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Variables influencing the appearance of metabolic syndrome with three different definitions in 418.343 spanish workers

Variables que influyen en la aparición del síndrome metabólico con tres definiciones diferentes en 418.343 trabajadores españoles

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Abstract

Introduction: Metabolic syndrome (MS) is a clinical entity whose prevalence is increasing worldwide. It is a multifactorial condition that increases cardiovascular risk. The aim of this study is to assess the influence of sociodemographic variables and healthy habits on the appearance of MS.
Material and methods: Descriptive and cross-sectional study in 418.343 Spanish workers in which the influence of sex, age, social class, educational level, physical activity, adherence to the Mediterranean diet and tobacco consumption on the prevalence of metabolic syndrome was assessed by applying three different criteria: NCEP ATPIII, IDF and JIS.
Results: Multivariate analysis showed that the variables that most increased the risk of presenting MS were sedentary lifestyle, low adherence to the Mediterranean diet and age. Of all the variables analyzed, the only one that showed no influence was social class.
Conclusions: In our study, all the variables analyzed except social class increased the risk of MS, of which the most influential were low physical activity, low adherence to the Mediterranean diet, and age.

Keywords: Metabolic syndrome, physical activity, adherence to the Mediterranean diet.

Resumen

Introducción: El síndrome metabólico (SM) es una entidad clínica que va aumentando su prevalencia en el mundo. Es un cuadro multifactorial que incrementa el riesgo cardiovascular. El objetivo de este estudio es valorar la influencia de variables sociodemográficas y hábitos saludables en la aparición de SM.
Material y métodos: Estudio descriptivo y transversal en 418.343 trabajadores españoles en los que se valora la influencia del sexo, la edad, la clase social, el nivel de estudios, la actividad física, la adherencia a la dieta mediterránea y el consumo de tabaco en la prevalencia de síndrome metabólico determinado aplicando tres criterios diferentes: NCEP ATPIII, IDF y JIS.
Resultados: En el análisis multivariante se observa que las variables que más incrementan el riesgo de presentar SM son el sedentarismo, la baja adherencia a la dieta mediterránea y la edad. De todas las variables analizadas la única que no muestra influencia es la clase social.
Conclusiones: En nuestro estudio todas las variables analizadas salvo la clase social incrementan el riesgo de SM, de ellas las que más influyen son la baja actividad física, la escas adherencia a la dieta mediterránea y la edad.

Palabras clave: Síndrome metabólico, actividad física, adherencia a la dieta mediterránea.

Introduction

Metabolic syndrome (MS) is a clinical entity that groups together in the same person different metabolic alterations such as abdominal obesity, elevated triglycerides, lower HDL cholesterol, increased blood pressure and hyperglycemia[1].

MS is currently considered one of the most important public health problems[2]. Its presence is five times the prevalence of diabetes mellitus[3] and almost three times the prevalence of cardiovascular disease[4], which translates into a significant increase in health care costs worldwide[5].

MS has been known for a century thanks to the studies of Kylin in Sweden[6]. Since this first approach to the problem, which included hypertension, hyperglycemia and gout, there have been different definitions. Currently, the most commonly used criteria are those of the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP-III)[7] and those of the International Diabetes Federation (IDF)[7].

Many risk factors have been associated with the appearance of MS, including advanced age[8], low socioeconomic level[9], family history[10], genetics[11], obesity[12], polycystic ovary[13], psoriasis[14], sleep disorders[15], and sarcopenia[16], among others.

The aim of this study was to assess whether there is an association between the appearance of MS (applying three different criteria) and different sociodemographic variables (age, sex, social class, and level of education) and healthy habits (physical activity, adherence to the Mediterranean diet, and tobacco consumption).

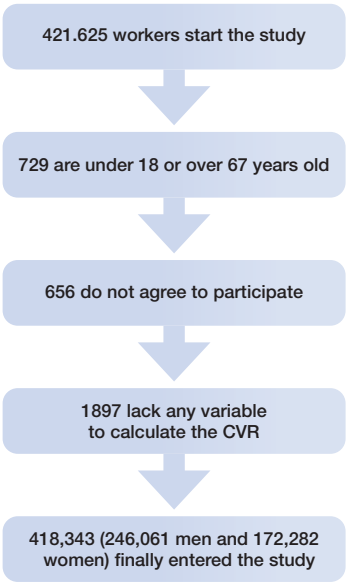
Methods

A descriptive and cross-sectional study was carried out in 418343 workers from different regions of Spain and from different labor sectors, mostly public administration, health, construction and commerce. The workers were selected from those who attended the periodic medical examinations of the companies January 2017 and December 2019.

Inclusion criteria:

- Age between 18 and 67 years.
- Working in one of the companies included in the study.
- Not being in a situation of temporary disability.
- Sign informed consent to participate in the study and to use their data for epidemiological purposes.

Figure 1: Flow diagram of the study participants.



Measurements and data collection

Different anthropometric and analytical parameters were measured in the people who participated in the study.

The anthropometric, clinical and analytical determinations were performed by the occupational health professionals of the companies, after standardization of the different measurement techniques.

Weight and height were obtained from the SECA model scale-measuring scale. Waist circumference (WC) was measured while standing upright, feet together, trunk straight and abdomen relaxed. The measuring tape was placed parallel to the floor at the level of the last floating rib.

Blood pressure was obtained with a calibrated OMRON M3 automatic sphygmomanometer while seated and after at least 10 minutes of rest. Three determinations were made at one-minute intervals and the mean of the three was obtained. Blood parameters were obtained after at least 12h of fasting. Samples were processed in reference laboratories within 48-72 hours. Glycemia, total cholesterol and triglycerides were determined by automated enzymatic methods. HDL-c was determined by a precipitation process with dextran sulfate-MgCl2. LDL-c was calculated indirectly by applying the Friedewald formula, which is valid for triglyceride values below 400 mg/dL. All these parameters are expressed in mg/dL.

Friedewald formula: LDL = cholesterol - HDL - triglycerides/5

Five age groups were established: 18 to 29 years, 30 to 39 years, 40 to 49 years, 50 to 59 years, and 60 to 67 years.

Social class was obtained from the proposal of the social determinants group of the Spanish Society of Epidemiology[17]. Three categories were considered: Class I: directors/managers, university professionals, sportsmen and artists; Class II: intermediate occupations and skilled self-employed workers; Class III: unskilled workers.

The level of education was classified as primary or elementary, secondary and university. We considered smokers to be those who had consumed at least one cigarette daily (or its equivalent in other types of consumption) during the last month, or had quit smoking less than 12 months before.

Heart-healthy eating habits are determined with the "Mediterranean diet adherence questionnaire" used in the PREDIMED study[18]. The questionnaire consists of 14 questions that are scored with 0 and 1 point. Values of 9 or more indicate good adherence and therefore that the diet is heart-healthy.

Physical activity is assessed with the International Physical Activity Questionnaire (IPAQ), which evaluates the physical activity performed in the last week[19].

19 To assess the metabolic syndrome (MS), we used 3 different criteria, those of the National Cholesterol Education Program Adult Treatment Panel III (NCEP/ATP-III), the Joint Interim Statement (JIS) and the update of the International Diabetes Federation (IDF)[20].

Statistical analysis

A descriptive analysis of the categorical variables was performed, calculating the frequency and distribution of the responses for each of them. For quantitative variables, the mean and standard deviation were calculated following a normal distribution.

Bivariate association analysis was performed using the chi2 test (with correction for Fisher's exact statistic when conditions required it) and Student's t test for independent samples (for comparison of means). Multivariate techniques were used to establish the variables associated with the most significant risk factors. Multinomial logistic regression was used for multivariate analysis, with calculation of the odds ratio and the Hosmer-Lemeshow goodness-of-fit test. Statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS) version 28.0 (IBM Company, New York, NY, USA) for Windows, with an accepted statistical significance level of 0.05.

Ethical considerations and/or aspects

The research team undertook at all times to follow the ethical principles of health sciences research established nationally and internationally (Declaration of Helsinki), paying special attention to the anonymity of the participants and the confidentiality of the data collected.

Approval was requested from the Ethics and Research Committee of the Balearic Islands (CEI-IB), which was obtained with indicator IB 4383/20. Participation in the study was voluntary, so the participants gave their written and oral consent to participate in the study after receiving sufficient information about the nature of the study. To this end, they were given an informed consent form, as well as an information sheet explaining the objective of the study. The data collected for the study were identified by a code and only the person responsible for the study can relate these data to the participants. The identity of the participants will not be disclosed in any report of this study. The investigators will not disseminate any information that could identify them. In any case, the research team undertakes to strictly comply with the Organic Law 3/2018, of December 5, on the protection of personal data and guarantee of digital rights, guaranteeing the participant in this study that he/she may exercise his/her rights of access, rectification, cancellation and opposition of the data collected.

Results

Table I shows the anthropometric and clinical characteristics of the 418.343 (246.061 men and 172.282 women) persons included in the study. The mean age of the sample was 40.2 ± 11.0 years, the largest group being between 30 and 49 years. Anthropometric, clinical and analytical values were more unfavorable in men. Most people belonged to social class III and had primary education. More than half of them do not engage in regular physical activity and do not have a heart-healthy diet. One out of three workers smoked.

Table II shows the prevalence of metabolic syndrome, applying the three criteria, according to the different sociodemographic variables and healthy habits. The prevalence, applying any of the criteria, increases with age, as one descends in social class or level of education. Smokers, sedentary people or those with low adherence to the Mediterranean diet have higher prevalences of MS. In all cases, the prevalence of MS is higher in men.

Table III shows the results of the multivariate analysis using multinomial logistic regression. The risk of presenting metabolic syndrome with the three criteria is greater in men, with increasing age, in people with a lower level of education, in sedentary people, in those with low adherence to the Mediterranean diet, and in smokers. The variables that most increase the risk of presenting MS are sedentary lifestyle, followed by diet and age. It should be noted that social class showed no effect on the appearance of MS.

Table I: Characteristics of the population.

	Women n=172.282 Mean ± SD	Men n=246.061 Mean ± SD	Total n=418.343 Mean ± SD	p-value
Age	39.6 (10.8)	40.6 (11.1)	40.2 (11.0)	<0.0001
Height	161.8 (6.5)	174.6 (7.0)	169.4 (9.3)	<0.0001
Weight	66.2 (14.0)	81.4 (14.7)	75.1 (16.2)	<0.0001
BMI	25.3 (5.2)	26.7 (4.5)	26.1 (4.8)	<0.0001
Waist	74.8 (10.6)	86.2 (11.1)	81.5 (12.2)	<0.0001
SBP	117.4 (15.7)	128.2 (15.5)	123.7 (16.5)	<0.0001
DBP	72.6 (10.4)	77.8 (11.0)	75.6 (11.0)	<0.0001
Cholesterol	190.6 (35.8)	192.6 (38.9)	191.8 (37.7)	<0.0001
HDL-c	56.8 (8.7)	50.3 (8.5)	53.0 (9.1)	<0.0001
LDL-c	116.1 (34.8)	118.0 (36.7)	117.2 (35.9)	<0.0001
Triglycerides	89.1 (46.2)	123.7 (86.4)	109.5 (74.6)	<0.0001
Glycaemia	87.8 (15.1)	93.3 (21.3)	91.0 (19.2)	<0.0001
	%	**%**	**%**	**p-value**
18-29 years	20.7	18.8	19.6	<0.0001
30-39 years	3.0	27.6	17.4	
40-49 years	29.6	30.0	29.9	
50-59 years	16.8	19.7	18.5	
60-69 years	3.2	3.9	3.6	
Primary school	51.8	61.2	57.3	<0.0001
Secondary school	40.7	34.0	36.8	
University	7.5	4.8	5.9	
Social class I	6.9	4.9	5.7	<0.0001
Social class II	23.4	14.9	18.4	
Social class III	69.7	80.3	75.9	
No physical activity	47.8	54.5	51.7	<0.0001
Yes physical activity	52.2	45.5	48.3	
No mediterranean diet	48.6	59.0	54.7	<0.0001
Yes mediterranean diet	51.4	41.0	45.3	
Non-smokers	67.2	66.6	66.8	<0.0001
Smokers	32.8	33.4	33.2	

SBP systolic bllood pressure. DBP diastolic blood pressure.

Table II: Prevalence of metabolic syndrome with different criteria according to sociodemographic variables and healthy habits.

	Women n	ATPIII %	p-value	IDF %	p-value	JIS %	p-value	Men n	ATPIII %	p-value	IDF %	p-value	JIS %	p-value
18-29 years	35617	0.86	<0.0001	1.39	<0.0001	1.77	<0.0001	46215	2.79	<0.0001	4.08	<0.0001	3.79	<0.0001
30-39 years	5115	1.99		2.69		3.13		67798	6.31		8.32		8.16	
40-49 years	51017	4.19		5.40		7.01		73935	11.51		14.70		14.92	
50-59 years	28951	9.15		7.93		13.13		48522	14.68		19.00		20.20	
60-69 years	5582	12.63		9.98		18.33		9591	14.48		21.44		24.06	
Primary school	89221	4.63	<0.0001	5.16	<0.0001	7.40	<0.0001	150602	9.40	<0.0001	12.20	<0.0001	12.51	<0.0001
Secondary school	70082	2.97		3.37		4.56		83734	8.09		10.86		10.88	
University	12979	2.27		2.34		3.10		11725	6.92		9.01		9.81	
Social class I	11894	2.46	<0.0001	2.38	<0.0001	3.20	<0.0001	11950	6.85	<0.0001	9.07	<0.0001	9.72	<0.0001
Social class II	40266	2.98		3.36		4.58		36590	7.97		10.90		10.77	
Social class III	120122	4.38		4.92		6.98		197521	9.17		11.92		12.21	
No physical activity	82373	7.71	<0.0001	8.63	<0.0001	11.99	<0.0001	134023	16.22	<0.0001	20.71	<0.0001	21.42	<0.0001
Yes physical activity	89909	0.68		0.71		0.78		112038	1.13		1.68		1.69	
No mediterranean diet	83651	7.57	<0.0001	8.48	<0.0001	11.76	<0.0001	145286	14.91	<0.0001	19.09	<0.0001	19.70	<0.0001
Yes mediterranean diet	88631	0.71		0.74		0.81		100775	1.92		2.04		1.89	
Non-smokers	115727	3.77	<0.0001	4.15	<0.0001	5.76	<0.0001	163920	7.35	<0.0001	10.75	<0.0001	10.19	<0.0001
Smokers	56555	3.81		4.38		6.23		82141	11.36		13.02		14.60	
Total	172282	3.78		4.22		5.92		246061	8.84		11.59		11.83	

Table III: Multinomial logistic regression.

	NCEP-ATPIII OR (95% CI)	IDF OR (95% CI)	JIS OR (95% CI)
Women	1	1	1
Men	2.07 (1.98-2.17)	2.62 (2.51-2.73)	1.83 (1.76-1.90)
18-29 years	1	1	1
30-39 years	1.11 (1.02-1.21)	1.18 (1.09-1.28)	1.34 (1.25-1.45)
40-49 years	1.43 (1.32-1.56)	1.39 (1.28-1.50)	1.81 (1.68-1.94)
50-59 years	2.13 (1.95-2.33)	2.04 (1.88-2.21)	2.83 (2.62-3.05)
60-69 years	3.50 (3.13-3.91)	3.01 (2.73-3.32)	4.32 (3.94-4.75)
Primary school	1	1	1
Secondary school	1.17 (1.11-1.24)	1.16 (1.11-1.22)	1.19 (1.13-1.25)
University	1.43 (1.14-1.789)	1.45 (1.19-1.78)	1.46 (1.20-1.77)
Social class I	1	1	1
Social class II	46.44 (35.80-60.23)	13.83 (12.12-15.77)	18.45 (16.05-21.22)
Social class III	1	1	1
No physical activity	5.37 (4.38-6.58)	3.25 (2.86-3.70)	3.73 (3.27-4.24)
Yes physical activity	1	1	1
No mediterranean diet	1.73 (1.67-1.80)	1.39 (1.34-1.44)	1.69 (1.64-1.75)

Discussion

All the sociodemographic variables analyzed, with the exception of social class, influence the appearance of MS applying any of the three criteria. Smoking, level of physical activity and adherence to the Mediterranean diet also have an influence. Of these, the one that most increases the risk of MS is sedentary lifestyle, followed by low adherence to the Mediterranean diet and age.

In our study, the prevalence of MS is considerably higher in men with the three scales and in all age groups, although the differences become smaller as age increases. This data partially coincide with those found in a review by Pucci et al[21], since in this study the prevalence in women exceeds that of men after the age of 50 years, that is, after menopause. The explanation given by the authors is that this is due to several factors, some related to sex and others to gender. Those related to sex are due to hyperandrogenism, insulin resistance and the associated increase in abdominal obesity and reduction of HDL cholesterol that appears after menopause. Those related to gender are sensitive to social and cultural behaviors, dietary habits and psychosocial factors. Women are more likely than men to develop MS in response to work stress and low socioeconomic status. The negative effect of menopause on the prevalence of MS was also highlighted in a meta-analysis by Pu et al[22] in which the main conclusion was that menopause negatively affects all components of MS. Similar results were found in another meta-analysis by Hallajzadeh et al[23].

Our work shows the negative effect of more unfavorable socioeconomic levels on the prevalence of MS. A study carried out in a Mexican population by Bustamante-Villagómez et al[24] in which the influence of quality of life and socioeconomic status on MS was assessed showed that lower quality of life and low socioeconomic status increased the risk of MS; however, if quality of life was improved, the negative effect of low socioeconomic status on MS could be diminished. A study by Zhan et al[25] in the Chinese population found an association between lower levels of income and education and a higher prevalence of MS, although statistical significance was only found in women. In the Iranian population, Gharipour et al[26] also found a higher prevalence of MS in persons with lower socioeconomic levels.

Our study has shown the negative effect of smoking, sedentary lifestyle, and low adherence to the Mediterranean diet on the prevalence of MS.

There is unanimity in considering the beneficial effect of physical activity on MS, and both observational and interventional studies suggest this protective role. Each of the components of MS is, to some extent, favorably influenced by interventions that include physical activity[27-29].

There is also unanimity on the beneficial effect of the Mediterranean diet on MS. The Mediterranean diet can be considered a therapy for MS as it prevents the formation of abnormal fat[30-32].

The negative effect of smoking on MS observed in our study was also seen in a study in Palestinian adolescents by Damiri et al[33]. Another study by Bermudez et al[34] in more than 2000 Venezuelan adults of both sexes showed that smoking was associated with lower HDL values, increased waist circumference and elevated triglycerides.

Strengths and limitations

The strengths of the study include the large sample size (more than 400,000 workers) and the variety of metabolic

syndrome criteria, sociodemographic variables and healthy habits used. Among the possible limitations, we would point out that the study was carried out in the 18-67 age group (working population), which could prevent extrapolation of the results to the entire population. In addition, there may be a sample selection bias since the study included people who go for occupational medical check-ups, so that they could be people who are more concerned about their health.

Conclusions

Male sex, age, educational level, physical activity, adherence to the Mediterranean diet, and tobacco consumption influence the appearance of MS applying any of the three criteria. Social class has shown no influence.

Conflict of Interest

The authors declare that no competing interests exist.

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