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ORIGINAL RESEARCH ARTICLE

Workers particularly sensitive to cardiovascular risk

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ABSTRACT

Background: Of the 607 fatal occupational accidents that occurred in Spain in 2016, 37.9% were due to ischemic heart disease and stroke. Working conditions such as night work, noise or respiratory contaminants were associated with a higher cardiovascular incidence. The aim of the present study was to assess whether health surveillance in workers exposed to these conditions should include assessment of cardiovascular risk.

Subjects and methods: A cross-sectional study was conducted in 680 workers in a public administration. The qualification of working conditions was obtained from the company risk assessment and from personal, anthropometric and analytical data, which allowed the assessment of cardiovascular risk in the medical examination performed in 2015.

Results: 30.1% of the sample were exposed to these working conditions, with significant differences by sex (37% in men, 11.9% in women, $p<0.05$). According to REGICOR, 13.2% of those exposed were classified as particularly sensitive to cardiovascular risk.

Conclusions: A large percentage of workers are exposed to TC related to a greater prevalence of cardiovascular pathology. The percentage of workers classified as especially sensitive to cardiovascular risk among those exposed suggests that this risk should be assessed in occupational health surveillance when there are working conditions related to cardiovascular pathology.

Keywords: occupational accident, ischemic heart disease, cardiovascular risk function, health surveillance, special sensitivity

1. Introduction

Cardiovascular diseases are the leading cause of mortality in Spain, accounting for 29.4% of all deaths, with a circulatory mortality rate of 267.6 per 100,000 people[1] .

The Law on Occupational Risk Prevention[2] considers as “work-related damages those illnesses, pathologies or injuries suffered as a result of or on the occasion of work”. Case law has been including in

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the term "bodily injury" diseases of sudden onset, which has led to acute myocardial infarction and cerebrovascular accident, occurring in the workplace and during working hours, and if it is not proven that the working conditions (TC) have not intervened in their production (iuris tantum), being considered an occupational accident[3] .

In 2016, fatal occupational accidents were reported in Spain[4] 607, of which cardiovascular disease (CVD) was responsible for 37.9%. Workers are entitled to effective occupational health and safety protection. Preventive measures include health surveillance, which should establish whether the worker's biological state or personal characteristics make him or her particularly sensitive.

Marmot et al[5] observed differences in cardiovascular health according to social class. Subsequently, evidence of the association of certain TC with cardiovascular disease became more evident. Night and shift work has been associated with a higher incidence of cardiovascular disease[7–10], dementia[11] , diabetes[12] and breast cancer[13], although there is no unanimity regarding the latter[14–18] . Noise has been associated with cardiovascular risk, hypertension, ischemic heart disease and diabetes[19–26].

The increased risk of cardiovascular disease, ischemic heart disease, metabolic disorders (such as low high-density lipoprotein or high blood glucose levels) and cerebrovascular disease has been related to psychosocial work factors such as low levels of control[27,28], high stress[25,29], imbalance between effort and reward(31) or long working hours[32,33]. Workers exposed to high concentrations of environmental pollutants such as professional drivers[34,35], welders[36], miners[37]or metalworkers[38] have a higher prevalence and incidence of cardiovascular disease.

In Spain, there are frequent studies in primary care[39–43] that assess the risk of developing cardiovascular processes in the future, most notably the regidor and score scales[44] . The European Society of Cardiology for the Prevention of Cardiovascular Disease proposes the SCORE risk calculation to identify CVR.

The general objective of the present study was to consider whether, in the light of the current scientific evidence on TC, CVD, and labor legislation, it would be appropriate to include the assessment of cardiovascular risk using scales validated for the Spanish population (such as REGICOR or Score Heart) for health surveillance in workers exposed to certain TC. The secondary objectives were to propose criteria for the qualification of workers exposed to cardiovascular risk and to determine the prevalence of CVR exposure in a working population belonging to a public administration.

2. Subjects and methods

The occupational health unit of a local public administration in southern Spain developed a cross-sectional study with 1,800 workers based on health surveillance carried out during 2015.

The sample size was established on the basis of an expected prevalence of metabolic syndrome (MetS)[45] in workers of 12.4%, an absolute precision of 2.5% and a safety of 95%, obtaining a minimum value of 484 workers by using the Epidat4.2 epidemiological-statistical program. 680 workers were finally studied among those who underwent health surveillance and met the inclusion criteria.

The inclusion criteria were to be a non-temporary worker, to be over 35 years of age, and to have the required data for the study. Those who did not meet the inclusion criteria or who had presented CVD or diabetes mellitus prior to admission were excluded.

Variables and their measurement:

- Age (years).
- Sex: male (M) or female (F).
- Weight in kg (P).
- Size in meters (T).
- Systolic blood pressure in mmHg (SBP).

- Diastolic blood pressure in mmHg (DBP).
- Total cholesterol in mg/dl (TC).
- Cholesterol bound to high-density lipoproteins (Co-HDL mg/dl).
- Low-density lipoprotein cholesterol (Co-LDL mg/dl).
- Basal glucose in mg/dl (GLUC).
- Tobacco use: smokers were considered smokers if they smoked 1 cigarette or more per day.
- Physical activity according to the IPAQ questionnaire[46] .
- Body Mass Index (BMI), kg/height$^{(2)}$ in meters.
- Metabolic syndrome (Smet) according to harmonized criteria[47].
- Coronary risk according to algorithm derived from the Registre Gironí del Cor (REGICOR)[39].

Mortality risk per cardiovascular event according to SCORE calibrated for Spain[44] .

A scale and an Atlántida S11 stadiometer were used to measure height and weight. Blood pressure was measured using an automatic sphygmomanometer (OMROM-M3) and according to the guidelines of the Spanish Guide to Arterial Hypertension 2013(48), always taking at least two measurements. If there were differences of more than 10mmHg, a third measurement was taken, with an interval of one minute between measurements, and the average value was then used.

Blood samples for the determination of analytes were obtained by venipuncture after twelve hours of fasting, and were analyzed following standardized automated procedures in clinical biochemistry (ILAB-600 automator).

The workers studied belonged to four professional groups: technical-administrative personnel, tradesmen (gardening, carpentry, driving, masonry, electricity, etc.), auxiliary personnel (orderlies, watchmen) and security personnel (police and firemen). Exposure was considered to be under one or more of the following working conditions, in accordance with the company's risk assessment according to current regulations:

- Night work is work that takes place "between 10 p.m. and 6 a.m." and night workers are considered to be those who "spend no less than three hours of their daily work or at least one third of their annual working time on this type of schedule", as established by the Workers' Statute[49].
- Work with exposure to noise[50] or vibration (Royal Decree 286/2006 and Royal Decree 1311/2005, respectively) where the lowest exposure level (LAeq,d=80 dB(A) or Lpico=135 dB (C)) or an acceleration equal to or greater than 2.5 m/s^2 is reached.
- Jobs with exposure to psychosocial risk are those considered as target population by the health surveillance protocol for workers exposed to psychosocial risks PSICOV-2012 (responsibility towards third parties, under control and high demand, in direct attention to people, with shifts, shift work or with a score greater than or equal to 12 in the Psychosocial Risk Index Q10-FRP).

The criterion for classifying a worker as having special cardiovascular sensitivity due to the condition of his or her work was defined among those exposed with a CVR classified as moderate, high or very high according to the SCORE or REGICOR scales.

Informed consent was obtained in accordance with current legislation. The study protocol complied with the Declaration of Helsinki; according to the 2000 revision for medical studies, and was approved by the Bioethics Commission of the Doctoral Program of the University of Cordoba.

Quantitative variables were presented with mean and standard deviation and qualitative variables were shown as percentages. The Kolmogorov-Smirnov test was used to contrast the goodness-of-fit to a normal distribution if N>50 and the Shapiro-Wilk test if N<50. The contrast of the differences between two independent means was performed using Student's t test or the Mann-Whitney U test, as indicated. Comparison of percentages was performed using the chi-squared test. The level of statistical significance was set in all contrasts for an alpha error

of less than 5%, and confidence intervals were calculated with 95% confidence.

3. Results

The percentages of men and women studied were 72.8% and 27.2%, respectively, with no significant differences with respect to the workforce (**Table 1**).

Thirty-seven percent of the men belonged to the group exposed to TC related to cardiovascular risk, compared to 11.9% of the women, with a significant difference ($p<0.05$) by sex. Of the total number of exposed workers, 84.9% belonged to security, 8.3% were technical-administrative personnel and 5.9% belonged to trades.

Regarding the analytical and anthropometric variables related to cardiovascular risk (**Table 2**), the mean TC, glucose, and BMI were found to be above normal values (TC<200 mg/DL, glucose<100 mg/LD, and BMI<25). The mean cardiovascular risk of the population studied, calculated according to the SCORE scale, was found to be within the moderate risk group. The group of exposed workers, with a lower mean age than the non-exposed group, showed better performance in the means of TC, glucose, smoking prevalence and physical activity, while the non-exposed group showed better performance in HDL cholesterol, BMI, DBP and CC. The 10-year cardiovascular risk according to the REGICOR and Score scales was significantly lower in the exposed group.

Table 1. Distribution of the sample according to gender and job positions and according to exposure to cardiovascular risk conditions

riables		**Global (n, %)**	**Exposed (n, %)**	**Not exposed (n, %)**	**p[1]**	**p[2]**	**p[3]**
Genre	Sample	680	205 (30,1)	475 (69,9)	<0,001	<0,001	-
	Women	185 (27,2)	22 (11,9)	163 (88,1)			
	Men	495 (72,8)	183 (37)	312 (63)			
Post	Administration	261 (38,4%)	17 (6,5%)	244 (93,5%)		-	<0,001
	Manual trades	138 (20,3%)	12 (8,7%)	126 (91,3%)			
	Auxiliary personnel	107 (15,7%)	2 (1,9)0%	105 (98,1%)			
	Security	174 (25,6%)	174 (100%)	(0) 0%			

Table 2. Description of the study sample according to groups of exposed and unexposed workers

Variables	**Global (680)**	**Exposed (205)**	**Not exposed (475)**	**Statistical significance**
	X(DE)	**X(DE)**	**X(DE)**	
Age (years)	53 (5,39	52,0 (4,8)	53,4 (5,4)	<0,01
TC (mg/dl)	206,3 (35,9)	200,8(35,2)	208,7 (35,9)	<0,01
Co-LDL (mg/dl)	125,6 (32,6)	124,2 (32,1)	126,2 (32,8)	0,46
Co-HDL (mg/dl)	57,6 (14,6)	54,2 (12,6)	59,1 (14,9)	<0,001
Glucose(mg/dl)	100,9 (18,7)	97,1 (12,8)	102,5 (20,6)	<0,001
BMI	27,3 (4)	27,6 (3,6)	27,1 (4,1)	0,11
SBP (mmHg)	123,3 (15,4)	122,5 (13,7)	123,6 (16,1)	0,39

Table 2. *(continued)*

Variables	Global (680)	Exposed (205)	Not exposed (475)	Statistical significance
ICT	0,54 (0,07)	0,54 (0,06)	0,54 (0,07)	1
REGICOR %				
REGICOR %				
REGICOR %	3,4 (2,3)	3,1 (1,5)	3,5(2,5)	<0,05
REGICOR %				
REGICOR % REGICOR				
SCORE % SCORE	2,1 ((2,7)	1,5 (1,8)	2,3 (3,0)	<0,001
Training (years)	11,5 (3,8)	11,4 (2,8)	11,5 (4,1)	0,71
Variables	n y %	n y %	n y %	p
Tobacco (yes)	169 (24,8)	38 (18,5)	131 (27,6)	<0,05
AF[(a)]	320 (47,1)	122 (59,5%)	198 (41,7)	<0,001
Smet[(b)]	148 (21,8)	33 (16,1)	115 (24,2)	<0,05

Table 3. Rating of special cardiovascular sensitivity in exposed patients

REGICOR([a])			**SCORE[(b)]**		
Moderate	High and very high	Total	Moderate	High and Very high	Total
25 (12,2%)	2 (1,0%)	27 (13,2%)	132 (64,4%)	9 (4,4%)	141 (68,8%)

According to the criteria established for classifying workers exposed to TC with special sensitivity using the REGICOR function, 13.2% of those exposed were classified as having special cardiovascular sensitivity due to their work conditions, compared to 68.8% using SCORE, with significant differences ($p<0.05$) (**Table 3**).

4. Discussing

The risk of presenting a fatal episode due to ischemic heart disease or stroke (SCORE), with a mean of 2.1% observed in our study, is similar to that published by Divisón-Garrote et al (1.6%). Amor et al found, in a population-based study, that 87.1% of those studied were at low and moderate risk compared to 22.8% at high and very high risk. The lower proportion observed in the high and very high risk group in our study (4.4%) may be related to the initial absence of persons with declared cardiovascular disease. In both studies, the proportion of persons classified as low risk is similar (33.7% vs 31.2%). López-González observed a mean risk in the working population of 2.4% (according to REGICOR), which is low and similar to the 3.4% in the present study.

Of these, 13.2% according to the CVR assessed by the REGICOR scale and 68% according to SCORE are considered particularly sensitive to CVR. Although there are frequent studies that relate the higher prevalence of various CVR factors in workers exposed to noise, night work, and high stress, there are few studies that compare CVR assessed by risk functions in these groups. No results were obtained in the literature review detailing the prevalence of workers who, for one, another or several causes, were exposed to CVR with their respective assessment, which makes it difficult to compare the results of the present study. The VII National Survey of Working Conditions®[6] does not ask about possible exposure to CVR factors by working conditions, but rather by

each of the factors (noise, night work, psychosocial risk, etc.), so direct comparison is not possible. Although many workers are subjected to multiple factors, the population exposed to high noise (2-8%), vibrations (2.9%), fatigue (13.66%), psychosocial risk (20.7%) or night work (8.9%) seems to indicate that it would not be lower than the 30.1% in our study. Both Sobotova[20] in a population exposed to noise, and Yang SC in workers with high occupational stress, found a higher risk of coronary heart disease based on the Framingham model. The lower CVR observed among the exposed population in our study may be due to a lower mean age and a higher proportion of workers belonging to security forces (police and firefighters).

Since one of the objectives of the study was to propose at what percentage of CVR at 10 years a worker should be classified as particularly sensitive to CVR, the results obtained using the REGICOR and SCORE scales show great divergence if the moderate risk groups are included (13.2% vs. 68.8%), whereas if only the high and very high risk groups are taken into account, the difference is reduced (1% vs. 4.4%).

It is proposed that CVR assessment and stratification should form part of health surveillance in all workplaces that involve exposure to conditions that favor cardiovascular pathology.

30.1% of workers (37% of men and 11.9% of women) are exposed to working conditions related to cardiovascular pathology. Of these, 68% according to SCORE and 13.2% according to REGICOR are classified as workers with special cardiovascular sensitivity.

Most of the workers have a low risk of presenting an ischemic heart disease event, whether fatal or not, while they have a moderate risk of a fatal cardiovascular event, with a different rating depending on the scale used.

A large percentage of workers are exposed to TC related to a higher prevalence of cardiovascular pathology. The percentage of workers classified as especially sensitive to cardiovascular risk among those exposed suggests that this risk should be assessed in occupational health surveillance when there are working conditions related to cardiovascular pathology.

The limitations of the study include the origin of the sample (a working population of the public administration) and the differences in gender and age of the groups analyzed.

Conflict of interest

The authors declare no conflict of interest.

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