**SUPPLEMENTARY MATERIAL**

**Psychosocial work exposures of the job strain model and suicide in France:**

**findings from the STRESSJEM prospective study**

**of 1.5 million men and women over 26 years of follow-up**

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**CONTENTS**

Supplementary Methods

Supplementary Results

Supplementary Discussion

Supplementary References

Supplementary Tables S1-2

**Supplementary Methods**

*Job-exposure matrix*

A job-exposure matrix (JEM) was constructed and its validity was studied in a previous publication.1 One of the main advantages of JEMs is to reduce reporting bias. The JEM was constructed using the data of the national SUMER survey, and provided estimates of exposures for the job strain model2 according to three job title variables that were occupation, economic activity of the company, and company size. A segmentation method called Classification And Regression Tree (CART) with a cross-validation was used to construct the JEM. The exposure estimates were imputed in the present study using the three job title variables for all job held within the 1976-2002 period.

*Measures of exposure*

Three time-varying measures of exposure were constructed:

1. Current exposure at time i.
2. Cumulative exposure until time i, based on an average measure at time i calculated using the estimates of exposure and the time spent in all jobs up to and including time i.
3. Recency-weighted cumulative exposure at time i, using both past and current exposures and the time elapsed since exposure with higher weights assigned to more recent exposures. We assumed that psychosocial work exposure effects persisted for a period of up to 5 years after the end of exposure and decreased linearly over a 5-year period to be null after 5 years.

The measures used for the current exposure were the following:

-the three binary exposures for psychological demands, decision latitude, and social support, derived from the JEM scores dichotomized at the median of the distribution for the first job among the total sample of men and women

-the two binary variables for job strain and isostrain constructed from the binary variables of demands, latitude and support

-the variable with 4 categories corresponding to the four quadrants by Karasek, i.e. high strain (high demands and low latitude), low strain (low demands and high latitude), passive job (low demands and low latitude), and active job (high demands and high latitude), used as the reference group.

The measures used for the two cumulative exposures (cumulative exposure and recency-weighted cumulative exposure) were based on time-weighted scores for demands, latitude, and support as previously defined and dichotomized. Job strain, isostrain and the 4-quadrant variable were constructed as mentioned earlier.

*Statistical methods*

The hazard ratio (HR) of suicide was estimated according to time-dependent exposures using Cox proportional hazards models. Age was the time scale. Calendar time and four occupational variables related to biomechanical, physical, chemical and biological exposures were included as adjustment variables. These four variables of occupational exposures were constructed using a JEM following the same methodology as described previously.1 They were used because of their strong associations with occupation,3 and consequently may be considered as indirect markers of social position. More details on exposure definition and assessment can be found in a previous publication.4 We used a model with delayed entry. Individuals entered the cohort on the 1st January 1976 if they already had a job or when they started a first job within the 1976-2002 period.

For the 3 exposure measures, we studied suicide until the end of last job, i.e. during time intervals with a job (‘on-the-job’ suicide); thus in this analysis, the follow-up ended at the time of death, or at the end date of the last job within the 1976-2002 period, or at the end of follow-up (31th December 2002) if still working at this time, whichever came first.

For the 2 measures of cumulative exposure, to study delayed effects, the follow-up was extended and ended at the time of death or on the 31th December 2002, whichever came first.

Death for other causes than suicide were censored at that time.

Three types of models were performed: (i) with each exposure only, (ii) with demands, latitude and support together, (iii) with job strain, isostrain, and the 4-quadrant variable individually.

Comparisons between the models according to exposure measure were performed to identify the model with the best relative quality using Akaike's Information Criterion (AIC).

Finally, we calculated the fractions of suicide attributable to job strain and isostrain in France with Pe being the prevalence of exposure and HR being the hazard ratio for suicide associated with exposure:

AF = Pe(HR-1)/[1+Pe(HR-1)].

Pe was calculated from the weighted prevalence of exposure to job strain (19.94% among men, 28.70% among women) and iso-strain (12.72% among men, 17.44% among women) using the SUMER survey data. HR was estimated by the results from the present study. Simulation-modelling techniques were used to obtain confidence intervals for AFs, as previously described.5

All analyses were performed for men and women separately and using SAS and R. Interaction terms were tested between gender and psychosocial work exposures in the total sample to explore potential gender-related differences.

*Sensitivity analyses*

The following sensitivity analyses were performed:

-using scores for the measure of exposure instead of binary variables

-adjusting for the large groups of occupations instead of adjusting for the four occupational exposures of biomechanical, physical, chemical and biological nature

-imputing the lowest level of exposure in case of multiple job-holder instead of the highest level of exposure (only 3% of the sample had more than one job at the same time).

-studying mortality until 2005 instead of 2002

**Supplementary Results**

*Study of cumulative exposure*

Supplementary Table S1 shows the results of the associations between cumulative exposure and suicide. Low decision latitude was associated with suicide among men. Low social support was found to be a risk factor especially when this exposure was studied alone. Psychological demands were found to be a risk factor for ‘on-the-job’ suicide among women and displayed protective effects on suicide when the follow-up was extended to the end of 2002. Job strain and iso-strain were associated with ‘on-the-job’ suicide among women. Passive job and high strain were associated with suicide among men.

*Study of recency-weighted cumulative exposure*

Supplementary Table S2 presents the results for the associations between recency-weighted cumulative exposure and suicide. Low decision latitude and low social support were associated with suicide in most models and especially among men. Psychological demands were found to be a risk factor for ‘on-the-job’ suicide among women and displayed protective effects on suicide when the follow-up was extended to the end of 2002 among men. Job strain and iso-strain were associated with suicide among men and with ‘on-the-job’ suicide among women. Passive job and high strain were associated with suicide among men.

*Study of gender-related interactions*

Some interactions between gender and psychosocial work exposures were found suggesting differences in exposure-outcome associations by gender. An interaction between gender and psychological demands observed in all models suggested that this factor was associated with ‘on-the-job’ suicide among women and not among men. Interactions between gender and job strain (respectively iso-strain) showed that these two exposures were associated with suicide until 31/12/2002 among men than not among women.

*Relative quality of the models*

The calculation of AICs showed that the model with the lowest values of AIC (or with the highest relative quality) was the model with current exposure, however, there was no significant difference between this model and the two models with cumulative or recency-weighted cumulative exposures. This is why we calculated the attributable fractions using current exposure to job strain and iso-strain.

*Comparison between cumulative and recency-weighted cumulative exposures*

The comparison between the models for the two cumulative exposure measures (Supplementary Tables S1-2) showed that, although the statistical power was higher, the study of suicide with a follow-up extended until 31/12/2002 (i.e. after the end of the last job) led to reduce the magnitude of most of HRs (dilution) compared to the study of ‘on-the-job’ suicide.

*Sensitivity analyses*

The sensitivity analyses confirmed the robustness of the results, except adjustment for occupation that reduced the number of significant associations. However, as JEM exposures were partially derived from occupation, this adjustment may be considered as an overadjustment.

**Supplementary Discussion**

*Gender differences*

We found gender differences in:

- the prevalence of exposure: women were more likely to be exposed to most exposures than men6,

- suicide: the occurrence of suicide was higher among men than among women,

- exposure-outcome associations: some associations were observed in one gender and not in the other, and in particular there were gender differences in the results for the 4-category variable by Karasek, which may be explained by gender differences in the low-risk situation, that was active job for men and low strain for women,

- attributable fractions: these fractions were higher among women than among men, due to a higher prevalence of exposure among women.

These gender differences may be explained by gender differences in employment and occupational status, and working conditions, and more generally in various biological, behavioural, psychological and social factors. More research is needed to explore and better understand the differences between genders.

*About the results for psychological demands*

Psychological demands were not found as a risk factor for suicide, especially among men, in our study. However, as the exposure assessment was based on a JEM using occupation among the job title variables, the absence of significant associations for psychological demands may be expected. Indeed, the increased risk of outcome in people exposed to high demands may be attenuated by the decreased risk of outcome in people working in high-skilled occupations (given that people in high-skilled occupations are more likely to be exposed to high demands). The lack of association between demands and suicide may thus be explained at least in part by the use of JEM. However, the three previous studies examining psychological demands also found conflicting results for the association between high demands and suicide among men, that was either significant7 or non-significant8 or protective.9 Our study is thus the fourth one to report no evidence for this exposure as risk factor among men. However, we may be the first to support the effects of high demands on ‘on-the-job’ suicide among women.

*Highly exposed groups of workers*

Multiple exposures to psychosocial work exposures such as those defined by job strain and iso-strain were found to be important in association with suicide in our study. These two exposures are particularly prevalent among low-skilled occupations, such as clerks, service workers and blue collar workers, and in manufacturing and some services such as hotels/restaurants, transports, and financial intermediation for both genders, and wholesale and retail trade and health and social work among women. More details on these highly exposed groups may be found in our previous study.1 The identification of these groups may be useful from a preventive point of view.

*Changes in exposures over time*

There may have been changes in the exposures over time, and particularly during periods of economic crisis. Indeed, we found that the prevalence of a large number of psychosocial work exposures increased in the 2000s in France.10 These changes may not modify the exposure-suicide associations (i.e. HRs), but may lead to a higher exposure prevalence and consequently a higher burden of suicide attributable to psychosocial work exposures (as attributable fractions are calculated from both HR and prevalence of exposure). Consequently, our results of attributable fractions that may be valid for the 1976-2002 period might be underestimated for the present time.

*Magnitude of the associations*

The effect sizes in our suicide study may be lower than those found in previous results on psychiatric morbidity outcomes. Indeed, two recent reviews and meta-analyses11,12 showed that job strain was associated with suicide ideation (OR=1.77, 95% CI: 1.42-2.20)12 and with clinical depression in both published (RR=1.77, 95% CI: 1.47-2.13) and unpublished studies (RR=1.27, 95% CI: 1.04-1.55).11 However, the studies are lacking for suicide per se, preventing any comparison. The use of JEM that leads to non-differential misclassification and bias towards the null hypothesis might also contribute to observed associations of lower magnitude.

**Supplementary References**

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Supplementary Table S1. Associations between cumulative exposure and suicide among men and women

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | MEN  N=798,547 |  | WOMEN  N=697,785 |  |
| Follow-up | **On-the-job** | **Follow-up until 31/12/2002** | **On-the-job** | **Follow-up until 31/12/2002** |
|  | HR (95% CI)  (Suicides=1,595) | HR (95% CI)  (Suicides=4,486) | HR (95% CI)  (Suicides=361) | HR (95% CI)  (Suicides=1,206) |
| High psychological demandsa | **0.87 [0.76-0.99]**  **\*** | **0.83 [0.77-0.90] \*\*\*** | **1.46 [1.13-1.90] \*\*** | 0.89 [0.78-1.01] ns |
| Low decision latitudea | **1.34 [1.20-1.49] \*\*\*** | **1.26 [1.18-1.34] \*\*\*** | 1.03 [0.79-1.32] ns | 1.12 [0.97-1.29] ns |
| Low social supporta | **1.27 [1.14-1.42] \*\*\*** | **1.08 [1.01-1.15]**  **\*** | **1.29 [1.01-1.64]**  **\*** | 1.11 [0.98-1.27] ns |
| High psychological demandsb | 0.91 [0.80-1.05] ns | **0.87 [0.81-0.94] \*\*\*** | **1.41 [1.07-1.85]**  **\*** | **0.86 [0.75-0.99] \*** |
| Low decision latitudeb | **1.23 [1.09-1.40] \*\*\*** | **1.24 [1.16-1.34] \*\*\*** | 0.99 [0.75-1.32] ns | 1.03 [0.88-1.21] ns |
| Low social supportb | **1.15 [1.02-1.31]**  **\*** | 0.98 [0.91-1.05]  ns | 1.22 [0.93-1.60] ns | 1.14 [0.98-1.32] ns |
| Job straina | 1.15 [0.97-1.37] ns | **1.12 [1.01-1.25]**  **\*** | **1.30 [1.03-1.65]**  **\*** | 0.96 [0.84-1.10] ns |
| Isostraina | 1.15 [0.95-1.38] ns | 1.05 [0.94-1.18]  ns | **1.33 [1.05-1.69]**  **\*** | 0.96 [0.84-1.10] ns |
| **Quadrants by Karasek**a |  |  |  |  |
| Active job (ref) | 1 | 1 | 1 | 1 |
| Low strain | 1.07 [0.91-1.26] ns | **1.19 [1.09-1.32] \*\*\*** | 0.71 [0.43-1.15] ns | 1.04 [0.83-1.32] ns |
| Passive job | **1.42 [1.21-1.66] \*\*\*** | **1.43 [1.30-1.57] \*\*\*** | 0.73 [0.52-1.03] ns | **1.22 [1.02-1.47] \*** |
| High strain | **1.31 [1.08-1.58] \*\*** | **1.32 [1.17-1.48] \*\*\*** | 1.10 [0.83-1.47] ns | 1.07 [0.90-1.26] ns |

a Each exposure was studied separately

b Demands, latitude and support were studied simultaneously

High strain (high demands and low latitude), low strain (low demands and high latitude), passive job (low demands and low latitude), and active job, the reference group (high demands and high latitude)

All models were adjusted for calendar time, biomechanical, physical, chemical and biological exposures

\*p<0.05, \*\*p<0.01, \*\*\*p<0.001

Supplementary Table S2. Associations between recency-weighted cumulative exposure and suicide among men and women

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | MEN  N=798,547 |  | WOMEN  N=697,785 |  |
| Follow-up | **On-the-job** | **Follow-up until 31/12/2002** | **On-the-job** | **Follow-up until 31/12/2002** |
|  | HR (95% CI)  (Suicides=1,595) | HR (95% CI)  (Suicides=4,486) | HR (95% CI)  (Suicides=361) | HR (95% CI)  (Suicides=1,206) |
| High psychological demandsa | 0.92 [0.81-1.05] ns | **0.84 [0.77-0.92] \*\*\*** | **1.37 [1.07-1.76] \*** | 0.88 [0.75-1.02] ns |
| Low decision latitudea | **1.43 [1.28-1.59] \*\*\*** | **1.19 [1.11-1.28] \*\*\*** | 1.31 [0.99-1.72] ns | **1.33 [1.11-1.59] \*\*** |
| Low social supporta | **1.50 [1.34-1.68] \*\*\*** | **1.20 [1.11-1.29] \*\*\*** | **1.30 [1.03-1.65] \*** | 1.10 [0.95-1.28] ns |
| High psychological demandsb | 1.04 [0.91-1.19] ns | **0.88 [0.80-0.96]**  **\*\*** | **1.41 [1.08-1.83] \*** | 0.90 [0.76-1.06] ns |
| Low decision latitudeb | **1.20 [1.05-1.38] \*\*** | 1.09 [0.99-1.19]  ns | 1.30 [0.94-1.80] ns | **1.30 [1.05-1.61] \*** |
| Low social supportb | **1.35 [1.18-1.55] \*\*\*** | **1.12 [1.02-1.23]**  **\*** | 1.12 [0.85-1.49] ns | 1.01 [0.85-1.21] ns |
| Job straina | **1.47 [1.25-1.72] \*\*\*** | **1.24 [1.11-1.39] \*\*\*** | **1.44 [1.13-1.85] \*\*** | 1.03 [0.87-1.22] ns |
| Isostraina | **1.52 [1.29-1.78] \*\*\*** | **1.21 [1.07-1.36]**  **\*\*** | **1.48 [1.16-1.90] \*\*** | 1.03 [0.87-1.23] ns |
| **Quadrants by Karasek**a |  |  |  |  |
| Active job (ref) |  |  |  |  |
| Low strain | 1.09 [0.92-1.29] ns | **1.32 [1.18-1.47] \*\*\*** | 0.63 [0.39-1.03] ns | 1.01 [0.77-1.33] ns |
| Passive job | **1.42 [1.22-1.66] \*\*\*** | **1.37 [1.23-1.53] \*\*\*** | 0.97 [0.69-1.37] ns | **1.45 [1.16-1.81] \*\*** |
| High strain | **1.67 [1.40-1.99] \*\*\*** | **1.47 [1.29-1.67] \*\*\*** | 1.36 [1.00-1.85] ns | **1.25 [1.01-1.55] \*** |

a Each exposure was studied separately

b Demands, latitude and support were studied simultaneously

High strain (high demands and low latitude), low strain (low demands and high latitude), passive job (low demands and low latitude), and active job, the reference group (high demands and high latitude)

All models were adjusted for calendar time, biomechanical, physical, chemical and biological exposures

\*p<0.05, \*\*p<0.01, \*\*\*p<0.001