 30.1% (95% CI 25.6 – 34.5%) in men and 30.9% in women (CI 95% 27.8 – 33.9%, p = 0.415).

Table 2 - Prevalence of metabolic syndrome and its components by gender

	Men n = 412	Women n = 908	Total n = 1,320	p
Metabolic syndrome	42.5 (38.8 – 46.1)	32.6 (29.1 – 36.0)	35.7 (32.2 – 39.2)	0.0001
Elevated blood glucose	26.0 (21.7 – 30.2)	16.9 (14.4 – 19.3)	19.1 (16.9 – 21.2)	0.0001
Abdominal obesity	57.8 (54.2 – 61.2)	49.4 (45.8 – 53.1)	52.0 (48.4 – 55.7)	0.0001
Increased blood pressure	46.6 (42.9 – 50.2)	31.3 (27.9 – 34.6)	36.1 (32.6 – 39.5)	0.0001
Low HDL-c	42.2 (38.6 – 45.8)	66.0 (62.5 – 69.4)	58.6 (54.9 – 62.1)	0.0001
Elevated triglycerides	49.5 (45.8 – 53.1)	35.2 (31.7 – 38.7)	39.7 (36.1 – 43.2)	0.0001

Data are presented as percentages (95% CI). Chi-square test. Metabolic syndrome was defined as the presence of three of the following: abdominal obesity (waist circumference ≥ 94 cm in men and ≥ 90 cm in women), triglycerides ≥ 150 mg/dL, HDL-c < 40 mg/dL in men and < 50 mg/dL in women, blood pressure ≥ 130/85 mmHg or antihypertensive treatment, and elevated blood glucose ≥ 100 mg/dL or self-reported diabetes.

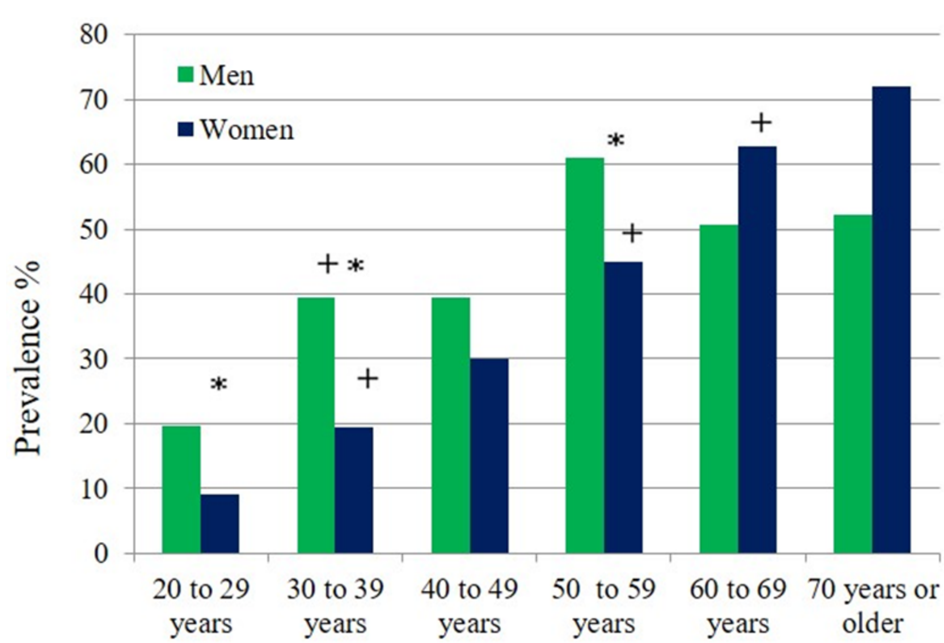

Figure 1 - Prevalence of metabolic syndrome (MS) by age and gender. (*) indicates a significant difference in MS prevalence between genders (p < 0.05; chi-square test). (+) indicates an increased MS prevalence in the indicated gender compared with the previous decade.

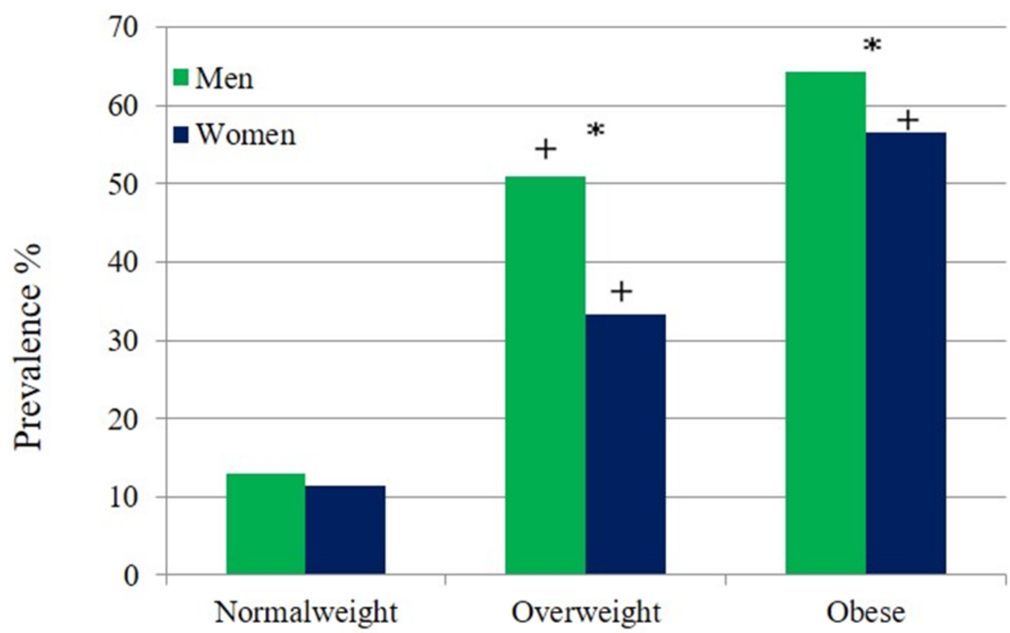

Figure 2 - Prevalence of metabolic syndrome (MS) by nutritional state and gender. (*) indicates a significant difference in MS prevalence between genders ($p < 0.05$; chi-square test). (+) indicates an increased MS prevalence in the indicated gender compared with the previous nutritional status.

Discussion

In this study, 35.7% of the subjects met the criteria for MS, while the most prevalent abnormalities were low HDL-c, abdominal obesity, and elevated triglycerides levels. These abnormalities increased with age and were more prevalent in men and subjects with overweight or obesity. These results are consistent with those of other studies conducted in Venezuela, which reported a prevalence of MS ranging from 27.4%, in 274 subjects from Mérida city[14] in the Andes region to 45.4% in 321 subjects in the Junquito municipality[15] in the Capital District. Using the NCEP/ATP-III definition, the prevalence of MS in this study was similar to that observed in the Florez et al. study (31.2%),[10] conducted in the Zulia region, but higher than that observed in the CARMELA study, conducted in Barquisimeto (25.8%).[12]

The prevalence observed in the present study is one of the highest reported in the American region. In a systematic review of MS in Latin American countries, the weighted prevalence of MS was 24.9% (range 18.8 – 43.3%).[16] A higher weighted mean for general MS prevalence has been reported in a Brazilian study (29.6%, range 14.9 – 65.3%).[17] The Central American Diabetes Initiative (CAMDI) study[18] included five major Central American populations and study data on 6,185 adults aged ≥ 20 years, with a survey response rate of 82.0%. This is higher than the data reported in the CARMELA study in Mexico City (27%).[12] The global prevalence of MS according to the NECP/ATP-III criteria was 30.3%, which is similar to the prevalence found in this study using the NECP/ATP-III definition. Compared with the population in the United States (US), the prevalence of MS in this report was similar to the one observed in Hispanics (35.4%) in the National Health and Nutrition Examination Survey (NHANES data 2003 – 2012); this population also showed an increasing prevalence of MS, from 34.3% in 2003 – 2004 to 38.6% in 2011 –2012.[19]

The higher prevalence of MS observed in this study using the most recent definition of MS can be explained, in part, by the different cutoff values applied. The NCEP/ATP-III definition[11] includes higher cutoff values for both elevated blood glucose (110 mg/dL) and abdominal obesity (using the cutoff values recommended for the US population). Therefore, the cutoff value to detect subjects with impaired fasting glucose was reduced to 100 mg/dL,[20] while the International Diabetes Federation[19] recommended the adaptation of the waist circumference cutoff values to ethnic and regional differences. Thus, for Latin American subjects, the values proposed are lower than those for men in the US, which increased the prevalence reported. This most recent definition, with more strict cutoff values as in the GLESMO study,[7] represents more appropriately the real public health problem related to the prevalence of MS in Venezuela.

The prevalence of metabolic abnormalities also varies among studies. Low HDL-c values and abdominal obesity were the most prevalent abnormalities in Latin America (62.9% and 45.8%, respectively),[16] in the Zulia study (65.3% and 42.9%, respectively),[10] and in a Brazilian study, which found similar results as those in the present study (58.6 and 52%, respectively). Low HDL-c has been established as the most frequent lipid abnormality in Venezuela, observed in 90% of 100 subjects in Valencia city,[21] in the central region, and in 81.1% in those in the Junquito municipality.[15] Similar to the observations in men in the present study (49.5%), the above studies (Valencia and Junquito) also reported a high prevalence of elevated triglycerides values (51%),[15,21] compared with those found in Latin America, of 62.5%,[16] and in the CAMDI, of 48.1%.[18] These findings support the need to monitor lipid profile in those subjects with other metabolic abnormalities (abdominal obesity, high blood glucose levels, or hypertension), and not only total cholesterol, as frequently occurs in some Latin American countries.

The elevated prevalence of cardiometabolic risk factors in Venezuelan adults could explain the higher burden related to these conditions. Cardiovascular disease and T2D, the most important complications related to MS and dyslipidemia, were the leading disability-adjusted life years (DALYs) risk factors and the leading causes of death, with 44,100 deaths (31% of global death) in 2012.[22] Cardiovascular disease is the first cause of death in Venezuela.[22] Nutritional transition has promoted adverse nutritional and lifestyle habits in Venezuela and other Latin American countries, clearly contributing to the incidence of noncommunicable diseases, especially related to obesity and T2D.[23] Besides, an elevated weighted prevalence of physical inactivity (68%) has been reported in Venezuela in two studies involving 3,422 adults.[23]

The present study has some limitations. The cohort did not represent the entire population of Venezuela, as only three of the eight regions of the country were included. Additionally, in the VEMSOLS, the eating pattern and the physical activity of the population were not investigated in all regions. Despite these limitations, this study is the first to report on MS in more than one region in Venezuela. A national survey in Venezuela is currently ongoing (Estudio Venezolano de Salud Cardiometabólica, EVESCAM study) and data collection was completed in 2017.

Conclusions

One-third of the subjects assessed in this study presented MS, characterized by abdominal obesity and atherogenic dyslipidemia. These data suggest the need to explore possible environmental factors increasing the cardiometabolic risk, especially those related to lifestyle. Considering that MS is associated with a high risk of mortality and increased health care costs, the cardiometabolic consequences of an inappropriate lifestyle can be monitored through the detection of MS. The high prevalence of MS makes mandatory the implementation of national policies for the prevention of this condition. In practical terms, we recommend promoting the detection of subjects at risk, using both BMI and waist circumference routinely measured in primary care practice, and identifying all MS components when one of them is present.

Author contributions

Conception and design of the research: Brajkovich I,. González–Rivas JP, Rísquez A, Nieto-Martínez R. Acquisition of data: Brajkovich I, González–Rivas JP, Rísquez A, Nieto-Martínez R. Analysis and interpretation of the data: Brajkovich I, González–Rivas JP, Ugel E, Nieto-Martínez R. Statistical analysis: González–Rivas JP, Ugel E. Writing of the manuscript: Brajkovich I. Critical revision of the manuscript for intellectual content: González–Rivas JP, Rísquez A, Nieto-Martínez R.

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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Ethics approval and consent to participate

This article does not contain any studies with human participants or animals performed by any of the authors.

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