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Metabolic syndrome: prevalence, associated factors, and C-reactive protein
The MADRIC (MADrid RIesgo Cardiovascular) Study

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Abstract

The *metabolic syndrome* (MS) is defined by the clustering of a number of cardiovascular risk factors. The aims of the present study were to estimate the prevalence of MS in Madrid (Spain) by 2 definitions and to investigate its relationship with several sociodemographic factors and C-reactive protein (CRP) levels. This was a cross-sectional population study, and participants were 1344 subjects aged 31 to 70 years. Clinical evaluation included data on sociodemographic and cardiovascular background, physical examination, fasting glucose, triglycerides, and high-density lipoprotein cholesterol. The CRP levels were determined in a subgroup of 843 subjects. The diagnosis of MS was made according to the 2005 Adult Treatment Panel III (ATP III) and International Diabetes Federation (IDF) definitions. The age- and sex-adjusted prevalence of MS was 24.6% (95% confidence interval [CI], 22.3%-26.9%) using the ATP III definition and 30.9% (95% CI, 28.4%-33.3%) using the International Diabetes Federation definition. The overall agreement rate was 91.5% (κ = 0.80; 95% CI, 0.76-0.83). Prevalence figures by both definitions were higher in men than in women and increased with age. Male sex, older age, low educational level, and physical inactivity were all determinants of ATP III–defined MS. The presence of MS or any of its components was associated with high CRP levels. In a logistic regression analysis, low educational level and waist circumference were the best predictors

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for high CRP level. The prevalence of MS in the Madrid region is one of the highest in Europe and confirms the strong Spanish regional variability in this syndrome frequency. Some sociodemographic and lifestyle factors, particularly educational level, are predictors for MS and high CRP levels.

1. Introduction

The concept of metabolic syndrome (MS), also known as *X syndrome* and *insulin resistance syndrome*, has long been recognized [1]. Systemic inflammation, as measured by plasma C-reactive protein (CRP) levels, is believed to be one of the common underlying mechanisms in the development of this syndrome [2].

Clinical research on MS has been hampered by a lack of agreement on its definition. Although several definitions have been proposed, the National Cholesterol Education Program Adult Treatment Panel III (ATP III) [3,4] has provided the first practical definition of this syndrome; its practicality lies in the fact that it merely requires readily available clinical variables. A new definition, proposed by the International Diabetes Federation (IDF) [5] and adopted by the European Association for the Study of Diabetes and the European Atherosclerosis Society, is also available.

The prevalence of MS is highly dependent on the criteria used for diagnosis. The Third National Health and Nutrition Examination Survey (NHANES III) [6] estimated that, in the United States, approximately 27% of adults have MS using the 2005 ATP III criteria [4]. The prevalence in European studies ranges from 13% in France [7] to 33% in Turkey [8]. Prevalence of MS in Spain is largely unknown, although several small-population studies have been published. Estimates range from 17% to 24% in adults, depending on the regions [9-11] and diagnostic criteria. These studies have included mainly populations from rural areas and small towns.

To our knowledge, no study has estimated the frequency of MS in the Madrid region, which has one of the highest population densities in Spain (about 6 million inhabitants). In addition, there is scarce information about the influence of sociodemographic and lifestyle factors on MS frequency in Mediterranean countries. Accordingly, the aims of the present study were (1) to estimate the prevalence of MS in a Madrid population using the ATP III definition, (2) to compare this prevalence estimate with that by the IDF definition and to asses the agreement between both MS definitions, (3) to investigate the relationship between MS and several socio-demographic and lifestyle factors, and (4) to assess the association between CRP levels and both MS and its features.

2. Patients and methods

2.1. Design and sampling procedure

The MADRIC (MADrid RIesgo Cardiovascular) study is a cross-sectional, multicenter, population-based survey aimed at estimating the prevalence of cardiovascular risk factors in Madrid. It comprises a random age- and sex-stratified sample of 1344 subjects living in the northern region of Madrid who were aged between 31 and 70 years in 2005. The sample was obtained from the Madrid Public Health census of the participating districts (14 different neighborhoods of the city of Madrid and its surroundings). These districts have a total population of 197 842 inhabitants aged 31 to 70 years and have an intermediate socioeconomic and educational status within the Madrid region. Most inhabitants are from urban and suburban areas where people mainly work in service industries. A minority (25%) lives in rural nuclei, with livelihoods based on service sectors, modern intensive agriculture, and cattle farming (in this order of frequency).

It was calculated that it would be necessary to recruit 1292 subjects stratified in four 10-year strata to have a power of 95% at the 5% significance level to estimate a prevalence of MS of 20%. Participating subjects were located and invited to participate in the survey by their own general physicians, who were provided with a list of random-sampled inhabitants living in their primary care center area along with the inhabitants' telephone numbers.

Exclusion criteria were (1) severe physical or mental disability, (2) pregnancy, (3) terminal disease, and (4) institutionalization. Out of 1689 eligible subjects, 1402 (83%) individuals agreed to participate in the study. Fifty-eight subjects were excluded because of incomplete information for the 5 variables needed to assess MS. The latter had similar demographic characteristics to the included ones.

For logistic reasons, CRP levels were determined only in subjects living in 10 of the 14 participating districts (n = 853). Subjects from the former districts had similar sociodemographic features to those from the nonparticipating districts. Individuals with known inflammatory, infectious, or neoplasic diseases were excluded from this substudy, leaving 843 individuals for analysis. The Hospital La Paz Research Ethics Committee approved the study. All participants gave their written informed consent, and the protocol adhered to the guidelines put forth in the Helsinki declaration.

2.2. Clinical and sociodemographic evaluation

Participant subjects were classified as residents in urban or rural areas depending on the municipal population size: urban if ≥10 000 inhabitants and rural if <10 000 inhabitants. According to their educational background, subjects were divided into 2 levels: level 1 = primary and secondary school education, and level 2 = education at the

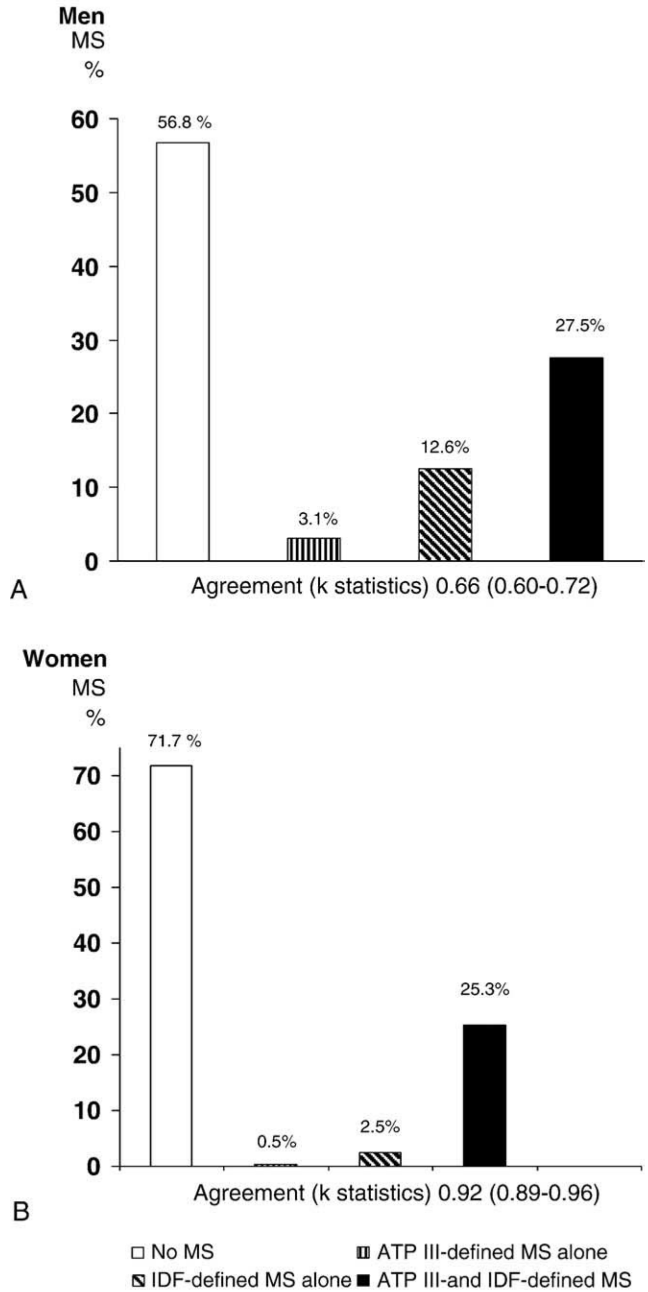

Fig. 1. Agreement between ATP III and IDF definitions of MS. The overall agreement (κ statistic) was 0.80 (95% CI, 0.76-0.83). Data are percentages (95% CIs).

college or university setting. Physical activity was measured by asking about work-related and leisure-time activities. Subjects were asked about the type and duration of physical efforts: time spent walking, handling heavy objects, and practicing sports (swimming, jogging, cycling, soccer, aerobics, tennis, etc). Grades were recoded as sedentary (<210 min/wk) or active (≥210 min/wk). The physical examination included the measurement of body mass index (BMI) and waist circumference. Blood pressure (BP) was measured twice using a validated oscillometric sphygmomanometer (OMRON HEM 757). The mean of the 2 readings was used for analysis. After an overnight fast, blood samples were drawn for the measurement of serum glucose, total cholesterol, high-density lipoprotein cholesterol (HDL-C), triglycerides, and CRP.

2.3. Definition of MS

According to the modified ATP III criteria (published in 2005) [4], the diagnosis of MS was made when 3 or more of the following risk factors were present: waist circumference ≥102 cm in men and ≥88 cm in women; fasting glucose ≥5.55 mmol/L or use of antidiabetic medication; systolic BP ≥130 mm Hg, diastolic BP ≥85 mm Hg, or use of antihypertensive medication; fasting triglycerides ≥1.7 mm/L; and HDL-C <1.0 mm/L in men and <1.3 mm/L in women. The original ATP III definition (published in 2001) [3] differs mainly from the revised definition [4] by a higher

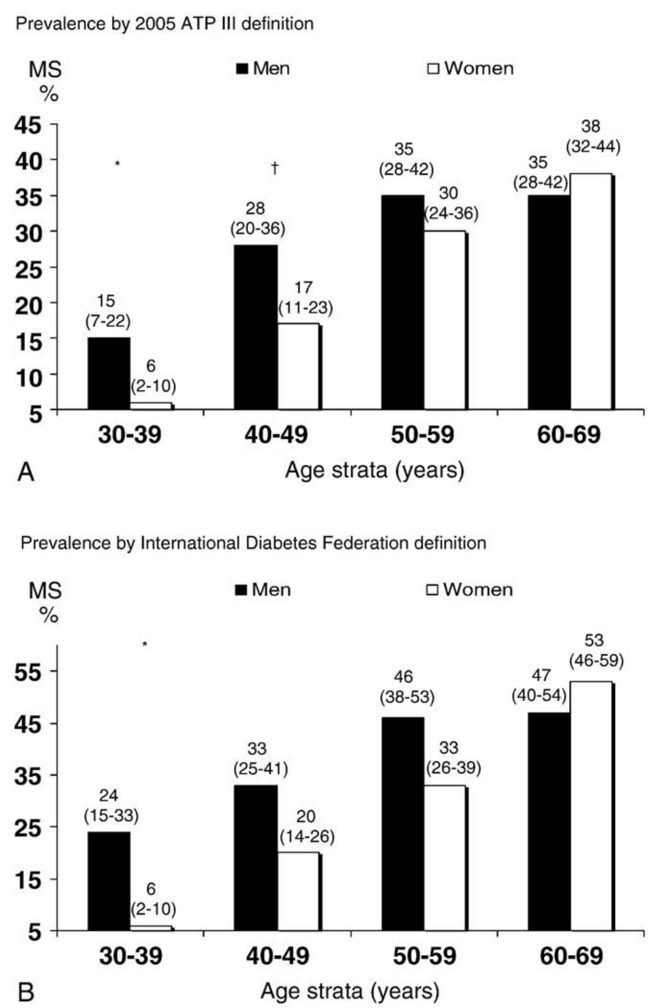

Fig. 2. Prevalence of MS by sex and age strata. A, Prevalence by 2005 ATP III definition. B, Prevalence by IDF definition. Data are percentages (95% CIs). $^*P<.05$, $^{**}P<.01$, and $^{\dagger}P=.06$ between men and women. P for trend was .01 both in men and women. The number of subjects in each age stratum was as follows: 31 to 40 years, 89 men and 141 women; 41 to 50 years, 135 men and 156 women; 51 to 60 years, 176 men and 211 women; and 61 to 70 years, 192 men and 244 women.

glucose cutoff (6.1 mmol/L). For the IDF definition of MS [5], elevated waist circumference was always required, according to ethnic group–specific thresholds (>94 cm in men and >80 cm in women in Caucasian-origin populations). In addition to this risk factor, the IDF definition required at least 2 of the following criteria: hypertriglyceridemia, low HDL-C, high BP, and elevated fasting plasma glucose (using identical cutoffs as the revised ATP III definition).

2.4. Biochemical measurements

Levels of serum glucose, total cholesterol, HDL-C, and triglycerides were determined by enzymatic methods (Boehringer-Mannheim, Indianapolis, IN) using an autoanalyzer, whereas CRP levels were measured by latex-enhanced nephelometry (Dade Behring, Marburg, Germany). The average intraassay coefficient of variation for CRP was 7.8%, and the average interassay coefficient of variation was 2.5%.

2.5. Data analysis

Statistics were completed using SPSS for Windows (version 12.0; SPSS, Chicago, IL). Estimates were adjusted in line with the sampling design, with a weight assigned to all sample members according to the size of the respective strata to which they belonged (age and sex). We applied the κ statistic to analyze statistical agreement between ATP III and IDF definitions of MS.

Multivariable logistic regressions were performed to estimate the determinants of MS and high CRP levels. The CRP was analyzed both as a log-transformed and dichotomized variable. All probability values were 2-sided. Significance was considered to be $P < .05$.

3. Results

3.1. Study population

The study sample was composed of 1344 subjects (592 men and 752 women). Their mean age was 53.1 ± 11.1 years. Most subjects lived in urban areas (79.7%) and had medium to high levels of education (60.8%). Approximately half of individuals (52.9%) were sedentary. There were no significant differences between men and women in any of these features.

Men showed significantly higher waist circumference, BMI, systolic and diastolic BP, total cholesterol, and triglycerides than women, but lower HDL-C. The CRP levels were similar in both sexes (data not shown).

3.2. Prevalence of MS and its components

The IDF definition of MS generated greater age- and sex-adjusted prevalence estimates than the 2005 ATP III definition: 30.9% (95% confidence interval [CI], 28.4%-33.3%) and 24.6% (95% CI, 22.3%-26.9%), respectively. Age-adjusted prevalence was higher in men than in women by both definitions: 37.7% (95% CI, 33.8%-41.6%) vs 24.5% (95% CI, 21.4%-27.6%), respectively, using the IDF definition, and 28.7% (95% CI, 25.1%-32.3%) vs 20.8% (95% CI, 17.9%-23.7%) using the 2005 ATP III definition. To compare our data with those from older studies, we also estimated MS prevalence using the original ATP III criteria. According to this definition, the age- and sex-adjusted MS prevalence was the lowest: 20.0% (95% CI, 17.9%-22.2%).

The agreement rate, that is, the percentage of participants who were concurrently classified as either having or not having MS by both the 2005 ATP III and IDF definitions, was 91.5% (men, 84.3%; women, 97.1%) (Fig. 1).

Fig. 2 shows MS frequency by sex and age strata. A significant increase in MS percentage by age strata ($P < .01$) was observed with both definitions, except for men in the older strata. Men only had significantly higher ATP III–defined MS prevalence than women in the youngest stratum.

The prevalence of each MS component by age and sex strata is shown in Table 1. The frequency of MS criteria increased with age, except for low HDL-C and hypertriglyceridemia (in men). Men had a significantly higher prevalence of hypertension, hypertriglyceridemia, and hyperglycemia than women. However, women older than 50 years had ATP III–defined abdominal obesity more frequently than men. Interestingly, no significant differences were found in the frequency of IDF-defined abdominal obesity between both sexes.

3.3. Relationship between MS, lifestyle, and demographic variables

Subjects with ATP III–defined MS had lower levels of education ($P = .03$) and lived more often in urban areas than subjects without the syndrome ($P < .001$). They were also more sedentary ($P < .01$) and had poorer clinical and biochemical cardiovascular profiles (data not shown).

In a logistic regression model with MS diagnosis as the dependent variable (Table 2), age, sedentarism, male sex, low level of education, and residence in an urban area were independently associated with MS. When separate regression models were made for men and women, results were similar, except that residence in an urban area was significantly associated to MS only in men (odds ratio [OR] in men, 1.75 [95% CI, 1.07-2.89], $P = .03$; OR in women, 1.26 [95% CI, 0.81-1.96], $P = .309$). We also modified the regression model in Table 2 by adding either systolic or diastolic BP (in millimeters of mercury) as independent variables, but no relevant changes were observed in the ORs. However, when BMI (in kilograms per square meter) was added as an independent variable, level of education was no longer significantly associated with MS (OR for low vs medium-high level of education, 1.15 [95% CI, 0.86-1.55]).

3.4. Relationship between MS components and CRP

We analyzed the univariate relationship between high CRP (>3 mg/L) and several clinical variables in 843

Table 1
Individual components of MS by sex ad age strata

A. Frequencies of the individual components of MS

MS component	Age stratum (y)	Men		Women		P (men vs women)
		% (95% CI)	P for trend (among age strata)	% (95% CI)	P for trend (among age strata)	
High waist circumference			.002		<.001	
(ATP III criteria)	31-40	21.6 (13.1-30.1)		24.3 (17.2-31.4)		.381
	41-50	31.1 (23.3-38.9)		40.0 (32.3-47.7)		.073
	51-60	33.7 (26.7-40.8)		56.1 (49.3-62.7)		<.001
	61-70	44.1 (37.1-51.1)		66.3 (60.3-72.2)		<.001
High waist circumference			<.001		<.001	
(IDF criteria)	31-40	51.1 (40.7-61.5)		53.6 (45.4-61.8)		.796
	41-50	62.9 (54.8-71.0)		67.1 (59.7-74.5)		.459
	51-60	70.9 (64.2-77.6)		78.9 (73.4-84.4)		.075
	61-70	82.4 (77.0-87.8)		87.9 (83.8-92.0)		.128
High BP			<.001		<.001	
	31-40	42.7 (32.4-53.0)		17.0 (10.8-23.2)		<.001
	41-50	57.0 (48.6-65.4)		37.2 (29.6-44.8)		.001
	51-60	72.7 (66.0-79.3)		53.1 (46.4-59.8)		<.001
	61-70	81.3 (75.7-86.8)		76.2 (70.9-81.5)		.125
Hypertriglyceridemia			.356		.021	
	31-40	26.1 (17.0-35.2)		8.0 (3.5-12.5)		<.001
	41-50	28.0 (20.4-35.6)		12.7 (7.5-17.9)		<.001
	51-60	31.8 (24.9-38.7)		18.5 (13.3-23.7)		.002
	61-70	23.4 (17.4-29.4)		18.3 (13.4-23.2)		.122
Low HDL-C			.525		.142	
	31-40	22.1 (13.5-30.7)		29.7 (22.2-37.2)		.136
	41-50	27.9 (20.2-35.5)		29.3 (22.2-36.4)		.455
	51-60	25.3 (18.9-31.7)		22.7 (17.0-28.4)		.320
	61-70	21.2 (15.4-27.0)		21.3 (16.2-26.4)		.540
High fasting glucose			<.001		<.001	
	31-40	15.9 (8.3-23.5)		4.3 (1.0-7.6)		.003
	41-50	30.1 (22.4-37.8)		10.4 (5.6-15.2)		<.001
	51-60	48.0 (40.6-55.4)		29.7 (23.5-35.9)		<.001
	61-70	48.7 (41.6-55.8)		35.2 (29.2-41.2)		.003

B. Means of the individual components of MS

MS component	Age stratum (y)	Men		Women		P (men vs women)
		Mean (SD)	P for trend (among age strata)	Mean (SD)	P for trend (among age strata)	
Waist circumference (cm)			<.001		<.001	
	31-40	94.2 (11.9)		81.4 (10.7)		<.001
	41-50	97.2 (13.9)		85.9 (12.6)		<.001
	51-60	98.9 (10.5)		91.2 (14.6)		<.001
	61-70	102.1 (11.5)		93.1 (12.2)		<.001
Systolic BP (mm Hg)			<.001		<.001	
	31-40	125.8 (13.2)		113.3 (12.6)		<.001
	41-50	128.8 (15.6)		120.5 (17.0)		<.001
	51-60	132.9 (15.9)		126.3 (15.6)		<.001
	61-70	136.0 (17.8)		134.1 (17.1)		.268
Diastolic BP (mm Hg)			.041		<.001	
	31-40	78.3 (8.9)		71.0 (9.8)		<.001
	41-50	81.0 (10.2)		75.5 (11.3)		<.001
	51-60	81.9 (10.4)		78.6 (8.9)		.001
	61-70	79.9 (10.3)		79.2 (10.1)		.462
Triglycerides (mg/dL)			.087			
	31-40	131.4 (92.4)		80.7 (43.5)		<.001
	41-50	150.1 (145.6)		95.3 (65.0)		<.001
	51-60	142.7 (91.9)		106.5 (50.8)		<.001
	61-70	123.3 (65.3)		113.4 (58.8)		.100
HDL-C (mg/dL)			.082		.524	
	31-40	46.2 (10.0)		59.6 (16.6)		<.001

Table 1 (*continued*)

B. Means of the individual components of MS

MS component	Age stratum (y)	Men		Women		*P* (men vs women)
		Mean (SD)	*P* for trend (among age strata)	Mean (SD)	*P* for trend (among age strata)	
HDL-C (mg/dL)	41-50	49.3 (18.8)		59.0 (16.9)		<.001
	51-60	50.1 (18.8)		61.4 (16.5)		<.001
	61-70	52.0 (18.6)		60.4 (14.4)		<.001
Glucose (mg/dL)			<.001		<.001	
	31-40	90.6 (10.8)		84.6 (7.5)		<.001
	41-50	98.3 (28.0)		87.8 (9.9)		<.001
	51-60	106.6 (29.0)		96.0 (20.3)		<.001
	61-70	107.5 (28.4)		100.9 (27.0)		.014

The number of subjects in each age stratum was as follows: 31 to 40 years, 89 men and 141 women; 41 to 50 years, 135 men and 156 women; 51 to 60 years, 176 men and 211 women; and 61 to 70 years, 192 men and 244 women. CI, confidence interval; SD, standard deviation; HDL, high density lipoprotein.

individuals. High CRP levels were observed in 35% of individuals. In the univariate analysis, high CRP was associated with sedentarism ($P < .01$) but not with sex, smoking, education, or area of residence. An almost significant association was found for age ($P = .06$). Metabolic syndrome and all its individual components (except for HDL-C) were associated with high CRP levels, with the strongest association being found for high waist circumference ($P < .001$). There was a gradual increase in the levels of logCRP with increasing numbers of MS components (Fig. 3).

In a multiple logistic regression analysis, high CRP was more frequent among participants who had MS than among those who did not (OR, 1.74 [1.27-2.38]) after controlling for age, sex, and physical activity. A backward stepwise logistic regression analysis with age, sex, educational level, physical activity, and all 5 components of MS added as continuous independent variables showed that waist circumference (in centimeters) and low educational level were the best predictors for high CRP (Table 3).

4. Discussion

The present study provides a comprehensive description of the prevalence and clinical features of MS in a Madrid adult population. To the best of our knowledge, this is the first study to estimate the frequency of MS in a large Spanish city and one of the few that describe the sociodemographic factors associated with MS in Mediterranean countries.

Spain, along with Italy and Portugal [12], is one of the European countries with the lowest cardiovascular mortality rates. However, there is a considerable regional variation with a north to south gradient. The Madrid region has been reported to have low rates of cardiovascular disease incidence and mortality within Spain [13].

4.1. Agreement between ATP III and IDF definitions of MS

The IDF definition produced greater prevalence estimates for MS than did the ATP III because the former definition has a lower threshold of abdominal obesity. In our study, the prevalence by the IDF definition was 6.4% higher than that by the ATP III. In addition, the difference in prevalence was larger among women than among men. Similar differences between estimates by both definitions were observed in studies based on populations in the United States [9,14], Central and South American cities [9], and Europe[15]. In contrast, a study performed in a Korean population found similar prevalence estimates by both

Table 2
Multivariate-adjusted ORs of sociodemographic and lifestyle variables for ATP III–defined MS by logistic regression analysis

	β	OR	95% CI	*P*
Age (>50 y vs ≤50 y)	.961	2.616	1.964-3.484	<.001
Sex (male vs female)	.261	1.298	1.009-1.671	.042
Physical activity (no vs yes)	.668	1.950	1.506-2.525	<.001
Educational level (low vs medium-high level)	.483	1.621	1.249-2.103	<.001
Area of residence (urban vs rural)	.395	1.484	1.067-2.064	.019

The variables introduced in the model were age (years), sex (male vs female), physical activity (no vs yes), educational level (low vs medium-high), and area of residence (urban vs rural).

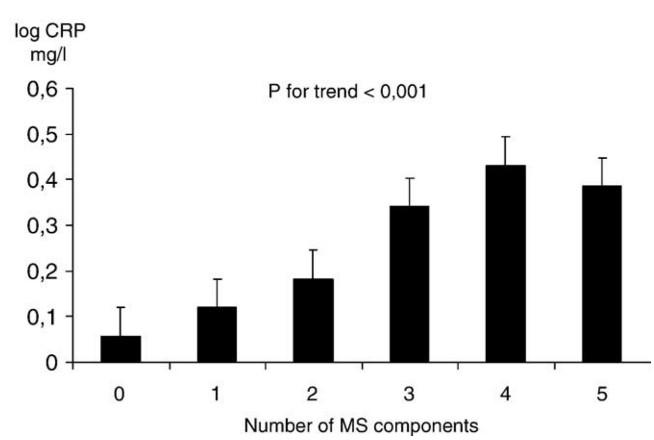

Fig. 3. Levels of CRP by components of ATP III–defined MS. Data are presented as means ± SE. The CRP levels were available in 843 subjects. Data were adjusted by age.

Table 3
Results of backward stepwise logistic analysis with high CRP (>3 mg/L) as the dependent variable

Independent variables	*β*	OR	95% CI	*P*
Sex (female vs male)	.298	1.347	0.986-1.840	.061
Waist circumference (cm)	.033	1.034	1.021-1.046	<.001
Educational level (low vs medium-high)	.312	1.366	1.015-1.839	.04

The variables introduced in the model were age (years), physical activity (yes/no), systolic BP (millimeters of mercury), triglycerides (millimoles per liter), HDL-C (millimoles per liter), waist circumference (centimeters), glucose (millimoles per liter), and educational level (low vs medium-high).

MS definitions [16]. Although we found good overall agreement between the ATP III and IDF definitions, it was much closer in women than in men ($\kappa = 0.92 \pm 0.07$ vs $\kappa = 0.66 \pm 0.06$).

4.2. Prevalence of the MS

Overall age- and sex-adjusted prevalence of MS (2005 ATP III criteria) was close to 25%, which represents one of the highest frequencies of MS reported in a Spanish general population [9-11]. Only studies performed in the Canary Islands [10] showed similar prevalences. Our estimates on MS frequency are also significantly higher than those reported in nearby countries, such as Italy [17] and France [7], but lower than those from the United States [6] and Greece [18]. The high prevalence observed in the present study could be partially explained by the fact that we used the revised ATP III criteria [4], whereas most mentioned studies used the original [3]. In our study, the frequency of MS by the modified ATP III criteria was 4.6% higher than that by the original one's criteria. However, there may be other additional causes: it is likely that people living in the large city of Madrid have different lifestyle and nutritional habits than those living in smaller neighboring communities where a lower frequency of MS was found. A recent population-based study from Segovia [11] (a neighboring region of Madrid) found a 17% prevalence of MS defined by the revised ATP III criteria. The authors also reported a lower percentage of sedentarism and obesity as compared with the population herein studied. Our data agree with those published in other surveys performed in our region in which an increase in obesity and sedentarism rates was reported [19]. Nutritional factors might play a role in promoting a high frequency of MS in our region. A 2006 Madrid survey [20] reported a decrease in the consumption of some ingredients of the traditional Mediterranean diet, such as wine and legumes, and an increase in the consumption of precooked food and restaurant meals.

A Spanish study by Schröder et al [21] showed that the adherence to the Mediterranean diet was inversely associated with BMI and obesity. In the ATTICA study [22], a health and nutritional study performed in Athens, the OR of having MS among participants who consumed the Mediterranean diet was 0.81 (95% CI, 0.68-0.97), compared with those who did not, after controlling for several confounding factors.

This trend toward a higher consumption of a nonhealthy diet, along with an increase in sedentarism and obesity rates, has also been reported in other European countries and the United States [23,24].

The prevalence of MS increases with age in both sexes, reaching peak levels in the sixth and seventh decades [6,7]. In our study, the OR of having ATP III–defined MS in subjects aged >50 years was more than twice that of participants who were ≤50 years. Most studies found similar MS frequencies in both sexes [6,7,17]. Unlike these, we found a higher overall frequency of MS in men than in women. However, this difference was limited to the younger participants (aged <50 years). Women older than 50 years experienced a sharp increase of abdominal obesity, compared with men, leading to a similar frequency of MS in both sexes in this age group. The increase in waist circumference at this age can be partially attributed to menopausal hormonal changes. In a recent population survey [25], both insulin resistance and menopause had a significant effect on MS independent of age and obesity. The synergistic contribution of insulin resistance and menopause to the components of MS was found particularly in BP and waist circumference.

4.3. Social and lifestyle characteristics

Metabolic syndrome was twice as frequent in sedentary subjects as in physically active ones. This higher frequency remained even after adjusting for other covariables, such as abdominal obesity. It is known that increased physical activity favorably modifies several cardiovascular risk factors, including improvement of insulin sensitivity, increase of HDL-C, and decrease of triglyceride levels [26]. The independent association between physical activity and MS has not been widely studied. In middle-aged French subjects, the frequency of most MS components increased with time spent in front of a screen and decreased with increasing physical activity [27]. In the NHANES III survey [28], the OR for MS significantly increased for sedentarism only in men (OR, 1.4; 95% CI, 1.0-2.0).

There is limited information on the relationship between socioeconomic variables and MS prevalence. Education is considered to be an important indicator of socioeconomic level. In our study, we observed a significant association of low educational levels with high prevalence of MS for both sexes. This relationship remained even after adjusting for other sociodemographic factors and BP, but did not remain significant after controlling for BMI. Studies performed in Mediterranean countries [10,11,29] found that low educational level was associated with increased prevalence of MS, although multivariable adjusted ORs were not estimated.

Two European studies compared the prevalence of MS in urban vs rural populations. These studies, performed in Central Spain [11] and Greece [18], showed similar frequencies of MS in urban and rural areas. In the present study, we found that men living in urban areas had a higher prevalence of MS than those living in rural ones. Interestingly, a recent study performed in Central America [30] showed that the frequency of MS was not influenced by the habitat per se (urban or rural), but by differences in physical activity level, mainly attributable to occupation. Unfortunately, we have not been able to confirm this fact in our population because we neither have assessed the type of occupation nor have applied a validated physical activity questionnaire. However, considering that more than 50% of Madrid rural inhabitants work in service sectors, it is plausible that other socioeconomic and lifestyle variables, rather than occupation, are responsible for the difference in MS prevalences between urban and rural areas.

4.4. Relationship with CRP

The clustering of CRP with obesity, diabetes mellitus, and traditional risk factors has been addressed in a number of studies. Patients with MS have higher levels of CRP than those without the syndrome [30,31]. A particular strength of this study is that most confounding factors for MS risk were carefully taken into consideration in the regression analyses.

In our survey, the strongest association between ATP III criteria and CRP levels was found for waist circumference. Juhan-Vague et al [32] first demonstrated a significant linear increase of CRP levels with increasing insulin concentrations. This could explain our finding of a gradual increase in logCRP levels with increasing numbers of MS components.

In the NHANES study [33], cardiovascular disease was more common in those subjects with MS or diabetes who had high CRP, after adjusting for several covariables. Therefore, the authors suggested that stratification by CRP might add prognostic information in patients with MS or diabetes.

The main limitation of the present study is that CRP levels were determined only in a subgroup of individuals and at a single time point. However, the sociodemographic characteristics in the subjects in whom CRP was determined were not significantly different from those in whom CRP was not available. On the other hand, we cannot exclude that some subjects had a transient increase of CRP levels because of an acute inflammatory process, although primary care physicians excluded from this substudy those subjects with known inflammatory, infectious, or neoplasic diseases.

5. Conclusions

Our study shows that the prevalence of MS in the Madrid region is one of the highest in Europe and confirms the strong Spanish regional variability in MS frequency. Some sociodemographic and lifestyle factors, particularly education, are associated with the presence of MS and a systemic inflammatory response.

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