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METABOLIC SYNDROME IN POST-MENOPAUSAL WOMEN FROM AN OTOMI ETHNIC GROUP: PREVALENCE OBTAINED THROUGH THREE CRITERIA

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Abstract: *Objective:* To determine the prevalence of metabolic syndrome (MS) in post-menopausal Otomi women from Tlaxcala, México. *Design:* Cross sectional study. *Setting:* Non-institutionalized active women living in Ixtenco, Tlaxcala. *Participants:* 139 women aged 43-93. *Measurements:* MS was determined according to the National Cholesterol Education Program Adult Treatment Panel III (ATP III), the American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement (AHA/NHLBI), and the International Diabetes Foundation (IDF) criteria. Fisher's exact tests and logistic regression analyses were done to examine associations of MS and other metabolic illness with the variables of interest. *Results:* According to ATP III, AHA/NHLBI, and IDF criteria, 58.3%, 73.4%, and 70.5% of participants were identified with MS, respectively. Means of weight, body mass index (IBM), waist circumference (WC), fasting glucose, serum insulin, systolic pressure, and serum triglycerides were significantly high in women with MS, independently of the diagnostic criterion. Logistic regression analyses showed that the risk to have type 2 diabetes (DM) of participants with MS was big using the AHA/NHLBI criterion. Younger had a bigger risk to present DM, insulin resistance, overweight-obesity, and MS using the IDF criterion than older women. Neither the presence of MS nor other metabolic variables were affected by stature of participants. *Conclusion:* Prevalence of MS in Otomi post-menopausal women was high independently of the diagnostic criterion, although it was low in the oldest women at same time that obesity decreased. Efforts are needed to ensure if genetic and environmental conditions are implicated in this high prevalence.

Key words: Metabolic syndrome, post-menopausal women, Otomi ethnic group, elderly.

Introduction

Metabolic syndrome (MS) is a set of biochemical and physiological alterations occurring in the same individual that increases the likelihood of developing cardiovascular disease and type 2 diabetes (DM), which are the main causes of disease and death worldwide. MS includes insulin resistance, hyperinsulinemia, hyperglycemia, obesity, hypertriglyceridemia, and low level of high density lipoprotein (HDL-C), and is related with more than one cause including lifestyle behavior (obesity, diet and physical activity) and genetic predisposition (1, 2).

The most used diagnostic criteria for MS are those proposed by the World Health Organization (WHO) in 1999, the National Cholesterol Education Program-Adult Treatment Panel III (ATP III) in 2001, the International Diabetes Federation (IDF) in 2005, and the American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement (AHA/NHLBI) in 2005. The last two are based on the proposal done by the ATP III in 2001 (Table 1) (1-3).

In México, the prevalence of MS has been duplicated in the past years. The last report given by the National Health and Nutrition Survey (ENSANUT) 2006 showed a prevalence of 38.6%, 41.6%, and 49.8% using ATP III, AHA/NHLBI, and IDF criteria, respectively, being women more affected than men, older more than younger (especially after 40 years old), and people with lower educational level more than higher (4, 5). The aim of our study was to determine the prevalence of MS in women from an Otomi community of Tlaxcala, México, using three definitions validated by ATP III, AHA/NHLBI, and IDF. This study was only focused to post-menopausal women due to many components of MS are more frequent in women with this hormonal

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Table 1
Common criteria proposed for clinical diagnosis of metabolic syndrome in women

Components	ATPIII	AHA/NHLBI	IDF
	Requires at least three of the following components:	Requires at least three of the following components:	Obesity and at least two of the following components:
Obesity	• waist circumference greater than 88 cm;	• waist circumference greater than or equal to 88 cm;	• waist circumference greater than or equal to 80 cm;
Hyperglycemia	• fasting glucose greater than or equal to 1.10 g/L (include diabetes);	• fasting glucose greater than or equal to 1.00 g/L or previous diagnostic of diabetes;	• fasting glucose greater than or equal to 1.00 g/L or previous diagnostic of diabetes;
Triglycerides	• greater than or equal to 1.50 g/L;	• greater than or equal to 1.50 g/L or a specific treatment for reducing triglycerides;	• greater than or equal than 1.50 g/L to a specific treatment for lipid abnormalities;
HDL-C*	• lower than 0.50 g/L;	• less than 0.50 g/L or a specific treatment for reducing HDL-C;	• lower than 0.50 g/L or a specific treatment for lipid abnormalities;
Arterial tension	• systolic pressure greater than or equal to 130 mmHg or diastolic pressure greater than or equal to 85 mmHg.	• systolic pressure greater than or equal to 130 mmHg or diastolic pressure greater than or equal to 85 mmHg or antihypertensive treatment	• systolic pressure greater than or equal to 130 mmHg or diastolic pressure greater than or equal to 85 mmHg or antihypertensive treatment.

* HDL-C, high density lipoprotein.

condition (4-9).

In México, Otomies live in the states of Hidalgo, Michoacán, Querétaro, Estado de México, Puebla, Veracruz, and Tlaxcala (10). In Tlaxcala, Otomies formed a group since 1532, localized in the community of Ixtenco. Their ancestors lived in the Estado de México and Hidalgo. Although Otomies farm its own food, and retain their traditional lifestyle, Otoman language is not spoken and a high grade of acculturation is observed. Mortality is related with infectious illness such as pneumonia, cirrhosis, vascular and metabolic diseases, like DM and hypertension (11).

Methods

Subjects

This was a cross-sectional study in volunteer subjects. Post-menopausal women were recruited through personal invitations by the health institution from Ixtenco. Post-menopause was defined as the lack of the menstrual period occurring naturally (12). All participants were active, they could skillfully walk, and most of them were farmer. Women with chronic liver disease or chronic renal disease, cancer or active neoplasm and with thyroid medication or estrogen replacement were excluded. The study was done in accordance with the Helsinki Declaration of Human Studies, and was approved by ethical committee of the Health Office of México, and the Universidad Autónoma de Tlaxcala, México. Thus, 154 subjects included in this study provided a written inform consent, and anthropometric and clinical measurements were done by specialized personnel.

Anthropometry

Body mass index (BMI) was calculated as weight (kg) divided by square of height (m^2) and was used as an index of overall adiposity. Overweight was considered with a BMI 25–29.9 kg/m^2 and obesity was defined as BMI $\geq$ 30 kg/m^2. Due to elderly subjects commonly are shorter and slimmer than their younger counterparts, the height was estimated by the half arm span (13, 14). Short stature was defined as a height $\leq$ 1.50 m for women (15). The obesity determination, using the waist circumference (WC), was done according to each MS criteria.

Metabolic syndrome determination

MS was diagnosed using three definitions (ATP III, AHA/NHLBI, and IDF; see table 1). For this, blood samples were obtained in conditions of 12 h fasting. Serum glucose and triglycerides were measured using standard enzymatic methods (ELITech, France); and HDL-C was measured by a precipitating method (ELITech, France). DM was determined to women with fasting glucose level $\geq$126 mg/dL or when they had been previously diagnosed. Blood pressure monitor (Heine) and stethoscope (Heine Optotechnik) were used to measure systolic and diastolic pressures. Hypertension was diagnosed when the systolic pressure was $\geq$ 140 mmHg; the diastolic pressure was $\geq$ 90 mmHg or when women had a current use of antihypertensive medication. Additionally, serum insulin and estradiol levels were measured by chemiluminescence. Insulin resistance was estimated using the Homeostasis Model Assessment (HOMA-IR) [fasting insulin (μU/mL) x fasting serum glucose (g/dL)/405], using a cutoff of $\geq$ 2.5.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences software version 17. According it was necessary; data are expressed as mean ± standard deviation (SD), prevalence, or odds ratio (OR) and 95% confidence intervals. U Mann Whitney or t Student tests were used to compare the mean values of variables between women with and without MS, whereas Fischer tests were used to compare prevalence. For detecting the range of age or stature more affected by metabolic illness, logistic regressions were done. Statistical significance was considered with $p \leq 0.05$.

Results

From 154 women enrolled, 139 (90%) were only included in the analyses. The sample included women with a range of age of 43-93 years and a mean of 66 ± 11 years, a range of size from 1.32 to 1.63 m, with an average of 1.50 ± 0.07 m, and 60 ± 12 kg of body weight. According to BMI, 41% of women were overweight, and 19% were obese. Prevalence of hypertension was 40%, diabetes was 36%, HOMA-IR was 55%, and short stature was 54%. The mean of estradiol was 11.1 ± 3.7 pg/mL. According to ATP III, AHA/NHLBI, and IDF definitions, 58.3%, 73.4%, and 70.5% of participants were identified with MS, respectively. However, the ATP III definition detected a high percentage of women with three components (Figure 1).

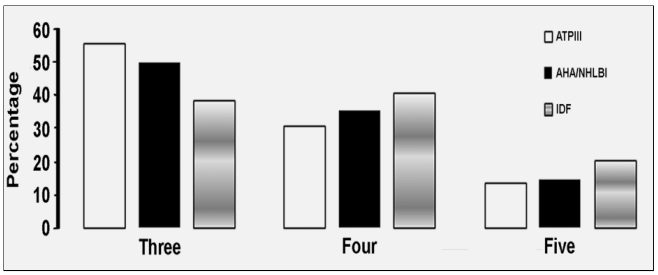

Figure 1. Prevalence of number of components in women with metabolic syndrome according to each diagnostic criterion

Means of weight, BMI, WC, fasting glucose, serum insulin levels, systolic pressure, and triglycerides were significantly higher in women having MS, independently of the diagnostic criterion. But, the diastolic pressure and the HDL-C level were significantly high in women with MS using the ATPIII criterion, followed by AHA/NHLBI and IDF criteria. Prevalence of DM, hypertension, hypertryglyceridemia, obesity (using WC), and HOMA-IR were significantly high in women having MS, independently of the diagnostic criterion. However, participants having MS showed a big prevalence of overweight and obesity, using IDF or ATPIII criteria, respectively; and a high prevalence of low level of HDL-C, using AHA/NHLBI and IDF criteria (Table 2). Although, the prevalence of DM was high in women having MS, the risk to have this illness was big using the AHA/NHLBI criterion (OR 9.7, 95% CI 2.7-33.5; $p<0.0001$), followed by the ATPIII (OR 5.6, 95% CI 2.4-12.8; $p<0.0001$), and the IDF (OR 4.7, 95% CI 1.8-12.3; $p<0.0001$).

Simple regression analysis showed a negative relation between age and BMI ($\beta=-0.41$; $p<0.0001$), WC ($\beta=-0.36$; $p<0.0001$), serum insulin level ($\beta=-0.28$; $p<0.0001$), and HOMA-IR ($\beta=-0.23$; $p<0.0001$). Logistic regression analyses using quartiles calculation for age denoted that younger women had a bigger risk to present DM, insulin resistance, overweight-obesity, and MS (IDF) than older. The oldest women (>67 years) had a major risk to have hypertension (Table 3). Due to simple regression analysis showed that short stature was presented in the oldest women ($\beta=-0.31$; $p<0.0001$). Logistic regression analyses between age and metabolic illness were done adjusting the height and differences before mentioned were maintained (Table 3). Also simple regression analysis showed that tall women had big values of WC ($\beta=0.36$; $p<0.0001$), and diastolic pressure ($\beta=0.21$; $p<0.01$). When participants were grouped in short (≤1.50 m) or high (≥1.51 m) stature, tall women showed a major risk to have overweight-obesity and MS, using the IDF definition; this risk disappeared when age was including in the model (Table 4).

Discussion

Prevalence of DM, obesity and hypertension in Mazatecos, Pimas, Mexicaneros, Huicholes, Tepehuanos, and Otomies (from Querétaro) are lower than that described by the ENSANUT 2006 (16-22). But Yaquis and Mayas have shown a high prevalence of overweight, obesity, DM, and dyslipidemia (21, 23). Now, Otomi women from Tlaxcala, older than 43 years, showed a lower prevalence of obesity and hypertension, but a higher prevalence of overweight, DM, and MS than that reported nationwide (5, 24-28). It may be explained by changes in the dietetic pattern and acculturation that induce to Otomíes from Ixtenco to adopt diets with high intake of saturated fat (nutrition transition), and a current lifestyle with less physical activity. It has been reported that women might be most susceptible to the acculturation process lacking the physical activity and expressing more metabolic illness than men (29). In addition, a low socio-economic status, a low level of education, the lack of public or private pension, and the inadequate health insurance that have most of elderly people in México, most dramatic in indigenous communities, could be strongly related with components of MS (30, 31).

Both AHA/NHLBI and IDF definitions shared a high

Table 2

Clinical and metabolic characteristics of women without and with metabolic syndrome according to each diagnostic criterion

	ATPIII				AHA/NHLBI				IDF			
	Without MS (n=58)		With MS (n=81)		Without MS (n=37)		With MS (n=102)		Without MS (n=41)		With MS (n=98)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	67.7	11.3	65.3	10.5	65.2	11.7	66.7	10.5	68.4	12.0	65.4	10.2
Weight (kg)	55.9	11.6	62.8[c]	10.7	56.6	13.1	61.1[a]	10.8	53.4	13.2	62.6[c]	9.6
BMI (kg/m2)	25.1	4.4	27.5 [c]	4.2	25.3	5.1	27.0 [a]	4.2	24.3	5.2	27.5[c]	3.8
WC (cm)	85.4	12.2	95.4[c]	10.2	85.4	13.3	93.4[c]	11.0	82.2	13.9	95.0[c]	9.0
Fasting glucose (mg/dL)	100.3	19.9	136.7[c]	52.4	95.7	17.4	130.9[c]	49.1	101.9	23.9	129.8[c]	50.0
Insulin (mg/dL)	9.2	5.6	12.2[a]	6.9	9.2	5.4	11.6[a]	6.9	9.0	6.4	11.8[c]	6.5
SBP (mmHg)	119.8	17.3	130.9[c]	17.1	117.6	17.4	129.5[c]	17.3	119.8	16.8	129.1[b]	17.9
DBP (mmHg)	72.0	9.4	76.1[a]	9.4	73.5	9.2	74.8	9.8	73.4	9.1	74.9	9.8
Triglycerides (mg/dL)	132.5	5.0	188.7[c]	98.0	132.0	54.5	177.3[c]	92.1	138.5	54.3	176.4[b]	94.1
HDL-C (mg/dL)	46.2	16.1	43.4	17.3	50.2	18.2	42.5[b]	15.9	48.9	18.5	42.8[b]	15.8
Prevalence	%		%		%		%		%		%	
Overweight (BMI)	41		41		35		41		24		51 [b]	
Obesity (BMI)	9		27[b]		13		22		10		23	
Obesity (WC)*	34		79 [c]		39		72 [c]		39		100 [c]	
Hypertension†	26		51 [b]		16		49 [c]		19		49 [b]	
Type 2 diabetes ‡	15		51 [c]		8		46 [c]		15		45 [c]	
Insulin resistance§	29		74 [c]		27		65 [c]		29		66 [c]	
Hypertrygliceridemia ‖	24		70 [c]		19		63 [c]		32		59 [b]	
Low HDL-C	70		81		57		84[b]		58		85 [b]	

BMI, Body mass index; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL-C, HDL cholesterol; MS, metabolic syndrome.; *According to every definition; † Systolic pressure ≥140 mmHg, diastolic pressure ≥90 mmHg, and/or when women had a current use of antihypertensive medication; ‡ Fasting glucose values ≥126 mg/dL, or when women had been previously diagnosed; §HOMA IR ≥2.5; ‖ Serum triglycerides ≥150 mg/dL or 1.7 mmol/l; ¶ HDL-C <50 mg/dL or 1.7 mmol/l; Significance of the difference between women without and with metabolic syndrome (t-Student, U-Mann Whitney or Fischer's tests according the case): [a]p<0.05; [b]p<0.001, and [c]p<0.0001.

Table 3

Results of logistic regression analyses among age and various anthropometric and clinical parameters. Prevalence and odds ratio (95% CI) are shown. Model 1 without height adjusted and model 2 with height adjusted. The second model only was applied when a significantly risk was found in the first model

								Metabolic syndrome		
	n	Estradiol levels (pg/mL)	Short Height*	Type 2 diabetes†	Insulin resistance‡	Overweight/ Obesity §	Hypertension ‖	ATPIII	AHA/ NHLBI	IDF
43-57 years	36	11.9 ± 4.7	42%	22%	72%	83%	28%	66%	66%	69%
Unadjusted			REF	1.1 (0.3-3.9)	4.7 (1.6-13.3)[c]	12.2 (3.7-39.3)[c]	REF	1.6 (0.6-4.4)	REF	2.4 (0.8-6.5)[d]
Height adjusted			----------	1.4 (0.4-4.9)	5.1 (1.7-15.3)[c]	10.7 (3.2-35.5)[c]	REF	----------	----------	1.9 (0.6-4.9)
58-66 years	38	11.4 ± 1 4.9	35%	50%	71%	74%	38%	65%	76%	82%
Unadjusted			0.7 (0.2-2.0)	4.4 (1.4-13.6)[a]	4.3 (1.5-12.3)[c]	6.7 (2.2-20.1)[c]	1.6 (0.5-4.3)	1.5 (0.5-4.0)	1.6 (0.5-4.6)	4.9 (1.6-15.3)[c]
Height adjusted			----------	5.2 (1.5-17.3)[a]	4.8 (1.6-14.4)[c]	5.8 (1.8-17.9)[c]	1.5 (0.5-4.3)	----------	----------	3.9 (1.2-12.7)[a]
67-74 years	34	10.4 ± 2.3	58%	50%	42%	53%	50%	47%	76%	79%
Unadjusted			1.9 (0.7-4.8)	4.1 (1.3-12.4)[a]	1.3 (0.4-3.5)	2.7 (0.9-7.4)[a]	2.6 (0.9-6.8)[a]	0.7 (0.2-1.9)	1.6 (0.5-4.4)	4.0 (1.3-11.4)[a]
Height adjusted			----------	4.8 (1.5-15.4)[a]	1.4 (0.5-3.8)	2.4 (0.8-6.8)[d]	2.7 (1.0-7.4)[a]	----------	----------	3.4 (1.1-10.1 [a]
75-93 years	31	10.5 ± 1.4	80%	19%	35%	29%	45%	55%	74%	48%
Unadjusted			5.8 (1.9-17.7)[c]	REF	REF	REF	2.1 (0.7-5.9)	REF	1.4 (0.4-4.1)	REF
Height adjusted			----------	REF	REF	REF	2.6 (0.8-7.7)[d]	----------	----------	REF

*≤ 1.50 m; † Fasting glucose values ≥126 mg/dL, or when women had been previously diagnosed; ‡ HOMA IR ≥ 2.5; § BMI ≥ 25 kg/m^2; ‖ Systolic pressure ≥ 140 mmHg, diastolic pressure ≥ 90 mmHg, and/or when women had a current use of antihypertensive medication.

Table 4

Results of logistic regression analyses among height and various anthropometric and clinical parameters. Prevalence and odds ratio (95% CI) are shown. Model 1 without age adjusted and model 2 with age adjusted. The second model only was applied when a significantly risk was found in the first model

						Metabolic Syndrome		
	n	Type 2 diabetes‡	Insulin resistance§	Overweight Obesity ‖	Hypertension¶	ATPIII	AHA/NHLBI	IDF
Short stature*	74	35%	51%	52%	42%	53%	73%	63%
Unadjusted		REF	REF	REF	1.1 (0.5-2.2)	REF	REF	REF
Age adjusted		_____	_____	REF	_____	_____	_____	REF
High stature †	65	37%	60%	70%	38%	65%	74%	78%
Unadjusted		1.0 (0.5-2.1)	1.0 (0.7-2.7)	2.2 (1.1-4.6) [a]	REF	1.6 (0.8-3.2)	1.0 (0.4-2.2)	2.0 (0.9-4.4) [a]
Age adjusted		_____	_____	1.4 (0.6-3.0)	_____	_____	_____	1.8 (0.8-4.1)

*≤ 1.50 m; † ≥ 1.51 m; ‡Fasting glucose values ≥126 mg/dL, or when women had been previously diagnosed; §HOMA IR ≥ 2.5; ‖BMI ≥ 25 kg/m^2; ¶Systolic pressure ≥ 140 mmHg, diastolic pressure ≥ 90 mmHg, and/or when women had a current use of antihypertensive medication; Significance of OR compared with the respective reference (REF) according to each model: [a] p<0.05.

prevalence of MS, and differentiated all components between without and with MS women; but the risk factor for having DM in women was big using the AHA/NHLBI criterion. Moreover, due to the IDF definition has to the obesity as the principal component, and this decreases in the oldest women, the AHA/NHLBI might be the best diagnostic criteria for detecting MS, at least in this old Otomí population. In this regard, it has been shown that IDF and AHA/NHLBI criteria, but the ATP III, are associated with a high carotid intima-media thickness in women (32, 33). The correlation of MS and cardiovascular diseases depends on the genetic, gender, environment conditions, and economic status of each population (2, 31).

We also found that the prevalence of MS, using ATPIII and AHA/NHLBI criteria, did not change by age, but the oldest women showed a big prevalence using the IDF criterion. This may be due to this component of MS is significantly reduced in the oldest women. Although, some studies have shown that MS components such as hypertension, obesity, and triglycerides may increase after menopause (34, 35), others have reported that prevalence of obesity and MS is low, as well as exists a reduction of inflammatory markers and oxidative stress related molecules such as plasminogen activator inhibitor 1 (PAI-1), isoprostanes, C reactive protein and insulin levels (36-39). In this way, the weight loss found in the oldest women might improve their metabolic condition, similarly to those post-menopausal women participating in weight reduction programs (40). The weight loss in the oldest women might be due to a decrement in the caloric intake owing to changes in social environment, chewing abilities, taste perception, food selection, food ingestion (caused by pain or discomfort associated with periodontal diseases or caries), and the slowing of gastric emptying (41-43). Prevalence of MS for Otomi women from Tlaxcala was higher than those from USA or China, with similar ranges of age and considering similar diagnostic criteria (44, 45), suggesting that not only aging or estradiol status determine the presence of MS, but genetic.

Although, the short height has been associated with a high percent of body fat and insulin resistance, as well as a major prevalence of hypertension and coronary heart diseases (46-49), we did not find that women with short stature had a big risk to present neither metabolic disease nor MS. The major risk to overweight-obesity and MS observed in women ≥1.51 m was annulated in an analysis model when with adjusted age; suggesting an important influence of this variable, because the oldest women had a minor stature.

Limitations of the study

These results should be interpreted with caution due to the cross-sectional design of the study, and a relatively small number of participants.

Conclusion

Old Otomi women from Tlaxcala have a high prevalence of overweight-obesity, hypertension, DM, and MS. The importance of our work lies in health complications such bad blood circulation, kidney damage, depression, even cognitive decline, that it would carry out. It is necessary to performance more studies in the oldest population to help preserving their independent life.

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