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ΕΡΕΥΝΗΤΙΚΗ ΕΡΓΑΣΙΑ

## Sex-stratified analysis of sociodemographic and lifestyle factors linked to QDiabetes score (QDScore) and Finnish diabetes risk score (FINRISK) in workers

**OBJECTIVE** To examine the association between sociodemographic, educational, and lifestyle factors, as well as QDiabetes score (QDScore) and Finnish diabetes risk score (FINRISK) estimates in a large cohort of Spanish workers. **METHOD** This cross-sectional study analyzed 139,634 employed individuals (83,282 men and 56,352 women) who underwent occupational health check-ups between 2009 and 2019. Diabetes and cardiovascular risk were assessed using the QDScore and FINRISK tools, respectively. Associations with age, sex, social class, educational attainment, smoking, alcohol intake, physical activity, and adherence to the Mediterranean diet were evaluated using sex-stratified logistic regression models. **RESULTS** Men had higher mean FINRISK scores (6.1 versus 4.3) and a greater proportion classified as high or very high risk (6.9% versus 4.5%). Physical inactivity, low education, and non-adherence to the Mediterranean diet were significantly associated with elevated QDScore (>3%) and FINRISK levels. Alcohol consumption demonstrated the strongest association with high cardiovascular risk in both sexes (odds ratio [OR] >6.5,  $p < 0.001$ ). From 2009 to 2019, the prevalence of high-risk categories increased markedly, particularly among the physically inactive and those with lower educational levels. **CONCLUSIONS** Sociodemographic and lifestyle factors strongly influence diabetes and cardiovascular risk in Spanish workers. Strategies promoting physical activity, adherence to the Mediterranean diet, and alcohol reduction –particularly among socioeconomically disadvantaged groups– are essential. These findings highlight the need for integrated workplace prevention programs targeting modifiable risk factors.

Cardiovascular disease (CVD) remains the leading cause of death globally, accounting for nearly 18 million deaths annually, representing 32% of all global fatalities.<sup>1</sup> In Europe, CVD contributes to 37% of total mortality, disproportionately affecting younger individuals and those from socioeconomically disadvantaged backgrounds.<sup>2</sup> The early identification of high-risk individuals through validated predictive tools is essential for effective prevention strategies.

Among existing models, QDiabetes score (QDScore) and Finnish diabetes risk score (FINRISK) are widely used

and validated for estimating diabetes and cardiovascular risk.<sup>3,4</sup> QDScore incorporates conventional risk factors such as age, sex, body mass index (BMI), smoking, and blood pressure, along with socioeconomic status and ethnicity.<sup>3</sup> FINRISK, developed in Finland, is based on classical variables and has demonstrated robust predictive accuracy across European populations.<sup>4,5</sup>

Despite their utility, few studies have examined how these risk scores relate to broader social determinants and lifestyle behaviors in working populations. This is a critical gap, as modifiable behaviors and social inequali-

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Ανάλυση κατά φύλο των κοινωνικοδημογραφικών και παραγόντων τρόπου ζωής που σχετίζονται με το QDiabetes score (QDScore) και το Finnish diabetes risk score (FINRISK) στους εργαζόμενους

Περίληψη στο τέλος του άρθρου

### Key words

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ties are major contributors to cardiovascular risk.<sup>6,7</sup> For example, adherence to the Mediterranean diet –rich in fruits, vegetables, legumes, nuts, and olive oil– has been shown to significantly reduce cardiovascular events. The PREDIMED trial reported a 30% risk reduction among high-risk individuals adhering to this dietary pattern.<sup>8</sup> Similarly, regular physical activity has been associated with decreased incidence of coronary heart disease and overall mortality.<sup>9</sup>

Conversely, smoking and alcohol consumption are major modifiable drivers of CVD. Tobacco use accelerates atherosclerosis and promotes thrombosis,<sup>10</sup> while alcohol intake elevates the risk of hypertension and arrhythmias.<sup>11</sup> According to the Global Burden of Disease 2021 report, over 10% of global deaths are attributable to these two factors combined.<sup>12</sup>

Socioeconomic factors such as educational attainment and occupational class also shape cardiovascular outcomes by influencing access to healthcare, health literacy, and health behaviors.<sup>13</sup> Lower education levels are consistently associated with higher rates of obesity, diabetes, and CVD.<sup>14,15</sup> Within the occupational context, individuals in lower social classes are more likely to experience job strain, engage in shift work, and face barriers to preventive healthcare services.<sup>16</sup>

In Spain, despite declining CVD mortality rates, cardiovascular risk remains a major public health concern due to population aging and persistent unhealthy behaviors. The workplace represents a strategic setting for health promotion, as it reaches a large segment of the population during their most productive years.<sup>17</sup> Nevertheless, large-scale studies examining how QDScore and FINRISK vary according to sociodemographic and behavioral factors in Spanish workers are scarce.

This study sought to address this gap by analyzing data from over 139,000 workers assessed between 2009 and 2019.

The objectives of the present study were to: (a) Describe the sex-stratified distribution of QDScore and FINRISK; (b) examine associations between these risk scores and variables such as age, sex, social class, educational level, smoking, alcohol intake, physical activity, and adherence to the Mediterranean diet; and (c) assess temporal trends in risk categories over a ten-year period.

To our knowledge, this is one of the largest studies of cardiovascular risk in the Spanish workforce using both QDScore and FINRISK. By incorporating sex-specific analyses and a broad set of sociodemographic and lifestyle factors, the findings provide important insights into both

structural and modifiable determinants of cardiovascular risk in working adults, crucial for informing targeted and equitable preventive strategies.<sup>18,19</sup>

We hypothesized that lower educational attainment, physical inactivity, poor diet, and alcohol consumption would be independently associated with higher cardiovascular risk, with potential moderating effects by sex and social class. We also anticipated an increasing trend in cardiovascular risk from 2009 to 2019, particularly among vulnerable socioeconomic groups.

## MATERIAL AND METHOD

### Study design and population

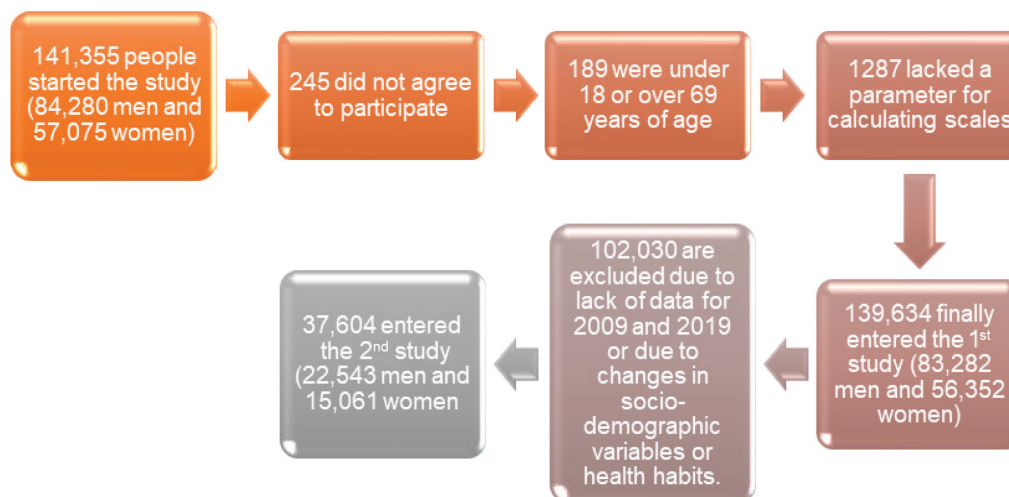
This cross-sectional study was based on data collected from routine occupational health evaluations conducted across Spain between January 2009 and December 2019. The study population comprised actively employed individuals from various geographic regions and economic sectors (e.g., industry, services, commerce) who underwent periodic medical check-ups mandated by national occupational health regulations.

Inclusion criteria were as follows: (a) Age between 18 and 69 years. (b) Active employment at the time of the health assessment. (c) Availability of complete data required to compute both QDScore and FINRISK (e.g., age, sex, systolic blood pressure, smoking status, body mass index [BMI], lipid profile, and glucose). (d) Provision of informed consent to use anonymized health data for research purposes. Exclusion criteria included: (a) Incomplete or missing data for any key sociodemographic, clinical, or lifestyle variable. (b) Documented history of established cardiovascular disease (e.g., myocardial infarction, stroke, angina) reported during occupational assessments. (c) Pregnancy at the time of evaluation (due to altered glucose and lipid metabolism).

A total of 139,634 workers (83,282 men and 56,352 women) met all inclusion criteria and were included in the final analysis. Figure 1 outlines the participant selection process. From the total pool of workers who underwent occupational health assessments between 2009 and 2019, individuals meeting the inclusion criteria (aged 18–69, with complete sociodemographic and clinical data, and no prior cardiovascular disease) were retained. Excluded individuals are clearly indicated in the flow diagram, resulting in a final study sample of 139,634 participants (83,282 men and 56,352 women). This transparent process enhances the reproducibility of the study and helps contextualize the findings.

### Data collection

Standardized data were collected by trained occupational health professionals following national protocols. Sociodemographic variables included sex, age (categorized in five-year bands), social class –classified according to occupation as I (managerial/



**Figure 1.** Flow chart of the participants.

professional), II (intermediate), and III (manual work)<sup>20</sup>– and educational level (elementary, secondary/high school, or university). Lifestyle factors were assessed using structured, validated questionnaires: (a) Smoking status was recorded as current smoker versus non-smoker, with the latter category including both never and former smokers. (b) Alcohol consumption was quantified in units of alcohol (UA), where one UA equals 10 g of pure ethanol, following national guidelines. High alcohol intake was defined as  $\geq 14$  UA/week for women and  $\geq 21$  UA/week for men.<sup>21</sup> (c) Physical activity was measured using the International Physical Activity Questionnaire (IPAQ),<sup>22</sup> a self-administered tool designed to estimate the amount and intensity of physical activity performed in the previous seven days. (d) Adherence to the Mediterranean diet was assessed using a validated 14-item questionnaire. Each item was scored 0 or 1 point, with a total score of  $\geq 9$  indicating high adherence to the Mediterranean dietary pattern.<sup>23</sup> Clinical variables included systolic and diastolic blood pressure, total cholesterol, HDL- and LDL-cholesterol, triglycerides, fasting glucose, height, and weight. BMI was calculated as weight in kilograms divided by height in meters squared ( $\text{kg}/\text{m}^2$ ).

### Cardiovascular risk estimation

Two validated cardiovascular risk scores were calculated for each participant: (a) QDScore: A 10-year risk prediction model that includes age, sex, BMI, systolic blood pressure, smoking status, diabetes diagnosis, and indicators of social deprivation.<sup>24</sup> (b) FINRISK: A 10-year estimator of fatal and non-fatal cardiovascular events, based on age, sex, systolic blood pressure, total cholesterol, smoking status, and antihypertensive treatment.<sup>25</sup> For analytical purposes, participants with a QDScore  $>3\%$  or classified in the high/very high category according to FINRISK were considered to have elevated cardiovascular risk.

### Ethical considerations

The research strictly followed the ethical principles established in the revised Declaration of Helsinki (2013) and complied with all relevant ethical standards for human research. The confidentiality and anonymity of participants were safeguarded at every stage. Ethical approval was obtained from the Research Ethics Committee of the Balearic Islands (CEI IB), with the assigned protocol number IB 4383/20, dated 23 November 2020. All personal data were pseudonymized, and access to identifiable information was restricted solely to the principal investigator. The procedures adhered to the provisions of Spain's Organic Law 3/2018 of December 5, on the protection of personal data and digital rights, ensuring that participants could exercise their rights to access, rectify, delete, or object to the processing of their data at any time.

### Data availability

The data generated and analyzed during this study are securely stored in a restricted-access database maintained by ADEMA-Escuela Universitaria. Data management complies with institutional security protocols and is supervised by the appointed Data Protection Officer, Dr Ángel Arturo López-González.

### Author contributions

Conceptualization, ÁA L-G, JI R-M, and J OdH; data collection and analysis, ÁA L-G, J OdH, MG S, and C B-C; data curation, ÁA L-G, and MG S; methodology, JI R-M, and ÁA L-G; validation, P R-S, MG S, and PJ T-L; formal analysis, ÁA L-G, and P R-S; investigation, J OdH, P R-S, C B-C, and PJ T-L; draft, J OdH; revision, JI R-M, and ÁA L-G. All authors have read and agreed to the published version of the manuscript.

## Statistical analysis

Descriptive statistics were used to summarize baseline characteristics. Comparisons between men and women were conducted using Student's t-test for continuous variables and the Chi-square test for categorical variables. Multivariate logistic regression models were developed to assess the association between elevated cardiovascular risk (dependent variable) and the following independent predictors: Sex, age, educational level, social class, smoking status, alcohol consumption, physical activity, and adherence to the Mediterranean diet. Results are presented as odds ratios (OR) with 95% confidence intervals (CI). Separate models were constructed for QDScore and FINRISK, and all analyses were stratified by sex. Temporal comparisons were made between the years 2009 (PRE) and 2019 (POST). Relative changes in the prevalence of high-risk categories were calculated as percentage differences. All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS Statistics for Windows), version 29.0 (IBM Corp, Armonk, NY, USA). A two-tailed p-value of <0.05 was considered statistically significant.

## RESULTS

Baseline characteristics revealed statistically significant differences between men and women ( $p < 0.001$ ). On average, men had notably higher systolic and diastolic blood pressure, weight, total cholesterol, LDL-cholesterol, triglycerides, and fasting glucose levels. In contrast, women

exhibited higher HDL-cholesterol values, indicative of a more favorable lipid profile. Sociodemographic disparities were also evident: A higher proportion of women belonged to upper social classes and had attained university education, whereas men were more frequently engaged in manual labor. Unhealthy lifestyle patterns were markedly more common in men, including higher prevalence of smoking (33.2% versus 32.1%), physical inactivity (62.4% versus 51.4%), low adherence to the Mediterranean diet (65.8% versus 52.8%), and alcohol consumption (32.7% versus 15.6%) (tab. 1).

Both QDScore and FINRISK estimates increased progressively with age across both sexes. Individuals aged  $\geq 50$  years showed substantially higher mean scores, particularly for FINRISK. Significant gradients were observed according to educational and occupational level, with workers in social class III and those with only elementary education displaying the highest risk scores. Behavioral factors also played a major role: Non-adherence to the Mediterranean diet, physical inactivity, and alcohol intake were consistently associated with elevated QDScore and FINRISK values. These associations were strong in both sexes, although slightly more pronounced among women for QDScore (tab. 2).

The proportion of individuals classified as high risk (QDScore  $> 3\%$  or high/very high FINRISK) increased sharply with age, peaking in the 60–69 age group. Social gradients

**Table 1.** Baseline characteristics by sex [Men (n=83,282), Women (n=56,352)].

	Men Mean (SD)	Women Mean (SD)	p value*		Men %	Women %	p value**
Age (years)	41.4 (10.7)	40.1 (10.4)	<0.001	<30 years	15.1	18.0	<0.001
Height (cm)	173.8 (7.1)	161.2 (6.5)	<0.001	30–39 years	29.6	31.0	
Weight (kg)	83.2 (14.6)	66.3 (13.9)	<0.001	40–49 years	30.2	30.3	
SBP (mmHg)	126.2 (15.9)	115.6 (15.7)	<0.001	50–59 years	20.9	17.7	
DBP (mmHg)	76.6 (10.9)	71.1 (10.7)	<0.001	60–69 years	4.2	3.0	
Total cholesterol (mg/dL)	199.6 (38.6)	194.6 (36.9)	<0.001	Social class I	7.5	13.6	<0.001
HDL-cholesterol (mg/dL)	50.0 (7.7)	54.7 (9.2)	<0.001	Social class II	23.8	32.1	
LDL-cholesterol (mg/dL)	122.6 (37.4)	121.5 (37.1)	<0.001	Social class III	68.7	54.1	
Triglycerides (mg/dL)	133.8 (95.6)	90.8 (49.7)	<0.001	Elementary school	66.4	48.1	<0.001
Glucose (mg/dL)	93.0 (25.4)	86.8 (18.1)	<0.001	High school	26.9	40.0	
				University	6.7	11.9	
				Smokers	33.2	32.1	<0.001
				Yes PhA	37.6	48.6	<0.001
				Yes MD	34.2	47.2	<0.001
				Yes alcohol	32.7	15.6	<0.001

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HDL: High density lipoprotein, LDL: Low density lipoprotein, SD: Standard deviation, PhA: Physical activity, MD: Mediterranean diet

**Table 2.** Mean QDScore and FINRISK values by subgroups.

	Men n	QDScore Mean (SD)	n	FINRISK Mean (SD)	Women n	QDScore Mean (SD)	n	FINRISK Mean (SD)
<30 years	7,798	1.1 (2.2)	12,398	2.7 (3.5)	6,566	1.2 (2.8)	10,014	2.2 (3.4)
30–39 years	24,060	1.3 (1.8)	24,060	4.2 (4.0)	17,164	1.3 (2.3)	17,164	3.0 (3.8)
40–49 years	23,754	1.5 (1.6)	23,754	6.6 (4.6)	16,550	1.5 (2.0)	16,550	5.4 (4.7)
50–59 years	15,086	1.7 (1.4)	15,086	9.3 (4.6)	9,268	1.8 (1.9)	9,268	8.6 (4.8)
60–69 years	2,804	1.7 (1.2)	2,804	10.6 (4.6)	1,508	1.8 (1.4)	1,508	10.4 (4.6)
Social class I	5,630	1.2 (1.5)	5,842	5.2 (4.7)	6,874	0.9 (1.7)	7,440	2.8 (3.9)
Social class II	18,220	1.4 (1.5)	18,684	6.1 (4.8)	16,940	1.2 (1.9)	17,652	4.3 (4.7)
Social class III	49,652	1.5 (1.8)	53,576	6.5 (4.9)	27,242	1.7 (2.4)	29,412	5.4 (5.0)
Elementary school	50,562	1.5 (1.8)	54,410	6.0 (5.0)	24,678	1.8 (2.4)	26,446	5.8 (5.1)
High school	17,900	1.4 (1.6)	18,532	5.8 (4.8)	20,346	1.3 (1.9)	21,574	4.0 (4.5)
University	5,040	1.2 (1.5)	5,160	5.4 (4.7)	6,032	0.9 (1.7)	6,484	2.7 (3.8)
Non-smokers	49,540	1.4 (1.6)	52,194	5.2 (4.8)	34,746	1.4 (2.0)	36,908	4.1 (4.5)
Smokers	23,962	1.5 (1.9)	25,908	6.3 (4.9)	16,310	1.5 (2.5)	17,596	5.0 (5.0)
Non PhA	46,614	2.0 (1.9)	47,884	8.7 (4.1)	26,444	2.4 (2.7)	27,486	8.3 (4.2)
Yes PhA	26,888	0.5 (0.3)	30,218	1.5 (2.0)	24,612	0.5 (0.3)	27,018	1.1 (1.7)
Non MD	49,166	1.9 (1.9)	50,656	8.3 (4.2)	27,170	2.3 (2.7)	28,300	8.0 (4.4)
Yes MD	24,336	0.5 (0.3)	27,446	1.4 (2.0)	23,886	0.5 (0.3)	26,204	1.1 (1.8)
Non alcohol	51,826	1.0 (1.1)	56,022	3.8 (3.5)	44,204	1.0 (1.3)	47,536	3.4 (3.5)
Yes alcohol	21,676	2.5 (2.3)	22,080	11.2 (3.7)	6,852	4.3 (3.8)	6,968	13.7 (3.3)

QDScore: Q Diabetes score, FINRISK: Finnish diabetes risk score, PhA: Physical activity, MD: Mediterranean diet, SD: Standard deviation

persisted: Class III workers and participants with elementary education showed the highest prevalence. Lifestyle factors further exacerbated risk: Among physically inactive women, 25.3% had a QDScore >3%, compared to only 3.8% in their physically active counterparts. Similarly, alcohol consumers exhibited dramatically higher risk, especially among women (26.6% with QDScore >3% versus 6.2% in non-drinkers) (tab. 3).

Multivariate logistic regression models confirmed that several variables were independently associated with elevated cardiovascular risk. Age, low educational level, belonging to social class III, physical inactivity, non-adherence to the Mediterranean diet, and alcohol consumption emerged as the strongest predictors (all with ORs >6 and  $p < 0.001$ ). Male sex was associated with higher odds of elevated FINRISK (OR=1.48) but with slightly lower odds of QDScore >3% compared to females (OR=0.89), suggesting different patterns of risk expression between sexes (tab. 4).

Between 2009 and 2019, the prevalence of high cardiovascular risk increased across nearly all sociodemographic and lifestyle subgroups. The most notable absolute increases were observed among middle-aged adults (40–59

years), manual workers (class III), and individuals with poor lifestyle habits. For example, the percentage of inactive men with QDScore >3% rose from 16.3% in 2009 to 19.8% in 2019 (+21.6% relative increase). Similarly, alcohol-consuming women experienced a marked increase in FINRISK high/very high category prevalence, from 13.3% to 15.3% (+14.9%). These temporal trends underscore a growing public health concern and the urgent need for effective preventive interventions targeting vulnerable working populations (tab. 5).

## DISCUSSION

This large cross-sectional study of 139,634 Spanish workers revealed a significant increase in cardiovascular risk between 2009 and 2019, particularly among individuals with low educational attainment, manual occupations, and unhealthy lifestyles. Physical inactivity, poor adherence to the Mediterranean diet, and alcohol consumption emerged as the strongest modifiable predictors of elevated QDScore and FINRISK values. These findings support the integration of cardiovascular risk screening and behavioral interventions into occupational health programs.

**Table 3.** Prevalence of high diabetes risk scales by subgroups.

	Men n	QDscore >3 %	n	FINRISK high/ very high %	Women n	QDscore >3 %	n	FINRISK high/ very high %
<30 years	7,798	7.6	12,398	0.7	6,566	8.6	10,014	0.4
30–39 years	24,060	9.5	24,060	2.0	17,164	10.8	17,164	1.2
40–49 years	23,754	12.2	23,754	5.7	16,550	13.7	16,550	5.1
50–59 years	15,086	14.6	15,086	12.0	9,268	15.5	9,268	13.2
60–69 years	2,804	15.9	2,804	19.7	1,508	18.4	1,508	20.8
Social class I	5,630	8.1	5,842	3.5	6,874	6.0	7,440	1.7
Social class II	18,220	9.9	18,684	5.3	16,940	10.0	17,652	4.1
Social class III	49,652	12.2	53,576	5.7	27,242	16.9	29,412	6.0
Elementary school	50,562	12.2	54,410	6.0	24,678	17.1	26,446	6.7
High school	17,900	10.1	18,532	4.5	20,346	10.5	21,574	3.4
University	5,040	8.1	5,160	3.5	6,032	5.6	6,484	1.5
Non-smokers	49,540	11.0	52,194	5.2	34,746	12.3	36,908	1.5
Smokers	23,962	12.1	25,908	5.6	16,310	13.5	17,596	5.6
Non PhA	46,614	17.9	47,884	8.9	26,444	25.3	27,486	9.6
Yes PhA	26,888	2.9	30,218	1.2	24,612	3.8	27,018	1.5
Non MD	49,166	17.0	50,656	8.4	27,170	24.6	28,300	9.3
Yes MD	24,336	3.8	27,446	1.7	23,886	4.5	26,204	1.9
Non alcohol	51,826	4.7	56,022	0.2	44,204	6.2	47,536	0.5
Yes alcohol	21,676	27.3	22,080	18.8	6,852	26.6	6,968	37.6

QDscore: Q Diabetes score, FINRISK: Finnish diabetes risk score, PhA: Physical activity, MD: Mediterranean diet

The link between sedentary behavior and CVD is well established. A harmonized meta-analysis demonstrated a strong dose-response relationship between sedentary time and all-cause mortality.<sup>26</sup> In another meta-analysis, the authors found that individuals who spent most of their day engaged in sedentary behaviors had approximately a 30% higher risk of developing CVD compared to their more active counterparts. Moreover, the analysis revealed a clear dose-response pattern, showing that each additional hour devoted to sedentary activities was associated with a further 5% increase in CVD risk. Importantly, the study also highlighted that replacing just one sedentary hour with light physical activity could lower the overall cardiovascular risk by about 20%.<sup>27</sup>

A review sought to clarify whether strategies to reduce CVD risk should primarily emphasize increasing physical activity or decreasing sedentary behavior.<sup>28</sup> Their conclusion was that both approaches are essential and complementary. A robust body of scientific evidence demonstrates that prolonged sedentary behavior is an independent risk factor for CVD. However, the benefits of reducing sitting time are maximized when that time is replaced with physical activity, particularly at moderate-to-vigorous intensities.

Individuals who remain largely sedentary and physically inactive experience a significantly greater CVD risk. Among those who are already physically active, additional reductions in risk seem to require not only higher total volumes of activity, but also greater intensity.

The current United States (US) physical activity guidelines recommend 150–300 min per week of moderate-intensity aerobic activity, or 75–150 min of vigorous-intensity activity.<sup>29</sup> For adults who spend large portions of the day sedentary, aiming for the higher end of these targets is especially important to fully realize cardio-protective benefits. Nonetheless, many adults in the US still fail to achieve even the minimum recommended activity levels. For such individuals, replacing sedentary time with any form of physical movement –including light-intensity activity– can yield meaningful health benefits. Simply sitting less and moving more, regardless of intensity, represents a practical and impactful behavioral goal that should be encouraged for all adults.<sup>30</sup> In our study, physically inactive workers had more than a sevenfold increased likelihood of high cardiovascular risk, emphasizing the urgent need to promote physical activity within the workplace.

**Table 4.** Multivariate logistic regression models.

	QDscore >3 OR (95% CI)	p-value	FINRISK high/very high OR (95% CI)	p-value
Female	1		1	
Male	0.89 (0.85–0.94)	<0.001	1.48 (1.40–1.57)	<0.001
<30 years	1		1	
30–39 years	1.42 (1.36–1.49)	<0.001	1.35 (1.29–1.42)	<0.001
40–49 years	1.71 (1.60–1.82)	<0.001	2.68 (2.28–3.09)	<0.001
50–59 years	1.98 (1.79–2.18)	<0.001	5.60 (4.70–6.51)	<0.001
60–69 years	2.68 (2.40–2.97)	<0.001	8.89 (7.18–10.70)	<0.001
Social class I	1		1	
Social class II	1.39 (1.31–1.47)	<0.001	1.62 (1.50–1.75)	<0.001
Social class III	1.98 (1.79–2.18)	<0.001	1.83 (1.54–3.13)	<0.001
University	1		1	
High school	1.42 (1.33–1.52)	<0.001	1.71 (1.53–1.89)	<0.001
Elementary school	2.09 (1.85–2.34)	<0.001	1.95 (1.60–2.30)	<0.001
Non-smokers	1		1	
Smokers	1.18 (1.14–1.23)	<0.001	2.53 (1.98–3.09)	<0.001
Yes PhA	1		1	
Non PhA	7.45 (6.04–8.87)	<0.001	7.11 (5.98–8.25)	<0.001
Yes MD	1		1	
Non MD	4.26 (3.60–4.93)	<0.001	6.10 (5.01–7.19)	<0.001
Non alcohol consumption	1		1	
Yes alcohol consumption	6.65 (5.25–8.06)	<0.001	6.95 (5.84–8.05)	<0.001

QDscore: Q Diabetes score, FINRISK: Finnish diabetes risk score, PhA: Physical activity, MD: Mediterranean diet, OR: Odds ratio, CI: Confidence interval

Alcohol consumption also stood out as a major contributor to elevated risk. Our findings align with those of other authors who reported significant reductions in blood pressure with decreased alcohol intake.<sup>37</sup> Although earlier studies suggested that moderate alcohol consumption might confer some cardioprotective effects, more recent evidence indicates that these potential benefits are highly dependent on individual factors such as genetic background, metabolic profile, and the presence of comorbidities.<sup>32</sup> Importantly, a large systematic review including over 1.5 million participants reported that excessive alcohol intake is consistently linked to disturbances in lipid metabolism, with particularly harmful effects observed in individuals with a family history of CVD or metabolic syndrome.<sup>33</sup> The review also highlighted that there is no clear evidence of a safe threshold of alcohol intake for cardiovascular health. Current evidence therefore emphasizes the importance of minimizing alcohol consumption, especially among working populations, where binge drinking patterns are more prevalent and contribute to increased cardiovascular risk.

Several studies have consistently demonstrated that adherence to the Mediterranean diet exerts a favorable impact on atherogenic indices, with particular emphasis on the triglyceride-to-HDL-cholesterol ratio, which is considered a key biomarker in cardiovascular risk assessment.<sup>34</sup> This dietary pattern is characterized by a high intake of nutrient-dense, bioactive-rich foods such as fruits, vegetables, legumes, whole grains, nuts, oily fish, and extra virgin olive oil. Regular consumption of these foods has been associated with reductions in plasma LDL-cholesterol and triglyceride levels, together with increases in HDL-cholesterol concentrations, thereby contributing to an overall improvement in the lipid profile.<sup>35</sup> Importantly, adherence to the Mediterranean diet has shown a particularly consistent protective effect among women, suggesting possible sex-specific benefits. These findings are in line with clinical trials demonstrating that following a Mediterranean dietary pattern significantly reduces the risk of recurrent cardiovascular events after myocardial infarction.<sup>36</sup> The protective effects are thought to be mediated largely through the diet's anti-inflammatory, antioxidant,

**Table 5.** Temporal trends in diabetes risk scales (2009–2019).

	Men n	QDScore >3 PRE-POST %	Dif %	FINRISK high/ very high PRE-POST %	Dif %	Women n	QDScore >3 PRE-POST %	Dif %	FINRISK high/ very high PRE-POST %	Dif %
<30 years	3,645	8.4–9.1	7.7	2.3–2.5	6.9	2,833	10.3–11.0	6.6	1.4–1.5	6.1
30–39 years	6,933	10.8–11.9	10.5	5.3–5.9	10.3	4,824	11.6–12.8	9.9	4.9–5.4	9.9
40–49 years	7,013	12.2–14.0	14.8	10.2–11.7	14.6	4,636	13.3–15.0	13.1	11.9–13.5	13.2
50–59 years	4,952	12.9–15.4	19.2	15.4–18.5	20.2	2,768	15.8–18.3	15.6	17.7–21.0	18.8
Social class I	1,760	8.2–8.9	8.8	4.3–4.6	6.9	1,973	8.2–8.8	7.7	1.7–1.8	6.6
Social class II	5,368	9.9–11.2	12.8	7.9–8.8	10.8	4,920	11.7–12.9	10.6	3.9–4.3	10.7
Social class III	15,415	13.7–16.4	19.8	9.8–11.4	16.4	8,168	15.2–17.5	14.8	5.2–6.1	16.2
Elementary school	14,914	13.5–16.0	18.7	9.5–11.0	16.0	7,289	15.1–17.3	14.5	5.5–6.4	15.9
High school	6,053	10.1–11.5	13.4	8.3–9.2	11.2	6,056	11.8–13.1	10.9	3.5–3.9	11
University	1,576	8.3–9.1	9.3	4.4–4.7	7.3	1,716	8.4–9.1	8.0	1.9–2.0	7.0
Non-smokers	15,122	10.4–11.5	11.0	7.9–8.8	11.8	10,236	11.7–12.9	9.9	1.7–1.8	10.9
Smokers	7,421	10.9–12.8	16.9	9.8–11.3	14.9	4,825	14.8–16.8	13.4	5.1–5.9	14.7
Yes PhA	8,535	4.5–4.8	5.5	4.2–4.4	5.5	7,317	4.0–4.1	3.1	1.8–1.9	5.1
Non PhA	14,008	16.3–19.8	21.6	15.0–17.8	18.8	7,744	17.2–20.6	19.5	7.5–8.8	17.7
Yes MD	7,767	5.3–5.7	6.7	5.6–5.9	6.1	7,029	4.7–4.9	3.8	2.1–2.2	5.9
Non MD	14,776	14.5–17.2	18.8	13.3–15.6	17.1	8,032	16.1–18.9	17.6	8.1–9.4	16.2
Non alcohol	15,107	5.1–5.5	7.1	5.7–6.1	6.4	12,750	5.2–5.5	5.1	1.7–1.8	6.1
Yes alcohol	7,436	11.9–14.3	20.3	13.3–15.4	15.8	2,311	15.2–17.5	15.2	13.3–15.3	14.9

QDScore: Q Diabetes score, FINRISK: Finnish diabetes risk score, PhA: Physical activity, MD: Mediterranean diet, PRE: Year 2009, POST: Year 2019

The formula for calculating the difference is [(POST–PRE)/PRE] as a percentage

and endothelial function-enhancing properties.

Sociodemographic disparities in cardiovascular risk were clearly evident in our study. Manual workers, typically classified as social class III, and individuals with only elementary education had significantly higher odds of being categorized in high-risk groups, even after adjusting for age and sex. These results reflect the well-documented social gradient in CVD risk, whereby individuals of lower socioeconomic status (SES) consistently experience worse health outcomes compared to their more advantaged counterparts.

SES has been strongly associated with higher rates of obesity<sup>37</sup> and metabolic syndrome,<sup>38</sup> both of which are key risk factors for CVD. Several mechanisms contribute to this relationship. Populations with lower SES often face reduced access to healthy foods, safe environments for physical activity, and quality healthcare services.<sup>39</sup> Diets in disadvantaged groups are frequently characterized by a high consumption of ultra-processed foods rich in trans fats, refined carbohydrates, and sugars, which promote hepatic steatosis and metabolic dysfunction. Moreover,

limited access to mental health care can exacerbate the effects of chronic stress, an increasingly recognized driver of metabolic and CVD.<sup>40</sup>

Educational attainment also plays a crucial role. Individuals with lower levels of education tend to have reduced health literacy, which can limit their ability to adopt and sustain healthy behaviors. Consistently, those from lower social classes demonstrate poorer cardiometabolic profiles, regardless of shift work status. This aligns with broader epidemiological evidence linking social disadvantage to metabolic disease through pathways such as chronic stress, unhealthy behaviors, and structural barriers to health-promoting resources.<sup>6,41</sup>

In contrast, individuals with higher SES are more likely to engage in protective health behaviors, including adherence to a balanced diet and regular physical activity, which mitigate cardiovascular risk. Evidence from a large meta-analysis involving more than 200,000 workers underscores the importance of work environment: job strain, particularly in occupations with low control, was identified as a major predictor of coronary heart disease.<sup>42</sup> The mechanisms

underlying this association include occupational stress, socioeconomic constraints, and limited healthcare access, all of which hinder the adoption of healthy lifestyles. Addressing socioeconomic inequalities must therefore be considered a central strategy in reducing the burden of CVD at the population level.

Temporal analyses showed a steady increase in cardiovascular risk across nearly all subgroups. This upward trend was especially pronounced among sedentary workers, smokers, and alcohol consumers. These patterns reflect broader societal shifts toward more sedentary lifestyles and poorer dietary quality, trends that were likely exacerbated by the economic downturn following the 2008 financial crisis and its prolonged effects on job security and public health investment.

The primary strengths of this study included its large and diverse sample, the comprehensive assessment of sociodemographic and clinical variables, and the use of two validated cardiovascular risk scoring tools (QDScore and FINRISK), allowing for cross-validation and comparison. Additionally, stratified analyses by sex and detailed subgroup evaluations enhanced the external validity and applicability of our findings to real-world occupational settings.

Nevertheless, several limitations should be noted. First, the cross-sectional design prevents causal inference. Second, lifestyle behaviors were self-reported, which may introduce recall and social desirability biases. Third, data

on medication use (e.g., antihypertensive or lipid-lowering agents) were unavailable, potentially affecting the accuracy of risk score estimations. Finally, the study population consisted exclusively of actively employed individuals, possibly underrepresenting unemployed or informally employed workers who may have different risk profiles.

In conclusion, this study highlighted the strong influence of sociodemographic and lifestyle factors on cardiovascular risk as estimated by QDScore and FINRISK in a large population of Spanish workers. Male sex, older age, lower educational attainment, manual occupations, physical inactivity, poor adherence to the Mediterranean diet, and alcohol consumption were all significantly associated with elevated risk.

Notably, the prevalence of high-risk categories increased between 2009 and 2019, particularly among socially and behaviorally vulnerable subgroups. These findings emphasize the need for tailored preventive strategies in the workplace that focus on modifiable risk factors, especially promoting physical activity, healthy dietary habits, and alcohol reduction.

Integrating cardiovascular risk assessment tools into routine occupational health check-ups can support early identification of high-risk individuals and guide the implementation of cost-effective interventions. Public health policies should prioritize socially disadvantaged workers to mitigate long-term inequalities in cardiovascular outcomes.

## ΠΕΡΙΛΗΨΗ

### Ανάλυση κατά φύλο των κοινωνικοδημογραφικών και παραγόντων τρόπου ζωής που σχετίζονται με το QDiabetes score (QDScore) και το Finnish diabetes risk score (FINRISK) στους εργαζόμενους

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**ΣΚΟΠΟΣ** Εξέταση της συσχέτισης μεταξύ κοινωνικοδημογραφικών, εκπαιδευτικών και παραγόντων τρόπου ζωής καθώς και των εκτιμήσεων QDiabetes score (QDScore) και Finnish diabetes risk score (FINRISK) σε μια μεγάλη ομάδα εργαζομένων. **ΥΛΙΚΟ-ΜΕΘΟΔΟΣ** Αναλύθηκαν 139.634 εργαζόμενα άτομα (83.282 άνδρες και 56.352 γυναίκες) που υποβλήθηκαν σε υγειονομικούς ελέγχους στον χώρο εργασίας μεταξύ 2009 και 2019. Ο διαβήτης και ο καρδιαγγειακός κίνδυνος αξιολογήθηκαν χρησιμοποιώντας τα εργαλεία QDScore και FINRISK, αντίστοιχα. Οι συσχετίσεις με την ηλικία, το φύλο, την κοινωνική τάξη, την εκπαιδευτική επίδοση, το κάπνισμα, την κατανάλωση οινοπνεύματος, τη σωματική δραστηριότητα και τη συμμόρφωση με τη μεσογειακή διατροφή αξιολογήθηκαν με τη χρήση λογιστικών μοντέλων αναδρομικής ανάλυσης κατά φύλο. **ΑΠΟΤΕΛΕΣΜΑΤΑ** Οι άνδρες είχαν υψηλότερους μέσους βαθμούς FINRISK (6,1 έναντι 4,3) και μεγαλύτερο ποσοστό υψηλού ή πολύ υψηλού κινδύνου (6,9% έναντι 4,5%). Η σωματική αδράνεια, η χαμηλή εκπαίδευση και η μη συμμόρφωση με τη μεσογειακή διατροφή συσχετίστηκαν σημαντικά με επί πλέον

επίπεδα QDScore (>3%) και FINRISK. Η κατανάλωση οιοπνεύματος ανέδειξε τη σημαντικότερη συσχέτιση με υψηλό καρδιαγγειακό κίνδυνο και για τα δύο φύλα (σχετικός λόγος: >6,5,  $p < 0,001$ ). Κατά το χρονικό διάστημα 2009–2019 η επικράτηση των κατηγοριών υψηλού κινδύνου αυξήθηκε σημαντικά, ιδίως μεταξύ των σωματικά ανενεργών και εκείνων με χαμηλότερα επίπεδα εκπαίδευσης. **ΣΥΜΠΕΡΑΣΜΑΤΑ** Οι κοινωνικοδημογραφικοί και οι παράγοντες τρόπου ζωής επηρεάζουν σημαντικά τον διαβήτη και τον καρδιαγγειακό κίνδυνο στους Ισπανούς εργαζόμενους. Είναι απαραίτητες στρατηγικές που προωθούν τη φυσική δραστηριότητα, τη συμμόρφωση στη μεσογειακή διατροφή και τη μείωση της κατανάλωσης οιοπνεύματος, ιδιαίτερα μεταξύ των κοινωνικά και οικονομικά μειονεκτούντων ομάδων. Τα εν λόγω ευρήματα τονίζουν την ανάγκη για ολοκληρωμένα προγράμματα πρόληψης στον χώρο εργασίας που στοχεύουν σε τροποποιήσιμους παράγοντες κινδύνου.

**Λέξεις ευρητήριο:** Κατανάλωση οιοπνεύματος, QDScore, Κοινωνικοδημογραφικές μεταβλητές, Τρόπος ζωής, FINRISK

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