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# **Associations between multiple occupational exposures and sleep problems: results from the national French Working Conditions survey**

*Short title:* Multiple occupational exposures and sleep problems

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## **Conflict of interests**

No conflicts of interest declared.

## **Author contributions**

The study was designed by IN and SB. Literature review was performed by IN, SB and NA. Statistical analysis was performed by SB, NA and JFC. All co-authors contributed to the interpretation of the results. The manuscript was written by SB and IN. The manuscript was reviewed by all co-authors.

## **Abstract**

Studies evaluating the effects of multiple occupational exposures on sleep are very rare. We assessed the associations between a wide range of occupational exposures and sleep problems, and investigated the cumulative effects of these exposures on this outcome. We used data from the French 2016 Working Conditions survey conducted on a nationally representative sample of workers, including 20430 employees aged 15-65 years (8579 men, 11851 women). Sleep problems were defined by either sleep disturbances or sleep medication, almost daily or several times a week. Occupational exposures included 21 psychosocial work factors grouped into 5 dimensions, 4 factors related to working time/hours and 4 factors related to the physical work environment. Unadjusted and adjusted weighted robust Poisson regression analyses were performed. Almost all psychosocial work exposures were associated with sleep problems, while the only significant working time/hours factor associated with sleep problems was night work among women. Some gender differences in the exposure-outcome associations were found. The prevalence ratio of sleep problems increased with the number of exposures for most dimensions of psychosocial work factors. Physical work exposures were associated with sleep problems, and there was a linear association between the number of these occupational exposures and sleep problems in both genders, although the trend did not reach statistical significance among women. Workplace preventive strategies targeting the work environment comprehensively may be effective to improve sleep among working populations. More attention should be given to multiple exposures at the workplace.

## **KEYWORDS**

working conditions, occupational factors, job stress, multiple exposures, insomnia symptoms

## 1 | INTRODUCTION

The presence of at least one symptom related to insomnia affects between 30% and 50% of the population (Kronholm et al., 2016; Ohayon & Reynolds, 2009), and 5% to 20% of people meet the diagnostic criteria for insomnia disorder as defined by expert consensus (Ohayon & Reynolds, 2009; Riemann et al., 2017). Three literature reviews suggested that psychosocial working conditions may have an impact on sleep (Van Laethem, Beckers, Kompier, Dijksterhuis, & Geurts, 2013; Linton et al., 2015; Yang et al., 2018). As shown by these reviews, most previous studies investigated the factors of the job strain model (i.e. job demands, job control, and social support), which is the most commonly used model to measure psychosocial work exposures (Karasek et al., 1998). Van Laethem et al. (2013) concluded that high job demands (strong evidence), low job control and low social support (moderately strong evidence) predicted poor sleep quality. Based on a slightly different (more restricted) selection of the same prospective or randomized studies and an additional Japanese longitudinal study later published, the review by Linton et al. (2015) provided evidence for the associations of high work demands and low social support with sleep disturbances. Finally, the pooled results of the review and meta-analysis by Yang et al. (2018) showed an increased risk of insomnia associated with high job demands and low social support. In these two last reviews, job control was not associated with sleep.

Other psychosocial work exposures may be associated with sleep, and may require further exploration. Van Laethem et al. (2013) reported moderately strong evidence for effort-reward imbalance and organizational injustice, and limited evidence for role conflict, as risk factors for sleep quality. Linton et al. (2015) provided evidence for an association between organizational injustice and sleep disturbances. Yang et al. (2018) reported significant associations between effort-reward imbalance and work-life imbalance and insomnia. The results from recent studies suggested that some other psychosocial work factors may be relevant for sleep-related outcomes,

such as high cognitive demands (Park, Nakata, Swanson, & Chun, 2013), high emotional demands (Chazelle, Chastang, & Niedhammer, 2016; Johannessen & Sterud, 2017; Park et al., 2013) and job insecurity (Mai, Hill, Vila-Henninger, & Grandner, 2018; Park et al., 2013; Virtanen, Janlert, & Hammarström, 2011; Yoo, Ye, Kim, & Park, 2016).

One of the limitations of the literature is that most studies explored a limited number of occupational exposures only. Another gap is related to the lack of studies on the impact of multiple occupational exposures, i.e. on the cumulative effects of occupational factors (Van Laethem et al., 2013). An exception was the study by Stauder et al. (2017) that showed an increase in the prevalence of sleep troubles with a composite risk score based on 22 psychosocial work factors and reflecting exposure severity to multiple factors. In another study, both a higher level of perceived stress severity and a higher frequency of occupational stressors (related to administrative and organizational pressure, physical and psychological threat, and lack of support) were associated with poor sleep quality (Ma et al., 2019). Furthermore, in the literature on the associations between psychosocial work factors and sleep problems, working time and work schedules (such as long working hours, shift work, night work) and the physical work environment are not always taken into account and studied.

The aim of this study was therefore to explore the associations of a wide range of occupational exposures with sleep problems in a large nationally representative sample of French workers. An additional objective was to study multiple exposures to occupational factors and sleep problems.

## **2 | METHODS**

### **2.1 | Study sample**

This cross-sectional study was based on the data from the seventh and to date latest available edition of the national periodic survey on working conditions conducted by the French Ministry of Labour (DARES) since 1978 in France. The 2016 Working Conditions survey had a special focus on psychosocial work factors. The data were collected between October 2015 and June 2016 on a nationally representative sample of the French working population aged 15 years or over. Workers were randomly selected through a two-stage sampling process: firstly at the household level using national population and housing census data, and secondly at the individual level if there was more than one worker in the selected household. A face-to-face interview was conducted at respondent's home and was followed by a self-administered questionnaire. This survey received approval from the French ethics committees (CNIL no 2015-079 and CNIS no 2015X073TV).

## **2.2 | Assessment of sleep problems**

Sleep problems were assessed using the following two items from the face-to-face interview: (i) "Within the last 12 months, have you experienced sleep disturbances (difficulty falling asleep, night awakenings, premature awakening without being able to return to sleep, etc.)?" and (ii) "Within the last 12 months, have you taken any sleep medication?" The items were based on 4 response categories: "never/seldom", "several times a month", "several times a week", "almost every day". Respondents were classified as having sleep problems if they reported sleep disturbances and/or sleep medication almost daily or several times a week. The definition of sleep problems was chosen in agreement with the definition criteria of insomnia from DSM-V and ICSD-3 classifications that included the threshold of three or more nights per week (Riemann et al., 2017).

## **2.3 | Measurement of occupational factors**

A total of 79 items were used for the construction of 21 psychosocial work factors, inspired at least in part from the Copenhagen Psychosocial Questionnaire (COPSOQ) (Kristensen, Hannerz, Høgh, & Borg, 2005; Pejtersen, Kristensen, Borg, & Bjorner, 2010). These items were collected through the face-to-face interview and by the self-administered questionnaire. The constructed factors were grouped as follows:

1. Demands at work: quantitative demands (7 items), cognitive demands (3 items), emotional demands (2 items), demands for hiding emotions (2 items)
2. Work organization and job content: influence at work (6 items), degree of freedom (3 items), possibilities for development (5 items), meaning of work (3 items)
3. Interpersonal relations and leadership: social support from supervisors and colleagues (7 items), sense of community (3 items), quality of leadership (5 items), predictability (2 items), role clarity (2 items), role conflict (9 items)
4. Work-individual interface: job satisfaction (3 items), work-family conflict (2 items), job insecurity (2 items), changes at work (2 items), temporary employment (1 item)
5. Workplace violence: internal violence at work (i.e. from colleagues, supervisors, etc.) (6 items), external violence at work (i.e. from the public, patients, clients, customers, etc.) (4 items)

The score of each psychosocial work factor was calculated by summing all items of the factor (each item was coded on a scale from 0 to 1, with 0 indicating no exposure and 1 exposure) and was dichotomized at the median of the total sample in order to classify workers in no/low or high exposure groups. Multiple exposure was assessed by counting the number of psychosocial work factors for which the individual was classified as having high exposure, firstly for each group of factors, and secondly for all groups together. Thus, the score for each group of factors ranged from 0 (workers having no/low exposure for all factors) to the total number of factors in the group

(workers having high exposure for all factors). As there was a total of 21 psychosocial work factors, the overall measure of psychosocial work exposure ranged from 0 to 21.

Four factors related to working time/hours from the face-to-face interview were studied: long working hours (1 item: working more than 48 hours per week, following the European directive on working time), night work (1 item: working between midnight and 5 am at least 50 nights a year), shift work (1 item: working on alternating/rotating shifts), and unsocial work days (1 item: working on Saturday or Sunday at least 40 times a year).

Physical work exposures assessed in the face-to-face interview included: exposure to fumes or dust (1 item), exposure to toxic and dangerous products (1 item), exposure to noise (1 item) and biomechanical exposure (a sum score was calculated from 7 binary items including long-term exposure to standing, difficult or tiring position, walking, heavy loads, painful or tiring movements, vibrations, repetitive tasks, and high biomechanical exposure was defined as a score higher than the median of the total sample).

An index of multiple exposure was also calculated for working time/hours factors and physical working conditions.

## **2.4 | Covariates**

The covariates were age, marital status (living with or without a partner), social support outside work (2 items: having someone to rely on to discuss personal issues or take a difficult decision, and need more help than help received), life events before the age of 18 (5 items: serious personal health problems, serious health problems or death of close family member, family conflict, exposure to violence, school or neighbourhood bullying), life events within the last 3 years (4 items: serious personal health problems, serious health problems or death of close family member, family conflict, exposure to violence), and employment characteristics including



occupation and economic activity of the company (both coded using French standard classifications by the National Institute of Statistics and Economic Studies - INSEE -). These covariates were chosen because they were found to be risk factors for sleep problems in the literature. Life events and social support outside work were collected by the self-administered questionnaire, and the other covariates came from the face-to-face interview.

## 2.5 | Statistical analyses

All analyses were conducted using weighted data. Weights were used to take into account a potential bias related to non-response and to provide representative results for the whole French working population in 2016. Non-response was corrected both at household level and at individual level. Weights were calculated using inverse probability weighting and marginal calibration. The following calibration variables were used to calculate weights: gender, age, economic activity of the company, occupation and employment status.

Comparisons between genders were performed for all studied variables using the Rao-Scott chi-square test (Rao & Scott, 1981, 1984). Differences in the prevalence of sleep problems according to covariates were tested using the same test. Weighted Poisson regression analyses with robust estimate of standard errors were used to investigate the associations between each occupational factor and sleep problems (Barros & Hiraakata, 2003). Unadjusted and adjusted prevalence ratios compared to the group with no/low exposure and 95% confidence intervals were calculated. All covariates were taken into account as adjustment variables in the multivariate models. The associations of multiple exposures to occupational factors with sleep were also studied using weighted robust Poisson regression models, and trend tests were performed using orthogonal polynomial contrasts to assess whether the prevalence ratio of sleep problems compared to the

reference category (no/low exposure) increased with the number of exposures. These analyses were adjusted for covariates.

Sensitivity analyses were performed: (1) additional adjustment was performed for full/part time work, public/private sector, company size, and chronic disease, (2) for the study of exposures to multiple psychosocial work factors, additional adjustment was done for working time/hours factors and physical work exposures, and (3) tertiles of the score for each occupational factor were used instead of exposure dichotomized at the median.

As gender differences in the associations of occupational factors with sleep problems were found in the total sample (i.e. significant gender-related interaction terms), statistical analyses were performed in men and women separately using SAS version 9.4 and Stata version 15.1.

### **3 | RESULTS**

#### **3.1 | Description of the study sample**

The participation rate to the survey was of 74% and the response rate to the self-administered questionnaire was 94%. Among the 27610 participants, 24252 people were working at the time of the survey (Figure 1). Among them, 20430 were employees aged 15-65 years who completed the self-administered questionnaire, including 8579 men and 11851 women. A description of the study sample is shown in Table 1. The prevalence of sleep problems was higher among women (31.9%) than among men (21.7%). There were also significant gender differences in all covariates except age.

#### **3.2 | Prevalence of sleep problems according to covariates**

In both genders, the prevalence of sleep problems was higher among those with a higher age, lower social support outside work, and with a higher number of life events during childhood and within the last 3 years (Table 1). In women, the prevalence of sleep problems was significantly higher in low skilled occupational groups. No significant difference in the prevalence of sleep problems was found according to marital status and economic activity of the company.

### 3.3 | Associations between occupational exposures and sleep problems

Significant associations were found between almost all psychosocial work factors and sleep problems, except emotional demands in women, influence at work in men, and predictability and temporary employment in both genders (Tables 2-3). There were some gender differences in the strength of the associations between psychosocial work factors and sleep problems, especially for emotional demands ( $p = 0.009$  for interaction term with gender), job insecurity ( $p = 0.043$ ) and changes at work ( $p = 0.005$ ). The associations of these three factors with sleep problems were stronger for men than for women.

Adjustment for covariates attenuated the prevalence ratios for most occupational factors but all remained statistically significant, except for poor development possibilities in both genders. After adjustment, the exposure to almost all significant psychosocial work factors was associated with a higher prevalence of sleep problems by at least 30% in men. The adjusted prevalence ratios ranged between 1.16 and 1.47 in women, and they were higher than 1.20 for more than half of the psychosocial work factors. Night work increased the prevalence of sleep problems in women, no other factor related to working time/hours was associated with sleep problems. Exposures to toxic and dangerous products, fumes and dust, and noise in both genders, and biomechanical exposure in women, were associated with sleep problems.

In the sensitivity analyses, the results were unchanged. Furthermore, dose-response associations between most psychosocial work factors and sleep problems were observed when these factors were studied using tertiles instead of exposure dichotomized at the median.

### **3.4 | Multiple occupational exposures and sleep problems**

For demands at work, work organization and job content, interpersonal relations and leadership, and work-individual interface, the prevalence ratio of sleep problems increased with the number of psychosocial work factors in both men (Figure 2) and women (Figure 3). Trend tests for the increase in prevalence ratios were all significant after adjustment for covariates.

There was a marked linear association between the total number of psychosocial work exposures and sleep problems. All trends remained significant after additional adjustment for working time/hours factors and physical work exposures in the sensitivity analyses.

No significant increase in the prevalence ratios was observed for the number of working time/hours factors. There was a linear trend between the number of physical work exposures and sleep problems in both genders, although the linear trend was not significant among women.

In the sensitivity analyses, no changes in the results were found.

## **4 | DISCUSSION**

### **4.1 | Main findings**

This study is one of the first to explore the associations of multiple exposures to various types of occupational factors with sleep. Many psychosocial work factors were found to be associated with sleep problems, and the prevalence of sleep problems increased with multiple exposure to these factors. The cumulative effects of psychosocial work factors were observed for most of their

dimensions and for all factors together. Regarding working time/hours, night work only was significantly associated with sleep problems in women. Most physical exposures were associated with sleep problems and a significant trend towards increasing prevalence ratio of sleep problems with the number of exposures to physical work factors was observed. The results of this study provide new insights into the associations between working conditions and sleep problems, suggesting that taking multiple exposure into account may improve the assessment of the associations of psychosocial working conditions with sleep problems.

## **4.2 | Comparison with the literature**

Most of our results were found to be consistent with the literature, and the rare discrepancies might be explained by differences between studies in populations, exposure and/or outcome assessment, or other study characteristics. Some novel results were found in our study, and were described in the following paragraphs.

Our results are in line with the conclusions of literature reviews for demands at work as a general measure of job demands and for heavy work load (quantitative demands) and insomnia symptoms (Linton et al., 2015; Van Laethem et al., 2013; Yang et al., 2018). Cognitive (Park et al., 2013) and emotional (Chazelle et al., 2016; Johannessen & Sterud, 2017; Park et al., 2013) demands were previously found to be associated with sleep problems, in agreement with our results. Another study observed a significant association between emotional stress related to job requirement for hiding feelings, among other factors, and sleep disorder (Kim, Min, Jung, Paek, & Cho, 2016). However, to our knowledge, no previous study reported an association between demands for hiding emotions at work per se and sleep problems.

Our findings are consistent with a literature review regarding low job control or low decision latitude (Van Laethem et al., 2013), although two other reviews did not report a significant

association (Linton et al., 2015; Yang et al., 2018). We were able to explore three components of job control: degree of freedom, influence at work, and possibilities for development. Only the last component was not significantly associated with sleep problems in both genders. The review by Van Laethem et al. (2013) showed moderately strong evidence for the association between low influence over decisions and sleep.

According to our results, low social support at work was associated with sleep problems. Literature reviews found moderately strong evidence for this association (Linton et al., 2015; Van Laethem et al., 2013; Yang et al., 2018). In our study, no/low leadership quality increased the prevalence of sleep problems; this factor included items related to organizational injustice that was found to be associated with sleep disturbances with moderately strong evidence in two reviews (Linton et al., 2015; Van Laethem et al., 2013). There is limited evidence for an association between role conflict and sleep according to the literature review by Van Laethem et al. (2013), but our results are in agreement with those of several recent studies (Deguchi et al., 2017; Hansen et al., 2018; Johannessen & Sterud, 2017; Vleeshouwers, Knardahl, & Christensen, 2016). We found no association between low predictability of work and sleep problems, in line with the results from the only other study (Vleeshouwers et al., 2016). Two studies reported significant associations between low role clarity (Vleeshouwers et al., 2016) or role ambiguity (Hansen et al., 2018) and sleep problems. Our results also showed a significant association of low sense of community with sleep, which has never been observed before.

There was an association of no/low job satisfaction with sleep problems in our study. Another study did not find any association between a factor with similar meaning called 'organizational system dissatisfaction' and sleep disorders, such as insomnia or general sleep difficulties (Kim et al., 2016). Work-family imbalance was associated with insomnia according to a meta-analysis (Yang et al., 2018), which is in line with our results. Job insecurity (defined as perceived threat of job loss and job transfer) was associated with sleep problems in our study, as reported by some

previous studies (Mai et al., 2018; Park et al., 2013; Virtanen et al., 2011). In addition, our findings showed significant associations for changes at work, an understudied psychosocial work factor.

According to a literature review (Linton et al., 2015) the association between bullying and sleep was not significant. Several recent studies (Cheng & Cheng, 2017; Johannessen & Sterud, 2017; Park et al., 2013; Sakurai, Nakata, Ikeda, Otsuka, & Kawahito, 2014; Yoo et al., 2016) showed however that workplace violence, threat of violence and interpersonal conflict were associated with sleep problems, in agreement with our results. Our study highlighted that both internal and external violence were associated with sleep problems, as suggested by another study (Yoo et al., 2016).

To our knowledge, only two previous studies showed that the prevalence of sleep problems increased with multiple exposure to psychosocial work factors (Ma et al., 2019; Stauder et al., 2017), underlying the lack of studies on this topic. In addition, theoretical models of job stress assume that the combination of some exposures may be important such as the job strain (combination of high job demands and low control) and effort-reward imbalance (combination of high effort and low reward) models (Karasek et al., 1998; Siegrist et al., 2004), in particular for sleep problems (Van Laethem et al., 2013; Linton et al., 2015). Our study addressed the issue of multiple exposure in a more comprehensive way. Indeed, our measures of multiple exposure for each dimension and for all factors together can be considered as measures of exposure intensity. Consequently, our findings may be considered as an additional element in the understanding of the etiological role of occupational factors, in particular psychosocial work factors, on sleep, although the observation of a dose-response association is not sufficient for concluding to a causal association (Rothman et al., 2008).

Among the factors related to working time/hours, only night work was associated with sleep problems in women in our study, which is consistent at least in part with literature reviews reporting the impact of shift and night work on sleep (Kecklund & Axelsson, 2016; Linton et al.,

2015). Inconclusive results were reported in the literature regarding long working hours (Åkerstedt et al., 2015; Chazelle et al., 2016; Linton et al., 2015). The lack of association in our study is in agreement with the results of two studies (Åkerstedt et al., 2015; Chazelle et al., 2016).

Few studies are available on the associations between physical working conditions and sleep problems. Some associations were reported for chemical (Linton et al., 2015) and biomechanical (Chazelle et al., 2016; Yoo et al., 2016) exposures, in agreement with our results. A significant association between noise exposure and sleep problems was also found in our study. Occupational exposure to noise may alter health status and also sleep quality (Domingo-Pueyo, Sanz-Valero, & Wanden-Berghe, 2016).

#### **4.3 | Strengths and limitations of the study**

The study was based on a large nationally representative sample of the French working population in 2016. The participation/response rates to the survey (74%) and to the self-administered questionnaire (94%) were high. All statistical analyses were performed using weighted data, consequently the results can be extrapolated to the whole French working population of employees. All statistical analyses were stratified by gender, and this stratification was justified by gender differences in the prevalence of sleep problems, occupational exposures and covariates, and because there were some gender-related interactions. This is in agreement with the best practices regarding gender-related research (Niedhammer, Saurel-Cubizolles, Piciotti, & Bonenfant, 2000). Taking sleep medication into account may have reduced classification errors for sleep problems (particularly false negatives, as people taking sleep medication may not report sleep disturbances). However, the association between sleep medication and sleep disturbances was very strong, and there were only very few people who reported sleep medication but no sleep disturbances (124 men and 211 women, i.e. 1.7% of men and 2.4% of women). The assessment of



working conditions and occupational exposures in this study included a high number and a wide range of psychosocial work factors, including both classical and understudied factors, together with factors related to working time/hours and physical work exposures. As our study was exploratory, it was not necessary to control for multiple testing (Bender & Lange, 2001). A major strength of the study was the assessment of multiple occupational exposures that has very seldom been explored in the literature. The analysis of multiple exposure was performed using trend test which had dual benefits: firstly to take all groups of exposure (i.e. exposure to 1, 2, 3, etc. factors) into account for a global statistical test, secondly to have a higher statistical power than the analysis of each group of exposure separately. Our results underlined that multiple occupational exposures may increase the prevalence of sleep problems linearly. Although in line with theoretical models of job stress that focus on a limited number of factors, our study broadens the issue of the combinations of exposures to a large set of factors. Thus, identifying and preventing multiple exposures at the workplace might be beneficial to sleep outcomes. All our analyses were adjusted for covariates that were important factors in association with sleep but had a low confounding effect on the associations between work factors and sleep problems. Sensitivity analyses were performed and confirmed the robustness of the results.

Because of the cross-sectional design of our study, no causal or temporal inferences can be made. Consequently, reverse causation cannot be fully excluded, as chronic sleep problems may negatively influence the experience and reporting of work factors. This reverse causation may be more likely for psychosocial work factors than for more objective factors (e.g. working time/hours factors, physical work exposures). As sleep problems were assessed within the last 12 months, sleep problems might have occurred before the exposure to occupational factors (assessed at the time of the survey). Furthermore, as sleep problems might vary within this 12-month period, this might have induced inaccuracy in the observed associations. A healthy worker effect may also be assumed and lead to an underestimation of the associations, as employees with sleep problems

may have changed job or left the labour market because of their occupational exposures. The assessment of sleep problems was not based on a validated questionnaire. Our definition of sleep problems was based on a frequency threshold (i.e. almost daily or several times a week) that was consistent with the international definition of insomnia (i.e. 3 or more nights per week for 3 months) (Riemann et al., 2017) but was not strictly equivalent. However, the observed prevalence of sleep problems in our study was very close to previous estimates in the working population in France (Chazelle et al., 2016). The associations with covariates were also consistent with the literature. Our assessment of occupational exposures was not based on validated questionnaires. However, the large number of available items allowed us to study a wide range of exposures, especially understudied exposures in association with sleep. As both occupational factors and sleep problems were measured using self-reported data, a reporting bias is possible and may lead to an overestimation of the observed associations.

#### **4.4 | Conclusion**

This study showed associations between many occupational exposures, especially psychosocial work exposures, and sleep problems. It also underlined the increase of sleep problems with multiple occupational exposures. More studies are needed to confirm these associations and the cumulative effects of occupational exposures. Longitudinal or intervention studies would be helpful to improve our knowledge of these associations and would bring more evidence towards causality. More studies using less subjective exposure assessment methods are also needed to confirm these associations. Our findings suggest that comprehensive preventive strategies towards the work environment may be useful to reduce occupational exposures and improve sleep of working populations.

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**TABLE 1** Description of the study sample and 12-month prevalence of sleep problems according to covariates

	Men				Women			
	n	% <sup>b</sup>	Sleep problems <sup>a</sup>		n	% <sup>b</sup>	Sleep problems <sup>a</sup>	
			% <sup>b</sup>	p-value <sup>c</sup>			% <sup>b</sup>	p-value <sup>c</sup>
All	8579	100.0	21.7	-	11851	100.0	31.9	-
Age (years)				<0.001				<0.001
< 30	1020	19.0	16.8		1283	18.1	22.2	
30-39	1864	25.5	17.2		2473	23.6	24.7	
40-49	2799	28.6	26.0		3820	28.1	33.1	
≥ 50	2896	26.9	24.8		4275	30.2	42.2	
Marital status				0.721				0.320
Living with a partner	6827	76.2	21.9		8849	72.6	31.3	
Alone	1752	23.8	21.1		3001	27.4	33.4	
Social support outside work				<0.001				<0.001
Yes and don't need more help	6924	81.7	19.4		8939	78.5	28.6	
No and don't need more help	340	4.2	34.1		353	2.9	35.5	
Yes but need more help	1006	12.0	29.9		1952	15.3	43.4	
No and need more help	191	2.0	41.9		432	3.3	53.8	
Life event(s) during childhood				<0.001				<0.001
None	4154	48.1	16.6		4608	38.5	25.4	
1	2462	28.4	22.6		3556	30.1	30.8	
≥ 2	1926	23.6	31.2		3644	31.3	41.2	
Life event(s) within the last 3 years				<0.001				<0.001
None	4675	56.4	16.3		4854	42.6	25.1	
1	2588	29.4	25.6		3945	32.1	31.9	
≥ 2	1286	14.2	34.6		3012	25.3	43.6	
Occupation				0.079				0.002
Managers, professionals	2025	22.4	18.7		1691	14.9	27.4	
Associate professionals, technicians	2402	25.9	22.2		3978	27.9	29.4	
Clerks, service workers	1397	14.4	26.0		5357	48.3	33.1	
Blue-collar workers	2681	37.3	21.7		751	8.9	40.8	
Economic activity				0.057				0.888
Agriculture	116	1.5	8.8		75	0.6	28.0	
Manufacturing	1776	21.8	20.6		802	8.2	32.7	
Construction	687	10.6	19.6		102	1.1	26.8	
Services	5993	66.2	22.7		10866	90.1	32.0	

<sup>a</sup> Defined by sleep disturbances and/or sleep medication, almost daily or several times a week within the last 12 months. Data on sleep problems were available for 8574 men and 11839 women.

<sup>b</sup> Weighted percentages.

<sup>c</sup> Differences in the weighted prevalence of sleep problems according to covariates were tested using Rao-Scott Chi-square test.



**TABLE 2** Associations of occupational exposures with sleep problems within the last 12 months in men. Results from weighted robust Poisson regression analyses (each occupational factor studied separately)

Men (N=7789) <sup>a</sup>	Unadjusted			Adjusted for covariates <sup>c</sup>		
	PR	95% CI	p-value	PR	95% CI	p-value
<b>Psychosocial work factors <sup>b</sup></b>						
<i>Demands at work</i>						
High quantitative demands	1.50	1.27 - 1.76	<0.001	1.48	1.25 - 1.74	<0.001
High cognitive demands	1.36	1.15 - 1.60	<0.001	1.36	1.14 - 1.63	0.001
High emotional demands	1.43	1.22 - 1.67	<0.001	1.30	1.10 - 1.53	0.002
High demands for hiding emotions	1.87	1.59 - 2.20	<0.001	1.58	1.35 - 1.86	<0.001
<i>Work organization and job content</i>						
No/Low influence	1.09	0.92 - 1.27	0.316	1.07	0.92 - 1.24	0.391
No/Low degree of freedom	1.46	1.25 - 1.71	<0.001	1.35	1.16 - 1.57	<0.001
No/Low possibilities for development	1.27	1.08 - 1.49	0.004	1.14	0.96 - 1.35	0.135
No/Low meaning of work	1.46	1.24 - 1.72	<0.001	1.35	1.14 - 1.59	<0.001
<i>Interpersonal relations and leadership</i>						
No/Low predictability	1.09	0.92 - 1.29	0.303	1.09	0.93 - 1.29	0.291
No/Low role clarity	1.40	1.20 - 1.65	<0.001	1.32	1.13 - 1.55	0.001
High role conflict	1.58	1.33 - 1.87	<0.001	1.45	1.22 - 1.72	<0.001
No/Low quality of leadership	1.55	1.31 - 1.83	<0.001	1.40	1.19 - 1.65	<0.001
No/Low social support	1.42	1.20 - 1.69	<0.001	1.27	1.07 - 1.50	0.007
No/Low sense of community	1.53	1.30 - 1.81	<0.001	1.38	1.18 - 1.63	<0.001
<i>Work-individual interface</i>						
No/Low job satisfaction	1.52	1.29 - 1.80	<0.001	1.34	1.14 - 1.58	<0.001
Work-family conflict	1.39	1.19 - 1.63	<0.001	1.31	1.11 - 1.55	0.001
High job insecurity	1.55	1.32 - 1.81	<0.001	1.41	1.20 - 1.65	<0.001
High changes at work	1.90	1.61 - 2.26	<0.001	1.69	1.43 - 2.00	<0.001
Temporary employment	0.79	0.55 - 1.14	0.202	0.92	0.65 - 1.31	0.638
<i>Workplace violence</i>						
High internal violence	1.66	1.41 - 1.97	<0.001	1.44	1.21 - 1.70	<0.001
High external violence	1.43	1.22 - 1.68	<0.001	1.29	1.09 - 1.53	0.003
<b>Working time/hours factors</b>						
Long working hours (> 48h/week)	1.05	0.84 - 1.31	0.649	1.13	0.91 - 1.41	0.256
Night work (> 50/year)	1.28	0.98 - 1.66	0.068	1.19	0.90 - 1.58	0.221
Unsocial work days (> 40/year)	1.14	0.92 - 1.42	0.228	1.00	0.81 - 1.24	0.979
Shift work	1.00	0.76 - 1.30	0.974	0.99	0.76 - 1.29	0.948

**Physical work exposures**

High biomechanical exposure <sup>b</sup>	1.18	1.01 - 1.39	0.041	1.08	0.89 - 1.30	0.424
Fumes and dust exposure	1.28	1.09 - 1.50	0.003	1.29	1.09 - 1.52	0.003
Toxic and dangerous products exposure	1.24	1.05 - 1.45	0.009	1.19	1.02 - 1.39	0.027
Noise exposure	1.39	1.17 - 1.65	<0.001	1.34	1.12 - 1.59	0.001

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Abbreviations: CI, confidence interval; PR, prevalence ratio.

<sup>a</sup> Reported results are those from complete case analyses that included participants with no missing data for the variables of interest (sleep problems, all occupational exposures, covariates). The observed associations were similar using all available data for each occupational exposure.

<sup>b</sup> Median cut-off of the total sample was used to classify workers in no/low or high exposure groups.

<sup>c</sup> Adjusted for age, marital status, social support outside work, life events before the age of 18, life events within the last 3 years, occupation, and economic activity of the company.

**TABLE 3** Associations of occupational exposures with sleep problems within the last 12 months in women. Results from weighted robust Poisson regression analyses (each occupational factor studied separately)

Women (N=10683) <sup>a</sup>	Unadjusted			Adjusted for covariates <sup>c</sup>		
	PR	95% CI	p-value	PR	95% CI	p-value
<b>Psychosocial work factors<sup>b</sup></b>						
<i>Demands at work</i>						
High quantitative demands	1.43	1.27 - 1.60	<0.001	1.47	1.31 - 1.65	<0.001
High cognitive demands	1.18	1.05 - 1.33	0.005	1.26	1.12 - 1.41	<0.001
High emotional demands	1.09	0.97 - 1.24	0.153	1.05	0.93 - 1.20	0.404
High demands for hiding emotions	1.54	1.35 - 1.76	<0.001	1.41	1.24 - 1.60	<0.001
<i>Work organization and job content</i>						
No/Low influence	1.16	1.04 - 1.30	0.010	1.16	1.04 - 1.30	0.007
No/Low degree of freedom	1.25	1.11 - 1.40	<0.001	1.20	1.07 - 1.34	0.002
No/Low possibilities for development	1.27	1.13 - 1.43	<0.001	1.12	0.99 - 1.26	0.067
No/Low meaning of work	1.43	1.27 - 1.60	<0.001	1.32	1.18 - 1.48	<0.001
<i>Interpersonal relations and leadership</i>						
No/Low predictability	1.06	0.94 - 1.19	0.353	1.11	0.99 - 1.24	0.061
No/Low role clarity	1.17	1.05 - 1.32	0.006	1.14	1.02 - 1.28	0.022
High role conflict	1.37	1.22 - 1.54	<0.001	1.32	1.18 - 1.49	<0.001
No/Low quality of leadership	1.30	1.16 - 1.47	<0.001	1.22	1.09 - 1.37	0.001
No/Low social support	1.58	1.40 - 1.79	<0.001	1.41	1.25 - 1.59	<0.001
No/Low sense of community	1.54	1.37 - 1.74	<0.001	1.39	1.23 - 1.56	<0.001
<i>Work-individual interface</i>						
No/Low job satisfaction	1.33	1.18 - 1.50	<0.001	1.23	1.09 - 1.38	0.001
Work-family conflict	1.27	1.13 - 1.43	<0.001	1.29	1.15 - 1.45	<0.001
High job insecurity	1.26	1.12 - 1.42	<0.001	1.20	1.06 - 1.34	0.003
High changes at work	1.41	1.25 - 1.59	<0.001	1.32	1.17 - 1.48	<0.001
Temporary employment	0.80	0.63 - 1.00	0.053	0.83	0.67 - 1.02	0.082
<i>Workplace violence</i>						
High internal violence	1.45	1.29 - 1.63	<0.001	1.37	1.22 - 1.54	<0.001
High external violence	1.20	1.07 - 1.35	0.002	1.21	1.08 - 1.36	0.001
<b>Working time/hours factors</b>						
Long working hours (> 48h/week)	1.04	0.84 - 1.29	0.699	1.06	0.86 - 1.30	0.588
Night work (> 50/year)	1.42	1.10 - 1.84	0.007	1.43	1.07 - 1.90	0.014
Unsocial work days (> 40/year)	1.04	0.90 - 1.20	0.587	1.08	0.93 - 1.25	0.333
Shift work	1.13	0.88 - 1.45	0.355	1.10	0.87 - 1.40	0.419

### Physical work exposures

High biomechanical exposure <sup>b</sup>	1.31	1.17 - 1.47	<0.001	1.21	1.07 - 1.37	0.002
Fumes and dust exposure	1.28	1.12 - 1.47	<0.001	1.15	1.00 - 1.31	0.048
Toxic and dangerous products exposure	1.31	1.15 - 1.49	<0.001	1.23	1.08 - 1.40	0.002
Noise exposure	1.52	1.32 - 1.76	<0.001	1.39	1.20 - 1.62	<0.001

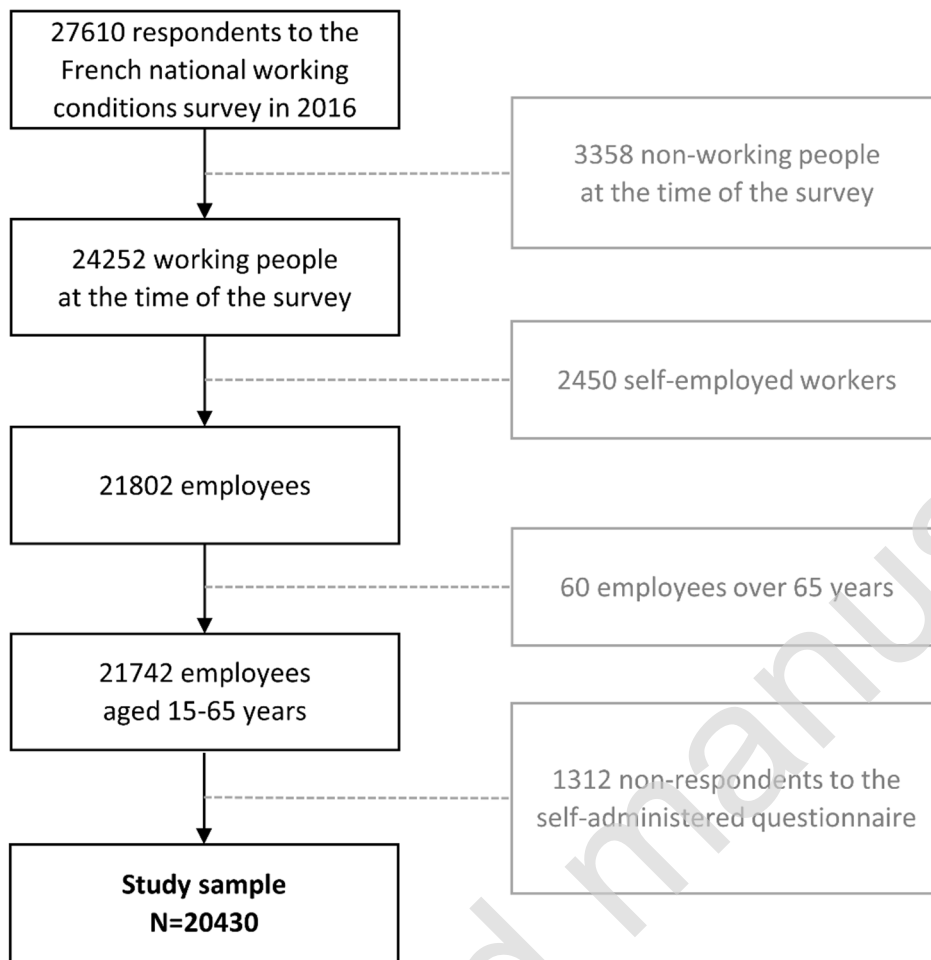
Abbreviations: CI, confidence interval; PR, prevalence ratio.

<sup>a</sup> Reported results are those from complete case analyses that included participants with no missing data for the variables of interest (sleep problems, all occupational exposures, covariates). The observed associations were similar using all available data for each occupational exposure.

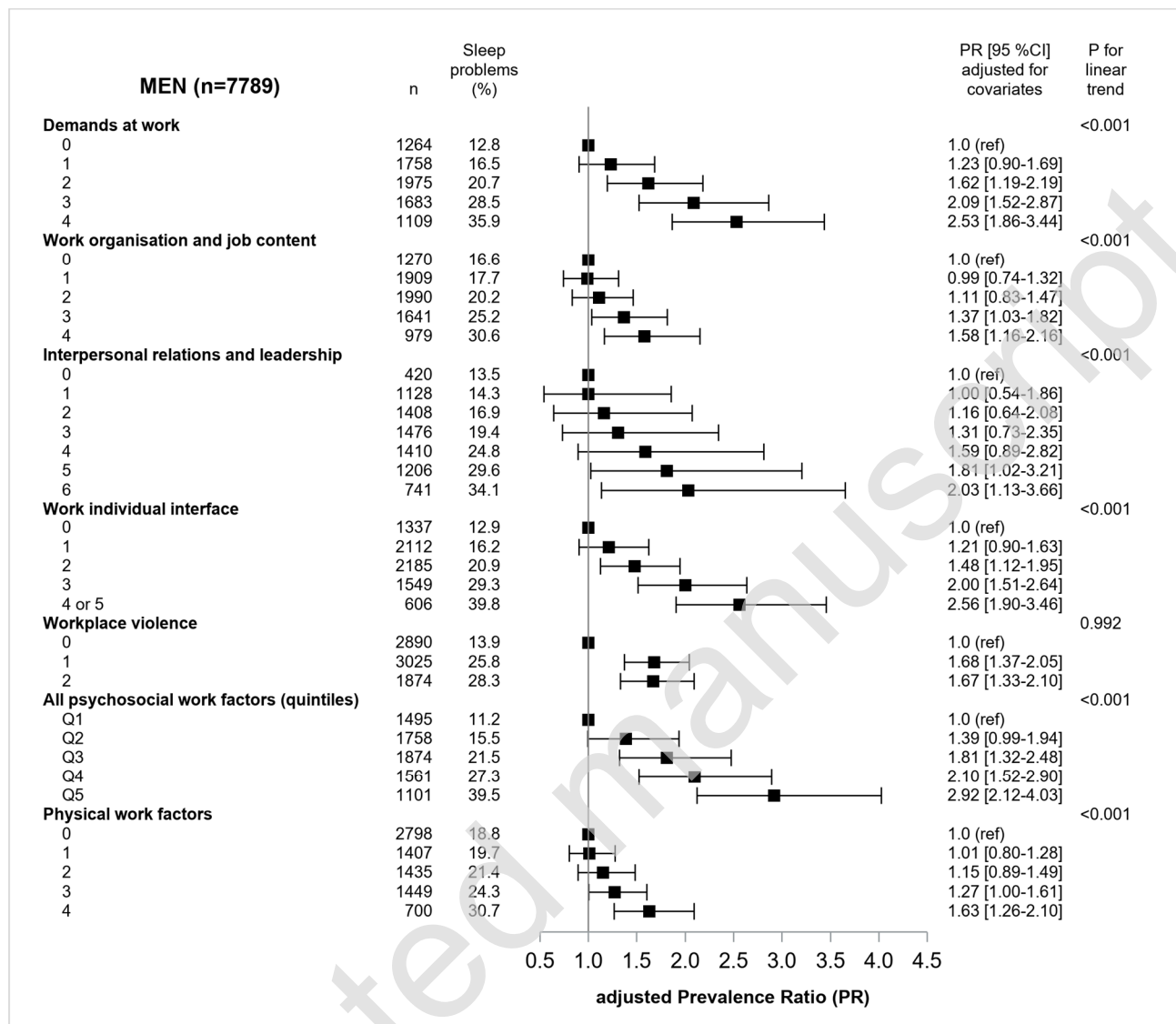
<sup>b</sup> Median cut-off of the total sample was used to classify workers in no/low or high exposure groups.

<sup>c</sup> Adjusted for age, marital status, social support outside work, life events before the age of 18, life events within the last 3 years, occupation, and economic activity of the company.

**FIGURE 1** Study sample flowchart



**FIGURE 2** Multiple occupational exposures and sleep problems within the last 12 months in men: results from robust Poisson regression analyses on weighted data after adjustment for covariates



**FIGURE 3** Multiple occupational exposures and sleep problems within the last 12 months in women: results from robust Poisson regression analyses on weighted data after adjustment for covariates

