Association between sociodemographic factors and metabolic syndrome in Mexican older adults

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Abstract

Objective. To estimate the prevalence of metabolic syndrome (MetS) and its association with sociodemographic factors in Mexican older adults (OA). **Materials and methods.** This study analyzes data from the Mexican National Health and Nutrition Survey 2016. We incorporated data from 804 participants aged 60 years or older. Information on sex, age, body mass index, scholar level, ethnicity, smoking status, geographic region, socioeconomic status, and alcohol consumption was analyzed. For MetS, the International Diabetes Federation harmonized definition was used. Multiple logistic regression models were used to assess the odds ratio (OR) and 95% confidence interval (95%CI) between sociodemographic factors and MetS. **Results.** The prevalence of MetS was 77.4% (95%CI 72.2,81.9), 71.2% for men, (95%CI 63.2,78.9) and 83.7% for women (95%CI 77.9,88.2). The OA presented higher odds of MetS when they lived with overweight, obesity, and those who had more years of education. **Conclusion.** The prevalence of MetS among Mexican OA is substantial. Moreover, individuals living with obesity exhibit a heightened odd of experiencing elevated Fasting Plasma Glucose and high blood pressure. This study provides a comprehensive perspective underscoring the imperative

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Resumen

Objetivo. Estimar la prevalencia del síndrome metabólico (SMet) y su asociación con factores sociodemográficos en adultos mayores (AM) mexicanos. **Material y métodos.** Se analizaron datos de la Encuesta Nacional de Salud y Nutrición 2016; se incluyó información de 804 participantes ≥60 años. Se analizó información sobre sexo, edad, índice de masa corporal, escolaridad, origen étnico, tabaquismo, región geográfica, nivel socioeconómico y consumo de alcohol. Para el SMet, se utilizó la definición armonizada de la Federación Internacional de Diabetes. Se utilizaron modelos de regresión logística múltiple para evaluar la razón de momios (RM) e intervalos de confianza de 95% (IC95%) entre los factores sociodemográficos y el SMet. **Resultados.** La prevalencia del SMet fue de 77.4% (71.8% en hombres y 83.7% en mujeres). Los AM presentaron mayores momios de MetS cuando viven con sobrepeso, con obesidad, y los que tienen más años de escolaridad. **Conclusión.** La prevalencia de SMet en AM mexicanos es alta. Las mujeres, los fumadores y quienes viven con sobrepeso u obesidad presentan un mayor riesgo de padecer este síndrome. Este estudio es una visión panorámica de la necesidad de políticas para reducir la obesidad y otras enfermedades crónicas en esta población.

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for policies aimed at mitigating obesity and addressing other chronic conditions within this population.

Keywords: metabolic syndrome; National Health and Nutrition Survey; older adults; sociodemographic factors; Mexico

Palabras clave: síndrome metabólico; Encuesta Nacional de Salud y Nutrición; adultos mayores; factores sociodemográficos; México

In older adults, metabolic syndrome (MetS) is an important public health problem.[1-3] In 2015, the Global Burden of Disease study estimated that 28.9% of the global burden was attributable to adults over 60 years, and non-communicable diseases (NCD) accounted for 86.8% of the burden of disease in this age-group.[4] Also, MetS increase the risk of all-cause mortality; a meta-analysis observed a 24% increased risk of cardiovascular disease (CVD) mortality and a 23% increased risk of all-cause mortality compared to older adults without MetS.[1] In 2016, in México, the majority of disability-adjusted lost years were caused by ischemic heart disease.[5] The prevalence of MetS is increasing worldwide, including in Mexico, as the aging of the population keeps moving forward.[1,6,7] MetS is a cluster of conditions[8] associated with geriatric syndromes, such as sarcopenia,[9,10] osteosarcopenic obesity,[11] frailty,[12] and cognitive decline.[13]

The increased prevalence of MetS in older adults had been associated with an unfunctional disability, decreased physical activity, an unbalanced diet,[14] and a low intake of fruits and vegetables.[15] In addition, previous studies in China, Brazil, and Colombia considered sociodemographic variables, including urban or rural areas, regions of residence, educational level, and socioeconomic status, as independent risk factors for MetS in this population.[16-18] Nevertheless, in Mexico, there is not previous literature of the prevalence of this syndrome and its association with sociodemographic factors in the in the population aged 60 years and older from a national representative sample.

Therefore, this study aimed to estimate the prevalence of metabolic syndrome and its association with sociodemographic factors in older Mexican adults.

Materials and methods

Study design and study population

This study examined data from the Mexican National Health and Nutrition Survey 2016 (Ensanut, by its acronym in Spanish). This national survey of the Mexican population was a cross-sectional, multistage, stratified, and clustered probabilistic sample with national, regional, and urban-rural representativity. Sample size calculation and more details about the survey design were described in previous reports.[19,20] For the present analysis, we included 804 older adults (≥60 years old) with a complete sociodemographic questionnaire, anthropometric measures, and a blood sample.

The *Instituto Nacional de Salud Pública* (INSP) Committees of Research, Ethics, and Biosafety approved the protocol of Ensanut 2016 with strict adherence to the principles set by the Declaration of Helsinki. For participants who agreed, their sign was recorded in the informed consent and assent forms.

Sociodemographic variables measurement

The sociodemographic and anthropometric variables were obtained by trained and standardized personnel. Variables such as: sex, age, BMI, scholar level, ethnicity (indigenous or not), smoking status, geographic region, socioeconomic status, and alcohol consumption were based on a self-reported survey.

An asset index was generated for the socioeconomic status indicator. This index was calculated with information on specific services and characteristics of the household, such as construction material, number of rooms, water disposal, car ownership, number of appliances, and number of electronic devices.[21] Then, we divided by tertiles as cut-off into low, medium, and high. The area of residence was classified as urban (≥2 500 residents) and rural (<2 500 residents). Ethnicity was defined if the participant speaks an indigenous language or considers himself indigenous. The smoking habit was categorized as "Current smoker" for those who had smoked >100 cigarettes lifetime and who currently smoke; "Former smoker" for those who have smoked ≤100 cigarettes lifetime and are currently non-smokers; and never smoker.

Clinical variables

For blood pressure (BP), trained personnel take two measurements with an automatic device (Omron HEM-907 XL); the patient was seated and had five minutes of rest before the first measurement, then 30 seconds difference between each measurement, the mean of those was used.[22] The blood sample was collected and preserved in cryotubes. Triglycerides (TG), total cholesterol, and

high-density lipoprotein cholesterol (HDL-c) concentrations were determined in a minimum of 250 microliters of serum.[23] The Abbot Architect CI8200 equipment was used with the enzymatic method of glycerol phosphate oxidase to determine TG; for cholesterol was used the enzymatic colorimetric method of quinonimine and for HDL-c was via peroxidase.[24] Fasting plasma glucose (FPG) was estimated by centrifuging venous blood samples at 3 000 g, *in situ*, for 20 min. The samples were quantified using a Beckman-Coulter autoanalyzer (Brea, CA), using the glucose oxidase technique and the reference material NIST965 to ensure its precision (variation between assays<3%).[25]

Weight was measured with a calibrated electronic TANITA scale (model BC-533), and participants were with minimal clothing and were barefoot. For the measure of height, a conventional stadiometer was used. Waist circumference was measured at the high point of the iliac crest at the end of normal expiration to the nearest 0.1 cm. Body mass index (BMI) was weight (kg) divided by the square of height in meters (m^2); for effects of this study, we use the classification of BMI proposed for older adults; underweight (<23 kg/m^2), normal weight (23-28 kg/m^2), overweight (28-31.9 kg/m^2) and obesity (≥32 kg/m^2).[26]

Metabolic syndrome definition

For the definition of MetS were used the consensus of the joint of International Diabetes Federation Task Force on Epidemiology and Prevention (IDF); National Heart, Lung, and Blood Institute (NHLBI); American Heart Association (AHA); World Heart Federation (WHF); International Atherosclerosis Society (IAS); and International Association for the Study of Obesity (IASO) with the presence of any three of five risk factors:[27] 1) Elevated waist circumference: ≥90 cm for women and ≥80 cm for men; 2) Elevated triglycerides: ≥150 mg/dL (1.7 mmol/L); 3) Reduced HDL-c: <40 mg/dL (1.0 mmol/L) for men and <50 mg/dL (1.3 mmol/L) for women; 4) Elevated blood pressure: Systolic ≥130 and/or diastolic ≥85mm Hg and; 5) Elevated FPG: ≥100mg/dL.

Statistical analysis

We conducted a comprehensive descriptive analysis of baseline characteristics. Significant differences between means (M±SD) for individuals with MetS versus those without MetS were determined using ANOVA. The prevalence (%) was calculated using the chi-square test (X2). Multiple logistic regressions were employed to evaluate the odds ratio (OR) and 95% confidence intervals (95%CI) for sociodemographic factors in relation to each MetS component and its overall prevalence.

For the prevalence of MetS and elevated waist circumference, multivariate logistic regression was adjusted for the following variables: sex, age, BMI, scholar level, ethnicity, smoking status, geographic region, socioeconomic status, and alcohol consumption. Conversely, in the case of elevated FPG, elevated triglycerides, reduced HDL-c, and elevated blood pressure, adjustments were made for sex, age, scholar level, ethnicity, smoking status, geographic region, socioeconomic status, and alcohol consumption.

P values <0.05 were considered statistically significant. All analyses were conducted while accounting for expansion factors and adjusting for design effects using Stata's SVY module, which incorporates the complex sampling structure of the survey. The analysis was performed using Stata 17.0.*

Results

Detailed characteristics of the study population are presented in tables I and II. The majority of the total population fell within the 60-69 age group (65.3%, 95%CI: 60.0,70.0). Women constituted 51.8% (95%CI: 42.0,54.4), and 78.2% (95%CI: 74.4,81.4) resided in urban areas, with 63.5% (95%CI: 57.3,69.3) having completed elementary school. In terms of socioeconomic status, 50.6% (95%CI: 43.8,57.4) of females and 45.0% (95%CI: 34.8,53.6) of males were classified as high-income earners. Regarding BMI, obesity was prevalent in 30.2% of women (95%CI: 22.9,38.7) and 19.8% of men (95%CI: 13.0,28.9). Additionally, 30.4% (95%CI: 23.2,38.6) of older women and 33.2% (95%CI: 24.8,42.8) of older men were living with overweight. The overall prevalence of chronic diseases such as diabetes and hypertension was 33.8% and 58.5%, respectively. Women exhibited higher mean levels of total cholesterol, triglycerides, and low-density lipoprotein cholesterol (LDL-c) compared to men.

The overall prevalence of MetS in the population was 77.4% (95%CI: 72.2,81.9), with 71.2% (95%CI: 63.2,78.9) for men and 83.7% (95%CI: 77.9,88.2) for women. Analyzing MetS criteria, 83.8% (95%CI: 78.9,87.7) had elevated waist circumference, with a higher prevalence in women at 91.8% (95%CI: 87.1,95.0). Elevated triglycerides were present in 55.3% (95%CI: 49.1,61.3), with a higher prevalence in women compared to men (62.1 vs. 50.7%). Reduced HDL-C was found in 73.7% (95%CI: 68.1,78.6), elevated FPG in 53.8% (95%CI: 47.5,60.0), and elevated blood pressure in 69.0% (95%CI: 62.7,74.6) of older adults (table III).

* StataCorp. Stata Stadistical Software 17.0. Collage Station, TX: StataCorp LLC, 2021.

Table I

Characteristics of the sociodemographic factors of older adults in the Mexican Ensanut 2016. Mexico

Characteristics	*N expanded (N= 12.2) (millions)*	*Total* (n= 793) % (95%CI)*	*Male‡ (n= 317) % (95%CI)*	*Female§ (n= 476) % (95%CI)*
Age (years)				
60-69	7.9	65.3 (60.0,70.0)	64.7 (56.3,72.4)	65.9 (58.1,73.0)
70-79	2.8	23.3 (19.3,27.9)	19.1 (14.3,25.2)	27.8 (21.3,35.3)
≥80	1.4	11.3 (8.0,16.0)	16.1 (10.0,24.9)	6.3 (4.2,9.4)
Area of residence				
Urban	9.4	78.2 (74.4,81.4)	81.3 (76.8,85.0)	74.8 (70.0,79.1)
Rural	2.6	21.8 (18.5,25.6)	18.1 (15.9,23.2)	25.2 (21.0,30.0)
Education level				
None	2.7	22.3 (18.1,27.2)	20.1 (14.7,28.2)	24.0 (18.6,30.4)
Elementary school	7.7	63.5 (57.3,69.3)	63.6 (53.5,72.7)	63.3 (55.7,70.3)
High school	0.7	5.7 (3.3,9.7)	4.2 (1.8,9.8)	7.2 (3.5,14.2)
Bachelor's degree or high	1.0	8.6 (4.5,15.6)	11.5 (5.3,23.2)	5.5 (2.3,12.5)
Indigenous (yes)	3.73	30.8 (25.3,36.9)	29.7 (22.3,38.3)	31.9 (25.7,38.9)
Socioeconomic status				
Low	2.6	21.7 (17.5,26.7)	21.3 (15.2,29.1)	22.2 (17.9,27.1)
Medium	3.8	31.1 (25.3,37.5)	34.7 (25.4,45.4)	27.2 (21.6,33.7)
High	5.7	47.2 (41.1,53.4)	44.0 (34.8,53.6)	50.6 (43.8,57.4)
Region				
North	3.3	26.9 (22.4,32.0)	24.9 (18.7,32.5)	29.0 (23.8,34.9)
Central	3.4	27.7 (23.3,32.6)	26.9 (20.4,34.4)	28.7 (23.6,34.4)
Mexico City	2.3	18.8 (13.8,25.1)	22.1 (14.5,32.2)	15.2 (11.5,20.0)
South	3.2	26.5 (22.6,30.9)	26.0 (21.0,31.8)	(27.0 (22.4,32.3)
Smoking				
Never smoker	5.4	56.2 (49.1,63.0)	30.1 (22.1,41.3)	82.4 (75.1,88.0)
Current smoker	3.3	34.2 (28.0,41.1)	55.7 (44.5,66.3)	12.0 (7.6,18.5)
Former smoker	0.9	9.6 (5.3,16.6)	13.4 (6.2,26.6)	5.6 (2.6,11.6)
Alcohol consumption (drinks/week)#,&				
<3.5	1.1	9.8 (6.3,15.0)	15.0 (8.9,24.3)	3.8 (1.8,7.9)
>3.5	3.8	33.8 (27.4,40.8)	30.8 (22.1,41.1)	37.2 (29.6,45.6)
Former drinker	6.3	56.4 (49.4,63.2)	54.2 (44.4,63.7)	59.0 (50.8,66.7)
Medication consumption				
None	0.4	5.9 (3.2,10.5)	7.0 (2.6,17.7)	5.3 (2.2,11.5)
1	1.4	21.1 (14.0,30.6)	12.3 (11.5,36.1)	20.9 (13.0,32.0)
2	1.6	24.6 (18.4,32.1)	25.6 (16.6,37.2)	23.9 (16.3,33.5)
3 or more	3.2	48.4 (40.7,56.3)	46.1 (33.4,59.3)	50.1 (39.5,60.7)

%: percent; N: number; CI95%: 95% confidence interval; Ensanut: *Encuesta Nacional de Salud y Nutrición*.
* Total sample size: n= 793 representing 12 117 078 older adults >60 years old.
‡ Sample size for men: n= 317 representing 6 227 783 older man >60 years old.
§ Sample size for women: n= 476 representing 5 831 067 older woman >60 years old.
# Among drinkers.
& Alcohol consumption for women was considered as <2.5 and >2.5 drinks per week.

In the sex-stratified analysis (table IV), men with MetS exhibited a high prevalence of obesity (92.6%), elevated FPG (90.6%), elevated triglycerides (50.8%), reduced HDL-C (78.9%), and elevated blood pressure (89.6%). Women with MetS showed prevalence rates of 45% for obesity, 91.9% for abdominal obesity, 62.1% for elevated triglycerides, 76.5% for low HDL-C, and 71.3% for high blood pressure. Multivariate logistic regression analysis results, detailed in table V, indicate that older adults with basic and medium scholar levels had OR of 2.51 (95%CI: 1.20,5.26) and 8.25 (95%CI: 1.49,45.6), respectively, compared to those with no scholar level. Those with a bachelor's degree or higher had an increased OR of 9.10 (95%CI: 2.43,33.72) for elevated triglycerides. Individuals living with obesity exhibited increased odds of presenting elevated FPG (OR= 1.69, 95%CI: 9.75,3.82) and elevated waist circumference (OR= 9.21, 95%CI: 3.60,23.5). Elevated triglycerides were more prevalent in individuals residing in the Central and South geographic regions compared to the North (OR=3.93, 95%CI: 1.72,8.96 and OR=3.68, 95%CI: 1.72,7.87). Concerning alcohol consumption, former drinkers had an OR= 1.40 (95%CI: 9.46,4.30) for reduced HDL-C compared with non-drinkers.

Discussion

The prevalence of MetS identified in Mexican older adults was 77.4% using data from Ensanut 2016, according to the definition proposed by consensus of IDF/NHLBI/AHA/WHF/IAS/IASO;[27] by gender, it was 71.2% for men and 83.7% for women. According to the sociodemographic factors, older adults with more school years had a higher risk of present MetS. This study did not find significant differences in geographic region, ethnicity, and socioeconomic status regarding the presence of MetS.

The prevalence of MetS in our population was higher than in previous studies with similar group age populations in other middle-income countries in

Table II
CHARACTERISTICS OF THE METABOLIC FACTORS OF OLDER ADULTS IN THE MEXICAN ENSANUT 2016. MEXICO

Characteristics	*N expanded (N= 12.1) (millions)*	*Total* (n= 793) (95%CI)*	*Male‡ (n= 317) (95%CI)*	*Female§ (n= 476) (95%CI)*
BMI (%, kg/m^2)				
Underweight	1.3	10.7 (7.9,14.4)	10.0 (6.3,16.6)	11.5 (7.4,17.5)
Normal weight	3.9	32.7 (27.4,38.3)	37.1 (29.7,45.1)	27.9 (20.7,36.4)
Overweight	3.7	31.8 (26.4,37.7)	33.2 (24.8,42.8)	30.4 (23.2,38.6)
Obesity	3	24.8 (19.9,30.4)	19.8 (13.0,28.9)	30.2 (22.9,38.7)
Waist circumference (mean, cm)	11.5	98.6 (97.0,100.3)	100.0 (97.5,102.6)	97.0 (95.1,98.9)
Type 2 diabetes (%, yes)	4.1	33.8 (28.4,39.8)	(30.4 (23.2,38.7)	37.5 (39.2,45.5)
FPG (mean, mg/dL)	12.1	116.1 (111.5,120.7)	114.3 (108.0,120.5)	118.0 (111.7,124.3)
HbA1c (%)	11.8	6.3 (6.15,6.5)	6.2 (6.0,6.37)	6.5 (6.2,6.7)
Hypertension (%, yes)	11.3	58.5 (52.2,64.5)	56.6 (47.8,65.1)	60.6 (52.3,68.2)
Systolic blood pressure (mean, mmHg)	11.3	136.9 (134.1,139.8)	137.2 (132.3,142.2)	136.6 (133.2,140.0)
Diastolic blood pressure (mean, mmHg)	11.3	74.5 (73.0,75.9)	74.6 (72.1,77.1)	74.3 (72.4,76.1)
Total cholesterol (mean, mg/dL)	12.1	192.8 (187.0,198.7)	184.0 (175.5,192.5)	202.3 (194.6,210.1)
Triglycerides (mean, mg/dL)	12.1	187.2 (174.9,199.5)	173.6 (156.9,190.3)	201.8 (184.2,219.5)
LDL-c (mean, mg/dL)	11.7	117.6 (113.3,121.9)	113.1 (107.0,119.3)	122.6 (116.5,128.8)
HDL-c (mean, mg/dL)	12.1	39.2 (38.1,40.3)	36.3 (34.9,37.7)	42.3 (40.9,43.9)

BMI: body mass index; FPG: fasting plasma glucose; HbA1c: glycated hemoglobin; LDL-c: low-density lipoprotein cholesterol; HDL-c: high-density lipoprotein cholesterol; CI95%: 95% confidence interval; Ensanut: *Encuesta Nacional de Salud y Nutrición*.
BMI for older adults: underweight (<23 kg/m^2), normal weight (23-28 kg/m^2), overweight (28-31.9 kg/m^2) and obesity (≥32 kg/m^2).
* Total sample size: n= 793 representing 12 058 850 older adults >60 years old.
‡ Sample size for men: n= 317 representing 6 227 783 older man >60 years old.
§ Sample size for women: n= 476 representing 5 831 067 older woman >60 years old.

Table III
Prevalence of MetS of older adults in the Mexican Ensanut 2016, following the harmonized definition. Mexico

Prevalence	N expanded (N= 11.3) (millions)	Total* (n= 734) % (95%CI)	Male‡ (n= 294) % (95%CI)	Female§ (n= 440) % (95%CI)
MetS#				
No	2.8	22.6 (18.1,27.8)	28.3 (21.1,36.8)	16.3 (11.8,22.1)
Yes	9.5	77.4 (72.2,81.9)	71.2 (63.2,78.9)	83.7 (77.9,88.2)
Elevated waist circumference&				
No	1.9	16.4 (12.3,21.1)	23.7 (16.9,32.1)	8.2 (5.0,12.9)
Yes	9.7	83.8 (78.9,87.7)	76.3 (67.9,83.1)	91.8 (87.1,95.0)
Elevated triglycerides≠				
No	5.4	44.7 (38.6,50.9)	51.0 (41.1,60.8)	37.9 (30.7,45.6)
Yes	6.7	55.3 (49.1,61.3)	49.0 (39.2,58.9)	62.1 (54.4,69.3)
Reduced HDL-c∞				
No	3.2	26.3 (21.4,31.9)	28.9 (21.1,38.3)	23.5 (17.4,30.9)
Yes	8.9	73.7 (68.1,78.6)	71.1 (61.7,78.9)	76.5 (69.1,82.6)
Elevated FPGº				
No	5.6	46.2 (40.0,52.5)	48.8 (40.2,57.4)	43.4 (35.1,52.0)
Yes	6.5	53.8 (47.5,60.0)	51.2 (42.6,59.8)	56.6 (48.0,64.9)
Elevated blood pressure◊				
No	3.6	31.0 (25.4,37.3)	32.9 (24.9,41.9)	29.0 (22.3,36.7)
Yes	8.0	69.0 (62.7,74.6)	67.1 (58.1,75.1)	71.0 (63.3,77.7)

FPG: fasting plasma glucose; LDL-c: low-density lipoprotein cholesterol; HDL-c: high-density lipoprotein cholesterol; 95%CI: confidence interval; Ensanut: *Encuesta Nacional de Salud y Nutrición*; MetS: metabolic syndrome
* Total sample size: n= 734 representing 11 263 993 older adults >60 years old.
‡ Sample size for men: n= 294 representing 5 893 432 older man >60 years old.
§ Sample size for women: n= 440 representing 5 370 561 older woman >60 years old.
# Metabolic syndrome was defined as the presence of any three of five risk factors: elevated waist circumference, elevated triglycerides, reduced HDL-c, elevated fasting glucose or elevated blood pressure.
& Elevated waist circumference: ≥90 cm for women and ≥80 cm for men.
≠ Elevated triglycerides: ≥150 mg/dL (1.7 mmol/L).
∞ Reduced HDL-c: <40 mg/dL (1.0 mmol/L) for men and <50 mg/dL (1.3 mmol/L) for women.
º Elevated fasting glucose: ≥100mg/dL.
◊ Elevated blood pressure: systolic ≥130 and/or diastolic ≥85mm Hg

Latin-American, results from Survey on Health, Well-Being, and Aging 2015 (SABE, by its Spanish acronym) in Colombia identified a prevalence of 54.9%.[17] Also, in the United States, with information from the National Health and Nutrition Examination Survey 2011-2016, a prevalence of 57.3% of MetS in Hispanic older adults was identified.

In Mexico, previous studies reported the prevalence of MetS in older adults, 73% in the *Encuesta Nacional de Salud y Nutrición del Derechohabiente 2007* (Ensader 2007),[6] in Northwest Mexico in were identified a wide range from 36% to 52% using diverse definitions,[28] and another study in the North of Mexico identified a prevalence in ≥65 years old of 61% in 2011/2012 health survey.[7] But they are not comparable to our analysis because of the differences in inclusion and the diagnosis of MetS criteria, differentiated mainly by the cut points in the waist circumference depending on the geographical location or ethnicity.[28]

Concerning the sociodemographic factors, two times higher risk was identified in women, six times higher risk for older adults living with overweight, 13 times older adults living with obesity, and three times higher risk for smokers. Although MetS is a worldwide public health problem in older adults, sociodemographic risk factors remain controversial. Our study agrees with Barranco-Ruiz and colleagues, in the SABE study that suggests a higher risk for women, obesity, and smokers.[17] A previous study of non-diabetic older adults in the northwest region of Mexico also presents

Table IV

ANTHROPOMETRIC AND BIOCHEMICAL PARAMETERS OF THE OLDER ADULTS WITH AND WITHOUT METS IN THE MEXICAN ENSANUT 2016. MEXICO

Variable	*Men*				*Women*			
	N expanded (N= 5.8)*	*Without MetS (n= 104) (95%CI)*	*With MetS (n= 190) (95%CI)*	*P-value‡*	*N expanded§ (N= 5.4)*	*Without MetS (n= 76) (95%CI)*	*With MetS (n= 364) (95%CI)*	*P-value‡*
Age (years, %)				0.091				0.091
60-69	4.0	25.4 (16,6,36.9)	74.6 (63.1,83.4)		3.8	15.8 (10.2,23.8)	84.2 (76.2,89.9)	
70-79	1.2	26.4 (15.7,40.8)	73.6 (59.2,84.3)		1.6	19.8 (11.5,31.8)	80.2 (68.2,88.5)	
≥80	1.0	43.3 (22.0,67.5)	56.7 (32.5,78.0)		0.4	8.6 (3.5,19.8)	91.4 (80.3,96.5)	
BMI (kg/m^2), %				<0.001				0.001
Underweight	0.7	84.1 (66.7,93.4)	15.9 (6.6,33.3)		0.7	44.8 (24.3,67.3)	55.2 (32.7,75.7)	
Normal weight	2.7	46.5 (33.9,59.5)	53.5 (40.5,66.1)		1.7	13.3 (7.1,23.4)	86.7 (76.6,92.9)	
Overweight	2.2	5.3 (2.3,11.8)	94.6 (88.2,97.7)		2.0	12.8 (6.7,23.1)	87.2 (76.9,93.3)	
Obesity	1.3	7.4 (1.8,26.1)	92.6 (73.9,98.2)		1.9	9.0 (4.2,18.5)	91.0 (81.5,95.8)	
Waist circumference (cm, mean)	4.5	89.7 (87.8,91.6)	103.9 (101.1,106.7)	<0.001	4.9	89.8 (84.4,95.3)	98.7 (96.9,100.4)	<0.001
Elevated waist circumference (yes, %)#	5.1	16.2 (10.5,24.3)	83.8 (75.7,89.6)	<0.001	5.5	11.5 (8.0,16.3)	88.5 (83.7,92.0)	0.003
Glucose levels (mg/dL, mean)	4.5	94.2 (90.3,98.1)	122.7 (115.3,130.1)	<0.001	4.9	98.9 (87.1,110.1)	122.0 (115.3,128.7)	0.001
Elevated FPG (yes, %)&	3.5	9.4 (5.6,15.4)	90.6 (84.6,94.4)	<0.001	3.6	4.3 (2.0,91.2)	95.7 (91.2,98.0)	<0.001
Total cholesterol (mg/mL, mean)	4.5	185.5 (176.8,194.2)	187.3 (176.2,198.4)	0.795	4.9	201.0 (187.4,214.5)	205.4 (196.7,214.2)	0.580
TG (mg/dL, mean)	4.5	126.8 (101.0,152.6)	199.6 (178.4,220.1)	<0.001	4.9	118.0 (105.2,130.7)	222.2 (200.6,243.9)	<0.001
Elevated triglycerides (%, yes)≠	3.5	9.0 (3.4,21.8)	91.0 (78.2,96.6)	<0.001	4.0	15.5 (11.2,21.0)	84.6 (79.0,88.8)	<0.001
HDL-c (mg/dL, mean)	4.5	43.3 (40.1,46.6)	34.6 (32.9,36.4)	<0.001	4.9	53.1 (48.1,58.0)	40.4 (39.0,41.8)	<0.001
Reduced HDL-c (%, yes)∞	4.7	21.1 (13.3,31.8)	78.9 (68.2,86.7)	0.002	4.9	6.7 (3.8,11.5)	93.3 (88.5,96.2)	<0.001
LDL-c (mg/dL, mean)	4.4	117.0 (109.9,124.1)	113.0 (104.5,121.5)	0.475	4.6	124.1 (113.6,134.6)	124.5 (117.4,131.5)	0.955
Elevated blood pressure (yes, %)º	4.3	13.1 (7.5,21.9)	86.9 (78.1,92.5)	<0.001	4.0	6.6 (3.8,11.4)	93.4 (88.6,96.2)	<0.001
SBP (mmHg, mean)	4.5	121.8 (115.9,127.8)	142.0 (136.3,147.8)	<0.001	4.8	123.9 (118.0,129.8)	137.9 (134.1,141.7)	<0.001
DBP (mmHg, mean)	4.5	67.6 (65.8,69.4)	77.4 (74.7,80.0)	<0.001	4.8	70.4 (67.3,73.6)	75.3 (73.5,77.1)	0.004

BMI: body mass index; TG: triglycerides, HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol, Chol: total cholesterol, SPB: systolic blood pressure, DBP: diastolic blood pressure; 95%CI: 95% confidence interval; Ensanut: *Encuesta Nacional de Salud y Nutrición*; MetS: metabolic syndrome

* Sample size for men: n= 294 representing 5 893 432 older man >60 years old.

‡ Significant differences (with MetS vs. without MetS) between means (M±SD) were obtained by ANOVA, and prevalence (%) was obtained by chi^2.

§ Sample size for women: n= 440 representing 5 370 561 older woman >60 years old.

Elevated waist circumference: ≥90 cm for women and ≥80 cm for men.

& Elevated triglycerides: ≥150 mg/dL (1.7 mmol/L).

≠ Reduced HDL-c: <40 mg/dL (1.0 mmol/L) for men and <50 mg/dL (1.3 mmol/L) for women.

∞ Elevated fasting glucose: ≥100mg/dL.

º Elevated blood pressure: Systolic ≥130 and/or diastolic ≥85mm Hg.

Note: The presence of any three of five risk factors: elevated waist circumference, elevated triglycerides, reduced HDL-c, elevated fasting glucose or elevated blood pressure.

Table V

MetS prevalence and its components according to sociodemographic and lifestyle variables of the older adults in the Mexican Ensanut 2016. Mexico

Variable	*MetS prevalence* OR (95%CI)*	*Elevated FPG‡ OR (95%CI)*	*Elevated triglycerides‡ OR (95%CI)*	*Reduced HDL-c‡ OR (95%CI)*	*Elevated waist circumference* OR (95%CI)*	*Elevated blood pressure‡ OR (95%CI)*
Sex						
Male	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
Female	1.64 (0.89,3.04)	1.92 (0.99,3.75)	1.42 (0.76,2.65)	1.58 (0.76,3.27)	2.38 (0.94,6.03)	1.24 (0.57,2.72)
Age (years)						
60-69	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
70-79	1.24 (0.63,2.42)	0.97 (0.55,1.69)	0.75 (0.40,1.41)	0.85 (0.43,1.70)	0.82 (0.37,1.81)	1.94 (0.90,4.17)
≥80	0.50 (0.17,1.51)	0.24 (0.09,0.65)	0.37 (0.10,1.40)	1.19 (0.30,4.77)	0.26 (0.09,0.76)	0.77 (0.20,2.89)
BMI						
Normal weight	--	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
Overweight	--	1.30 (0.64,2.64)	1.50 (0.73,3.08)	1.42 (0.70,2.88)	--	2.01 (0.89,4.53)
Obesity	--	1.69 (9.75,3.82)	0.82 (0.41,1.65)	1.57 (0.62,4.00)	--	9.21 (3.60,23.5)
Scholar level						
None	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
Basic	2.51 (1.20,5.26)	0.84 (0.44,1.62)	1.39 (0.77,2.52)	0.95 (0.44,2.02)	1.29 (0.62,2.68)	0.70 (0.33,1.49)
Medium school	8.25 (1.49,45.6)	0.70 (0.17,2.98)	1.40 (0.32,6.15)	0.91 (0.22,3.87)	--	0.53 (0.10,2.87)
Bachelor's degree or more	2.34 (0.58,9.50)	0.42 (0.13,1.32)	9.10 (2.43,33.72)	1.66 (0.40,6.92)	0.58 (0.13,2.53)	0.61 (1.62,1.28)
Ethnicity						
Indigenous (no)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
Indigenous (yes)	0.82 (0.46,1.47)	1.68 (0.89,3.17)	1.43 (0.77,2.67)	0.93 (0.47,1.81)	0.70 (0.34,1.43)	0.99 (0.51,1.92)
Smoking						
Never smoker	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
Smokers	2.92 (1.58,5.37)	1.14 (0.52,2.50)	2.10 (1.17,3.76)	1.09 (0.28,1.88)	3.33 (1.33,8.33)	1.41 (0.80,2.48)
Former smoker	3.41 (1.39,8.35)	1.51 (0.86,2.65)	2.37 (1.20,4.70)	1.11 (0.52,1.73)	4.18 (2.12,8.24)	1.31 (0.27,6.37)
Geographic region						
North	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
Central	0.67 (0.32,1.43)	0.49 (0.22,1.08)	3.93 (1.72,8.96)	0.82 (0.40,1.64)	0.50 (0.19,1.29)	0.65 (0.24,1.72)
Mexico City	1.79 (0.71,4.53)	0.60 (0.22,0.65)	2.55 (0.88,7.35)	0.52 (0.21,1.25)	3.02 (0.66,13.90)	1.44 (0.47,0.43)
South	1.12 (0.52,2.37)	0.49 (9.24,1.03)	3.68 (1.72,7.87)	0.88 (0.51,1.49)	0.94 (0.41,2.15)	1.46 (0.66,3.23)
Socioeconomic status						
Low	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
Medium	1.05 (0.47,2.35)	1.32 (0.60,2.90)	0.93 (0.41,2.09)	1.21 (0.56,2.60)	1.23 (0.53,2.86)	0.90 (0.37,2.19)
High	0.92 (0.40,2.11)	2.11 (0.97,4.59)	0.70 (0.34,1.43)	1.04 (0.47,2.30)	1.50 (0.60,3.70)	0.83 (0.34,1.98)
Alcohol consumption						
<3.5 d/w	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
>3.5 d/w	0.91 (0.30,2.75)	1.88 (0.51,6.93)	0.47 (0.16,1.35)	1.52 (0.44,5.24)	0.72 (0.22,2.33)	0.15 (0.05,0.48)
Former d/w	1.83 (0.44,7.60)	1.77 (0.61,5.10)	0.89 (0.33,2.42)	1.40 (9.46,4.30)	1.46 (0.48,4.46)	0.18 (0.58,0.56)

BMI: body mass index; HDL-C: high-density lipoprotein cholesterol; 95%CI: 95% confidence interval; d/w: drinks per week; OR: odds ratio; ; MetS: metabolic syndrome; Ensanut: *Encuesta Nacional de Salud y Nutrición*

* For MetS prevalence and Elevated waist circumference, multivariate logistic regression was adjusted for: sex, age, BMI, scholar level, ethnicity, smoking status, geographic region, socioeconomic status, and alcohol consumption.

‡ For elevated FPG; elevated triglycerides, reduced HDL-c, and elevated blood pressure, multivariate logistic regression was adjusted for: sex, age, scholar level, ethnicity, smoking status, geographic region, socioeconomic status, and alcohol consumption.

Note: Multiple logistic regressions were used to assess the association between sociodemographic factors (dependent variables) and each component and the prevalence of MetS (independent variable).

a significant association between MetS and sociodemographic characteristics like schooling or education level.[28] This national sample differed from that study because socioeconomic factors do not show a higher risk. While schooling, in a previous study in Brazil, the prevalence of MetS was higher in those with less education level,[18] but our study in Mexico identified higher risk in those with a bachelor's degree or more.

The increased risk of metabolic syndrome due to aging is challenging in this population. Insulin resistance in old age, chronic metabolic inflammation, changes in body composition proper of aging (increasing body fat, decreasing muscle mass), and cellular aging may play an essential role in the increased prevalence of MetS in this age-group.[2,3] In women, estrogen deficiency during menopause contributes to increased abdominal obesity, triglycerides, and reduced HDL-c; that is a possible explanation for the increased risk of MetS.[29] Nevertheless, some modifiable factors, such as a diet rich in fruits and vegetables and physical activity, have been associated with this syndrome and can improve some components to reduce the risk.[14,15,30] Also, modified risk habits such as smoking in this population can improve the fight to reduce the prevalence of this problem in Mexican OA.[31]

Our study presents some strengths; the large sample size, the population-based sampling, and the national coverage of the survey make certain that this report is representative of the Mexican older adult population. However, our findings should be interpreted in light of certain limitations. Firstly, the cross-sectional nature of the data restricts our ability to establish causality, emphasizing that this study can only illuminate associations between variables. Secondly, the potential for residual confounding exists due to unmeasured or imperfectly measured covariates, such as smoking, where considerations like intensity, duration, recent smoking (amount currently consumed), and life course smoking patterns were not fully captured. Thirdly, relying on self-reported questionnaires for age, smoking, education, and ethnicity introduces the possibility of measurement error stemming from self-reported bias. In fourth place, it is crucial to acknowledge the limited representativeness of the sample in capturing the entire spectrum of Mexican older adults, impacting the precision of our calculations. This consideration is crucial when interpreting the results. Lastly, because the study includes participants ≥60 years of age, we cannot rule out survival bias, therefore our findings may only be applicable to OA.

Conclusion

The prevalence of MetS is notably high among Mexican OA. Additionally, individuals living with obesity face an elevated risk of experiencing elevated FPG and high blood pressure. This study is essential to present the actual scenario of MetS and sociodemographic factors for OA in Mexico. With this panoramic view of the situation, it is necessary to promote more programs and policies to reduce obesity and overweight in this population. Additionally, reducing the prevalence of MetS can help to reduce other significant cardiovascular diseases.

Author contributions

A-GR, conceptualization, writing, editing, and review; BIA-G, resources, data curation, and review; SB, IC-N, PM-A, MAO-R, BIA-G and BLS-T, analysis, writing, editing and review; ED-G, conceptualization, methodology, editing and review. All authors reviewed and approved the final version.

Data statement

The databases of Ensanut 2016 are available to the public, as a matter of transparency, at: https://ensanut.insp.mx/

Declaration of conflict of interests. The authors declare that they have no conflict of interests.

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