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Original Article

The prevalence of metabolic syndrome among older adults in Ecuador: Results of the SABE survey

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Aims

To describe the prevalence of metabolic syndrome among older adults in Ecuador. A secondary objective was to examine the relationship between metabolic syndrome and its components and insulin resistance among non-diabetic participants.

Materials and methods

The National Survey of Health, Wellbeing, and Aging survey was used to examine the prevalence of metabolic syndrome according to demographic, behavioral, and health characteristics of the participants. Logistic regression models adjusted for covariates were used to examine the independent association of metabolic syndrome and its components and insulin resistance in non-diabetic older adults.

Results

Of 2298 participants with a mean age of 71.6 (SD 8.1) years, the prevalence of metabolic syndrome was 66.0% (95% CI, 62.6%, 69.3%) in women and 47.1% (95% CI, 43.2%, 50.9) in men. However, even higher prevalence rates were seen among literate individuals, residents from urban areas of the coastal and Andes Mountains region, obese subjects, those diagnosed with diabetes, and participants with ≥2 comorbidities. Overall, abdominal obesity followed by elevated blood pressure were the metabolic syndrome components more prevalent and associated with insulin resistance among older Ecuadorians. Moreover, after adjustment for covariates, older adults defined as having metabolic syndrome had a 3-fold higher odds of having insulin resistance as compared with those without.

Conclusions

The prevalence of metabolic syndrome is high among older adults in Ecuador. The present findings may assist public health authorities to implement programs of lifestyle and behavioral modification targeting older adults at increased risk for this cardio metabolic disorder.

1. Introduction

The Metabolic syndrome (MetS) is a cluster of cardio metabolic risk factors characterized by elevated blood pressure, abdominal obesity, dyslipidemia, and elevated fasting glucose [1]. In general, subjects with MetS are at increased risk of cardiovascular disease, type 2 diabetes mellitus, and mortality [2]. Although the pathogenesis of MetS and each of its components is complex, abdominal obesity and insulin resistance are considered to be the main characteristics of this syndrome. Certainly, studies have shown that abdominal obesity is associated with higher risk of type 2 diabetes, hypertension, dyslipidemia, and MetS [3,4].

While studies have described the prevalence of MetS in Ecuador, their study populations were limited to university students, postmenopausal women, and middle-aged subjects from a large urban city and rural community of the coastal region [5–8]. Sempertegui et al. previously reported that the prevalence of MetS among older adults from low-income neighborhoods of northwestern Quito was 40% and 33% according to the International Diabetes Federation (IDF) and the National Cholesterol Education Program Adult Treatment Panel III definitions (NCEP ATP III), respectively. Notably, up to 81% of older women were defined as having MetS [9]. More recently, Del Brutto et al. demonstrated that MetS defined according to the 2009 Joint Scientific Statement criteria was prevalent in 57% of adults aged 60 years and older from Atahualpa, a rural community in the coastal region of Ecuador [10].

In Ecuador, life expectancy has gradually increased over the past decades. For instance, Ecuadorians were expected to live 64.6 years in 1980–1985 and will reach 78.3 years by 2025–2030 [11]. These demographic changes along with an increased prevalence of MetS with aging may place Ecuadorians at increased risk for this cardio metabolic disorder [12]. Despite this evidence, there is limited epi-

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demiological data regarding the prevalence of MetS among older adults in Ecuador. Therefore, the present study aimed to describe the national prevalence of MetS among older adults aged 60 years and older. A secondary objective was to examine the relationship between MetS and its components and insulin resistance among non-diabetic subjects.

2. Methods

The present study was based on data from participants in the National Survey of Health, Wellbeing, and Aging (Encuesta National de Salud, Bienestar, y Envejecimiento). This survey is a probability sample of households with a least one person aged 60 years or older residing in the Andes Mountains and coastal regions of Ecuador. In the primary sampling stage, a total of 317 sectors from rural areas (<2000 inhabitants) and 547 sectors from urban areas of the country were selected from the 2001 population Census cartography. In the secondary sampling stage, 18 households within each sector were randomly selected based on the assumption that at least one person aged 60 years or older live in 24% and 23% of the households along the coast and Andes Mountains region, respectively. Between April and August 2010, participants underwent biochemical evaluation to determine their metabolic risk factors. Participants' laboratory data were processed at NetLab laboratory (Quito, Ecuador). Survey data and methodology, including operation manuals are publicly available [13]. Characteristics of participants

Age and sex were self-reported. The race of participants was classified according to the following question: "Do you consider yourself to be White, Black, Mestizo, Mulatto, or Indigenous?" Body height in centimeters and weight in kilograms were measured and the body mass index was calculated (kg/m^2). Subjects also reported their region (coast vs. Andes Mountains) and area of residence (urban vs. rural). Literacy was defined by answering affirmatively to the question "Can you write and read a message?" Smoking status was classified as current, former, and never. The average use of alcohol per week during the previous three months was classified as none, one day, or two or more days per week. Vigorous physical activity was evaluated by the question, "Have you exercised such as jogging, dance, or performed rigorous physical activity for the past year". Participants describes on average the number of days per week of vigorous physical activity and self-reported health was grouped as excellent to good and fair to poor. Subjects were defined as having diabetes if they had been previously diagnosed by a physician with this condition or a fasting plasma glucose was ≥126 mg/dl [14]. Moreover, the following physician-diagnosed chronic conditions were self-reported: cancer, chronic obstructive pulmonary disease (COPD), heart disease, and arthritis. Subsequently, these comorbidities were grouped into 3 categories (0, 1, > 2).

2.1. Definition of MetS

The present analysis used the 2009 harmonized Joint Scientific Statement to define MetS. Older adults were diagnosed with MetS if they met ≥3 of the following risk factors: (1) waist circumference ≥90 cm in men and ≥80 cm in women; (2) systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg; (3) HDL cholesterol ≤40 mg/dl for men, ≤50 mg/dl for women; (4) triglycerides ≥150 mg/dl; (5) fasting glucose ≥100 mg/dl. The waist circumference cutoffs in this analysis were those recommended by the IDF to define abdominal obesity in Central and South American populations [1].

2.2. Insulin resistance

The homeostasis model for insulin resistance (HOMA-IR), a validated method for evaluating insulin resistance was used in the present analysis [15]. The HOMA-IR score was calculated with the formula: fasting serum insulin (μU/ml) x fasting plasma glucose (mmol/l)/22.5, as described by Matthews et al. [16]. Although there is no general consensus to define insulin resistance based on this model, participants in the highest HOMA-IR quartile score were considered to have insulin resistance as previously reported [17].

2.3. Statistical analysis

The characteristics of participants were compared using *t*-test and chi-squared test for continuous and categorical variables, respectively. The crude prevalence of MetS was reported according to selected demographic, behavioral, and health characteristics. Subsequently, the prevalence of MetS and its components was age-adjusted to the Ecuadorian 2010 population. Likewise, the prevalence of insulin resistance among non-diabetic older adults with MetS and its components was examined by gender. Among non-diabetic subjects, gender-specific logistic regression models adjusted for age, race, residency, BMI, literacy, smoking status, alcohol use, physical activity, self-reported health, and number of comorbities were used to evaluate the relationship between the MetS components and insulin resistance. For this analysis, non-diabetic participants in the 75th HOMA-IR percentile score, corresponding to an HOMA-IR ≥ 2.4 for men and ≥3.5 for women were defined as having insulin resistance [17]. In general, older adults with diabetes (n = 401) were more likely to be women, blacks, literate, obese, residents of the urban coast, and reported their health to be fair to poor and greater number of comorbidities. Likewise, a significant higher proportion of diabetics had hypertension, hypertriglyceridemia, abdominal obesity, and low HDL cholesterol. All analyses used sample weights to account for nonresponse and the unequal probability of selection of the SABE survey and thus provide estimates representative of the older adult population in Ecuador. Statistical analyses were performed using SPSS, version 17 software (SPSS Inc., Chicago, IL).

3. Results

A total of 2298 subjects with a mean age of 71.6 (SD 8.1) years comprised the sample size, representing an estimated 1.1 million older adults in Ecuador. As shown in Table 1, the age, race, and residency of participants were similarly distributed by gender. However, men reported more frequently to be literate, smoke, drink alcohol, and participate in physical activities. On the contrary, a higher proportion of women described their health to be fair to poor and had greater number of comorbidities. Overall, there were no significant gender differences in the mean systolic and diastolic blood pressure and waist circumference. However, laboratory data demonstrated that women had higher triglycerides, HDL cholesterol, fasting glucose, and insulin concentrations.

In Ecuador, the prevalence of MetS was 66.0% (95% CI, 62.6%, 69.3%) in women and 47.1% (95% CI, 43.2%, 50.9) in men. As shown in Table 2, the prevalence of MetS differed according to certain demographic, behavioral, and health characteristics of participants. Indeed, even higher MetS prevalence rates were seen among literate subjects, residents from urban areas of the coastal and Andes Mountains region, and subjects with obesity, diabetes, and ≥2 comorbidities. Of interest, current smokers and participants who reported

Table 1
Characteristics of participants in the SABE survey.

	Men	Women	*P* value
	(n = 1041)	(n = 1257)	
Age, (years)	71.6 (0.3)	71.5 (0.2)	0.899
Race,%			0.937
Indigenous	9.9 (1.3)	11.0 (1.4)	
Blacks	3.6 (0.6)	3.5 (0.7)	
Mestizo	71.1 (1.8)	69.6 (1.8)	
Mulatto	3.7 (0.6)	3.3 (0.7)	
White	11.7 (1.4)	12.6 (1.2)	
Area of residency,%			0.188
Urban Andes Mountains	28.8 (1.8)	30.9 (1.7)	
Urban coast	35.4 (1.9)	37.0 (1.7)	
Rural Andes Mountains	20.3 (1.5)	20.5 (1.5)	
Rural coast	15.5 (1.4)	11.6 (1.2)	
BMI (kg/m^2)	25.4 (9.2)	27.9 (12.1)	<0.0001
Literacy,%	77.4 (1.6)	63.1 (1.8)	<0.0001
Smoking,%			<0.0001
Current	20.3 (1.7)	3.4 (0.7)	
Former	49.3 (2.0)	12.5 (1.2)	
Never	30.4 (1.8)	84.2 (1.3)	
Alcohol use,%			<0.0001
None	63.3 (1.9)	89.0 (1.2)	
1 day	31.2 (1.9)	10.4 (1.2)	
≥2 days	5.4 (1.0)	0.6 (0.3)	
Weekly physical activity,%			<0.0001
None	53.7 (2.0)	77.3 (1.5)	
1–4 days	19.3 (1.5)	12.9 (1.2)	
5–7 days	27.0 (1.9)	9.8 (1.0)	
Self-reported health,%			<0.0001
Good to excellent	30.4 (1.8)	20.4 (1.4)	
Fair to poor	69.6 (1.8)	79.6 (1.4)	
Diabetes,%	12.9 (1.2)	19.7 (1.4)	<0.0001
Number of comorbidties*,%			<0.0001
0	58.5 (1.9)	37.3 (1.7)	
1	31.5 (1.8)	40.1 (1.8)	
≥2	10.0 (1.1)	22.5 (1.6)	
Waist circumference (cm)	92.8 (0.3)	93.4 (0.5)	0.354
Systolic blood pressure (mmHg)	134.8 (0.7)	137.9 (0.7)	0.006
Diastolic blood pressure (mmHg)	76.7 (0.4)	76.0 (0.4)	0.267
HDL cholesterol (mg/dl)	45.9 (0.6)	49.8 (0.5)	<0.0001
Triglycerides (mg/dl)	157.7 (3.6)	169.5 (3.6)	<0.005
Glucose (mg/dl)	104.5 (1.4)	112.8 (1.5)	<0.0001
Insulin (uU/ml)	9.8 (0.3)	14.0 (1.3)	<0.005

*COPD, arthritis, cancer, and heart disease.
Parenthesis represent standard errors of the estimates.

Table 2
Prevalence of metabolic syndrome among older adults in Ecuador.

	Men	Women
	(n = 1041)	(n = 1257)
Age groups, (years),%		
60–69	49.9 (44.4, 55.5)	68.0 (63.1, 72.6)*
70–79	44.4 (38.0, 51.1)	68.7 (63.0, 73.9)
≥80	44.3 (35.6, 53.4)	56.0 (47.6, 64.1)
Race, %		
Indigenous	31.2 (20.2, 44.7)	49.4 (36.5, 62.5)*
Blacks	43.9 (27.2, 62.1)	47.2 (29.2, 65.9)
Mestizo	48.0 (43.3, 52.6)	70.0 (66.1, 73.7)
Mulatto	51.5 (34.8, 67.9)	81.3 (62.2, 92.0)
White	54.1 (42.0, 65.8)	61.4 (51.7, 70.2)
Area of residency, %		
Urban Andes Mountains	53.6 (46.2, 60.8)*	73.4 (67.5, 78.5)*
Urban coast	53.1 (46.3, 59.8)	70.5 (65.4, 75.1)
Rural Andes Mountains	33.7 (26.8, 41.4)	49.1 (41.1, 57.2)
Rural coast	38.6 (29.9, 48.1)	62.0 (51.1, 71.8)
BMI (kg/m^2), %		
Underweight	10.1 (2.8, 30.5)*	13.7 (4.2, 36.2)*
Normal	25.8 (21.0, 31.3)	46.5 (40.2, 52.8)
Overweight	67.9 (61.8, 73.5)	75.6 (70.9, 79.8)
Obese	80.7 (71.1, 87.7)	82.8 (77.3, 87.2)
Literacy,%		
Yes	50.4 (45.9, 54.8)*	68.8 (64.9, 72.5)*
No	35.7 (28.7, 43.4)	61.3 (54.8, 67.4)
Smoking status, %		
Current	38.7 (30.8, 47.4)	56.2 (35.8, 74.7)
Former	49.3 (43.7, 54.8)	70.8 (61.2, 78.8)
Never	49.1 (42.6, 55.7)	65.8 (62.1, 69.4)
Alcohol use,%		
None	47.8 (43.1, 52.5)	65.9 (62.2, 69.4)
1 day	48.7 (41.5, 55.8)	69.5 (58.5, 78.6)
≥2 days	29.4 (17.2, 45.6)	30.9 (8.6, 68.0)
Weekly physical activity, %		
None	48.5 (43.5, 53.6)	66.3 (62.3, 70.0)
1–4 days	51.3 (43.1, 59.5)	63.9 (54.0, 72.8)
5–7 days	40.7 (33.3, 48.6)	65.5 (54.4, 75.1)
Self-reported health, %		
Good to excellent	53.1 (46.5, 59.6)*	62.8 (55.2, 69.9)
Fair to poor	44.4 (39.8, 49.1)	66.7 (62.8, 70.4)
Diabetes, %		
Yes	79.0 (70.3, 85.7)*	87.3 (81.4, 91.5)*
No	42.2 (38.2, 46.4)	60.9 (56.9, 64.7)
Number of comorbidities, %		
0	41.6 (36.8, 46.6)*	61.6 (56.2, 66.7)*
1	51.6 (44.6, 58.5)	65.0 (59.4, 70.1)
≥2	64.6 (53.6, 74.3)	75.3 (67.0, 82.1)

* P value < 0.05.

drinking alcohol regularly had lower MetS prevalence rates as compared with those without. Similarly, the prevalence of MetS was lower among men who reported being physically active. As shown in Fig. 1, after adjustment for age, abdominal obesity followed by hypertension were the most frequent MetS components in both genders. Moreover, women consistently had a higher prevalence of MetS components as compared with men. For instance, 87.0% of women had ≥2 MetS components as compared with 67.3% in men.

Table 3 shows the prevalence of insulin resistance among non-diabetic older adults according to MetS components. Overall, abdominal obesity followed by elevated blood pressure were the MetS components with higher prevalence of insulin resistance. For instance, 98.5% of women and 88.8% of men with abdominal obesity were defined as having insulin resistance. Moreover, after adjustment for potential confounders, older women with hyperglycemia and abdominal obesity were 4.0 and 3.7 times more likely to have insulin resistance as compared with their counterparts without, respectively. Older men with abdominal obesity and hypertriglyceridemia also had a 3-fold higher rate of insulin resistance than those without. In general, non-diabetics older adults with MetS had a 3-fold higher odds of having insulin resistance in Ecuador.

4. Discussion

The present results indicate a high prevalence of MetS among adults aged 60 years and older in Ecuador, representing an estimated 667,000 (60%) older Ecuadorians. Moreover, the prevalence of MetS was even higher among older women, residents from the urban areas of the Andes Mountains and coastal region of the country, obese subjects, and those with diabetes and greater number of comorbidities. The prevalence of MetS among older adults nationwide was similar to that recently reported among adults aged 60 years and older from Atahualpa, a rural coastal community in Ecuador [10]. In contrast with our findings, Sampertegui et al. reported a lower prevalence of MetS ranging between 40% and 33% among older adults from low income neighborhoods in Quito, according to the IDF and the NCEP ATPIII definitions, respectively [9]. Likewise, Duarte et al. described

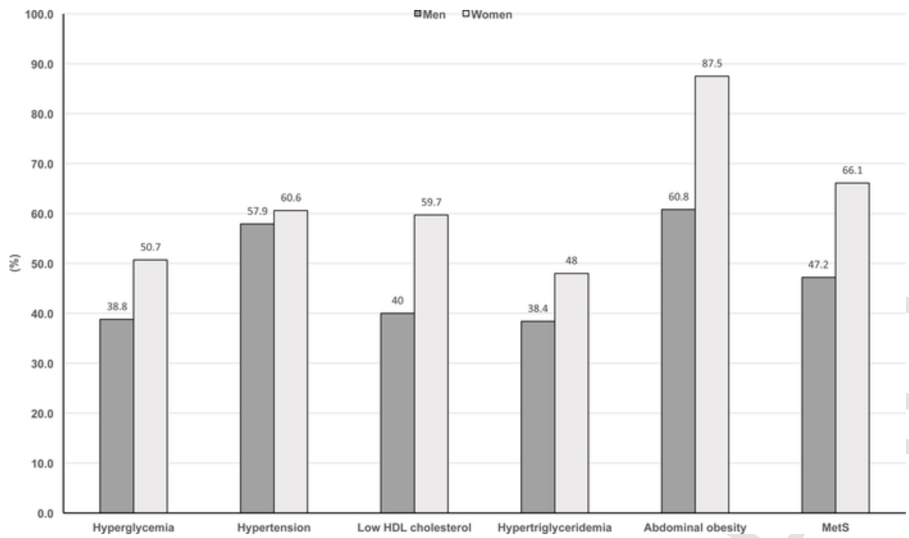

Fig. 1. Age-adjusted prevalence of MetS components among older adults in Ecuador.

Table 3
Association between MetS components and insulin resistance among non-diabetic older adults in Ecuador.

MetS components	Insulin resistance (%)	OR (95% CI)[a]	OR (95% CI)[b]
Women[c]			
Abdominal obesity	98.5 (94.7, 99.6)	14.2 (13.6, 14.9)	3.77 (3.57, 3.98)
Hypertension	72.9 (65.5, 79.2)	2.28 (2.25, 2.32)	1.79 (1.76, 1.82)
Hyperglycemia	70.8 (62.8, 77.7)	5.63 (5.55, 5.70)	4.07 (4.00, 413)
Low HDL cholesterol	72.3 (64.6, 78.8)	2.38 (2.35, 2.42)	2.37 (2.33, 2.41)
Hypertriglyceridemia	62.1 (54.2, 69.4)	2.47 (2.43, 2.50)	2.12 (2.09, 2.15)
MetS	86.3 (79.2, 91.2)	5.77 (5.67, 5.87)	3.77 (3.70, 3.85)
Men[d]			
Abdominal obesity	88.8 (82.0, 93.2)	9.15 (8.97, 9.33)	3.29 (3.21, 3.37)
Hypertension	62.1 (54.0, 69.6)	1.32 (1.30, 1.34)	1.12 (1.10, 1.14)
Hyperglycemia	55.3 (47.0, 63.3)	3.89 (3.83, 3.94)	2.48 (2.44, 2.52)
Low HDL cholesterol	54.8 (46.5, 62.9)	2.67 (2.64, 2.71)	1.53 (1.50, 1.55)
Hypertriglyceridemia	60.4 (52.2, 68.1)	4.22 (4.16, 4.28)	3.24 (3.19, 3.30)
MetS	75.1 (66.7, 81.9)	6.72 (6.62, 6.82)	3.42 (3.36, 3.48)

[a] Adjusted for age.

[b] Adjusted for age, race, residency, BMI, literacy, smoking status, alcohol use, physical activity, self-reported health, and number of comorbidities.

[c] HOMA-IR ≥ 3.5.

[d] HOMA-IR ≥ 2.4

that 64% of women aged 55 to 65 years from Guayaquil, Ecuador were defined as having MetS, which is consistent with the present findings [7]. Possible discrepancies in the reported prevalence of MetS in Ecuador may be related to variations in the criteria used to define MetS and socio-demographic characteristics of the study participants. Interestingly, using similar criteria, the prevalence of MetS in older women in Ecuador was higher than that recently reported among women in the age-groups 60–69 (57.6%) and ≥70 (63.5%) years and older in the U.S. [12]. In Mexico, the prevalence of MetS among subjects aged 60 year and older was 67.9% according to the IDF criteria definition, which is comparable to that found among older women in Ecuador [18].

Overall, abdominal obesity was the most prevalent MetS component among older adults in Ecuador. In fact, up to 87.5% of women and 60.8% of men were defined as having abdominal obesity. Similarly, previous studies conducted in the country have reported that abdominal obesity was the most frequent MetS component, with a frequency ranging between 61% and 75% [7,9,10]. In general, the present findings suggest that the prevalence of abdominal obesity in older Ecuadorian women was comparable with that described among African American and Mexican American women in the U.S. [12].

Of relevance, the mean waist circumference among older Ecuadorians was 92.8 cm for men and 93.4 cm for women, which was greater than that reported in South and East Asia populations (86.4 and 89.3 cm, respectively, for men and 80.2, and 84.1 cm respectively for women) [19]. In fact, a previous study conducted to evaluate the prevalence of abdominal obesity in Latin American and the Caribbean demonstrated that the age-adjusted prevalence of abdominal obesity was 70% for men and 76% for women according to the waist circumference cutoffs recommended for Latin American populations (≥90/80 cm in men/women) [19]. However, the authors concluded that a waist circumference cutoff of 80 cm may overestimate the visceral adiposity found particularly among Latin America women [1,19]. More recently, Aschner et al. in a multicenter study of five Latin American countries demonstrated that the cutoff points for waist circumference associated with visceral adipose tissue were 94 cm for men and between 90 and 92 cm for women [20]. Likewise, a study from 12 gynecological centers in major Latin American cities concluded that a waist circumference cutoff of 88 cm was optimal for defining MetS in postmenopausal women [21]. Therefore, a lower cutoff of waist circumference predominantly among women should be considered in future studies to define abdominal obesity in Latin America. While abdominal obesity is a highly prevalent component of MetS, the mechanisms by which abdominal obesity is causally related to the MetS have not been fully elucidated. Ross et al. previously demonstrated that among obese men, visceral adipose tissue was significantly associated with insulin resistance even after controlling for subcutaneous adipose tissue, non-abdominal adipose tissue, and cardiovascular fitness [22]. Moreover, it appears that the association of visceral fat and insulin resistance in the liver may be mediated through the release of fatty acids from visceral fatty tissue into the portal circulation [23].

Notably, after adjustment for potential confounders, abdominal obesity in non-diabetic older men and women was independently associated with a 3.2 and 3.7-fold higher odds of having insulin resistance, respectively. Likewise, women with elevated fasting glucose and men with hypertriglyceridemia were 4 and 3 times more likely to have insulin resistance than their counterparts without, respectively. Consistent with the present findings, Chedraui et al. recently reported higher HOMA-IR scores among postmenopausal women with abdominal obesity and higher glucose levels in Guayaquil, Ecuador [24]. In that particular study, the prevalence of insulin resistance among postmenopausal women with MetS was 31.2% and 56.2% as defined by a HOMA-IR >3.80 and ≥ 2.60, respectively, which was significantly lower than that seen among older women in the present study [24]. Possible explanations for the increased prevalence of insulin resistance among non-diabetic older women with MetS may be related to an older age distribution, and different criteria used to define insulin resistance and MetS. While the HOMA-IR is a validated method to define insulin resistance in epidemiologic studies, there is significant variability in the threshold of this model to define insulin resistance. Indeed, a previous study demonstrated that HOMA-IR values differ according to age, gender, ethnicity, diabetic status, and cutoff selection criteria [25].

Of interest, up to 79% of men and 87% of women with diabetes met the criteria diagnosis for MetS in Ecuador. Likewise, a recent study conducted across primary care practices in Spain reported that the MetS defined according to the IDF criteria was prevalent in 84.9% of men and 95.5% of women with type 2 diabetes [26]. Previously, a population-based study also demonstrated that MetS defined according to the WHO criteria was present in 84% of men and 81% of women aged 60 to 69 years with diabetes [27]. Moreover, results of a national survey indicate that the prevalence of MetS among Mexicans with diabetes ranged between 83.6% and 87.5%, which is in agreement with the present study results [18]. Thus, independently of the criteria diagnostic used to define the MetS, these cardio metabolic risk factors are highly prevalent among subjects with diabetes. Likewise, previous studies have demonstrated that the prevalence of MetS among subjects with diabetes significantly increased the risk of cardiovascular events [28,29].

Several limitations should be mentioned in interpreting the study results. First, participants self-reported their demographic, behavioral, and health characteristics, which may be a source of recall bias. Second, because of the cross-sectional study design, the relationship between the MetS components and insulin resistance does not necessarily infer causation. Third, the SABE survey does not evaluate participant's dietary intake, which has been previously documented to be of poor quality among older adults evaluated for MetS in Quito, Ecuador [9]. Despite these limitations, the present findings may be generalized to older adults residing in the coastal and Andes Mountains regions of the country, which represents 97% of the population aged 60 years or older in Ecuador [30].

In conclusion, MetS is highly prevalent among older adults in Ecuador. The present findings may assist public health authorities to implement programs of lifestyle and behavioral modification targeting older adults at increased risk for this cardio metabolic disorder.

Conflict of interest

The authors have no conflict of interest

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