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Original article

Association Between Improvement in Cardiovascular Risk Profile and Changes in Sickness Absence: Results of the ICARIA Study

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ABSTRACT

Introduction and objectives: The purpose of this study was to investigate whether changes in cardiovascular risk (CVR) are associated with the length and cost of sickness absence.
Methods: A prospective cohort of 179 186 participants was evaluated. Each participant's CVR (SCORE) was assessed on 2 consecutive medical examinations, approximately 1 year apart (365 ± 90 days). Cardiovascular risk was categorized as < 4% or ≥ 4%, and participants were divided into 4 groups according to changes in their risk between the 2 assessments. After the second CVR estimate, a 1-year follow-up was carried out to assess sickness absence. Differences between the 4 groups in terms of the total count of sickness absence days during the follow-up period were tested using Poisson regression models.
Results: After adjustment for covariates, participants who showed an improvement in CVR had a lower count of sickness absence days compared with both those who showed a worsening in risk and those who remained stable at ≥ 4% (RR, 0.91; 95%CI, 0.84-0.98). In comparison with participants whose CVR did not improve, more of the participants whose risk did improve had quit smoking (+17.2%; $P < .001$), and had controlled their blood pressure (+26.0%, $P < .001$), total cholesterol (+9.3%; $P < .001$), low-density lipoprotein cholesterol (+14.9%; $P < .001$), and triglyceride levels (+14.6%; $P < .001$).
Conclusions: Our results suggest that an improvement in CVR profile is accompanied by a decrease in sickness absence during a 1-year follow-up.
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Asociación entre la mejora en el perfil de riesgo cardiovascular y los cambios en la incapacidad temporal: resultados del estudio ICARIA

Palabras clave:
Riesgo cardiovascular
Enfermedad cardiovascular
Baja por enfermedad
Incapacidad temporal
Accidente de trabajo

RESUMEN

Introducción y objetivos: El propósito de este estudio es investigar si los cambios en el riesgo cardiovascular (RCV) se asocian con la duración y los costes de la incapacidad temporal.
Métodos: Se evaluó una cohorte prospectiva de 179.186 sujetos. Se calculó su RCV (SCORE) en 2 exámenes médicos consecutivos, separados aproximadamente 1 año (365 ± 90 días). Se categorizó el RCV en < 4% o ≥ 4% y se crearon 4 grupos de pacientes en función de los cambios en el RCV entre los 2 exámenes. Después de la segunda estimación, se realizó un seguimiento de 1 año para evaluar la incapacidad temporal. Las diferencias entre los 4 grupos en el recuento total de días de incapacidad temporal se evaluaron mediante modelos de regresión de Poisson.
Resultados: Tras ajustar por covariables, los sujetos que mejoraron su RCV tuvieron un menor recuento de días de incapacidad temporal que los que empeoraron su RCV y aquellos cuyo riesgo permaneció estabilizado en ≥ 4% (RR, 0,91; IC95%, 0,84-0,98). Comparados con los que no mejoraron el nivel de RCV, entre los que sí mejoraron más individuos habían dejado de fumar (+17,2%; p < 0,001) y habían controlado su presión arterial (+26,0%; p < 0,001), el colesterol total (+9,3%; p < 0,001), el colesterol unido a lipoproteínas de baja densidad (+14,9%; p < 0,001) y los triglicéridos (+14,6%; p < 0,001).
Conclusiones: Nuestros resultados indican que la mejora del RCV se acompaña de una disminución de la incapacidad temporal en el seguimiento a 1 año.
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Abbreviations

CVD: cardiovascular disease
CVR: cardiovascular risk
CVRF: cardiovascular risk factor
SCORE: Systematic COronary Risk Evaluation

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of mortality in developed countries.[1] Atherosclerosis is the basis of CVD, being present from its early stages.[2] Early intervention has been shown to improve outcome, but its cost-effectiveness is controversial.[3] Initial treatment consists mainly of lifestyle changes, predominantly those related to diet and physical activity. Some authors suggest that such interventions require trained personnel, which significantly increases cost, without a notable benefit in terms of the number of cardiovascular events and deaths.[3]

The effect of different cardiovascular risk (CVR) factors when analyzed individually confirms their influence on the duration of sick leave episodes.[4,5] In Spain, sickness absence is covered for both work-related and nonwork-related injuries and diseases, but with different regulations.[6] Classification as an occupational disease is constrained by a specific list of conditions for defined occupations, developed according to the influence of definitive exposures.[7] Occupational injuries, on the other hand, refer to those caused in the context of an accident at work or while commuting.[7] The remainder of injuries and diseases are considered nonwork-related. In the case of nonwork-related sickness absence, sick pay extends from the fourth day of sickness absence to 12 months, with the possibility of an additional period of 6 months following an evaluation by the Social Security Institute.[7] Sick leave from the beginning to the end of the episode must be certified by the patient's primary care physician and must be confirmed on a weekly basis.[6] Occupational diseases and injuries generally involve additional benefits (eg, sick pay from the first day).[7]

In a previous study, we showed that asymptomatic workers at high CVR, with only a clustering of CVR factors (CVRF), and therefore with undiagnosed underlying early CVD, contributed to a significant increase in the cost of sick leave, and the occurrence of early cardiovascular events.[8] According to our data, the estimated increase in the cost of sick leave for the whole Spanish working population was over €145 million per year, suggesting a huge potential for savings to be made.[8] The aim of the present study, conducted in a population similar to that included in our previous study,[8] was to investigate whether changes in CVR profile are associated with the length and cost of sickness absence.

METHODS

This prospective cohort analysis was a part of the Ibermutuamur CArdiovascular RIsk Assessment (ICARIA) study, the methodology of which has been described elsewhere.[9,10] Briefly, CVR factors and global CVR, as estimated using the SCORE (Systematic COronary Risk Evaluation) chart for European low-risk countries, were assessed in a broad and representative sample of the Spanish working population.[9,10] All participants who underwent a routine medical examination were approached and included in the ICARIA cohort, provided they gave informed consent. Medical examinations were conducted, consisting of a structured interview, anthropometric and blood pressure measurements, and blood testing. For current analyses, all participants with 2 consecutive medical examinations approximately 1 year apart (365 ± 90 days), and therefore 2 subsequent global CVR estimates, were selected. Participants with coronary heart disease, cerebrovascular disease, peripheral artery disease, or diabetes diagnosed prior to the first medical assessment, were excluded. After the second CVR estimate was performed, data regarding all medically-certified sick leave episodes, and the total count of sick leave days, were obtained from the official register of the Ibermutuamur mutual insurance company during a 1-year follow-up (365 days).[8] In Spain, mutual insurance companies provide health care for occupational injuries and diseases.[7] They also collaborate with the National Social Security System in case management and distribution of economic support for both work-related and nonwork-related sickness absence episodes.[7] The proportion of the working population covered by mutual insurance companies in Spain is 98% for work-related sickness absence and 83% for nonwork-related sickness absence.[11] The official records held by these companies are fundamental to the conduction of epidemiological research into sickness absence (especially in the case of nonwork-related sickness absence) due to the lack of an official, centralized, nationwide registry in Spain.

All participants were informed about their CVR and were given recommendations regarding CVRFs control and lifestyle changes (diet and physical exercise). Furthermore, a clinical summary was sent to their primary care physician to encourage the implementation of lifestyle changes and to support any eventual introduction of drug therapy.

Variables Measured

Sociodemographic data, including sex, age (< 45 years old/≥ 45 years old), occupation (blue collar/white collar), occupational categories, and economic activity sector were documented.[9] The SCORE system estimates the 10-year risk of a first fatal atherosclerotic event (heart attack, stroke, aortic aneurism, or other). In contrast to other CVR assessment tools, the SCORE charts are exclusively focused on fatal events.[12–15] Participants were categorized into 4 groups depending on the change or stability of their CVR: stable at < 4%; improvement in CVR (decrease from ≥ 4% in the first estimate to < 4% in the second estimate); worsening of CVR (increase from < 4% in the first estimate to ≥ 4% in the second estimate); and stable at ≥ 4%. The cutoff point was set at 4% to enable comparison of the results with prior reports from the ICARIA study, in which participants with a SCORE ≥ 4% were considered at moderate-to-high CVR following European Society of Cardiology Guidelines.[8,15]

In addition, the following variables were assessed:

- Tobacco consumption at the time of the medical examination (smoker/nonsmoker).
- Progression of tobacco consumption: *a)* nonsmoker at both medical examinations; *b)* smoker at the first medical examination but nonsmoker at the second; *c)* nonsmoker at the first medical examination but smoker at the second, and *d)* smoker at both medical examinations.
- Systolic and diastolic blood pressure (mmHg).
- Prior diagnosis of hypertension (yes/no).
- Antihypertensive drugs (yes/no).
- Progression of hypertension: *a)* no hypertension at either of the medical examinations; *b)* no hypertension at the first medical examination but blood pressure ≥ 140/90 mmHg without antihypertensive therapy at the second; *c)* no hypertension at the first medical examination but blood pressure ≥ 140/90 mmHg despite antihypertensive therapy at the second; *d)* hypertension at the first medical examination but blood pressure < 140/90 mmHg under antihypertensive therapy at the

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second; *e)* hypertension at the first medical examination but blood pressure < 140/90 mmHg without antihypertensive therapy at the second; *f)* hypertension at the first medical examination and blood pressure ≥ 140/90 mmHg despite antihypertensive therapy at the second, and *g)* hypertension at the first medical examination and blood pressure ≥ 140/90 mmHg without antihypertensive therapy at the second.

- Total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglyceride levels (mg/dL).
- Prior diagnosis of dyslipidemia (yes/no).
- Lipid-lowering therapy (yes/no).
- Dyslipidemia: defined as prior diagnosis of dyslipidemia, receipt of lipid-lowering therapy, total cholesterol ≥ 200 mg/dL, low-density lipoprotein cholesterol ≥ 160 mg/dL, high-density lipoprotein cholesterol < 40 mg/dL (men)/< 50 mg/dL (women), or triglycerides ≥ 200 mg/dL.
- Progression of dyslipidemia: *a)* no dyslipidemia; *b)* no dyslipidemia at the first medical examination but uncontrolled lipid levels despite lipid-lowering therapy at the second; *c)* no dyslipidemia at the first medical examination but uncontrolled lipid levels without lipid-lowering therapy at the second; *d)* dyslipidemia at the first medical examination but controlled lipid levels under lipid-lowering therapy at the second; *e)* dyslipidemia at the first visit but controlled lipid levels without lipid-lowering therapy at the second; *f)* dyslipidemia at the first medical examination and uncontrolled lipid levels despite lipid-lowering therapy at the second, and *g)* dyslipidemia at the first medical examination and uncontrolled lipid levels without lipid-lowering therapy at the second.
- Body mass index (kg/m^2).
- Diet: participants following a specific type of diet were identified (low carbohydrate, vegetarian, hypocaloric, low purine, macrobiotic, low sodium, gastric protection, low fat, hepatic protection).
- Physical exercise: no routine physical exercise or sport, or ≤ 2 hours/week; > 2 hours/week.
- Prior sickness absence (yes/no): occurrence or not of sick leave episodes between the first and the second CVR estimates.

Regarding dependent variables, the occurrence of sick leave episodes (yes/no) and the total count of sickness absence days during the 1-year follow-up period after the second CVR estimate, were registered. Both variables were assessed for sickness absence of all causes, with a distinction made between work-related sickness absence (sickness absence caused by work injuries and occupational diseases), nonwork-related sickness absence (sickness absence due to nonoccupational injuries and diseases), and sickness absence due to CVD. For sick leave episodes due to CVD, the International Classification of Diseases (Ninth Revision, Clinical Modification) codes 401-414 and 426-443 were considered, with the exception of codes 426.7, 429.0, 430.0, 432.1, 437.3, 437.4, and 437.5, which relate to nonatherosclerotic causes of death. This corresponds to the endpoints defined in the SCORE project.[12]

Contribution bases to the Social Security System: the contribution basis (€) used to calculate sick pay was also obtained to estimate sickness absence costs. These data are included in the official register of the Ibermutuamur mutual insurance company with the purpose of calculating sick pay during sickness absence. Contribution bases are mainly related to a worker's salary.

Statistical Analysis

Descriptive statistics were obtained for all variables. Categorical data are presented as percentages, with their 95% confidence intervals (95%CI), when appropriate. The total count of sickness absence days is described by medians with 25th and 75th percentiles, owing to the asymmetric distribution of this variable. Means ± standard deviation are also provided. Incidence density rates and their 95%CI for the different types of sickness absence episodes were calculated in the overall sample and by sex, age group, occupation, tobacco consumption progression, prior sickness absence, and CVR progression. Incidence density rates are expressed as incident cases per 100 worker-years. A chi-square test was used for univariate analysis of categorical data. A *t* test for independent samples, a Mann-Whitney *U* test, or Kruskal-Wallis 1-way ANOVA (analysis of variance) was used for quantitative data.

The association of changes in CVR profile with the total count of sickness absence days during the follow-up was tested using Poisson regression models (standard error correction), adjusted by sex, age, occupation, tobacco consumption progression, and prior sickness absence. Rate ratios (RR) and their 95%CI were calculated. Associations between changes in single CVRFs and the total number of sickness absence days during follow-up were assessed using Poisson regression analyses, with sex, age, occupation, prior sickness absence, and progression of hypertension, dyslipidemia, and tobacco consumption as covariables. Regression models were calculated for all sickness absence episodes, and for each type of sickness absence (work-related, nonwork-related, and due to CVD).

Finally, the economic impact of an eventual decrease in sickness absence among participants who improved their CVR was estimated by multiplying the mean contribution basis of employees by the estimated decrease in sickness absence days in participants with a SCORE of ≥ 4%, and then by the estimated number of workers with a SCORE of ≥ 4% in Spain (mean estimated decrease in sickness absence = mean sickness absence duration in the CVR ≥ 4% group * RR in the Poisson regression model for the improvement in CVR group). On the basis of the Economically Active Population Survey (fourth quarter of 2008), there were 19 154 000 workers in Spain at the end of the follow-up period.[16] The percentage of Spanish workers with an index SCORE of ≥ 4% was estimated to be about 6.9%; ie, 1 321 626 participants were expected to have a SCORE equal to or higher than 4%.[10]

Ethics Issues

Signed informed consent was obtained from all participants before enrolment in the ICARIA study, in accordance with the principles stated in the Declaration of Helsinki. The protocol was reviewed and approved by the local Ethics Committee.

RESULTS

Figure 1 shows patient flow. The sample consisted of 179 186 participants, 72.1% of whom were men (Table 1). The mean age (± standard deviation) was 36.7 ± 10.4 years. When the workers were categorized into the 4 groups according to changes in CVR, there were significant differences in their distribution by sex and age ($P < .001$): 92.9% of participants had a SCORE that was stable at < 4% in the 2 estimates (70.5% men; mean age: 35.7 ± 9.72 years); 2.4% of them displayed a worsening, from an initial SCORE of < 4%, to ≥ 4% in the second estimate (90.1% men; mean age: 48.0 ± 9.89 years); 1.9% of participants displayed an improvement, from an initial SCORE of ≥ 4%, to < 4% at the second medical examination (90.2% men; mean age: 47.3 ± 9.78 years); finally, 2.7% of participants remained stable at ≥ 4% (97.0% men; mean age: 55.06 ± 8.12 years).

Table 1 and Table 2 show incidence densities of new sickness absence episodes per 100 worker-years during a 1-year follow-up after the second CVR estimate, as well as the number of sickness

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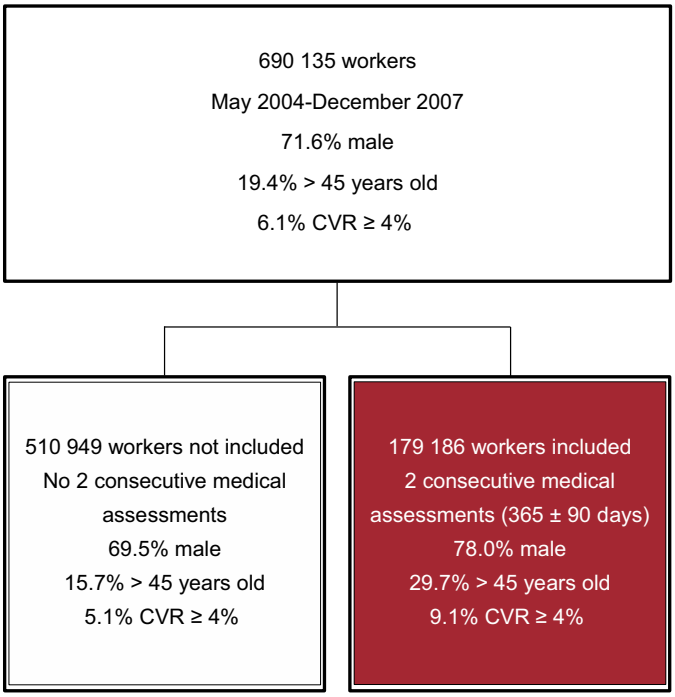

Figure 1. Patient flow and baseline characteristics. CVR, cardiovascular risk.

absence days. The total incidence density of sickness absence episodes of all causes was 22.22 per 100 worker-years (95%CI, 22.02-22.43). With regard to the specific cause of sickness absence, incidence density was 15.75 per 100 worker-years (95%CI, 15.57-15.92) for nonwork-related sickness absence, 6.88 per 100 worker-years (95%CI, 6.76-7.00) for work-related sickness absence, and 0.12 per 100 worker-years (95%CI, 0.11-0.14) for CVD-related sickness absence.

As shown in Figure 2, after adjustment for covariates, the 1-year change in CVR profile remained significantly associated with the total count of sickness absence days at the end of the study ($P < .001$). Participants with a stable CVR of < 4% in both routine medical examinations had a lower count of sickness absence days than participants with a stable CVR of ≥ 4% (Figure 2). The group of participants who improved their CVR level from ≥ 4% to < 4% also showed a lower count of sickness absence days during follow-up in comparison with participants with a stable SCORE of ≥ 4%. This decrease was observed for the whole group of sickness absence episodes (RR, 0.91; 95%CI, 0.84-0.98), for nonwork-related episodes (RR, 0.89; 95%CI, 0.82-0.96), and for sickness absence due to CVD (RR, 0.66; 95%CI, 0.61-0.71), but not for work-related sickness absence (RR, 0.96; 95%CI, 0.87-1.05). In contrast, the group of participants that displayed a worsening of their CVR did not differ from participants with a stable SCORE of ≥ 4% in terms of nonwork-related and work-related sickness absence ($P \geq .05$), but showed increased sickness absence due to CVD during follow-up (RR, 1.10; 95%CI, 1.04-1.17). Mean savings per participant in terms

Table 1
Incidence Densities per 100 Worker-years, and Duration of Sickness Absence Episodes During 1-year Follow-up, After the Second CVR Assessment, in a Cohort of Workers With 2 Consecutive (365 ± 90 Days) Estimates of Their CVR (SCORE Charts), Between 2004 and 2007

Variable	No. (%)	Worker-days (episodes)	Incidence density rate (95%CI)	P[a]	Median of sickness absence days (25th-75th percentiles)	Mean ± SD	P[b]
All causes							
Sex	179 186			< .001			< .001
Male	129 133 (72.1)	41 835 061 (25 844)	22.55 (22.31-22.79)		12 (6-31)	28.87 ± 44.78	
Female	50 050 (27.9)	16 328 710 (9570)	21.39 (21.01-21.77)		14 (6-39)	33.09 ± 47.82	
Age, y	179 186			< .001			< .001
< 45	136 357 (76.1)	44 015 182 (27 934)	23.16 (22.93-23.40)		12 (5-30)	27.21 ± 41.54	
≥ 45	42 829 (23.9)	14 148 589 (7480)	19.30 (18.90-19.69)		18 (8-47)	40.48 ± 57.32	
Occupation	178 339			< .001			< .001
Blue collar	110 017 (61.7)	34 740 532 (26 057)	27.38 (27.09-27.66)		13 (6-33)	30.62 ± 46.81	
White collar	68 322 (38.3)	23 138 347 (9233)	14.56 (14.29-14.84)		12 (5-32)	28.29 ± 42.21	
Occupational categories	176 194			< .001			< .001
General managers and government administrators	2633 (1.5)	928 351 (177)	6.96 (5.97-7.95)		20 (8-47)	41.32 ± 53.65	
Scientific professionals/ technicians and academics	18 815 (10.7)	6 472 717 (2071)	11.68 (11.21-12.15)		12 (5-32)	27.80 ± 41.22	
Support technicians and professionals	33 524 (19.0)	11 336 780 (4652)	14.98 (14.58-15.37)		12 (5-33)	28.55 ± 42.47	
Clerks and related jobs	11 205 (6.4)	3 709 461 (1895)	18.65 (17.89-19.40)		11 (5-32)	27.59 ± 42.43	
Catering and hospitality, personal and security service workers, salesmen/women and shop assistants	13 200 (7.5)	4 297 057 (2521)	21.41 (20.67-22.15)		15 (7-39)	33.48 ± 48.29	
Skilled workers in agricultural and fishing industries	1059 (0.6)	342 068 (199)	21.23 (18.62-23.85)		15 (7-30)	28.85 ± 45.25	
Craftsmen/women and skilled workers in manufacturing, construction, and mining	38 882 (22.1)	12 161 399 (9802)	29.42 (28.93-29.91)		13 (6-32)	29.59 ± 45.47	

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Table 1 *(Continued)*
Incidence Densities per 100 Worker-years, and Duration of Sickness Absence Episodes During 1-year Follow-up, After the Second CVR Assessment, in a Cohort of Workers With 2 Consecutive (365 ± 90 Days) Estimates of Their CVR (SCORE Charts), Between 2004 and 2007

Variable	No. (%)	Worker-days (episodes)	Incidence density rate (95%CI)	P[a]	Median of sickness absence days (25th-75th percentiles)	Mean ± SD	P[b]
Installation and machinery operators and assemblers	26 287 (14.9)	8 272 575 (6449)	28.45 (27.87-29.04)		12 (6-32)	29.45 ± 45.54	
Unskilled workers	30 589 (17.4)	9 667 433 (7086)	26.75 (26.22-27.29)		13 (6-34)	32.14 ± 49.17	
Economic activity	179 186			< .001			.916
Agriculture, livestock and fisheries	3139 (1.8)	1 067 777 (371)	12.68 (11.48-13.89)		12 (6-29)	28.61 ± 44.48	
Construction	40 597 (22.7)	12 967 670 (8934)	25.15 (24.70-25.60)		12 (6-32)	29.71 ± 46.31	
Industry	39 151 (21.8)	12 421 633 (9065)	26.64 (26.17-27.11)		13 (6-33)	30.47 ± 46.56	
Services	96 299 (53.7)	31 706 691 (17 044)	19.62 (19.36-19.88)		13 (6-34)	29.95 ± 44.84	
Tobacco consumption progression	179 176			< .001			.213
Nonsmoker/nonsmoker	91 973 (51.3)	30 390 933 (15 847)	19.03 (18.77-19.30)		13 (6-34)	30.19 ± 45.35	
Nonsmoker/smoker	4530 (2.5)	1 461 585 (937)	23.40 (22.09-24.71)		13 (6-32)	28.00 ± 41.44	
Smoker/nonsmoker	8070 (4.5)	2 615 069 (1598)	22.30 (21.34-23.27)		12 (5-32)	28.45 ± 44.06	
Smoker/smoker	74 603 (41.6)	23 693 556 (17 028)	26.23 (25.89-26.57)		13 (6-32)	30.10 ± 46.30	
Prior sickness absence	179 186			< .001			< .001
No	146 426 (81.7)	48 889 871 (22 987)	17.16 (16.96-17.36)		12 (6-32)	28.94 ± 43.60	
Yes	32 760 (18.3)	9 273 900 (12 427)	48.91 (48.30-49.52)		13 (6-35)	31.99 ± 49.16	
CVR progression	179 186			.270			< .001
Stable SCORE < 4%	166 547 (92.9)	54 052 212 (32 934)	22.24 (22.03-22.45)		12 (6-32)	29.07 ± 44.17	
Worsening CVR	4321 (2.4)	1 397 945 (885)	23.11 (21.77-24.44)		17 (8-44)	40.14 ± 57.87	
Improvement in CVR	3422 (1.9)	1 115 901 (671)	21.95 (20.48-23.41)		17 (7-43)	39.35 ± 59.42	
Stable SCORE ≥ 4%	4896 (2.7)	1 597 713 (924)	21.11 (19.90-22.32)		21 (9-53)	47.14 ± 64.00	
Tobacco consumption progression	179 176			< .001			.514
Nonsmoker	91 973 (51.3)	30 390 933 (15 847)	19,03 (18,77-19,30)		13 (6-34)	30.19 ± 45.35	
New smoker or relapse	4530 (2.5)	1 461 585 (937)	23,40 (22,09-24,71)		13 (6-32)	28.00 ± 41.44	
Ex-smoker	8070 (4.5)	2 615 069 (1598)	22,30 (21,34-23,27)		12 (5-32)	28.45 ± 44.06	
Always smoker	74 603 (41.6)	23 693 556 (17 028)	26,23 (25,89-26,57)		13 (6-32)	30.10 ± 46.30	
Hypertension progression	179 032			< .001			< .001
No hypertension	122 939 (68.7)	39 844 027 (24 525)	22.47 (22.22-22.71)		12 (5-32)	28.52 ± 43.14	
No hypertension at first assessment/blood pressure ≥ 140/90 mmHg, and no antihypertensive therapy at second assessment	15 341 (8.6)	4 982 718 (3051)	22.35 (21.65-23.05)		13 (6-33)	29.94 ± 45.57	
No hypertension at first assessment/blood pressure ≥ 140/90 mmHg, and antihypertensive therapy at second assessment	130 (0.1)	41 559 (29)	25.47 (17.47-33.47)		13 (5.5-44)	28.52 ± 32.37	
Hypertension at first assessment/blood pressure < 140/90 mmHg, and antihypertensive therapy at second assessment	2288 (1.3)	750 710 (432)	21.00 (19.24-22.76)		17.5 (8-50.75)	43.46 ± 64.23	
Hypertension at first assessment/blood pressure < 140/90 mmHg, and no antihypertensive therapy at second assessment	14 895 (8.3)	4 822 394 (2988)	22.62 (21.90-23.33)		13 (6-34)	30.80 ± 47.11	
Hypertension at first assessment/blood pressure ≥ 140/90 mmHg, and antihypertensive therapy at second assessment	4615 (2.6)	1 503 104 (887)	21.54 (20.28-22.79)		18 (8-48)	42.99 ± 61.45	
Hypertension at first assessment/blood pressure ≥ 140/90 mmHg, and no antihypertensive therapy at second assessment	18 824 (10.5)	6 170 307 (3470)	20.53 (19.92-21.14)		14 (7-37)	34.61 ± 52.46	

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Table 1 *(Continued)*
Incidence Densities per 100 Worker-years, and Duration of Sickness Absence Episodes During 1-year Follow-up, After the Second CVR Assessment, in a Cohort of Workers With 2 Consecutive (365 ± 90 Days) Estimates of Their CVR (SCORE Charts), Between 2004 and 2007

Variable	No. (%)	Worker-days (episodes)	Incidence density rate (95%CI)	P[a]	Median of sickness absence days (25th-75th percentiles)	Mean ± SD	P[b]
Dyslipidemia progression	174 609			< .001			< .001
No dyslipidemia	50 706 (29.0)	16 308 812 (10 612)	23.75 (23.36-24.14)		11 (6-23)	21.64 ± 32.69	
No dyslipidemia at first assessment/uncontrolled lipid levels and lipid-lowering therapy at second assessment	123 (0.1)	42 037 (17)	14.76 (8.28-21.24)		19 (7.75-84)	41.50 ± 47.91	
No dyslipidemia at first assessment/uncontrolled lipid levels and no lipid-lowering therapy at second assessment	16 843 (9.6)	5 489 375 (3207)	21.32 (20.67-21.98)		12 (6-28)	23.58 ± 31.67	
Dyslipidemia at first assessment/controlled lipid levels and lipid-lowering therapy at second assessment	4014 (2.2)	1 329 676 (698)	19.16 (17.88-20.44)		13 (8-31)	26.37 ± 38.05	
Dyslipidemia at first assessment/controlled lipid levels and no lipid-lowering therapy at second assessment	28 128 (16.1)	9 092 413 (5782)	23.21(22.69-23.74)		12 (7-27)	24.39 ± 35.17	
Dyslipidemia at first assessment/uncontrolled lipid levels and lipid-lowering therapy at second assessment	34 (0.0)	10 475 (9)	31.36 (14.39-48.34)		15 (5-43)	22.20 ± 26.26	
Dyslipidemia at first assessment/uncontrolled lipid levels and no lipid-lowering therapy at the second assessment	74 761 (42.8)	24 420 529 (14 122)	21.63 (21.36-21.90)		13 (7-29)	26.78 ± 39.71	
All causes	179 186	58 163 771 (35 414)	22.22 (22.02-22.43)		13 (6-33)	30.01 ± 45.65	
Nonwork-related sickness absence	179 186	60 213 442 (25 980)	16.30 (16.12-16.48)		11 (5-32)	29.71 ± 47.06	
Work-related sickness absence	179 186	63 022 112 (11 885)	6.88 (6.76-7.00)		12 (7-26)	24.49 ± 36.15	
Cardiovascular diseases	179 186	65 362 451 (217)	0.12 (0.11-0.14)		49 (19-116.50)	78.63 ± 76.51	

95%CI, 95% confidence interval; CVR, cardiovascular risk; SD, standard deviation.
[a] Chi-square test.
[b] Mann-Whitney *U* test/Kruskal-Wallis 1-way analysis of variance.

of sick pay associated with improvement in CVR were estimated at €40.03 per year (± €1766.37). When extrapolated to the whole Spanish working population at CVR ≥ 4%, the potential savings amounted to €52 026 686.80 per year (95%CI, €80 084 480.40-€1 503 558.30).

Table 3 shows the percentages of participants with differences in CVRFs and lifestyle, comparing those with improvement to those with no improvement in their CVR. These data show significantly higher percentages for those participants with an improvement in CVR, for all the parameters considered. The only exception was lifestyle (diet and physical exercise), which exhibited a positive trend that did not reach statistical significance.

When associations between CVRF progression and sickness absence were tested, tobacco consumption progression was consistently associated with sickness absence (Table 4). Workers who stopped smoking between the 2 medical examinations had a lower risk of sickness absence than those who continued to smoke (RR, 0.88; 95%CI, 0.84-0.92), although the risk was lower still for patients who were nonsmokers at both medical examinations (RR, 0.82; 95%CI, 0.81-0.84). The same trend was observed for nonwork-related sickness absence and sickness absence due to CVD, but not for work-related sickness absence.

Findings regarding the association between progression of hypertension and sickness absence were mixed (Table 4). Patients who were hypertensive at the first medical examination and under antihypertensive therapy at the second assessment had an increased risk of all-cause sickness absence, regardless of hypertensive status at the second visit (RR, 1.20; 95%CI, 1.11-1.30 for no hypertension; RR, 1.21; 95%CI, 1.14-1.28 for hypertension at the second visit). The same trend was also observed for nonwork-related sickness absence. Conversely, patients who were hypertensive at the first medical examination and under antihypertensive therapy at the second had a reduced risk of sickness absence due to CVD if blood pressure had been successfully controlled (RR, 0.59; 95%CI, 0.52-0.67), but not if blood pressure was still ≥ 140/90 mmHg (RR, 1.41; 95%CI, 1.33-1.49). Findings regarding dyslipidemia progression were also mixed (Table 4).

DISCUSION

The main finding of the present study was the decrease in sickness absence in participants showing an improvement in their CVR profile from ≥ 4% to < 4%, according to the SCORE chart, during

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Table 2
Incidence Densities per 100 Worker-years, and Duration of Sickness Absence Episodes During a 1-year Follow-up, After the Second CVR Assessment, in a Cohort of Workers With 2 Consecutive (365 ± 90 Days) Estimates of Their CVR (SCORE Charts), Between 2004 and 2007, as a Function of 1-year CVR Progression

Variable	No. (%)	Worker-days (episodes)	Incidence density rate (95%CI)	P[a]	Median of sickness absence days (25th-75th percentiles)	Mean ± SD	P[b]	Total of sickness absence days
All causes								
CVR progression	179 186			.270			< .001	1 062 759
Stable SCORE < 4%	166 547 (92.9)	54 052 212 (32 934)	22.24 (22.03-22.45)		12 (6-32)	29.07 ± 44.17		957 267
Worsening CVR	4321 (2.4)	1 397 945 (885)	23.11 (21.77-24.44)		17 (8-44)	40.14 ± 57.87		35 524
Improvement in CVR	3422 (1.9)	1 115 901 (671)	21.95 (20.48-23.41)		17 (7-43)	39.35 ± 59.42		26 407
Stable SCORE ≥ 4%	4896 (2.7)	1 597 713 (924)	21.11 (19.90-22.32)		21 (9-53)	47.14 ± 64.00		43 561
Nonwork-related sickness absence								
CVR progression	179 186			.002			< .001	771 862
Stable SCORE < 4%	166 547 (92.9)	55 936 990 (24 275)	15.84 (15.66-16.02)		11 (5-31)	28.62 ± 45.26		694 661
Worsening CVR	4321 (2.4)	1 455 720 (614)	15.40 (14.28-16.52)		16 (7-48)	42.50 ± 62.11		26 098
Improvement in CVR	3422 (1.9)	1 158 667 (461)	14.52 (13.30-15.75)		15 (7-46.5)	41.77 ± 63.87		19 257
Stable SCORE ≥ 4%	4896 (2.7)	1 662 065 (630)	13.84 (12.83-14.84)		20.5 (8-56)	50.55 ± 70.08		31 846
Work-related sickness absence								
CVR progression	179 186			< .001			< .001	291 073
Stable SCORE < 4%	166 547 (92.9)	58 600 991 (10916)	6.80 (6.68-6.92)		12 (7-26)	24.07 ± 35.71		262 769
Worsening CVR	4321 (2.4)	1 509 893 (347)	8.39 (7.54-9.23)		14 (7-28)	27.20 ± 39.34		9439
Improvement in CVR	3422 (1.9)	1 199 890 (260)	7.91 (6.99-8.83)		14 (7-29.75)	27.50 ± 40.85		7150
Stable SCORE ≥ 4%	4896 (2.7)	1 711 338 (362)	7.72 (6.96-8.48)		17 (9-37)	32.36 ± 41.25		11 715
Cardiovascular disease								
CVR progression	179 186			< .001			.001	17 063
Stable SCORE < 4%	166 547 (92.9)	60 762 546 (142)	0.09 (0.07-0.10)		44.5 (16-116.25)	72.80 ± 72.87		10 337
Worsening CVR	4321 (2.4)	1 570 867 (34)	0.79 (0.53-1.05)		58 (19.75-96)	68.47 ± 61.07		2328
Improvement in CVR	3422 (1.9)	1 246 730 (13)	0.38 (0.17-0.59)		59 (24-116)	85.15 ± 80.54		1107
Stable SCORE ≥ 4%	4896 (2.7)	1 782 308 (28)	0.57 (0.36-0.79)		99.5 (33.75-199)	117.54 ± 98.78		3291

95%CI, 95% confidence interval; CVR, cardiovascular risk; SD, standard deviation.
[a] Chi-square test.
[b] Mann-Whitney U test/Kruskal-Wallis 1-way analysis of variance.

the 1-year follow-up period. Such a reduction in sickness absence was observed for nonwork-related and CVD absence. The association of CVR reduction with decreased sickness absence was still significant after adjustment for sex, age, occupation, tobacco consumption, and the incidence of prior sickness absence.

Our results suggest that positive changes in CVRFs are involved in sickness absence reduction during a 1-year follow-up. The improvement in CVR profile was the result of higher percentages of participants achieving controlled blood pressure and total cholesterol, low-density lipoprotein cholesterol, and triglycerides levels, and stopping smoking by the second medical examination. The percentages of participants with hypertension taking antihypertensive drugs, and participants with dyslipidemia receiving lipid-lowering therapy, also increased in this group 1 year after the initial assessment. A consistent association between tobacco consumption and sickness absence was observed, ranging from the lowest risk in nonsmokers at both examinations to the highest risk in those who were smokers at both. Blood pressure control among hypertensive participants appeared to be associated with a decrease in the risk of sickness absence caused by CVD. In contrast, the consistent association between antihypertensive treatment and increase in the risk of all-cause (and, more specifically, nonwork-related) sickness absence suggests that antihypertensive drug prescription could be interpreted as a severity marker (ie, antihypertensive drugs were only prescribed in the most serious of cases). If this were true, it could imply the need for a revision of current prescription practice, especially when patients are theoretically "young and healthy". Our findings regarding progression of dyslipidemia are complex and could be related to the small number of participants receiving lipid-lowering therapy.

Our results also demonstrate that sickness absence of nonwork-related and work-related origin among participants with a worsening of their CVR from < 4% to ≥ 4% was similar to that observed in participants whose risk remained stable at ≥ 4%. Furthermore, sickness absence due to new-onset CV illnesses increased during the 1-year follow-up for this group. These findings should encourage occupational health care providers to focus health promotion programs not only on participants at high risk, but also on those at low risk who could potentially experience worsening of their risk.[5]

Several mechanisms have been proposed to explain the link between CVR and non-CVD sickness absence: the association of CVR with proinflammatory or prothrombotic states, which may contribute to a number of non-CVD diseases (eg, respiratory diseases, musculoskeletal pathology, or infectious diseases); involvement of health risk behaviors that are risk factors for other diseases; and a hypothetical underlying risky personality type.[8]

In a previous report, we showed that high CVR is associated with enormous cost in terms of sickness absence among the working population.[8] The present results suggest that those costs could be significantly reduced in the short-term if CVR was successfully improved. Our findings are in line with a previous report on changes in health care, pharmacy, and short-term

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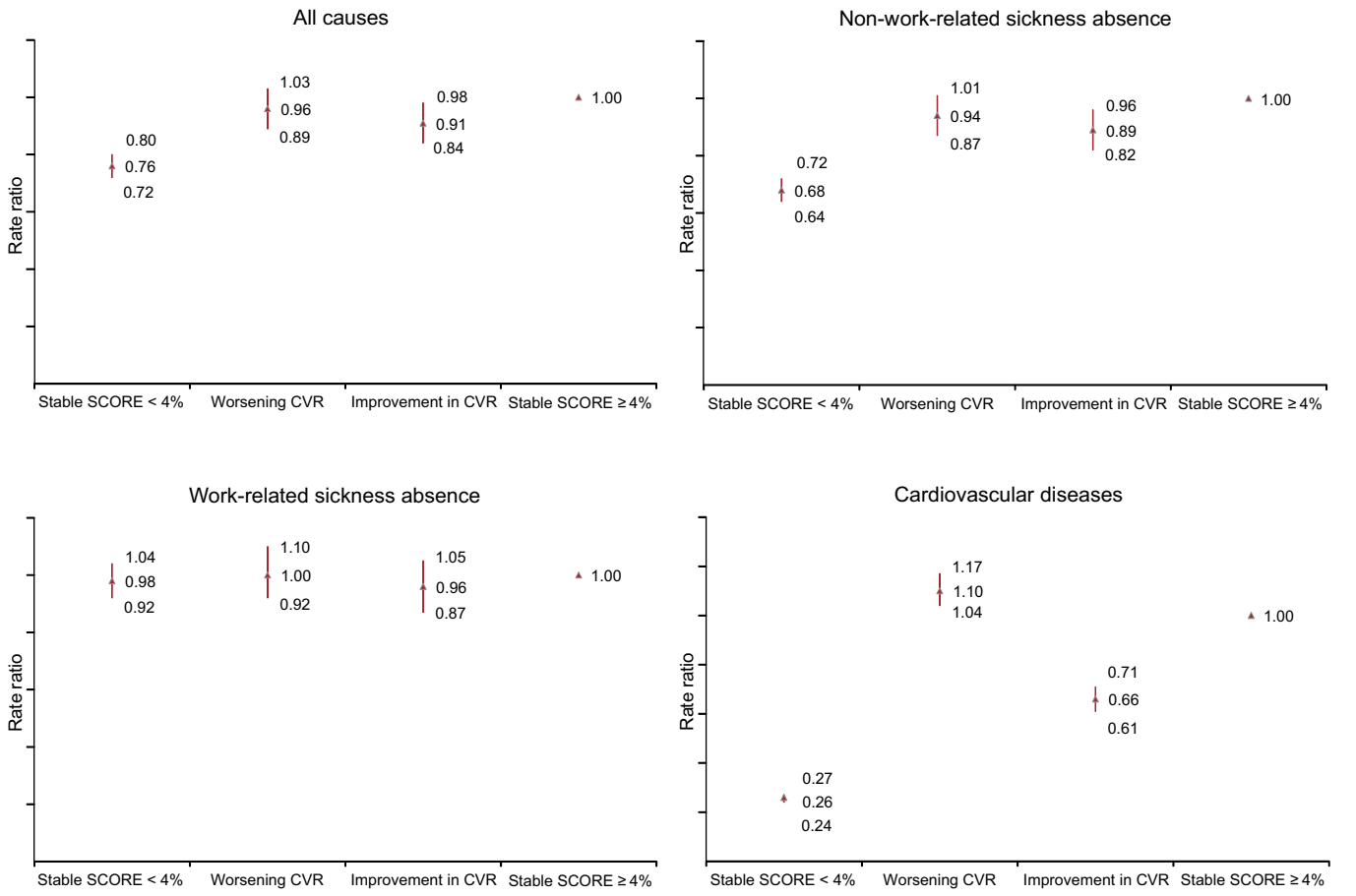

Figure 2. Association of 1-year cardiovascular risk trend (365 ± 90 days) with the total count of sickness absence days during 1-year follow-up after the second evaluation of their CVR (SCORE charts). Poisson regression analyses (standard error correction). CVR, cardiovascular risk.

Table 3
Differences in Percentage of Participants With Changes in CVR Factors Between the First and Second CVR Assessment, Among Participants Who Improved and did not Improve Their CVR Profile, From a SCORE of ≥ 4% to < 4%

Variable	No.	Participants who improved their CVR profile	Participants who did not improve their CVR profile	*P*[*]
Percentage of smokers quitting smoking	5777	22.5	5.3	< .001
Percentage of participants with high blood pressure in the first medical assessment but not in the second	6825	36.4	10.4	< .001
Percentage of participants with hypertension and without treatment in first assessment, with antihypertensive drugs in the second	5688	18.3	14.3	< .001
Percentage of participants reducing their total cholesterol levels (≤ 200 mg/dL)	6964	22.5	13.2	< .001
Percentage of participants reducing their LDL-C levels (≤ 160 mg/dL)	3447	55.1	40.2	< .001
Percentage of participants increasing their HDL-C levels (> 40 mg/dL [men] or > 50 mg/dL [women])	1142	69.5	72.2	.314
Percentage of participants reducing their triglyceride levels (≤ 200 mg/dL)	2003	53.4	38.8	< .001
Percentage of participants with dyslipidemia and without treatment in first assessment, with lipid-lowering therapy in the second	6873	12.1	6.8	< .001
Body mass index ranges				
Percentage of overweight participants in first assessment, with normal weight in the second	3652	10.2	8.1	.027
Percentage of obese participants in first assessment, without obesity in the second	2503	18.5	15.5	.046
Percentage of without diet in first assessment, with a specific diet in the second	1566	11.1	9.4	.267
Physical exercise				
Percentage of participants that previously did not do any physical exercise, and began to exercise to a certain extent	1074	20.3	20.3	.981
Percentage of participants doing less than 2 hours/week of physical exercise in the first assessment, and doing at least 2 hours/week in the second	1241	16.1	16.9	.711

CVR, cardiovascular risk; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.
[*] Chi-square test.

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Table 4
Associations Between 1-year CVR Factor Trend (365 ± 90 Days) and the Total Number of Sickness Absence Days During the 1-year Follow-up After the Second Evaluation of Their CVR (SCORE Charts), Stratified by Cause of Sickness Absence. Poisson Regression Analyses (Standard Error Correction), Adjusted by Sex, Age, Occupation, and Prior Sickness Absence

	No.	All-cause		Nonwork-related		Work-related		Cardiovascular diseases	
		RR (95%CI)	*P*	RR (95%CI)	*P*	RR (95%CI)	*P*	RR (95%CI)	*P*
Tobacco consumption progression	173 651								
Nonsmoker	89 039	0.82 (0.81-0.84)	< .001	0.83 (0.81-0.84)	< .001	0.82 (0.80-0.85)	< .001	0.41 (0.40-0.43)	< .001
New smoker or relapsed smoker	4384	0.90 (0.84-0.96)	.001	0.89 (0.83-0.95)	.001	0.93 (0.86-1.00)	.060	0.13 (0.10-0.16)	< .001
Ex-smoker	7856	0.88 (0.84-0.92)	< .001	0.85 (0.80-0.89)	< .001	0.96 (0.91-1.02)	.164	0.56 (0.51-0.61)	< .001
Always smoked	72 372	1		1		1		1	
Hypertension progression	173 651								
No hypertension	118 945	0.92 (0.89-0.95)	< .001	0.90 (0.87-0.93)	< .001	0.97 (0.93-1.00)	.080	0.35 (0.34-0.37)	< .001
No hypertension at first assessment/blood pressure ≥ 140/90 mmHg, and no antihypertensive therapy at second assessment	14 935	0.94 (0.90-0.98)	.004	0.89 (0.85-0.94)	< .001	1.04 (0.99-1.10)	.085	0.44 (0.41-0.47)	< .001
No hypertension at first assessment/blood pressure ≥ 140/90 mmHg, and antihypertensive therapy at second assessment	127	0.88 (0.62-1.24)	.455	0.86 (0.59-1.25)	.424	0.93 (0.62-1.40)	.732	0.00 (0.00-.b)	1.000
Hypertension at first assessment/blood pressure < 140/90 mmHg, and antihypertensive therapy at second assessment	2254	1.20 (1.11-1.30)	< .001	1.24 (1.14-1.35)	< .001	1.10 (0.99-1.21)	.085	0.59 (0.52-0.67)	< .001
Hypertension at first assessment/blood pressure < 140/90 mmHg, and no antihypertensive therapy at second assessment	14 511	0.98 (0.94-1.02)	.321	0.94 (0.89-0.98)	.008	1.08 (1.03-1.13)	.003	0.60 (0.57-0.64)	< .001
Hypertension at first assessment/blood pressure ≥ 140/90 mmHg, and antihypertensive therapy at second assessment	4533	1.21 (1.14-1.28)	< .001	1.27 (1.20-1.36)	< .001	1.03 (0.96-1.11)	.374	1.41 (1.33-1.49)	< .001
Hypertension at first assessment/blood pressure ≥ 140/90 mmHg, and no antihypertensive therapy at second assessment	18 346	1		1		1		1	
Dyslipidemia progression	173 651								
No dyslipidemia	50 446	0.97 (0.95-0.99)	.014	0.99 (0.97-1.02)	.500	0.91 (0.89-0.94)	< .001	0.45 (0.42-0.47)	< .001
No dyslipidemia at first assessment/uncontrolled lipid levels and lipid-lowering therapy at second assessment	123	0.66 (0.43-1.02)	.059	0.52 (0.30-0.90)	.018	0.94 (0.64-1.40)	.773	0.00 (0.00-.b)	1.000
No dyslipidemia at first assessment/uncontrolled lipid levels and no lipid-lowering therapy at second assessment	16 752	0.96 (0.92-0.99)	.016	0.96 (0.93-1.00)	.065	0.94 (0.90-0.98)	.002	0.44 (0.40-0.47)	< .001

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Table 4 *(Continued)*
Associations Between 1-year CVR Factor Trend (365 ± 90 Days) and the Total Number of Sickness Absence Days During the 1-year Follow-up After the Second Evaluation of Their CVR (SCORE Charts), Stratified by Cause of Sickness Absence. Poisson Regression Analyses (Standard Error Correction), Adjusted by Sex, Age, Occupation, and Prior Sickness Absence

	No.	All-cause		Nonwork-related		Work-related		Cardiovascular diseases	
		RR (95%CI)	*P*	RR (95%CI)	*P*	RR (95%CI)	*P*	RR (95%CI)	*P*
Dyslipidemia at first assessment/controlled lipid levels and lipid-lowering therapy at second assessment	3981	1.03 (0.96-1.09)	.407	1.15 (1.08-1.23)	< .001	0.72 (0.66-0.79)	< .001	0.98 (0.90-1.05)	.532
Dyslipidemia at first assessment/controlled lipid levels and no lipid-lowering therapy at second assessment	27 994	1.03 (1.00-1.06)	.025	1.05 (1.02-1.08)	.002	0.99 (0.95-1.02)	.448	1.09 (1.04-1.14)	< .001
Dyslipidemia at first assessment/uncontrolled lipid levels and lipid-lowering therapy at second assessment	34	0.75 (0.35-1.60)	.463	0.40 (0.13-1.26)	.116	1.54 (0.85-2.77)	.152	0.00 (0.00-.b)	1.000
Dyslipidemia at first assessment/uncontrolled lipid levels and no lipid-lowering therapy at the second assessment	74 321	1		1		1		1	

95%CI, 95% confidence interval; CVR, cardiovascular risk; RR, rate ratio.

disability costs among manufacturing participants who improved their metabolic syndrome status.[5] Prior research has not always demonstrated a reduction in sickness absence as a consequence of lifestyle modification.[17] The reasons for this apparent discrepancy with the results reported here could be differences in the explanatory variables (estimated CVR or lifestyle parameters) or in the methodology of the studies. In some cases, the scientific evidence was obtained from selected populations, or was exclusively based on self-reported data.[17] If our findings were to be confirmed, a reduction in sickness absence costs should be added to the decrease in the incidence of absences and in mortality associated with improvement in the control of CVRFs in most developed countries.[18]

Of importance, in our experience, 40% of participants with an elevated CVR profile at baseline showed an improvement 1 year later. In the remaining individuals, the CVR profile remained at ≥ 4%. In addition, the number of workers with a SCORE of ≥ 4% in the second medical examination increased as a consequence of the more than 4000 participants that moved from the < 4% to the ≥ 4% risk category. These results strongly suggest a need to improve the level of intervention used for our workers, with Health Promotion at Workplace Programs being potentially useful for this purpose.[17] Changes in lifestyle are critical for CVR reduction,[19] and the significant decrease in the cost of sick leave episodes that is associated with improvement in CVR profile is notable.

Strengths and Limitations

The strengths of the current study include the prospective design, with 2 consecutive assessments of CVR and CVRFs in a large sample of the Spanish working population. Data on sickness absence were based on the official registers of the Ibermutuamur mutual insurance company, and the association between CVR progression and sickness absence was also tested prospectively. In the ICARIA study, CVRFs were assessed by trained physicians, following a rigorous protocol by means of objective measures and structured interviews. In addition, the ICARIA cohort can be considered representative of the Spanish labor force.[9]

The limitations of the study are mainly related to the SCORE charts, which may overestimate CVR in individuals older than 65 years or in younger individuals. Another limitation is that important variables such as a family history of early-onset coronary heart disease, impaired glucose tolerance, and hypertriglyceridemia are not included in the charts. Furthermore, factors such as heart rate were not included in the current analysis, and there is a lack of information concerning the specific type and dosing of drugs prescribed for each patient. Mean age was significantly different among CVR progression groups, though this was adjusted for in the regression analyses. The 1-year follow-up in the current study could be too short. If that were true, we could hypothesize that the association of CVR with sickness absence reported here would have been underestimated. Finally, we cannot disregard the idea that workers who attend 2 consecutive medical assessments may be particularly health-conscious, and could therefore represent a select population. Indeed, data shown in Figure 1 suggest that there are differences between participants who attended 1 compared with > 1 medical assessment; however, these observations reveal that the latter participants were significantly less healthy.

CONCLUSIONS

A stable or improved CVR level during a 1-year period, as estimated by SCORE charts for low-risk European countries, was significantly associated with shorter nonwork-related sickness absence, and shorter absence due to CVD, during a subsequent 1-year follow-up period. Further research will determine whether Health Promotion at Workplace Programs is cost-effective.

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CONFLICTS OF INTEREST

None declared.

WHAT IS KNOWN ABOUT THE TOPIC?

- There is a high prevalence of CVRF among the working Spanish population.
- More than 6% of Spanish workers have a CVR of $\geq$ 4%.
- Cardiovascular risk in asymptomatic participants is significantly associated with the duration and cost of sickness absence due to cardiovascular and non-CVD causes.

WHAT DOES THIS STUDY ADD?

- A reduction in CVR translates into a reduction in sickness absence.
- This reduction could be explained by smoking cessation and control of blood pressure/lipid levels.

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