

# Metabolic syndrome in Mexican adults. Results from the National Health and Nutrition Survey 2006

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## Abstract

**Objective.** To examine the prevalence of metabolic syndrome (MS) and its associated risk factors in Mexican adults aged 20 years or older, using data derived from the National Health and Nutrition Survey 2006 (ENSANUT 2006). **Material and Methods.** The ENSANUT 2006 was conducted between October 2005 and May 2006. Questionnaires were administered to 45 446 adult subjects aged 20 years or older who were residents from urban and rural areas. Anthropometric and blood pressure measurements were obtained from all subjects and fasting blood specimens were provided by 30% of participants. We randomly selected a sub-sample of 6 613 from which laboratory measurements were carried out for glucose, insulin, triglycerides, total cholesterol and HDL-cholesterol. For this analysis, we included only results from eight or more hours of fasting samples (n=6 021). We used individual weighted factors in the statistical analysis and considered the survey's complex sampling design to obtain variances and confidence intervals. All analyses were done using SPSS 15.0. **Results.** In accordance with definitions by the National Cholesterol Education Program Adult Treatment Panel III (ATP III), the American Heart Association/National Heart, Lung and Blood Institute (AHA/NHLBI), and the International Diabetes Federation (IDF), the prevalence of MS in Mexican adults aged 20 years or older was 36.8, 41.6 and 49.8%, respectively. Women were more affected than men due to the higher prevalence of central obesity

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## Resumen

**Objetivo.** Describir la prevalencia de síndrome metabólico (SM) y los factores asociados en población mexicana de 20 años y más de edad a partir de datos de la Encuesta Nacional de Salud y Nutrición 2006 (ENSANUT 2006). **Material y métodos.** La ENSANUT 2006 se realizó entre octubre de 2005 y mayo de 2006. Se entrevistó a 45 446 adultos de 20 años y más residentes de localidades rurales y urbanas. A todos ellos se les tomaron medidas antropométricas y de tensión arterial. Al 30% de los adultos entrevistados se les tomó una muestra de sangre, preferentemente en ayunas. Se seleccionó al azar una submuestra de 6 613 individuos para la determinación de glucosa, insulina, triglicéridos, colesterol total y colesterol HDL. Para el análisis de laboratorio sólo se incluyeron las muestras obtenidas en ayuno de 8 horas o más (n=6 021). Se utilizaron las definiciones de SM publicadas por el ATP III, modificada por la American Heart Association; National Heart, Lung and Blood Institute (AHA/NHLBI) y la International Diabetes Federation (IDF). Para el análisis estadístico se utilizaron los factores de expansión individuales y para el cálculo de las varianzas e intervalos de confianza se tomó en consideración el diseño complejo de la encuesta usando SPSS 15.0. **Resultados.** La prevalencia nacional de SM en adultos de 20 años de edad y más, de acuerdo con el ATP III, AHA/NHLBI e IDF fue de 36.8, 41.6 y 49.8%, respectivamente. Con las tres definiciones, la prevalencia fue mayor en las mujeres que en los hombres, debido principalmente al

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among females. Prevalence of MS increased with age and was higher among populations living in metropolitan areas, in the west-central region, and those with lower education. **Discussion.** Regardless of the MS definition, a large proportion of Mexican adults has the condition, so preventive measures are needed to decrease the prevalence of the MS components in this population. MS can predict type 2 diabetes and cardiovascular disease, two of the main causes of death in the adult population in Mexico. The intentional search of MS components allows stratifying the population according to risk levels. Treatment for each component should be implemented properly to prevent or delay onset of type 2 diabetes and cardiovascular disease.

Key words: metabolism; nutrition surveys; obesity; Mexico

mayor porcentaje de obesidad en las mujeres. La prevalencia de SM aumentó conforme a la edad y fue ligeramente mayor en la población residente de las áreas metropolitanas, en la región centro-occidente y con el menor nivel de escolaridad. **Discusión.** Independientemente de la definición utilizada, una gran proporción de mexicanos presenta SM, el cual es considerado como predictor de diabetes tipo 2 y enfermedad cardiovascular; dos de las principales causas de mortalidad en población adulta en México. La búsqueda intencionada de los componentes del SM podrá ayudar a estratificar a la población en diferentes niveles de riesgo. El tratamiento adecuado de cada componente podrá prevenir o retardar la aparición de diabetes tipo 2 y enfermedad cardiovascular

Palabras clave: metabolismo; encuestas nutricionales; obesidad; México

**M**etabolic syndrome (MS) is a cluster of several cardio-metabolic risk factors, including abdominal obesity, hyperglycemia, dyslipidemia and elevated blood pressure.<sup>1</sup> Available data suggest that MS is a syndrome with more than one cause related with lifestyle behavior (overweight and obesity, physical inactivity, and high carbohydrate diets) and genetic predisposition.<sup>1-3</sup> Metabolic syndrome has proven to be a useful teaching tool for practitioners and a marker for increased risk of developing type 2 diabetes and cardiovascular disease in the short term. Indeed, the syndrome identifies individuals with elevated risk of cardiovascular disease (CVD) (OR 2-3)<sup>4-6</sup> and type 2 diabetes (OR 4-6).<sup>5,7,8</sup>

Prevalence of MS in adults from different populations varies between 20 to 40%<sup>3,9,10</sup> and age-adjusted prevalence of MS, as defined by the National Cholesterol Education Program Adult Treatment Panel III (ATP III), in Mexican adults was 26.6% in 1993.<sup>11</sup> Notable differences in the prevalence of MS have occurred over time, requiring regular updates based on nationally representative samples of individuals.

In the present study, we examined the prevalence of MS in the adult Mexican population aged 20 years or older using the MS definition by the 2001 NCEP Adult Treatment Panel III (ATP III), the ATP III definition modified by the American Heart Association/National Heart, Lung and Blood Institute (AHA/NHLBI),<sup>7</sup> and the International Diabetes Federation (IDF) definition focused on central obesity.<sup>12</sup>

## Material and Methods

The Mexican National Health and Nutrition Survey 2006 (ENSANUT 2006) was conducted between October 2005

and May 2006 using a probabilistic, multistage, stratified cluster sampling design. The survey objective was to update the prevalence of infectious and chronic diseases and their associated risk factors. A total of 47 152 households were visited, and from each one, a random selection was performed to interview the following subjects: a child (under age 10), an adolescent (ages 11 to 19 years), and an adult (ages 20 years and older). Population characteristics, sampling procedure, and other methodological details can be consulted in a previous publication.<sup>13</sup> A questionnaire was administered to 45 446 adult subjects aged 20 or older, from whom blood pressure and anthropometric measurements were obtained. Fasting blood samples were obtained from 30% of randomly selected adults. For this analysis, we randomly selected a nationally representative sub-sample of 6 613 blood specimens to gather values for glucose, insulin, triglycerides, total cholesterol, and HDL-cholesterol. Sub-sampling procedure and laboratory methodological details can be consulted in another publication.<sup>14</sup> This analysis only included values for blood samples from subjects with eight or more hours of fasting (n=6 021 subjects).

The protocol was approved by the Research, Ethics and Biosafety Committee of the Instituto Nacional de Salud Pública, Cuernavaca, Mexico. All participants signed an informed consent.

The questionnaires included information about participants' medical care coverage, such as: Mexican Institute of Social Security (IMSS), Institute of Security and Social Services for the State Workers (ISSSTE), Social Protection Health System (Seguro Popular), other (Private, Pemex, Sedena, Marina), or none. We also obtained information about previous medical diagnoses for diabetes, hypertension and myocardial infarction.

Smoking status was self-reported and categorized as "current" for those subjects having smoked at least 100 cigarettes during their lifetime and who currently smoke; "former" for those having smoked at least 100 cigarettes during their lifetime and who did not currently smoke; and "never."

Other variables included in this analysis were "gender" and "age" stratified as 20-39, 40-59, 60 and older. The sizes of the localities were categorized as "rural" (population under 2 500 inhabitants), "urban" (2 500 to 99 999 inhabitants) and "metropolitan area" ( $\geq 100\ 000$  inhabitants). "Region" was stratified according to north, west-center, center, and south. Socioeconomic status was determined by household income and was stratified into deciles.

According to the 2001 NCEP ATP III criteria,<sup>14</sup> MS was defined as having three or more of the following criteria: waist circumference  $>102$  cm in males and  $>88$  cm in females; elevated triglycerides (TG)  $\geq 150$  mg/dl; reduced HDL-cholesterol  $< 40$  mg/dl in males and  $< 50$  mg/dl in females; elevated blood pressure as systolic blood pressure (SBP)  $\geq 130$  mm Hg or diastolic blood pressure (DBP)  $\geq 85$  mm Hg or medical diagnosis of hypertension; impaired fasting glucose  $\geq 100$  mg/dl or medical diagnosis of diabetes mellitus.

ATP III MS definition was modified by the AHA/NHLBI in 2005 as having three or more of the following criteria:<sup>7</sup> waist circumference  $\geq 102$  cm in males and  $\geq 88$  cm in females; elevated triglycerides  $\geq 150$  mg/dl or medical treatment for elevated TG; reduced HDL-cholesterol  $< 40$  mg/dl in males and  $< 50$  mg/dl in females; elevated SBP  $\geq 130$  mm Hg or elevated DBP  $\geq 85$  mm Hg or medical diagnosis of hypertension; elevated fasting glucose  $\geq 100$  mg/dl or medical diagnosis of diabetes mellitus.

In 2005, the IDF published a new definition of MS;<sup>12</sup> for this analysis we considered it as having three or more of the following criteria: central obesity waist circumference  $\geq 90$  cm in males and  $\geq 80$  cm in females; elevated triglycerides  $> 150$  mg/dl or medical treatment for elevated TG; reduced HDL-cholesterol  $< 40$  mg/dl in males and  $< 50$  mg/dl in females; elevated blood pressure  $\geq 130$  mm Hg systolic blood pressure or  $\geq 85$  mm Hg diastolic blood pressure or medical diagnosis of hypertension; elevated fasting glucose  $\geq 100$  mg/dl or medical diagnosis of type 2 diabetes mellitus. Abdominal obesity is considered an obligate criterion in the IDF definition.

### Statistical analysis

Prevalence of MS with 95% confidence intervals (95% CI) is expressed in terms of percentages. Data from the 2005

National Population Census were used to estimate number of cases nationwide.<sup>15</sup> We used individual weighted factors for the statistical analysis and considered the survey's complex sampling design to obtain variances. All analyses were carried out using SPSS 15.0.

## Results

The study population showed a prevalence of more than 40% for three or more MS components from a total of five, as defined by ATP III, AHA/NHLBI and IDF.

Metabolic syndrome according to the 2001 ATP III definition: MS was present in 36.8% (95% CI 34.6-39.0) of the adult population, 42.2% of women and 30.3% of men (Table I). Central obesity was three times higher in women than in men (60.4% vs. 21.9%, respectively). Reduced level of HDL-cholesterol was more common in women than men (83% vs. 68.5%, respectively). Hypertension was more frequent in men (46.7%) than in women (39.1%) (Table I).

Metabolic syndrome according to the 2005 AHA/NHLBI definition: The prevalence of MS in adults was 41.6% (95% CI 39.4-43.8). It was higher in women (47.4%) than in men (34.7%) (Table II). When decreasing the glucose threshold 10 mg/dl, the prevalence of the disease increased nearly 5%.

Metabolic syndrome according to the IDF definition: Prevalence of MS was 49.8% (95% CI 47.5-52.1). It was more frequent in women (52.7%) than in men (46.4%) (Table III). Due to the lower cutoff applied, the percentage of MS cases with central obesity was 83.8% in females and 62.9% in males. Reduced HDL-cholesterol was higher in women (83%) than in men (68.5). Hypertension was more frequent in men than in women (46.7% vs. 39.1%, respectively) as was elevated triglycerides (37.4% vs. 29.3%, respectively) (Table III).

Comparisons between subsets of patients with MS: Individuals previously diagnosed with diabetes or hyperglycemia (glucose  $\geq 100$  mg/dl) showed similar prevalence for central obesity and elevated triglycerides; however, their values were higher than those with normoglycemia (Table IV). Elevated blood pressure was higher for individuals diagnosed with diabetes than for those with hyperglycemia and normoglycemia (Table IV).

Comparisons of MS prevalence by sociodemographic characteristics are shown in Table V. Compared with other definitions, prevalence of MS was higher when the IDF definition was used. Regardless of MS definition, prevalence of MS was higher in women than in men, and increased with age. By geographical region and socioeconomic status, the prevalence was largely unchanged. The prevalence of MS consistently increased as education decreased, with the lowest educational

**Table I**  
**PREVALENCE (%) OF MS AND ITS COMPONENTS ACCORDING TO ATP III DEFINITION, BY GENDER. MEXICO, ENSANUT 2006**

<i>Measure (any 3 of 5 constitute diagnosis of MS)</i>	<i>Males</i>	<i>Females</i>	<i>Total</i>
Elevated waist circumference Men >102 cm Women >88 cm	21.9 (19.3-24.6)	60.4 (57.7-63.1)	42.7 (40.7-44.7)
Elevated triglycerides $\geq$ 150 mg/dl	36.1 (32.9-39.5)	27.5 (24.8-30.3)	31.4 (29.2-33.8)
Reduced HDL-C Men < 40 mg/dl Women < 50 mg/dl	68.5 (65.5-71.3)	83.0 (80.7-85.1)	76.3 (74.4-78.2)
Elevated blood pressure $\geq$ 130/ $\geq$ 85 mm Hg*	46.7 (43.4-50.0)	39.1 (36.8-41.5)	42.6 (40.6-44.7)
Elevated fasting glucose $\geq$ 110 mg/dl†	22.2 (19.8-24.8)	20.0 (17.9-22.2)	21.0 (19.4-22.7)
MS prevalence	30.3 (27.3-33.5)	42.2 (39.4-44.9)	36.8 (34.6-39.0)

\* Or previous medical diagnosis of hypertension

† Or previous medical diagnosis of type 2 diabetes mellitus

**Table II**  
**PREVALENCE (%) OF MS AND ITS COMPONENTS ACCORDING TO AHA/NHLBI DEFINITION, BY GENDER. MEXICO, ENSANUT 2006**

<i>Measure (any 3 of 5 constitute diagnosis of MS)</i>	<i>Males</i>	<i>Females</i>	<i>Total</i>
Increased waist circumference Men $\geq$ 102 cm Women $\geq$ 88 cm	22.8 (20.2-25.7)	61.4 (58.6-64.1)	43.7 (41.6-45.7)
Elevated triglycerides $\geq$ 150 mg/dl or medical treatment for elevated TG	37.4 (34.2-40.8)	29.3 (26.7-32.1)	33.0 (30.8-35.4)
Reduced HDL-C Men < 40 mg/dl Women < 50 mg/dl	68.5 (65.5-71.3)	83.0 (80.7-85.1)	76.3 (74.4-78.2)
Elevated blood pressure $\geq$ 130/ $\geq$ 85 mm Hg or previous medical diagnosis of hypertension	46.7 (43.4-50.0)	39.1 (36.8-41.5)	42.6 (40.6-44.7)
Elevated fasting glucose $\geq$ 100 mg/dl or previous medical diagnosis of diabetes mellitus	34.2 (31.3-37.3)	32.8 (30.3-35.5)	33.5 (31.5-35.5)
MS prevalence	34.7 (31.6-37.9)	47.4 (44.6-50.2)	41.6 (39.4-43.8)

**Table III**  
**PREVALENCE (%) OF MS AND ITS COMPONENTS ACCORDING TO IDF DEFINITION, BY GENDER. MEXICO, ENSANUT 2006**

<i>Measure (any 3 of 5 constitute diagnosis of MS)</i>	<i>Males</i>	<i>Females</i>	<i>Total</i>
Central obesity increased waist circumference Men $\geq$ 90 cm Women $\geq$ 80 cm	62.9 (59.7-66.0)	83.8 (81.7-85.7)	74.2 (72.4-76.0)
Elevated triglycerides > 150 mg/dl or medical treatment for elevated TG	37.4 (34.2-40.8)	29.3 (26.7-32.1)	33.0 (30.8-35.4)
Reduced HDL-C Men < 40 mg/dl Women < 50 mg/dl	68.5 (65.5-71.3)	83.0 (80.7-85.1)	76.3 (74.4-78.2)
Elevated blood pressure $\geq$ 130/ $\geq$ 85 mm Hg or previous medical diagnosis of hypertension	46.7 (43.4-50.0)	39.1 (36.8-41.5)	42.6 (40.6-44.7)
Elevated fasting glucose $\geq$ 100 mg/dl or previous medical diagnosis of diabetes mellitus	34.2 (31.3-37.3)	32.8 (30.3-35.5)	33.5 (31.5-35.5)
MS prevalence	46.4 (43.0-49.7)	52.7 (49.9-55.5)	49.8 (47.5-52.1)

**Table IV**  
**PREVALENCE (%) OF MS AND ITS COMPONENTS BY GLUCOSE STATUS. MEXICO, ENSANUT 2006**

Measure (any 3 of 5 constitute diagnosis of MS)	Diagnosed diabetes	Hyperglycemia (glucose $\geq 100$ mg/dl)	Normoglycemia
Increased waist circumference			
Men $\geq 102$ cm	64.2 (56.5-71.2)	56.8 (52.9-60.6)	36.1 (33.7-38.6)
Women $\geq 88$ cm			
Central obesity increased waist circumference			
Men $\geq 90$ cm	88.0 (82.2-92.1)	85.8 (83.1-88.1)	68.0 (65.6-70.3)
Women $\geq 80$ cm			
Elevated triglycerides $> 150$ mg/dl or medical treatment for elevated TG	46.7 (38.8-54.7)	45.2 (41.0-49.5)	27.2 (24.7-29.7)
Reduced HDL-C			
Men $< 40$ mg/dl	83.0 (76.5-88.0)	71.9 (68.2-75.3)	77.3 (75.0-79.4)
Women $< 50$ mg/dl			
Elevated blood pressure $\geq 130/\geq 85$ mm Hg or previous medical diagnosis of hypertension	65.0 (56.5-72.6)	51.6 (47.8-55.4)	36.6 (34.2-39.0)
MS prevalence according to ATP III	86.9 (80.5-91.5)	58.5 (54.4-62.5)	23.4 (21.4-25.6)
MS prevalence according to AHA/NHLBI	87.5 (81.0-92.0)	75.3 (71.6-78.6)	24.2 (22.1-26.3)
MS prevalence according to IDF	83.6 (76.3-88.9)	81.4 (78.3-84.2)	34.4 (31.9-37.0)

**Table V**  
**COMPARISON OF MS PREVALENCE AND 95% CONFIDENCE INTERVALS AMONG DIFFERENT MS DEFINITIONS, BY SOCIODEMOGRAPHIC FEATURES. MEXICO, ENSANUT 2006**

		NCEP 2001	AHA/NHLBI 2005	IDF 2005
Gender	Male	30.3 (27.3-33.5)	34.7 (31.6-37.9)	46.4 (43.0-49.7)
	Female	42.2 (39.4-44.9)	47.4 (44.6-50.2)	52.7 (49.9-55.5)
Age group	20 to 39	23.8 (21.2-26.5)	27.9 (25.2-30.7)	36.0 (33.1-39.1)
	40 to 59	50.0 (46.6-53.4)	56.2 (52.9-59.4)	64.9 (61.5-68.2)
	60 and older	56.3 (51.9-60.6)	60.8 (56.4-65.0)	67.9 (63.8-71.7)
Locality size	Rural (less than 2 500 inhabitants)	30.0 (27.0-33.3)	35.1 (31.8-38.6)	44.2 (40.1-48.3)
	Urban (2 500 to 99 999 inhabitants)	37.7 (34.1-41.5)	42.8 (39.2-46.4)	50.9 (46.9-55.0)
	Metropolitan area (100 000 and more inhabitants)	39.0 (35.7-42.5)	43.6 (40.2-47.1)	51.6 (48.1-55.1)
Region	North	38.2 (34.8-41.6)	42.8 (39.5-46.1)	49.6 (46.3-52.9)
	West center	40.9 (36.3-45.8)	44.6 (40.0-49.3)	54.9 (50.1-59.7)
	Center	35.8 (31.1-40.8)	40.2 (35.3-45.4)	48.1 (42.9-53.4)
	South	32.5 (29.5-35.7)	39.3 (36.1-42.7)	47.2 (43.7-50.7)
Education level	Less than elementary	48.6 (45.3-51.9)	53.5 (50.2-56.8)	60.1 (56.9-63.3)
	Elementary	38.1 (34.1-42.2)	43.5 (39.6-47.5)	52.7 (48.2-57.1)
	Secondary	32.2 (28.2-36.4)	37.2 (33.1-41.4)	45.6 (41.3-49.9)
	High school	26.6 (21.8-32.1)	30.9 (25.8-36.5)	40.7 (34.9-46.8)
	More than high school	29.1 (22.6-36.6)	33.3 (26.5-40.8)	39.3 (32.5-46.6)
Socioeconomic status (income deciles)	1 - 2	33.5 (30.4-36.7)	38.0 (34.8-41.3)	46.5 (43.2-49.8)
	3 - 4	38.6 (34.6-42.9)	43.8 (39.7-48.1)	53.3 (49.1-57.4)
	5 - 7	39.0 (35.2-43.0)	44.3 (40.3-48.3)	50.1 (46.0-54.2)
	8 - 10	38.0 (32.0-44.3)	41.7 (35.4-48.4)	53.0 (46.1-59.7)
Medical insurance	IMSS	39.2 (35.4-43.2)	44.1 (40.2-48.0)	51.4 (47.4-55.4)
	Seguro Popular	38.0 (33.5-42.8)	42.4 (37.7-47.2)	49.1 (44.1-54.1)
	ISSSTE	45.7 (37.6-54.0)	53.7 (45.6-61.6)	58.1 (50.0-65.8)
	Other	37.1 (27.0-48.6)	43.1 (32.4-54.4)	48.5 (37.5-59.7)
	None	33.9 (31.3-36.7)	38.4 (35.7-41.3)	48.2 (45.2-51.2)

level having a 1.8 times higher prevalence than the highest level.

In terms of the prevalence of MS in association with certain risk factors for cardiovascular disease (CVD) (Table VI), subjects self-reporting myocardial infarction, stroke, elevated triglycerides, reduced HDL-cholesterol, or hypertension had a higher prevalence of MS than individuals without those conditions.

## Discussion

Metabolic syndrome prevalence among Mexican adults, according to ATP III, AHA/NHLBI and IDF, was 36.8%, 41.6% and 49.8%, respectively. Differences are mainly due to the waist circumference thresholds. Women were more affected than men using any of the three definitions, explained in part by the higher prevalence

**Table VI**  
**COMPARISON OF MS PREVALENCE AND 95% CONFIDENCE INTERVALS AMONG DIFFERENT MS DEFINITIONS, BY CVD RISK FACTORS. MEXICO, ENSANUT 2006**

		NCEP 2001	AHA/NHLBI 2005	IDF 2005
Smoking status	Current	31.3 (26.6-36.4)	34.9 (30.2-40.0)	46.0 (40.2-51.8)
	Former	40.7 (34.3-47.4)	45.3 (38.7-52.0)	53.0 (46.2-59.7)
	Never	37.7 (35.3-40.1)	42.8 (40.5-45.3)	50.4 (48.0-52.8)
Myocardial infarction self reported	No	36.4 (34.2-38.6)	41.2 (39.0-43.5)	49.4 (47.1-51.8)
	Yes	75.6 (58.8-87.0)	82.3 (68.8-90.8)	87.0 (75.4-93.6)
Stroke self reported	No	36.8 (34.6-39.0)	41.7 (39.4-43.9)	49.8 (47.5-52.1)
	Yes	40.2 (14.8-72.4)	43.1 (16.3-74.6)	53.4 (21.8-82.5)
BMI (Kg/m <sup>2</sup> )	18.5 - <25	13.7 (10.6-17.4)	16.2 (13.1-19.9)	19.6 (16.4-23.2)
	25 - <30	33.7 (30.7-36.8)	39.4 (36.4-42.5)	55.0 (51.4-58.7)
	>= 30	66.3 (62.9-69.6)	72.6 (69.3-75.6)	76.6 (73.6-79.4)
Glucose status	Normoglycemia	23.4 (21.4-25.6)	24.2 (22.1-26.3)	34.4 (31.9-37.0)
	Hyperglycemia (glucose >=100 mg/dl)	58.5 (54.4-62.5)	75.3 (71.6-78.6)	81.4 (78.3-84.2)
	Diagnosed diabetes	86.9 (80.5-91.5)	87.5 (81.0-92.0)	83.6 (76.3-88.9)
Insulin levels	<=15	27.7 (25.5-30.0)	31.7 (29.4-34.2)	39.9 (37.4-42.5)
	>15	52.4 (48.7-56.1)	58.6 (54.8-62.3)	66.9 (63.2-70.5)
Elevated total cholesterol	No	33.1 (30.4-35.8)	37.4 (34.6-40.2)	46.8 (43.9-49.7)
	>=200 mg/dl or medical treatment for elevated cholesterol	40.1 (36.8-43.5)	45.8 (42.3-49.2)	52.9 (49.4-56.4)
Elevated triglycerides	No	23.1 (21.2-25.2)	27.4 (25.3-29.6)	36.2 (33.8-38.8)
	> 150 mg/dl or medical treatment for elevated TG	65.2 (61.2-68.9)	71.2 (67.3-74.7)	78.1 (74.6-81.2)
Reduced HDL-C	No	15.5 (12.7-18.8)	21.5 (18.3-25.1)	28.4 (24.7-32.5)
	Men < 40 mg/dl	43.1 (40.7-45.6)	47.6 (45.1-50.1)	56.2 (53.6-58.7)
	Women < 50 mg/dl			
Elevated blood pressure	No	15.8 (13.6-18.3)	20.2 (17.9-22.8)	28.6 (25.8-31.7)
	>=130/>=85 mm Hg or previous medical diagnosis of hypertension	65.1 (62.1-68.1)	70.5 (67.5-73.2)	78.4 (75.6-81.0)

of central obesity among females. When we removed subjects with a medical diagnosis of diabetes mellitus from the analysis, prevalences were largely unchanged (33.1, 38.2, and 47.3 for ATP III, AHA/NHLBI and IDF MS definitions, respectively).

The prevalences reported here are higher compared against those obtained from NHANES 1999-2002. Ford *et al*<sup>5</sup> estimated the prevalence of MS among US adults aged  $\geq 20$  years as 34.5 (SE=0.9) and 39.0 (SE=1.1), according ATP III and IDF criteria, respectively; among Mexican-American women, 37.8 (SE=3.2) and 39.2 (SE=3.3), respectively; and among Mexican-American men, 32.2 (SE=3.6) and 42.3 (SE=3.7), respectively.<sup>5</sup>

Other age-adjusted prevalences of MS, according to the ATP III definition, in Hispanic population-based studies, were: 26.6% in Mexican urban adults in 1993;<sup>11</sup> 25.3% in an urban area in Colombia in 1996;<sup>16</sup> and 31.2% in Zula State, Venezuela in 2001.<sup>17</sup> The increased susceptibility of Mexican adults to having MS as compared to other populations was confirmed by the CARMELA study; Mexicans were the group with the highest prevalence (27.2% for the total population, 26.3% for men and 28% for women, using the 2001 ATP III definition).<sup>18</sup>

In Mexico, more than 17 million adults have MS, depending on the definition used. These numbers could increase up to 23 million. Based on the representativeness of this survey and using ATP III thresholds, we estimate that there are 3.5 million adults with diabetes already diagnosed; of those, 2.3 million have central obesity, 1.6 million present elevated triglycerides, 2.7 million have reduced HDL-cholesterol levels, and 2.4 million have hypertension. In addition, 12.8 million present abnormal fasting glucose, of which 7 million have central obesity, 5.6 million have elevated triglycerides, nearly 9 million have reduced HDL-cholesterol, and 6.7 million have hypertension. Finally, 31.8 million have normal glucose levels, of which 11.2 million have central obesity according ATP III and 21.6 million according IDF, 9.1 million have elevated triglycerides, 25.8 have reduced HDL-cholesterol, and 12.1 have hypertension. These numbers summarize the challenge that metabolic syndrome represents for the Mexican health system.

Notably, metabolic syndrome is present in similar proportions for individuals living in both rural and urban settings, as well as for those belonging to any of the Mexican health care systems. The prevalence is similar in the less developed southern region of the country and in the most developed areas (northern and central Mexico). The proportion of cases is more prevalent among the less educated and those with lower incomes. These characteristics should be considered to design actions to treat this more largely affected population.

The combined components of metabolic syndrome provides the epidemiologist an instrument with a strong predictive power and the primary care physician with an integrative view linking conditions frequently seen together. In addition, identifying MS provides a useful tool for planning public health policies. For example, the ATP III criteria identifies patients at risk of developing type 2 diabetes and coronary heart disease (CHD) later in life, with a relative risk of CHD of 2.7 (95% CI 1.2-6.2), and of 5.9 for incident diabetes (95% CI 3.5-11).<sup>6,19</sup> The ATP III predictive power is stronger for type 2 diabetes, particularly when applied to subjects around age 40 plus 10 years. Thus, the percentage of non-diabetic young adults (under age 40) affected by MS is a crude estimate of the population at high risk of developing type 2 diabetes within the next ten years. In this report, 22.9% of the non-diabetic individuals under age 40 fulfilled the ATP III criteria; the corresponding percentages were 27.0 and 35.6 for the AHA/NHLBI and the IDF definitions, respectively. This observation suggests that the incidence of diabetes among Mexican adults will continue to grow. A large percentage, 33.7, has central obesity, which has been considered a core component of this disease. Thus, diabetes prevention programs should be focused on achieving long-term body weight control, which has proved to be an effective approach to reduce the incidence of type 2 diabetes. Only 66.3% of young adults are free of abdominal obesity, 22.6% has acceptable HDL-cholesterol levels, and 70.5% has normal blood pressure.

These data show that metabolic syndrome allows the detection of cases at risk of developing type 2 diabetes and highlights conditions that, by diminishing their prevalence, could reduce the incidence of type 2 diabetes.

In addition, the concept of MS provides an integrative view of the pathophysiology of the disease and could be used as a diagnostic framework for cases with chronic non-transmissible diseases. Using the AHA/NHLBI definition, MS is present in 82.3% of self-reported CHD, 87.5% of type 2 diabetes cases, 43.1% of self-reported stroke, 72.6% of obese individuals, 71.2% of subjects with high triglycerides, 47.6% of subjects with low HDL-cholesterol levels, and 70.5% of adults with hypertension. These percentages provide a gross estimate of the contribution of MS to the outcomes mentioned above and justify the screening of MS components in persons with those conditions. These results will be useful for updating local guidelines for the prevention and treatment of specific chronic disorders, which requires a multidisciplinary team approach that implements lifestyle changes and a combination of drugs (when

appropriate). The primary goal of clinical management in individuals with MS is to reduce the risk of clinical atherosclerotic disease.<sup>7</sup>

In summary, large numbers of Mexican adults fulfilled the MS definitions. Our data describes the significant challenges that MS represents to our health system. The Mexican health system should develop specific management programs for all identified cases; failure to identify or treat cases of MS will result in a considerable increase in new cases of type 2 diabetes and/or CHD.

### Conflicts of interest

We declare that we have no conflicts of interest.

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