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# Distinct cardiovascular and cancer burdens associated with social position, work environment and unemployment: a cross-sectional and retrospective study in a large population-based French cohort

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## ABSTRACT

**Objectives** Distinguish the respective effects of social position, work environment and unemployment on cardiovascular and cancer risks.

**Design** A cross-sectional and retrospective observational study.

**Setting** A population-based French cohort (CONSTANCES).

**Participants** 130 197 adults enrolled between 2012 and 2021 without missing values.

**Primary outcome measures** The associations of social position, work environment and unemployment exposure with the prevalence of cardiovascular events and cancers simultaneously tested using logistic regression models adjusting for common risk factors.

**Results** While social position, work environment and unemployment exposure are strongly interrelated with each other, they are not linked to the same cardiovascular and cancer outcomes. Low social position and long unemployment duration are significantly associated with an increased prevalence of angina pectoris, myocardial infarction and peripheral arterial disease (OR=1.22 to 1.90, p<0.04 to p<0.0001) but not of stroke. In contrast, a bad work environment is associated with an increased prevalence of stroke (OR=1.29, p<0.01) but not of angina pectoris, myocardial infarction and peripheral arterial disease. Low social position is associated with an increased prevalence of cervical and lung cancers (OR=1.73 and 1.95, p<0.002 and p<0.03) and a decreased prevalence of skin cancer (OR=0.70, p<0.0001) while a bad work environment is associated with an increased prevalence of breast, skin, prostate and colon cancers (OR=1.31 to 2.91, p<0.0002 to p<0.0001). Unemployment exposure is not associated with the prevalence of any type of cancers.

**Conclusions** Social position, work environment and unemployment are associated with distinct cardiovascular and cancerous diseases that could add up during lifetime, they should therefore be considered all together in any preventive strategy.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study analysed recent data collected from a large population-based cohort.
⇒ The respective effects of social position, work environment and unemployment on the prevalence of cardiovascular diseases and cancers were simultaneously tested with multiple logistic regression models adjusting for common confounders.
⇒ Both social position and work environment were globally assessed using a wide array of indicators.
⇒ As the cohort was not totally representative of the general population, the external validity of the findings is not warranted.
⇒ The observational and retrospective nature of the study restricts the possibility of drawing causality.

## INTRODUCTION

Social position is a powerful determinant of health, influencing the risk of cardiovascular diseases and cancers in particular.[1–4] The reasons why individuals with low social position usually have higher cardiovascular and cancer risks are many, including material deprivation, limited educational and cultural attainment, easy adoption of unhealthy behaviours, low importance given to the care of one's own health, inability to cope with illness and to access healthcare. For example, individuals with low social position, as measured by educational level, occupational class or income, are more likely to be exposed to several risk factors such as smoking, alcohol consumption, leisure-time physical inactivity, obesity, diabetes, hypertension, dyslipidaemia, depression or sleep disorders.[5–13]

Work environment is another strong determinant of health.[14] Individuals with bad working conditions, as assessed by various physicochemical, biomechanical, organisational or psychosocial indicators, have higher cardiovascular and cancer risks.[15–17] Besides the health effects of bad working conditions, these individuals are also overexposed to common risk factors, including alcohol consumption, smoking, leisure-time physical inactivity, obesity, hypertension, diabetes, depression or sleep disorders.[8 18–25]

Unemployment can also influence health, independently from social position and work environment.[26–28] The reasons why unemployed individuals have higher cardiovascular and cancer risks[29–33] remain elusive but overexposure to risk factors, such as alcohol consumption, smoking, leisure-time physical inactivity, unbalanced diet, obesity, diabetes, depression or sleep disorders, is likely involved.[34–40]

Health burdens associated with low social position, bad work environment or unemployment are rarely assessed by taking into account these three conditions simultaneously, yet they are strongly inter-related[8 41] and often exert their effects in a cumulative way during the lifetime of individuals. The burden linked to one condition could be explained in part by the confounding of the other conditions. For example, the gradient in the incidence of behavioural risk factors (alcohol consumption, smoking, leisure-time physical inactivity) according to work environment is largely mediated by social position while the social gradient in the incidence of clinical risk factors (obesity, hypertension, dyslipidaemia, diabetes, sleep disorders, depression) is rather mediated by work environment.[8] Another potential issue is that social position and work environment are often characterised by a limited number of indicators, such as educational level, occupational class, income, job strain, night shift or chemical exposure, and are not considered as a whole, which is reality for individuals who are not facing only one or a few social constraints or occupational exposures.

The aim of this cross-sectional and retrospective study was to simultaneously assess the relationships between the prevalence of cardiovascular events and cancers, unemployment exposure and global estimates of social position and work environment in a large population-based cohort. Examining whether these inter-related socioeconomic variables are associated with distinct health burdens that could add up during lifetime may be helpful to optimally design preventive strategies.

## METHODS

### Study population

In total 205 203 adults who were affiliated to the general health insurance system (which covers 85% of the French population) were enrolled in the CONSTANCES cohort between February 2012 and September 2021 using a random sampling scheme stratified on age, sex, socioeconomic status and region.[42] Inclusion criteria comprised the obligation to provide written informed consent, to undergo a comprehensive health examination in 1 of the 21 participating medical centres scattered across metropolitan territory and to complete questionnaires on lifestyle, health-related behaviours, social and occupational conditions. The inclusion rate was rather low (7.3%)[43] in line with those observed in other large population-based cohorts when participants are required to visit a medical centre for health-related examinations.[44] Note that the authors of the present study did not have access to information that could have identified individual participants during or after data collection. Participants were not involved in the design of this study, nor in its implementation but they will be informed of the results. The cohort received approvals from the Ethics Evaluation Committee of the French National Institute of Health and Medical Research and from the National Committee for the Protection of Privacy and Civil Liberties.

The analyses were performed in a subset of 130 197 participants who had no missing values in all variables that were included in multi-adjusted regression models. The choice of selecting these participants rather than imputing randomly distributed missing data was driven by the fact that the cohort was not representative of the French population due to the low inclusion rate that resulted in the selection of socially privileged people, even though the stratified sampling strategy tried to compensate for the higher non-response rate of individuals with low socioeconomic status.[42] The selection of participants with no missing values only marginally accentuated this bias (online supplemental table S1) and the alternative of using multivariate imputation by chained equations would not have been devoid of other biases.[45]

### Patient and public involvement

Participants or members of the public were not involved in the design of this study, nor in its implementation. Participants and the general public will be informed of the results of the study through publication.

### Social position of participants

Several socioeconomic indicators whose distributions are shown in online supplemental table S2 were considered for assessing social position of participants at inclusion. Educational attainment was classified into four levels depending on the number of years of study: ≤11, 12–13, 14–16 or ≥17. Occupation of participants and spouses was reduced from a 10-level classification in the original inquiry to three grades: blue collar/clerk, intermediate and management. Income that included monthly earnings of all household members was ranked as low (below €1500), middle (between €1500 and €2800), high (between €2800 and €4200) or very high (above €4200). These thresholds were dictated by the inquiry that originally included seven levels of income and the need to balance the number of participants between groups. Social vulnerability was evaluated by a score that was calculated from a questionnaire comprising 11

binary items (Y/N) exploring material and social deprivation[46]: 'do you sometimes meet a social worker?', 'do you have complementary health insurance?', 'do you live as a couple?', 'are you a homeowner?', 'are there periods in the month when you have real financial difficulties to meet your basic needs?', 'have you done any sports activities in the last 12 months?', 'have you been to any show over the last 12 months?', 'have you been on holiday over the last 12 months?', 'have you seen any family member over the last 6 months?', 'if you have difficulties, is there anyone around who could take you in for a few days?', 'if you have difficulties, is there anyone around who could provide you with material assistance?'. This score was categorised into terciles (low, intermediate or high social vulnerability) for the analyses. Note that participants who were unemployed at inclusion reported the occupation, income and social vulnerability status they had just before the unemployment episode.

Given that these different indicators assess complementary and interdependent aspects of social position (online supplemental figure S1), a global score was calculated by giving for each indicator a value of 1 to the least privileged group, 2 or 3 to intermediary groups and 3 or 4 to the most privileged group, depending if the indicator encompassed three or four levels, by summing the values and by dividing the sum by the number of available indicators for each participant. This global score was categorised into terciles (low, middle or high social position) for the analyses, as previously reported.[8]

### Work environment of participants

A total of 19 occupational exposures whose distributions are shown in online supplemental table S3 were used to characterise the work environment of participants at inclusion. These included a series of organisational, physical, biomechanical, chemical and psychosocial factors such as commuting time, clocking in and out, regular working hours (on daily and weekly basis), long working hours (over 10 hours per week day), night work, dealing with the public, driving on public road, repetitive work (imposed by a machine, a procedure or someone), working with a screen, standing work posture, handling heavy loads (over 1 kg), physically demanding work, exposure to vibrations, exposure to noise, outdoor work, working in the cold, working in the heat, exposure to chemicals and the scale assessing effort-reward imbalance of work that was divided into terciles (low, average or high imbalance).[47] Note that participants who were unemployed at inclusion reported the work environment they had just before becoming unemployed.

Work environment was considered as a whole, which is reality for workers who are not facing only one or a few occupational exposures.[48] For that purpose, the exposures that were significantly inter-related with each other (online supplemental figure S2) were combined into a global score that was calculated by giving for each exposure a value of 1 to the least exposed group, 3 to the more exposed group and 2 to the intermediary groups whenever the exposure encompassed three levels, by summing the values and by dividing the sum by the number of available exposures for each worker. This global score was categorised into terciles (bad, average or good work environment) for the analyses, as already described.[49]

### Unemployment experienced by participants

Unemployment exposure of participants during their lifetime was documented by a questionnaire in which they were asked to report each time they had stopped working for a period of more than 6 months and why (unemployment, health issue, other reason). The existence of past episodes of unemployment was confirmed for each participant by administrative data from the French national pension system which also provided the total number of unemployed quarters. This number, that was used to estimate the duration of unemployment experienced by each participant, was arbitrarily categorised into three groups (0, 1–19, 20–148 quarters) for the analyses.

### Prevalence of risk factors among participants

Several risk factors commonly found in the population were assessed in participants at inclusion. These included four non-modifiable factors: sex, age that was divided into terciles (18–39, 40–54, 55–75 years old) and parental histories of cardiovascular event or cancer coded as binary variables (Y/N). Three behavioural factors: smoking coded into three categories (current, former, never), lifetime non-moderate alcohol consumption (more than two or three drinks on the same day in women or men, respectively)[50] classified as rarely (never or less than one time per month), sometimes (two or three times per month) or often (one time or more per week), leisure-time physical inactivity whose inquiry was based on a three-item questionnaire asking about regular practice of walking or cycling, practicing a sport or gardening or housekeeping over the past 12 months; each item was noted 0 if the answer was no, 1 if the practice was regular but low (less than 15 min for sport, or 2 hours for the two other items, per week), 2 if the practice was regular and higher; the score calculated by summing the three items ranged from 0 (not active at all) to 6 (very active) and was used to characterise leisure-time physical inactivity (participants with a score <2). Six clinical risk factors were also retained: body mass index, hypertension, dyslipidaemia (either hypercholesterolaemia or hypertriglyceridaemia), diabetes, sleep disorders and depression. The inquiry into the presence and the age of onset of hypertension, dyslipidaemia, diabetes and sleep disorders, which were coded as binary variables (Y/N), was performed by physicians in the medical centres. Body mass index (BMI) was calculated from measured weight and height and coded into three categories (optimal if BMI<25 $kg/m^2$, overweight if 25≤BMI<30 $kg/m^2$, obesity if BMI≥30 $kg/m^2$). Depression was assessed using the Centre of Epidemiologic Studies Depression scale and defined as a score≥19 in both sexes.[51]

As the validity of self-reported information, even when collected by physicians, can be questioned, the coherence of the relationships between common risk factors and the prevalence of cardiovascular events and cancers was tested (online supplemental table S4). The fact that most of the expected associations were observed after multi-adjustment was a good indication that the collected information was reliable. Notably, the associations of the prevalence of cardiovascular events with sex, age, parental history of cardiovascular event, smoking, hypertension, dyslipidaemia, sleep disorders, depression and the associations of the prevalence of cancers with sex, age, parental history of cancer, former smoking and sleep disorders. In any case, if a bias was present, it would likely have been under-reporting with rates varying from one disorder to another: 95.2% for diabetes, 80.4% for hypertension, 77.8% for peripheral arterial disease, 72.4% for myocardial infarction, 71.4% for angina pectoris and 54.5% for stroke.[52]

### Prevalence of cardiovascular events and cancers among participants

During the visit in the medical centres at inclusion, physicians inquired about any non-fatal cardiovascular event and cancer that occurred during the lifetime of participants. Four types of cardiovascular events, coded as binary variables (Y/N), were retained for the analyses: stroke, angina pectoris, myocardial infarction and peripheral arterial disease. The information on the occurrence of any type of cancers was collected but only eight based on body location (breast, skin, prostate, cervical, colon, thyroid, lymphoma, lung), coded as binary variables (Y/N), were analysed separately due to the limited number of cases in the other locations.

### Statistical analyses

The characteristics of participants with or without missing values or of individuals randomly selected from the French population were compared by pairs using Cohen's h measure of effect size with the rule of thumb to categorise substantial differences as small ($0.2 \leq h < 0.5$), medium ($0.5 \leq h > 0.8$) or large ($h \geq 0.8$).[53]

The characteristics of participants according to the past occurrence of cardiovascular event or cancer during their lifetime were compared by calculating standardised mean differences (SMD); values >0.1 being considered as showing significant differences.[54]

The analyses were cross-sectional using the data collected at inclusion of participants but also retrospective because some data, such as cumulated unemployment duration or non-moderate alcohol consumption during lifetime, described past events. The associations between social position, work environment, unemployment duration and the prevalence of cardiovascular events and cancers were tested with multiple logistic regression modelling. Several types of models were used: models 1 were adjusted for sex, age and parental history of cardiovascular event or cancer; models 2 were adjusted for sex, age, parental history of cardiovascular event or cancer, social position, work environment and unemployment duration; models 3 were adjusted for sex, age, parental history of cardiovascular event, social position, work environment, unemployment duration, lifetime non-moderate alcohol consumption, smoking, leisure-time physical inactivity, body mass index, hypertension, dyslipidaemia, diabetes, sleep disorders and depression when investigating the prevalence of cardiovascular events, or for sex, age, parental history of cancer, social position, work environment, unemployment duration, lifetime non-moderate alcohol consumption, smoking, body mass index and sleep disorders when investigating the prevalence of cancers.

Residual analyses were performed to assess the fit of the data, assumptions were checked and the potential influence of outliers was examined for all associations.[55] Statistical significance was fixed a priori at two-sided p value <0.05.

All analyses were performed with the statistical discovery software JMP 17 Pro (SAS, Cary, North Carolina, USA) except the calculation of SMD which was done with R software V.4.2.2 and 'tableone' package V.0.13.2.[56]

## RESULTS

### Inter-relationships between low social position, bad work environment and unemployment duration among participants

As shown in figure 1, social position, work environment and unemployment duration during lifetime were highly correlated, the lower the social position, the worse the work environment and the longest the unemployment duration.

### Characteristics of participants according to the occurrence of non-fatal cardiovascular events during lifetime

Compared with participants who never suffered from cardiovascular events, those who did (2340 participants representing 1.8% of the cohort) were more likely to be old men with parental history of cardiovascular events, low social position, bad work environment and long exposure to unemployment (table 1). They were also overexposed to several risk factors, including lifetime non-moderate alcohol consumption, former smoking, high body mass index, hypertension, dyslipidaemia and diabetes.

### Prevalence of non-fatal cardiovascular events among participants according to social position, work environment and unemployment duration

Low social position was associated with an increased prevalence of cardiovascular events (OR from 1.22 to 1.90) except stroke whose association was non-significant after adjustment for risk factors, work environment and unemployment duration (table 2).

Bad work environment was only associated with an increased prevalence of stroke (OR=1.29) (table 2). Associations with angina pectoris, myocardial infarction and peripheral arterial disease were non-significant after

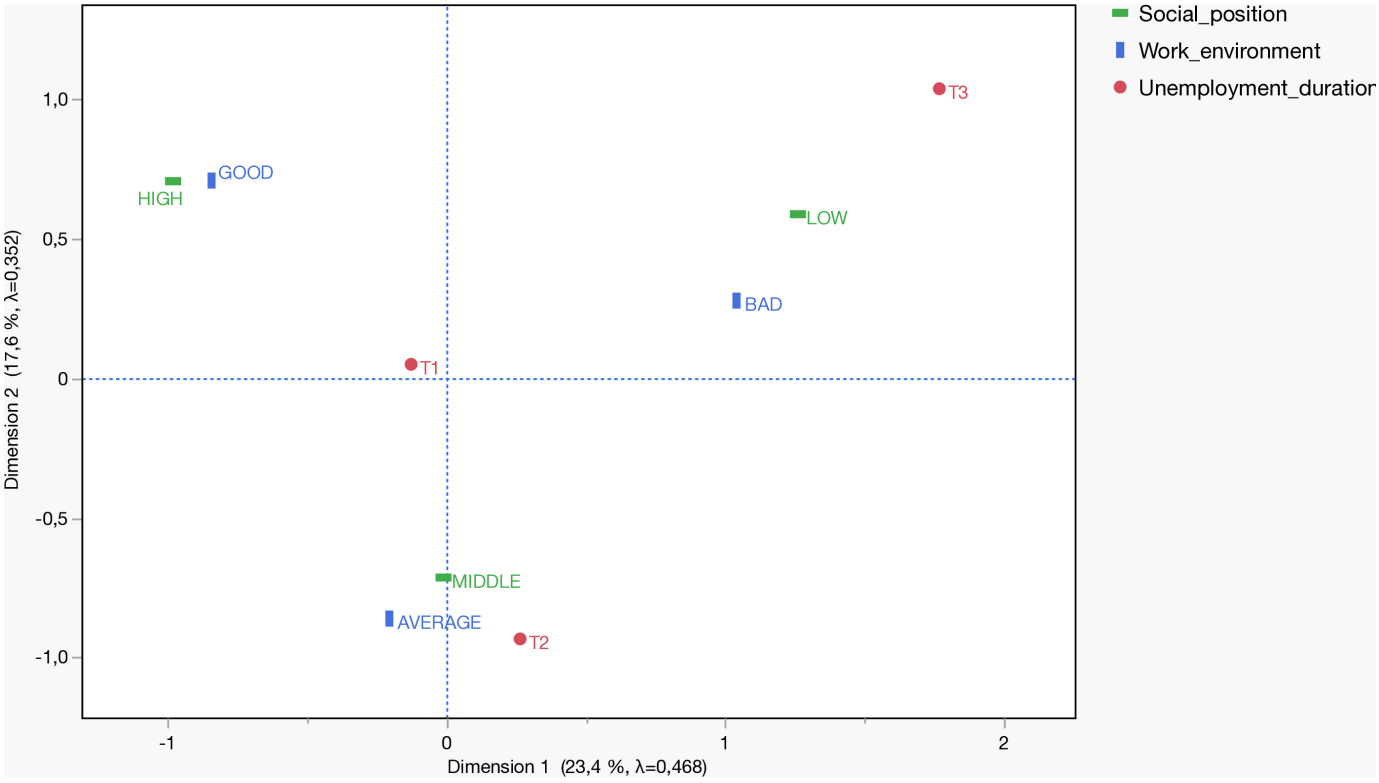


**Figure 1** Multiple correspondence analysis showing the association between social position, work environment and unemployment duration. The plot uses the two first dimensions which explain, respectively 23.4 and 17.6% of the total inertia (81.7 and 1.6% with Greenacre adjustment).

adjustment for risk factors, social position and unemployment duration.

After adjustment for risk factors, social position and work environment, long duration of unemployment (20–148 quarters) was associated with an increased prevalence of cardiovascular events (OR from 1.46 to 1.70) except stroke whose association was non-significant whatever the adjustment (table 2).

### Characteristics of participants according to the occurrence of non-fatal cancers during lifetime

Compared with participants who never suffered from cancer, those who did (5930 participants representing 4.6% of the cohort) were more likely to be old women with parental history of cancer, low social position and bad work environment (table 3). They were also overexposed to risk factors such as former smoking, high body mass index and marginally sleep disorders.

#### Prevalence of non-fatal cancers among participants according to social position, work environment and unemployment duration

After adjustment for risk factors, work environment and unemployment duration, low social position was not associated with the prevalence of cancers when they were considered globally (table 4). However, it was directly associated with cervical and lung cancers (OR=1.73 and 1.95, respectively) while it was strongly and inversely associated with skin cancer (OR=0.70).

After adjustment for risk factors, social position and unemployment duration, a bad work environment was associated with an increased prevalence of cancers when they were considered globally (OR=1.45) (table 4). More precisely, it was directly associated with breast, skin, prostate and colon cancers (OR from 1.31 to 2.91).

Unemployment duration was not associated with the prevalence of any type of cancers whatever the adjustment (online supplemental table S5).

### Summary of the associations between social position, work environment, unemployment duration and the prevalence of non-fatal cardiovascular events and cancers

The significant associations after adjustment for risk factors and their putative directions are summarised in figure 2.

### Chronology of unemployment, non-fatal cardiovascular events and cancers during the lifetime of participants

In order to test the possibility of reverse causation where cardiovascular events or cancers would have preceded unemployment, the age of participants at which unemployed quarters were declared was compared with the age at which cardiovascular events and cancers occurred. It appears that unemployment episodes popped up much earlier than cardiovascular events or cancers with a mean difference of approximately 5–20. Thus, the mean age at which the episodes happened was 34.4 (SD 9.2) in comparison to the mean age of occurrence of stroke 49.2 (12.0), angina pectoris 53.8 (8.3), myocardial infarction 51.7 (9.0), peripheral arterial disease 53.7 (7.9), breast 49.0 (8.6), prostate 59.2 (4.9), cervical 38.1 (8.9), colon

**Table 1** Characteristics of participants who have or have not had a cardiovascular event

| | | Cardiovascular event | | | | |
|---|---|---|---|---|---|---|
| | | No | | Yes | | |
| | | n | % | n | % | SMD |
| – | All | 127 857 | 98.2 | 2340 | 1.8 | – |
| Sex | Women | 66 147 | 51.7 | 596 | 25.5 | 0.560 |
| | Men | 61 710 | 48.3 | 1744 | 74.5 | |
| Age (years) | 18–39 | 42 048 | 32.9 | 87 | 3.7 | 1.147 |
| | 40–54 | 43 890 | 34.3 | 380 | 16.3 | |
| | 55–75 | 41 919 | 32.8 | 1873 | 80.0 | |
| Parental history of cardiovascular event | No | 97 502 | 76.3 | 1334 | 57.0 | 0.417 |
| | Yes | 30 355 | 23.7 | 1006 | 43.0 | |
| Social position | High | 37 520 | 29.3 | 419 | 17.9 | 0.384 |
| | Middle | 61 212 | 47.9 | 1015 | 43.4 | |
| | Low | 29 125 | 22.8 | 906 | 38.7 | |
| Work environment | Good | 40 354 | 31.6 | 386 | 16.5 | 0.662 |
| | Average | 46 701 | 36.5 | 473 | 20.2 | |
| | Bad | 40 802 | 31.9 | 1481 | 63.3 | |
| Unemployment duration (quarters) | 0 | 109 461 | 85.6 | 1946 | 83.2 | 0.162 |
| | 1–19 | 12 507 | 9.8 | 195 | 8.3 | |
| | 20–148 | 5889 | 4.6 | 199 | 8.5 | |
| Lifetime non-moderate alcohol consumption | Rarely | 18 104 | 14.2 | 272 | 11.6 | 0.165 |
| | Sometimes | 26 826 | 21.0 | 373 | 15.9 | |
| | Often | 82 927 | 64.8 | 1695 | 72.5 | |
| Smoking | Never | 59 425 | 46.5 | 704 | 30.1 | 0.432 |
| | Former | 43 778 | 34.2 | 1287 | 55.0 | |
| | Current | 24 654 | 19.3 | 349 | 14.9 | |
| Leisure-time physical inactivity | No | 116 132 | 90.8 | 2120 | 90.6 | 0.008 |
| | Yes | 11 725 | 9.2 | 220 | 9.4 | |
| Body mass index | Optimal | 75 836 | 59.3 | 793 | 33.9 | 0.539 |
| | Overweight | 38 037 | 29.8 | 1021 | 43.6 | |
| | Obese | 13 984 | 10.9 | 526 | 22.5 | |
| Hypertension | No | 116 148 | 90.8 | 1295 | 55.3 | 0.874 |
| | Yes | 11 709 | 9.2 | 1045 | 44.7 | |
| Dyslipidaemia | No | 119 939 | 93.8 | 1095 | 46.8 | 1.200 |
| | Yes | 7918 | 6.2 | 1245 | 53.2 | |
| Diabetes | No | 126 156 | 98.7 | 2113 | 90.3 | 0.373 |
| | Yes | 1701 | 1.3 | 227 | 9.7 | |
| Sleep disorders | No | 46 997 | 36.8 | 784 | 33.5 | 0.068 |
| | Yes | 80 860 | 63.2 | 1556 | 66.5 | |
| Depression | No | 109 684 | 85.8 | 1967 | 84.1 | 0.048 |
| | Yes | 18 173 | 14.2 | 373 | 15.9 | |

The percentages were calculated relatively to the number of participants who have or have not had a cardiovascular event; the differences between the two groups were assessed by computing standardised mean differences (SMD).

**Table 2** Adjusted ORs (95% CI) for the prevalence of non-fatal cardiovascular events in participants at inclusion according to their social position, work environment and unemployment exposure

| | | Type of event | n | % | Models 1 | P value | Models 2 | P value | Models 3 | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| Social position | High | All | 419 | 1.10 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 1015 | 1.63 | 1.41 (1.25 to 1.58) | <0.0001 | 1.26 (1.12 to 1.42) | 0.0001 | 1.13 (1.00 to 1.27) | 0.05 |
| | Low | | 906 | 3.02 | 2.01 (1.78 to 2.26) | <0.0001 | 1.63 (1.44 to 1.86) | <0.0001 | 1.27 (1.12 to 1.45) | 0.0003 |
| | High | Stroke | 195 | 0.51 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 395 | 0.63 | 1.18 (0.99 to 1.40) | 0.06 | 1.08 (0.91 to 1.29) | 0.37 | 1.01 (0.84 to 1.20) | 0.95 |
| | Low | | 308 | 1.03 | 1.57 (1.31 to 1.89) | <0.0001 | 1.35 (1.11 to 1.64) | 0.003 | 1.09 (0.89 to 1.33) | 0.38 |
| | High | Angina pectoris | 116 | 0.31 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 319 | 0.51 | 1.58 (1.27 to 1.96) | <0.0001 | 1.43 (1.15 to 1.78) | 0.001 | 1.27 (1.02 to 1.59) | 0.03 |
| | Low | | 285 | 0.95 | 2.16 (1.74 to 2.69) | <0.0001 | 1.78 (1.41 to 2.25) | <0.0001 | 1.40 (1.10 to 1.78) | 0.005 |
| | High | Myocardial infarction | 143 | 0.38 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 352 | 0.57 | 1.43 (1.18 to 1.75) | 0.0003 | 1.28 (1.05 to 1.57) | 0.01 | 1.11 (0.90 to 1.36) | 0.34 |
| | Low | | 326 | 1.09 | 2.04 (1.67 to 2.50) | <0.0001 | 1.65 (1.34 to 2.05) | <0.0001 | 1.22 (1.01 to 1.52) | 0.04 |
| | High | Peripheral arterial disease | 34 | 0.09 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 97 | 0.16 | 1.64 (1.11 to 2.43) | 0.01 | 1.46 (0.98 to 2.17) | 0.06 | 1.23 (0.82 to 1.84) | 0.31 |
| | Low | | 128 | 0.43 | 3.40 (2.32 to 4.98) | <0.0001 | 2.69 (1.79 to 4.02) | <0.0001 | 1.90 (1.26 to 2.86) | 0.002 |
| Work environment | Good | All | 386 | 0.95 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 473 | 1.00 | 1.03 (0.90 to 1.18) | 0.70 | 0.95 (0.83 to 1.09) | 0.50 | 0.93 (0.80 to 1.07) | 0.28 |
| | Bad | | 1481 | 3.50 | 1.88 (1.67 to 2.11) | <0.0001 | 1.61 (1.42 to 1.82) | <0.0001 | 1.26 (1.10 to 1.43) | 0.0005 |
| | Good | Stroke | 182 | 0.45 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 218 | 0.46 | 1.04 (0.86 to 1.27) | 0.66 | 1.01 (0.83 to 1.24) | 0.90 | 0.99 (0.81 to 1.21) | 0.93 |
| | Bad | | 498 | 1.18 | 1.68 (1.40 to 2.01) | <0.0001 | 1.54 (1.28 to 1.86) | <0.0001 | 1.29 (1.06 to 1.56) | 0.01 |
| | Good | Angina pectoris | 115 | 0.28 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 126 | 0.27 | 0.90 (0.70 to 1.16) | 0.41 | 0.81 (0.63 to 1.05) | 0.12 | 0.80 (0.62 to 1.04) | 0.09 |
| | Bad | | 479 | 1.13 | 1.79 (1.45 to 2.21) | <0.0001 | 1.49 (1.19 to 1.86) | 0.0004 | 1.09 (0.87 to 1.37) | 0.46 |
| | Good | Myocardial infarction | 126 | 0.31 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 164 | 0.35 | 1.05 (0.83 to 1.33) | 0.65 | 0.96 (0.76 to 1.22) | 0.76 | 0.93 (0.73 to 1.18) | 0.54 |
| | Bad | | 531 | 1.26 | 1.83 (1.49 to 2.23) | <0.0001 | 1.54 (1.24 to 1.90) | <0.0001 | 1.13 (0.91 to 1.40) | 0.28 |
| | Good | Peripheral arterial disease | 38 | 0.09 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 48 | 0.10 | 1.05 (0.69 to 1.61) | 0.81 | 0.90 (0.58 to 1.38) | 0.62 | 0.90 (0.58 to 1.38) | 0.62 |
| | Bad | | 173 | 0.41 | 2.16 (1.50 to 3.10) | <0.0001 | 1.55 (1.06 to 2.27) | 0.02 | 1.21 (0.83 to 1.78) | 0.32 |

Continued

Table 2 Continued

| | | Type of event | n | % | Models 1 | P value | Models 2 | P value | Models 3 | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| Unemployment duration (quarters) | 0 | All | 1946 | 1.75 | 1.00 | | 1.00 | | 1.00 | |
| | 1–19 | | 195 | 1.54 | 1.00 (0.86 to 1.16) | 0.97 | 0.98 (0.84 to 1.14) | 0.78 | 0.96 (0.82 to 1.12) | 0.62 |
| | 20–148 | | 199 | 3.27 | 1.56 (1.34 to 1.82) | <0.0001 | 1.40 (1.21 to 1.64) | <0.0001 | 1.39 (1.18 to 1.63) | <0.0001 |
| | 0 | Stroke | 767 | 0.69 | 1.00 | | 1.00 | | 1.00 | |
| | 1–19 | | 68 | 0.54 | 0.82 (0.64 to 1.06) | 0.13 | 0.81 (0.63 to 1.04) | 0.10 | 0.80 (0.63 to 1.04) | 0.09 |
| | 20–148 | | 63 | 1.03 | 1.18 (0.91 to 1.53) | 0.22 | 1.08 (0.83 to 1.40) | 0.58 | 1.08 (0.82 to 1.40) | 0.59 |
| | 0 | Angina pectoris | 598 | 0.54 | 1.00 | | 1.00 | | 1.00 | |
| | 1–19 | | 60 | 0.47 | 1.04 (0.80 to 1.36) | 0.77 | 1.01 (0.78 to 1.33) | 0.91 | 1.00 (0.76 to 1.32) | 0.98 |
| | 20–148 | | 62 | 1.02 | 1.61 (1.23 to 2.10) | 0.0004 | 1.45 (1.11 to 1.90) | 0.006 | 1.46 (1.11 to 1.92) | 0.007 |
| | 0 | Myocardial infarction | 667 | 0.60 | 1.00 | | 1.00 | | 1.00 | |
| | 1–19 | | 76 | 0.60 | 1.19 (0.94 to 1.52) | 0.15 | 1.16 (0.91 to 1.48) | 0.23 | 1.12 (0.88 to 1.44) | 0.35 |
| | 20–148 | | 78 | 1.28 | 1.89 (1.48 to 2.40) | <0.0001 | 1.71 (1.34 to 2.17) | <0.0001 | 1.64 (1.28 to 2.11) | <0.0001 |
| | 0 | Peripheral arterial disease | 204 | 0.18 | 1.00 | | 1.00 | | 1.00 | |
| | 1–19 | | 25 | 0.20 | 1.25 (0.82 to 1.89) | 0.30 | 1.17 (0.77 to 1.78) | 0.45 | 1.08 (0.71 to 1.65) | 0.71 |
| | 20–148 | | 30 | 0.49 | 2.30 (1.56 to 3.39) | <0.0001 | 1.91 (1.29 to 2.82) | 0.001 | 1.70 (1.14 to 2.53) | 0.009 |

The percentages were calculated relatively to the number of participants for each social position (high=37 939; middle=62 227; low=30 031), work environment (good=40 740; average=47 174; bad=42 283) or unemployment duration (0 quarter=111 407; 1–19 quarters=12 702; 20–148 quarters=6088).
Models 1 included either social position, work environment or unemployment duration and were adjusted for sex, age and parental history of cardiovascular events.
Models 2 included social position, work environment and unemployment duration and were adjusted for sex, age and parental history of cardiovascular events.
Models 3 included social position, work environment and unemployment duration and were adjusted for sex, age, parental history of cardiovascular event, lifetime non-moderate alcohol consumption, smoking, leisure-time physical inactivity, body mass index, hypertension, dyslipidaemia, diabetes, sleep disorders and depression.

52.8 (9.1), thyroid 41.4 (12.2) and lung 51.8 (11.1) cancers (online supplemental figure S3).

### Prevalence of non-fatal cardiovascular events and cancers among men and women according to social position, work environment and unemployment duration

The analyses by sex suggest that the associations are generally observed both in men and women (online supplemental tables S6 and S7). It is difficult to know if the occasional lack of associations (angina pectoris with unemployment duration, eg) or the differences in their magnitude (angina pectoris with social position, eg) between the sexes were real or due to the significantly decreased statistical power. Note that the results concerning the associations of non-fatal cancers with unemployment duration are not shown as none of them were statistically significant in both sexes.

## DISCUSSION

The present analyses report the prevalence of cardiovascular events and cancers according to social position, work environment and unemployment exposure in a large population-based French cohort. The retrospective design of the study privileges a holistic approach in which a wide array of indicators is used to globally characterise social position and work environment in order to provide a better assessment of what people face in real life. The results show that social position, work environment and unemployment exposure are strongly inter-related with each other in a way where people are either all good or all bad. The public health issue therefore first arises from people who cumulate a low social position, a bad work environment and a long exposure to unemployment.

The main finding is that, despite their strong interrelationships, social position, work environment and unemployment exposure are not linked to the same cardiovascular and cancerous outcomes. Thus, low social position and long unemployment duration are associated with an increased prevalence of angina pectoris, myocardial infarction and peripheral arterial disease but not of stroke. In contrast, bad work environment is associated with an increased prevalence of stroke but not of angina pectoris, myocardial infarction and peripheral arterial disease. These results add to previously reported data[1 2 31] by clearly showing distinct effects of social position and unemployment on one side and work environment on the other side on the risk of cardiovascular events. They also echo the fact that social position and work environment do not predict the incidence of the same risk factors, that is, mainly behavioural factors (non-moderate alcohol

Table 3 Characteristics of participants who have or have not had cancer

| | | Cancer | | | | |
|---|---|---|---|---|---|---|
| | | No | | Yes | | |
| | | n | % | n | % | SMD |
| – | All | 124 267 | 95.4 | 5930 | 4.6 | – |
| Sex | Women | 63 160 | 50.8 | 3583 | 60.4 | 0.118 |
| | Men | 61 107 | 49.2 | 2347 | 39.6 | |
| Age (years) | 18–39 | 41 738 | 33.6 | 397 | 6.7 | 0.920 |
| | 40–54 | 42 905 | 34.5 | 1365 | 23.0 | |
| | 55–75 | 39 624 | 31.9 | 4168 | 70.3 | |
| Parental history of cancer | No | 82 462 | 66.4 | 3088 | 52.1 | 0.282 |
| | Yes | 41 805 | 33.6 | 2842 | 47.9 | |
| Social position | High | 36 471 | 29.4 | 1468 | 24.7 | 0.151 |
| | Middle | 59 466 | 47.8 | 2761 | 46.6 | |
| | Low | 28 330 | 22.8 | 1701 | 28.7 | |
| Work environment | Good | 39 356 | 31.7 | 1384 | 23.3 | 0.441 |
| | Average | 45 771 | 36.8 | 1403 | 23.7 | |
| | Bad | 39 140 | 31.5 | 3143 | 53.0 | |
| Unemployment duration (quarters) | 0 | 106 389 | 85.6 | 5018 | 84.6 | 0.088 |
| | 1–19 | 12 170 | 9.8 | 532 | 9.0 | |
| | 20–148 | 5708 | 4,6 | 380 | 6.4 | |
| Lifetime non-moderate alcohol consumption | Rarely | 17 503 | 14.1 | 873 | 14.7 | 0.042 |
| | Sometimes | 25 994 | 20.9 | 1205 | 20.3 | |
| | Often | 80 770 | 65.0 | 3852 | 65.0 | |
| Smoking | Never | 57 498 | 46.3 | 2631 | 44.4 | 0.240 |
| | Former | 42 482 | 34.2 | 2583 | 43.6 | |
| | Current | 24 287 | 19.5 | 716 | 12.0 | |
| Body mass index | Optimal | 73 501 | 59.1 | 3128 | 52.8 | 0.165 |
| | Overweight | 37 093 | 29.9 | 1965 | 33.1 | |
| | Obese | 13 673 | 11.0 | 837 | 14.1 | |
| Sleep disorders | No | 45 861 | 36.9 | 1920 | 32.4 | 0.073 |
| | Yes | 78 406 | 63.1 | 4010 | 67.6 | |

The percentages were calculated relative to the number of participants who have or have not had cancer; the differences between the two groups were assessed by computing standardised mean differences (SMD).

consumption, smoking, leisure-time physical inactivity) for social position, mostly clinical factors (obesity, hypertension, dyslipidaemia, diabetes, sleep disorders, depression) for work environment.[8] Overall, these results point out the existence of distinct aetiological mechanisms underlying coronary/peripheral and cerebrovascular diseases with potentially different risk factors.[57] From a public health viewpoint, considering social position, work environment and unemployment exposure as risk factors remains of little practical interest to prevent cardiovascular events as they are hardly modifiable. However, they can indicate the need for more thorough monitoring of risk factors in people who cumulate low social position, bad work environment and long exposure to unemployment.

A similar conclusion can be drawn from the results showing that social position and work environment are not associated with the same types of cancers. While low social position is associated with an increased prevalence of cervical and lung cancers and a decreased prevalence of skin cancer, bad work environment is associated with an increased prevalence of breast, skin, prostate and colon cancers. These findings add to other studies[58–64] by delimiting in the same cohort the respective effects of social position and work environment on cancer risk. These distinct effects may be mediated by different risk factors such as sleep disorders in the case of bad work environment or smoking in the case of social position. The finding that unemployment exposure is not associated with the prevalence of any type of cancers is in disagreement with results from previous studies.[29 32] This discrepancy might arise from the absence of adjustment for work environment in these studies, leaving the possibility that the observed increase in the prevalence of some types of

**Table 4** Adjusted ORs (95% CI) for the prevalence of non-fatal cancers in participants at inclusion according to their social position and work environment

| | | Body location | n | % | Models 1 | P value | Models 2 | P value | Models 3 | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| Social position | High | All | 1468 | 3.87 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 2761 | 4.44 | 1.05 (0.98 to 1.12) | 0.16 | 0.97 (0.91 to 1.04) | 0.47 | 0.97 (0.91 to 1.04) | 0.44 |
| | Low | | 1701 | 5.66 | 1.12 (1.04 to 1.21) | 0.003 | 0.98 (0.91 to 1.06) | 0.63 | 0.98 (0.91 to 1.07) | 0.71 |
| | High | Breast | 385 | 1.01 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 753 | 1.21 | 1.00 (0.88 to 1.13) | 0.99 | 0.95 (0.84 to 1.08) | 0.44 | 0.95 (0.83 to 1.08) | 0.42 |
| | Low | | 452 | 1.51 | 1.08 (0.94 to 1.24) | 0.29 | 0.99 (0.85 to 1.15) | 0.87 | 0.99 (0.85 to 1.15) | 0.88 |
| | High | Skin | 453 | 1.19 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 679 | 1.09 | 0.85 (0.75 to 0.96) | 0.008 | 0.81 (0.71 to 0.92) | 0.0008 | 0.83 (0.73 to 0.94) | 0.003 |
| | Low | | 333 | 1.11 | 0.71 (0.62 to 0.82) | <0.0001 | 0.65 (0.56 to 0.76) | <0.0001 | 0.70 (0.60 to 0.81) | <0.0001 |
| | High | Prostate | 146 | 0.38 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 306 | 0.49 | 1.18 (0.96 to 1.44) | 0.11 | 0.91 (0.74 to 1.12) | 0.38 | 0.92 (0.75 to 1.13) | 0.44 |
| | Low | | 232 | 0.77 | 1.23 (0.99 to 1.51) | 0.06 | 0.82 (0.66 to 1.03) | 0.09 | 0.84 (0.67 to 1.05) | 0.12 |
| | High | Cervical | 60 | 0.16 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 162 | 0.26 | 1.53 (1.13 to 2.06) | 0.005 | 1.48 (1.09 to 2.00) | 0.01 | 1.41 (1.04 to 1.91) | 0.03 |
| | Low | | 103 | 0.34 | 2.01 (1.45 to 2.79) | <0.0001 | 1.86 (1.32 to 2.61) | 0.0003 | 1.73 (1.22 to 2.44) | 0.002 |
| | High | Colon | 61 | 0.16 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 146 | 0.23 | 1.29 (0.95 to 1.74) | 0.10 | 1.12 (0.82 to 1.52) | 0.47 | 1.12 (0.82 to 1.52) | 0.48 |
| | Low | | 104 | 0.35 | 1.43 (1.04 to 1.97) | 0.03 | 1.14 (0.82 to 1.59) | 0.44 | 1.15 (0.82 to 1.61) | 0.42 |
| | High | Thyroid | 74 | 0.20 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 160 | 0.26 | 1.23 (0.93 to 1.62) | 0.14 | 1.20 (0.91 to 1.60) | 0.19 | 1.21 (0.91 to 1.61) | 0.18 |
| | Low | | 91 | 0.30 | 1.34 (0.98 to 1.84) | 0.06 | 1.30 (0.94 to 1.80) | 0.12 | 1.31 (0.94 to 1.83) | 0.11 |
| | High | Lymphoma | 77 | 0.20 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 148 | 0.24 | 1.15 (0.87 to 1.51) | 0.33 | 1.14 (0.86 to 1.52) | 0.35 | 1.13 (0.85 to 1.50) | 0.41 |
| | Low | | 79 | 0.26 | 1.13 (0.82 to 1.56) | 0.44 | 1.11 (0.79 to 1.56) | 0.55 | 1.09 (0.77 to 1.54) | 0.63 |
| | High | Lung | 13 | 0.03 | 1.00 | | 1.00 | | 1.00 | |
| | Middle | | 32 | 0.05 | 1.40 (0.73 to 2.68) | 0.30 | 1.35 (0.70 to 2.61) | 0.37 | 1.24 (0.64 to 2.41) | 0.52 |
| | Low | | 33 | 0.11 | 2.36 (1.23 to 4.52) | 0.01 | 2.23 (1.12 to 4.42) | 0.02 | 1.95 (1.02 to 3.90) | 0.03 |

Continued

**Table 4** Continued

| | | Body location | n | % | Models 1 | P value | Models 2 | P value | Models 3 | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| Work environment | Good | All | 1384 | 3.40 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 1403 | 2.97 | 0.93 (0.86 to 1.01) | 0.06 | 0.93 (0.86 to 1.01) | 0.07 | 0.92 (0.85 to 1.01) | 0.06 |
| | Bad | | 3143 | 7.43 | 1.47 (1.37 to 1.57) | <0.0001 | 1.47 (1.37 to 1.58) | <0.0001 | 1.45 (1.35 to 1.56) | <0.0001 |
| | Good | Breast | 415 | 1.02 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 377 | 0.80 | 0.93 (0.81 to 1.07) | 0.34 | 0.93 (0.81 to 1.08) | 0.34 | 0.92 (0.80 to 1.06) | 0.26 |
| | Bad | | 798 | 1.89 | 1.31 (1.16 to 1.49) | <0.0001 | 1.32 (1.16 to 1.50) | <0.0001 | 1.31 (1.15 to 1.49) | <0.0001 |
| | Good | Skin | 380 | 0.93 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 362 | 0.77 | 0.86 (0.74 to 1.01) | 0.06 | 0.90 (0.77 to 1.04) | 0.14 | 0.91 (0.78 to 1.05) | 0.19 |
| | Bad | | 723 | 1.71 | 1.19 (1.04 to 1.35) | 0.01 | 1.33 (1.16 to 1.53) | <0.0001 | 1.34 (1.16 to 1.54) | <0.0001 |
| | Good | Prostate | 68 | 0.17 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 52 | 0.11 | 0.62 (0.43 to 1.01) | 0.06 | 0.65 (0.45 to 1.01) | 0.06 | 0.65 (0.45 to 1.02) | 0.07 |
| | Bad | | 564 | 1.33 | 2.72 (2.11 to 3.51) | <0.0001 | 2.90 (2.23 to 3.79) | <0.0001 | 2.91 (2.23 to 3.80) | <0.0001 |
| | Good | Cervical | 97 | 0.24 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 95 | 0.20 | 0.97 (0.73 to 1.29) | 0.86 | 0.93 (0.70 to 1.24) | 0.63 | 0.92 (0.69 to 1.22) | 0.56 |
| | Bad | | 133 | 0.31 | 1.28 (0.97 to 1.70) | 0.08 | 1.12 (0.84 to 1.50) | 0.42 | 1.14 (0.86 to 1.52) | 0.36 |
| | Good | Colon | 49 | 0.12 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 58 | 0.12 | 1.08 (0.73 to 1.58) | 0.70 | 1.06 (0.72 to 1.55) | 0.77 | 1.05 (0.72 to 1.54) | 0.80 |
| | Bad | | 204 | 0.48 | 2.00 (1.45 to 2.76) | <0.0001 | 1.94 (1.39 to 2.70) | 0.0001 | 1.90 (1.36 to 2.65) | 0.0002 |
| | Good | Thyroid | 86 | 0.21 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 103 | 0.22 | 1.14 (0.85 to 1.51) | 0.38 | 1.11 (0.83 to 1.48) | 0.47 | 1.09 (0.82 to 1.46) | 0.54 |
| | Bad | | 136 | 0.32 | 1.25 (0.94 to 1.66) | 0.13 | 1.18 (0.88 to 1.59) | 0.27 | 1.16 (0.86 to 1.56) | 0.33 |
| | Good | Lymphoma | 90 | 0.22 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 83 | 0.18 | 0.79 (0.59 to 1.07) | 0.13 | 0.78 (0.58 to 1.06) | 0.11 | 0.77 (0.57 to 1.04) | 0.09 |
| | Bad | | 131 | 0.31 | 1.07 (0.80 to 1.42) | 0.64 | 1.03 (0.77 to 1.40) | 0.83 | 1.01 (0.75 to 1.37) | 0.92 |
| | Good | Lung | 14 | 0.03 | 1.00 | | 1.00 | | 1.00 | |
| | Average | | 20 | 0.04 | 1.24 (0.62 to 2.46) | 0.54 | 1.12 (0.56 to 2.24) | 0.74 | 1.07 (0.54 to 2.15) | 0.84 |
| | Bad | | 44 | 0.10 | 1.62 (0.87 to 3.03) | 0.13 | 1.29 (0.67 to 2.47) | 0.45 | 1.24 (0.64 to 2.38) | 0.52 |

The percentages were calculated relatively to the number of participants for each social position (high=37 939; middle=62 227; low=30 031) or work environment (good=40 740; average=47 174; bad=42 283).
Models 1 included either social position, work environment or unemployment duration and were adjusted for sex, age and parental history of cancer.
Models 2 included social position, work environment and unemployment duration and were adjusted for sex, age and parental history of cancer.
Models 3 included social position, work environment and unemployment duration and were adjusted for sex, age, parental history of cancer, lifetime non-moderate alcohol consumption, smoking, body mass index and sleep disorders.

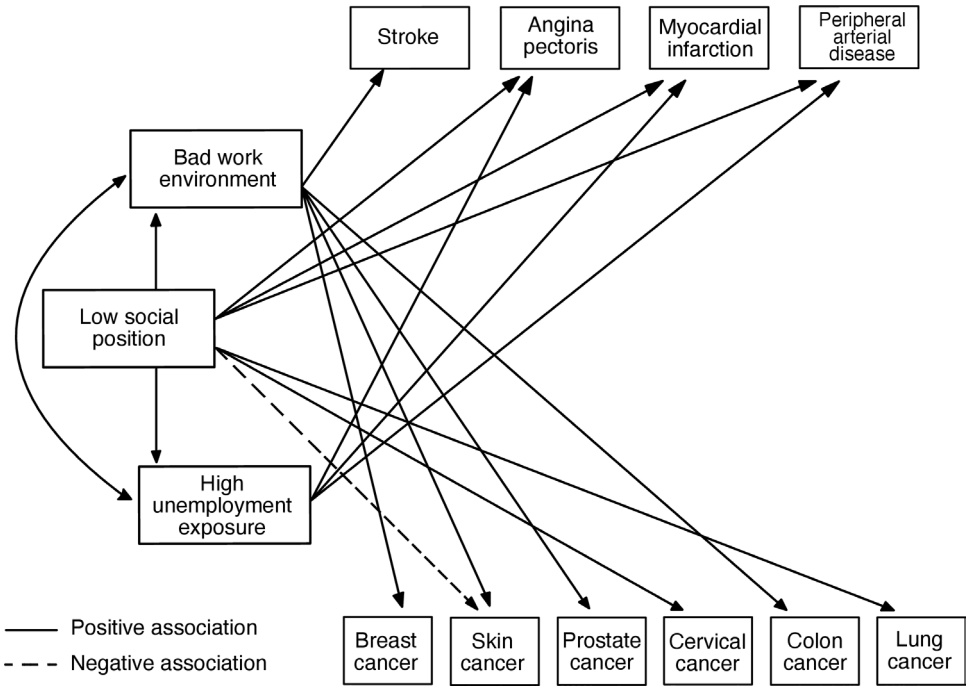


**Figure 2** Summary of the associations of social position, work environment and unemployment exposure with the prevalence of cardiovascular events and cancers after adjustment for risk factors. the putative directions of the associations are represented by arrows.

cancers would be related to bad work environment rather than unemployment.

It is interesting to note that social position, work environment and unemployment duration remain associated with the prevalence of cardiovascular events and cancers even after adjustment for risk factors, suggesting that they would increase cardiovascular and cancer risks not only by overexposure to risk factors but also through other pathways yet to be defined. Identifying these pathways may not be so easy as the potential stressful effects of social position, work environment and unemployment duration are numerous and entangled.

The present study has several limitations. First, the external validity of the findings is not guaranteed given that they were obtained in a cohort of participants which was not representative of the French population. Second, occupational and social data as well as health status were self-reported and may therefore have been imprecise, despite the fact that the information on health status was collected by a physician. Third, as a consequence of self-reporting, information on the occurrence of fatal cardiovascular events and cancers was not available and the diagnosis of these pathologies was relatively simple with no distinction, for example, between ischaemic and haemorrhagic strokes or between the different types of skin cancers. Fourth, social position and work environment were assessed at the time of the inclusion and may have not reflected the conditions in which participants lived during most of their lifetime, even though a complete disconnection is unlikely. Finally, due to the cross-sectional and retrospective design of the analyses, reverse causation cannot be ruled out but it is difficult to imagine how early occurrence of cardiovascular events and cancers could have strongly modified social position and created a bad work environment for people benefiting from the protective French social security system. Likewise, reverse causation is unlikely for unemployment exposure given that the episodes occurred on average prior to the occurrence of cardiovascular events and cancers.

In conclusion, this study indicates that although low social position, bad work environment and unemployment exposure are tightly inter-related, they are associated with distinct cardiovascular and cancerous outcomes that could add up during lifetime and should therefore be considered all together to optimally design preventive strategies.

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**Patient consent for publication** Consent obtained directly from patient(s).

**Ethics approval** The study received approval from the French National Data Protection Authority (Commission Nationale de l'Informatique et des Libertés, no. 910486) and the Institutional Review Board of the National Institute for Medical Research (INSERM, no. 01-011). Participants gave informed consent to participate in the study before taking part.

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**Data availability statement** Data are available upon reasonable request. Personal health data underlying the findings of our study are not publicly available due to legal reasons related to data privacy protection. However, the data are available upon reasonable request after approval from the French National Data Protection Authority. The email address for any inquiry is contact@constances.fr.



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## REFERENCES

1 Havranek EP, Mujahid MS, Barr DA, *et al*. Social determinants of risk and outcomes for cardiovascular disease: A scientific statement from the American heart Association. *Circulation* 2015;132:873–98.
2 Kaplan GA, Keil JE. Socioeconomic factors and cardiovascular disease: a review of the literature. *Circulation* 1993;88(4 Pt 1):1973–98.
3 Kogevinas M, Pearce N, Susser M. *Social inequalities and cancer*. International Agency for Research on Cancer Scientific Publications, 1997.
4 Vaccarella S, Lortet-Tieulent J, Saracci R. *Reducing Social Inequalities in Cancer: Setting Priorities for Research*. International Agency for Research on Cancer Scientific Publications, 2019.
5 Beenackers MA, Kamphuis CBM, Giskes K, *et al*. Socioeconomic inequalities in occupational, leisure-time, and transport related physical activity among European adults: a systematic review. *Int J Behav Nutr Phys Act* 2012;9:116.
6 Bloomfield KIM, Grittner U, Kramer S, *et al*. SOCIAL INEQUALITIES IN ALCOHOL CONSUMPTION AND ALCOHOL-RELATED PROBLEMS IN THE STUDY COUNTRIES OF THE EU CONCERTED ACTION 'GENDER, CULTURE AND ALCOHOL PROBLEMS: A MULTI-NATIONAL STUDY'. *Alcohol Alcohol Suppl* 2006;41:i26–36.
7 Chang-Quan H, Zheng-Rong W, Yong-Hong L, *et al*. Education and risk for late life depression: a meta-analysis of published literature. *Int J Psychiatry Med* 2010;40:109–24.
8 Hoertel N, Sanchez Rico M, Limosin F, *et al*. Respective mediating effects of social position and work environment on the incidence of common cardiovascular risk factors. *J Am Heart Assoc* 2022;11:e021373.
9 Jehan S, Myers AK, Zizi F, *et al*. Sleep health disparity: the putative role of race, ethnicity and socioeconomic status. Sleep Med Disord 2018;2:127–33.
10 Kanjilal S, Gregg EW, Cheng YJ, *et al*. Socioeconomic status and trends in disparities in 4 major risk factors for cardiovascular disease among US adults, 1971-2002. *Arch Intern Med* 2006;166:2348–55.
11 Lynch J, Davey Smith G, Harper S. Explaining the social gradient in coronary heart disease: comparing relative and absolute risk approaches. *Journal of Epidemiology & Community Health* 2006;60:436–41.
12 McLaren L. Socioeconomic status and obesity. *Epidemiol Rev* 2007;29:29–48.
13 Winkleby MA, Jatulis DE, Frank E, *et al*. Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. *Am J Public Health* 1992;82:816–20.
14 Burgard SA, Lin KY. Bad health? How work and working conditions contribute to health disparities. *Am Behav Sci* 2013;57:10.
15 Marant Micallef C, Shield KD, Baldi I, *et al*. Occupational exposures and cancer: a review of agents and relative risk estimates. *Occup Environ Med* 2018;75:604–14.
16 Sara JD, Prasad M, Eleid MF, *et al*. Association between work-related stress and coronary heart disease: A review of prospective studies through the job strain, effort-reward balance, and organizational justice models. *J Am Heart Assoc* 2018;7:e008073.
17 World Health organization and international labour organization. joint estimates of the work-related burden of disease and injury, 2000–2016. Global Monitoring Report 2021.
18 Fransson EI, Heikkilä K, Nyberg ST, *et al*. Job strain as a risk factor for leisure-time physical inactivity: an individual-participant meta-analysis of up to 170,000 men and women: the IPD-Work Consortium. Am J Epidemiol 2012;176:1078–89.
19 Heikkilä K, Nyberg ST, Fransson EI, *et al*. Job strain and alcohol intake: a collaborative meta-analysis of individual-participant data from 140,000 men and women. *PLoS One* 2012;7:e40101.
19 Heikkilä K, Nyberg ST, Fransson EI, *et al*. Job strain and tobacco smoking: an individual-participant data meta-analysis of 166,130 adults in 15 European studies. *PLoS One* 2012;7:e35463.
21 Landsbergis PA, Dobson M, Koutsouras G, *et al*. Job strain and ambulatory blood pressure: a meta-analysis and systematic review. *Am J Public Health* 2013;103:e61–71.
22 Linton SJ, Kecklund G, Franklin KA, *et al*. The effect of the work environment on future sleep disturbances: a systematic review. Sleep Med Rev 2015;23:10–19.
23 Nyberg ST, Heikkilä K, Fransson EI, *et al*. Job strain in relation to body mass index: pooled analysis of 160 000 adults from 13 cohort studies. J Intern Med 2012;272:65–73.
24 Nyberg ST, Fransson EI, Heikkilä K, *et al*. Job strain as a risk factor for type 2 diabetes: a pooled analysis of 124,808 men and women. Diabetes Care 2014;37:2268–75.
25 Theorell T, Hammarström A, Aronsson G, *et al*. A systematic review including meta-analysis of work environment and depressive symptoms. *BMC Public Health* 2015;15:738.
26 Brand JE. The far-reaching impact of job loss and unemployment. *Annu Rev Sociol* 2015;41:359–75.
27 Jin RL, Shah CP, Svoboda TJ. The impact of unemployment on health: a review of the evidence. CMAJ 1995;153:529–40.
28 Roelfs DJ, Shor E, Davidson KW, *et al*. Losing life and livelihood: a systematic review and meta-analysis of unemployment and all-cause mortality. *Soc Sci Med* 2011;72:840–54.
29 d'Errico A, Piccinelli C, Sebastiani G, *et al*. Unemployment and mortality in a large Italian cohort. *Journal of Public Health* 2021;43:361–9.
30 Dupre ME, George LK, Liu G, *et al*. The cumulative effect of unemployment on risks for acute myocardial infarction. *Arch Intern Med* 2012;172:1731–7.
31 Gallo WT. Evolution of research on the effect of unemployment on acute myocardial infarction risk. *Arch Intern Med* 2012;172:1737–8.
32 Lynge E. Unemployment and cancer: a literature review. IARC Sci Publ: 1997343–51.
33 Meneton P, Kesse-Guyot E, Méjean C, *et al*. Unemployment is associated with high cardiovascular event rate and increased all-cause mortality in middle-aged socially privileged individuals. *Int Arch Occup Environ Health* 2015;88:707–16.
34 Blanchflower DG, Bryson A. Unemployment and sleep: evidence from the United States and Europe. *Econ Hum Biol* 2021;43:101042.
35 Caban-Martinez AJ, Lee DJ, Goodman E, *et al*. Health indicators among unemployed and employed young adults. *J Occup Environ Med* 2011;53:196–203.

36 Henkel D. Unemployment and substance use: a review of the literature (1990-2010). *Curr Drug Abuse Rev* 2011;4:4–27.
37 Hughes A, Kumari M. Unemployment, Underweight, and obesity: findings from understanding society (UKHLS). *Prev Med* 2017;97:19–25.
38 Paul KI, Moser K. Unemployment impairs mental health: meta-analyses. *Journal of Vocational Behavior* 2009;74:264–82.
39 Plessz M, Ezdi S, Airagnes G, *et al*. Association between unemployment and the Co-occurrence and clustering of common risky health behaviors: findings from the Constances cohort. *PLoS One* 2020;15:e0232262.
40 Rautio N, Varanka-Ruuska T, Vaaramo E, *et al*. Accumulated exposure to unemployment is related to impaired glucose metabolism in middle-aged men: A follow-up of the northern Finland birth cohort 1966. *Prim Care Diabetes* 2017;11:365–72.
41 Benach J, Solar O, Santana V, *et al*. A micro-level model of employment relations and health inequalities. *Int J Health Serv* 2010;40:223–7.
42 Zins M, Goldberg M, CONSTANCES team. CONSTANCES team the French CONSTANCES population-based cohort: design, inclusion and follow-up. *Eur J Epidemiol* 2015;30:1317–28.
43 Goldberg M, Carton M, Descatha A, *et al*. CONSTANCES: a general prospective population-based cohort for occupational and environmental epidemiology: cohort profile. *Occup Environ Med* 2017;74:66–71.
44 Toledano MB, Smith RB, Brook JP, *et al*. How to establish and follow up a large prospective cohort study in the 21st century--lessons from UK COSMOS. *PLoS One* 2015;10:e0131521.
45 White IR, Carlin JB. Bias and efficiency of multiple imputation compared with complete-case analysis for missing Covariate values. *Stat Med* 2010;29:2920–31.
46 Guilloteau A, Binquet C, Bourredjem A, *et al*. Social deprivation among socio-economic contrasted French areas: using item response theory analysis to assess differential item functioning of the EPICES questionnaire in stroke patients. *PLoS One* 2020;15:e0230661.
47 Siegrist J, Starke D, Chandola T, *et al*. The measurement of effort–reward imbalance at work: European comparisons. *Soc Sci* Med 2004;58:1483–99.
48 Meneton P, Lemogne C, Herquelot E, *et al*. Primary cardiovascular disease risk factors predicted by poor working conditions in the GAZEL cohort. *Am J Epidemiol* 2017;186:815–23.
49 Meneton P, Hoertel N, Wiernik E, *et al*. Work environment mediates a large part of social inequalities in the incidence of several common cardiovascular risk factors: findings from the Gazel cohort. *Soc Sci Med* 2018;216:59–66.
50 Wood AM, Kaptoge S, Butterworth AS, *et al*. Risk thresholds for alcohol consumption: combined analysis of individual-participant data for 599 912 current drinkers in 83 prospective studies. *Lancet* 2018;391:1513–23.
51 Vilagut G, Forero CG, Barbaglia G, *et al*. Screening for depression in the general population with the center for epidemiologic studies depression (CES-D): A systematic review with meta-analysis. *PLoS One* 2016;11:e0155431.
52 Metzger MH, Goldberg M, Chastang JF, *et al*. Factors associated with self-reporting of chronic health problems in the French GAZEL cohort. *J Clin Epidemiol* 2002;55:48–59.
53 Sawilowsky SS. New effect size rules of thumb. *J. Mod. App. Stat. Meth*. 2009;8:597–9.
54 Austin PC. Using the standardized difference to compare the prevalence of a binary variable between two groups in observational research. *Communications in Statistics - Simulation and Computation* 2009;38:1228–34.
55 von Elm E, Altman DG, Egger M, *et al*. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Ann Intern Med* 2007;147:573.
56 Yoshida K, Bartel A. Package Tableone: create ‘table 1’ to describe baseline characteristics with or without propensity score weights. 2022. Available: https://CRANR-projectorg/package=tableone
57 Soler EP, Ruiz VC. Epidemiology and risk factors of cerebral ischemia and ischemic heart diseases: similarities and differences. *Curr Cardiol Rev* 2010;6:138–49.
58 deS, Bosch FX, Muñoz N. Social differences in sexual behaviour and cervical cancer. *IARC Sci Publ* n.d.:1997309–17.
59 Gan Y, Li L, Zhang L, *et al*. Association between shift work and risk of prostate cancer: a systematic review and meta-analysis of observational studies. *Carcinogenesis* 2018;39:87–97.
60 Lee J, Lee J, Ahn J, *et al*. Association of sedentary work with colon and Rectal cancer: systematic review and meta-analysis. *Occup Environ Med* 2022;79:277–86.
61 Mihor A, Tomsic S, Zagar T, *et al*. Socioeconomic inequalities in cancer incidence in Europe: a comprehensive review of population-based Epidemiological studies. *Radiol Oncol* 2020;54:1–13.
62 Sidorchuk A, Agardh EE, Aremu O, *et al*. Socioeconomic differences in lung cancer incidence: a systematic review and meta-analysis. *Cancer Causes Control* 2009;20:459–71.
63 Wei F, Chen W, Lin X. Night-shift work, breast cancer incidence, and all-cause mortality: an updated meta-analysis of prospective cohort studies. *Sleep Breath* 2022;26:1509–26.
64 Yousef E, Mitwally N, Noufal N, *et al*. Shift work and risk of skin cancer: A systematic review and meta-analysis. *Sci Rep* 2020;10:2012.