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► **To cite this version:**

Nathalie Havet, J. Fournier, J. Stefanelli, M. Plantier, A. Penot. Disparate exposure to physically demanding working conditions in France. *Epidemiology and Public Health = Revue d'Epidémiologie et de Santé Publique*, 2020, 68 (6), pp.327-336. 10.1016/j.respe.2020.09.008 . hal-03016411

**HAL Id: hal-03016411**

**<https://hal.science/hal-03016411>**

Submitted on 21 Nov 2022

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# **Disparate exposure to physically demanding working conditions in**

## **France**

### **Disparités d'expositions aux conditions de travail physiques pénibles en France**

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**Running title: Physical working conditions in France**

# Disparate exposure to physically demanding working conditions in France

Disparités d'expositions aux conditions de travail physiques pénibles en France

## Abstract

**Background:** Our study was aimed at examining disparate exposure to physically demanding working conditions in France, a key objective being to identify the types of employees/jobs requiring high-priority preventive actions.

**Methods:** We analyzed the data from the 2017 French nationwide cross-sectional survey (SUMER) on occupational hazards to which French employees in various sectors were subjected. The prevalence of several types of physically demanding working conditions (lifting of heavy loads, awkward body postures, vibrations, noise, and extreme temperatures) were explored. Potential associations of individual and job characteristics with these factors of hardship at work were studied by multivariate logistic regression.

**Results:** 48% of employees were exposed to at least one physically demanding working condition and 24.8% were exposed to multiple constraints. While managers and intellectual professionals were exposed relatively infrequently to physical constraints, blue-collar workers experienced the highest frequency of exposure. On the one hand, the role of company size depended on the factor of hardship at work considered; on the other hand, employees in large-scale companies were generally less exposed. As expected, employees in the construction industry were the most exposed to physical constraints; that said, our results also show that some activities in the services sector (e.g., personal care, administrative and support services) were quite significantly affected by a wide array of physically demanding working conditions.

**Conclusion:** Notwithstanding the establishment in France of *Plans de Santé au travail* (preventive workplace health and safety plans), occupational risks were found to be high, and above all, they were unevenly distributed among the various socio-professional categories, and strongly contributed to social inequalities in health. Our results identify the types of publics to be designated as high-priority targets for preventive measures aimed at reducing the adverse impacts of physically demanding working conditions and the incidence of associated musculoskeletal disorders.

**Keywords:** Health inequalities. Occupational exposure. Physically demanding working conditions. Physical workload. Harmful noise. Awkward body postures.

## **Résumé**

**Position du problème :** L'objectif de cette étude était d'examiner les disparités d'exposition aux facteurs de pénibilité physiques en France, afin d'identifier quels types de salariés et d'emplois nécessitent des actions de prévention prioritaires.

**Méthodes :** Ce travail repose sur l'exploitation de l'édition 2017 de l'enquête *Surveillance médicale des expositions aux risques professionnels* (SUMER), représentative de l'ensemble de la population salariée française. Les prévalences d'exposition à différentes conditions de travail physiques pénibles (manutention répétée de charges, postures pénibles, vibrations, nuisances sonores et thermiques) ont été calculées. Des régressions logistiques multivariées ont été réalisées pour examiner les associations potentielles de ces facteurs de pénibilité avec des caractéristiques individuelles, d'emploi et d'entreprise.

**Résultats :** 48% des salariés en France métropolitaine (11,3 millions de salariés) étaient exposés à au moins un facteur de pénibilité physique en 2017 et 24,8% étaient exposés à plusieurs d'entre eux. Les cadres et les professions intellectuelles étaient relativement moins exposés aux contraintes physiques, alors que les ouvriers présentaient les fréquences

d'exposition les plus élevées. L'influence de la taille de l'entreprise dépendait du facteur de pénibilité considéré, même si les salariés des grandes entreprises semblaient en général moins exposés. Comme attendu, les salariés dans le secteur de la construction étaient les plus exposés aux contraintes physiques. Mais nos résultats montrent que des activités de services (telles que les soins aux personnes, les activités de services administratifs et de soutien) étaient aussi significativement plus concernées par certaines conditions de travail physiques pénibles.

**Conclusion** : Malgré la mise en place de *Plans de Santé au Travail* axés sur la prévention des risques professionnels, les expositions aux facteurs de pénibilité sont encore relativement importantes aujourd'hui en France. Ils sont surtout toujours inégalement répartis entre les différentes catégories socioprofessionnelles et contribuent ainsi fortement aux inégalités sociales de santé. Nos résultats permettent d'identifier les publics à viser par des actions de prévention prioritaires afin de réduire les effets néfastes des conditions de travail physiques pénibles et les troubles musculo-squelettiques associés.

**Mots clés** : Inégalités de santé. Expositions professionnelles. Conditions de travail physiques. Port de charges. Bruit nocif. Postures pénibles.

## **Introduction**

In France, the contribution of occupational exposure to the occurrence of a number of serious diseases remains high. For example, it is estimated that 15,000-20,000 new cancer cases each year have an occupational origin [1–3] and that at least 20% of all carpal tunnel surgeries can be attributed to jobs involving repetitive motions of the wrist and hand [4]. Physically demanding working conditions (e.g., lifting of heavy loads, awkward body postures, vibrations...) are defined as occupational exposures given their possibly detrimental impact on musculoskeletal health. In 2016, musculoskeletal disorders (MSD) – periarticular/vibration disorders, chronic meniscus injuries, and low back pain – accounted for 87% of all recognized occupational diseases [5]. The prevention of work-related MSDs is therefore a major occupational and public health issue.

*Occupational Health Plans (OHPs) (2005-2009, 2010-2014, and 2016-2020)* have been devised with the aim of reducing MSDs. The 2010-2014 OHP recommended the development of ‘multi-year MSD plans’, including statistical indicators to accurately monitor the impact of prevention measures. The 2016-2020 OHP reaffirmed this target in order to reduce workplace-related claims and physical disabilities, and also to ensure continuity of employment. They pointed out that identification and knowledge of work situations that lead to occupational exhaustion should be developed in order to provide companies with relevant and effective recommendations. More generally, achieving better understanding of the social differences that exist between employees in terms of occupational exposures is a necessary step toward reducing social inequalities in health. Up until now, there has been a paucity of published studies investigating differences in physical working conditions across multiple occupations in France, and they have tended to focus on specific sectors or occupational factors [6-10].

The aim of our study was to provide a global and up-to-date overview of the prevalence of a number of physically demanding working conditions (lifting of heavy loads, awkward body postures, vibrations, noise, and extreme temperatures) and to examine their associations with a range of social class factors in a large-scale representative nationwide sample of French employees.

## **Methods**

### *Study population*

The SUMER survey is a national cross-sectional survey conducted periodically by the French Ministry of Labor and the Directorate for Research, Studies, and Statistics to assess occupational risks among a representative sample of the French employee population. The 2017 survey was based on two-level sampling involving 1,243 volunteer occupational physicians, who, over a period of 3 months, randomly selected 33,600 employees for whom they provide medical surveillance in their workplace. Full-time occupational physicians were asked to undertake 30 interviews, and the number of interviews was calculated pro-rata for physicians working part-time, with a minimum of 20 questionnaires. A total of 26,500 workers agreed to participate (response rate: 76%) [11]. For the sake of homogeneity, the sample of our study was restricted to employees working in metropolitan France (25,684 employees).

### *Physically demanding working conditions considered*

The physicians assessed individual exposures to various chemicals, biological agents, and physical constraints over a period of 1 week, based on statements provided by the employees and on their knowledge of the field and the nature of the job or the position. For each physical constraint identified, they assessed the duration of exposure (reported as a categorical variable: < 2 h, 2-10 h, 10-20 h,  $\geq$  20 h in a single workweek).

Using the SUMER survey, exposure to the following physical working conditions was analyzed: (i) *lifting, holding & carrying of heavy loads*; (ii) awkward body postures, divided into four sub-categories: *holding one's arms up* above shoulder level, *kneeling* and/or crouched position, *neck constraints* (fixed position of the head and neck), *other postural constraints*; (iii) *vibrations* (arm/hand vibrations; whole-body vibrations caused by fixed machinery); (iv) harmful noise, divided into two sub-categories: *noise > 85 dB*, *impulse noise*; (v) extreme temperatures: < 15 °C or > 24 °C imposed by the production process.

The risk that exposure of a worker to a physical constraint will eventually become manifest as an adverse effect on their health depends, among other factors, on the duration of the exposure: the longer the exposure, the greater the risk. However, it is impossible to determine a threshold for duration of exposure below which the health risk would be negligible. Here, we considered thresholds – definable with the SUMER survey – above which physical working conditions could be classified as *demanding* due to their arduousness and significantly increased pathogenicity when these thresholds are exceeded. The chosen thresholds, which were similar to those in previous studies [9,12–13], were not particularly restrictive, yet nonetheless relevant in terms of prevention. They were: 10 h/week for the lifting of heavy loads, extreme temperatures, noise > 85 dB, whole-body vibrations caused

by fixed machinery, and 2 h/week for awkward body postures, arm/hand vibrations, and impulse noise.

### *Statistical analysis*

A descriptive approach was used to examine the prevalence of the various physically demanding working conditions. Association of individual, job, and company characteristics with each exposure prevalence was studied using multivariate logistic regressions<sup>1</sup>. The covariates included were three variables describing employee characteristics (age, gender, and seniority), five variables related to job characteristics (nature of the employment contract, work hours, work schedules, occupation, and the main occupational duties), and company characteristics (activity sector, company size, geographical location, the presence of trade union representatives and/or a health committee, safety, working conditions, and intervention by occupational health and safety officers over the past 12 months). All analyses were performed using STATA V.15.0 software (StataCorp, College Station, TX, USA).

## **Results**

### *Descriptive statistics*

All in all, we estimated that 48% of employees, corresponding to 11.3 million French employees in 2017, were exposed to at least one of the physical working conditions identified in the SUMER survey, and that 24.8% (5.3 million employees) were exposed to multiple physically demanding constraints.

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<sup>1</sup> Multilevel analyses were also conducted but are not reported here because of the small number of individuals per cluster. However, they yielded results similar to the multivariate logistic regressions presented.

In 2017, the fraction of workers in France who reported carrying heavy loads was 7.8%, while for awkward body postures it ranged from 8.6% to 26.4%, for vibrations it was 7.6%, and for harmful noises it was approximately 9%. The main sources of painful physical constraints involved the neck or were related to other awkward postures (crouched, twisted, etc.), with exposure prevalence exceeding 20% (Table 1).

Table 1 provides descriptive statistics on exposure prevalence according to various employee, job, and company characteristics. Globally, men were more exposed to all demanding physical working conditions, except for adverse neck positions. The most pronounced gender gaps involved exposure to vibrations (16% for men versus 1.1% for women) and harmful noises (e.g., 8.4% versus 0.9% for noise > 85 dB). The differences in exposures were all the more pronounced between job types and activity sectors. For example, blue-collar workers (skilled or unskilled) represented the socio-professional category that was the most exposed to physically demanding working conditions (except for neck constraints). Prevalence of exposure to heavy loads and low temperatures (< 15 °C) was the highest among unskilled workers (18% and 6%, respectively). Nearly 61% of the skilled blue-collar workers were exposed to at least one awkward body posture, and 30% were exposed to vibrations. Managers and clerks were affected mostly by demanding physical neck constraints. Moreover, the main occupational duties with the highest prevalence of exposure to adverse neck positions were administrative assistant, typist, and receptionist (38%). Exposures to the lifting of heavy loads occurred mostly in handling, warehousing, and logistics duties, and to a lesser extent in production, manufacturing, and construction duties, which had the highest prevalence of noise > 85 dB. Installation, repair, and maintenance duties were the most affected by all of the other types of painful physical

conditions. As regards the activity sector, the most affected was the construction industry, followed by the manufacturing industry and agriculture. Conversely, companies with 500 employees or more had the lowest exposure prevalence, irrespective of the type of painful physical constraint considered.

In terms of employment contracts, apprentices and agency workers were more likely to be exposed to demanding physical constraints (except for those demanding neck postures and extreme temperatures) than others. The same phenomenon was also widely the case for shift workers (except for arm and neck postures). Night workers were more likely to be exposed to heavy loads, vibrations, harmful noise, and extreme temperatures.

#### *Multivariate regressions*

The results of our multivariate regressions on physical work exposures revealed substantial differences at multiple levels (Table 2). At the individual level, women were more likely to be exposed to awkward body postures, while men were more likely to be exposed to the lifting of heavy loads (OR = 1.25, 95% CI = [1.07,1.44]), vibrations (OR = 3.56, 95% CI = [2.89,4.38]), harmful noise (OR = 1.75 and 2.90, 95% CI = [1.46, 2.10], [2.30, 3.63]), and low temperatures (OR = 1.34, 95% CI = [1.01,1.78]). All in all, prevalence of exposure to physical working conditions significantly decreased with age, although it was not significantly associated with seniority (except positively for holding one's arms up and neck postural constraints).

At the occupational level, full-time workers were more likely to be exposed to most types of strenuous physical working conditions, particularly harmful noise (OR = 2.34, 95%

CI = [1.56,3.52]). Similarly, shift work was more frequently associated with higher exposure prevalence to harmful noise (OR = 1.81, 1.85, 95% CI = [1.53,2.14], [1.59,2.15]), extreme temperatures (for temperature > 24 °C OR = 1.82, 95% CI = [1.38,2.38]), and heavy loads (OR = 1.27, 95% CI = [1.10,1.47]). Night workers were less likely to be exposed to awkward body postures. On the other hand, they were more likely to be exposed to vibrations (OR = 1.20, 95% CI = [1.03,1.00]) and noise > 85 dB (OR = 1.32, 95% CI = [1.11,1.57]). For most of the physically demanding working conditions, there were no statistical differences in exposure, once the other characteristics were taken into account, between workers with permanent contracts and precarious workers (apprentices, agency workers, fixed-term and seasonal contracts), except for the fact that the latter were more likely to have to hold their arms up (OR = 1.34, 95% CI = [1.08,1.67]). Civil servants were more likely to be exposed to the lifting of heavy loads and physical postures involving the arms held high or kneeling positions. Workers with a specific status were more frequently associated with demanding neck postures, but less associated with the lifting of heavy loads, holding their arms up and kneeling, or exposure to extreme temperatures. Compared to technicians and associate professionals (reference category), managers and intellectual professionals were less frequently exposed at their workplace to physical constraints, while blue-collar workers were more likely to be exposed. For example, in the regression for the lifting of heavy loads, the odds ratio between unskilled blue-collar workers and technicians or associate professionals was 5.04 (95% CI = [1.08,1.67]). Similarly, the odds ratio between skilled blue-collar workers and technicians or associate professionals exceeded 6 in the regression concerning vibrations (OR = 6.03, 95% CI = [5.07,7.16]).

The results of the descriptive statistics regarding the main occupational duties were, for the most part, confirmed by our multivariate regressions. Demanding neck postures were

associated more with administrative duties such as administrative assistant, typist, receptionist, or management and accounting. Installation, repair, and maintenance duties had a highest probability of being exposed to work involving the arms being held high, kneeling, vibrations, and impulse noise. Carrying heavy loads was most likely to occur with handling, warehousing, and logistics duties (OR = 2.24, 95% CI = [1.86,2.71]). Prevalence of exposures to harmful noise and extreme temperatures was higher in production, manufacturing, and construction activities (reference category). However, it also appeared that personal care was an activity with a high probability of exposure to handling of heavy loads and involving postural constraints (kneeling, other postures), all other things being equal. This effect was also observed in the service sector in general.

The size of the company had different associations depending on the physical working conditions examined. Employees in companies with 10 to 249 employees were more frequently exposed to harmful noise and employees in companies with 250 to 499 employees were more frequently exposed to the lifting of heavy loads and physical postures involving the arms held high, while those in companies with fewer than 10 employees were more frequently exposed to vibration. There was no statistical difference in terms of exposure to kneeling positions and hot temperatures.

## **Discussion**

Physical working conditions represent long-term occupational risk factors that increase the probability of severe and eventually irreversible health issues. They can extend beyond the employees' working lives, and implicitly contribute to social inequalities in health and life expectancy. Detailed knowledge of occupational exposures by main activities facilitates

understanding of how to devise prevention strategies and prioritization of actions to be taken in regard to activities with the highest risk. In this context, the results from large representative samples of national working populations, such as the French SUMER survey, help to assess the associations between numerous work-related factors and the main occupational exposures. This information is of great value to nationwide and European governmental figures and social partners in their decision-making with regard to requirements for regulations and allocation of prevention resources. In-depth studies on inequalities in exposure to carcinogenic, mutagenic, and reprotoxic chemicals [14–17] or to psychosocial risks in the workplace [18–21] have been carried out using previous SUMER surveys. Moreover, in 2010, Havet et al. [9] examined whether night workers are more subject to painful working conditions than day workers. Our study of physical constraints for the entire working population complements these findings by providing more recent data.

It remains difficult to estimate the number of employees exposed to “demanding” physical working conditions insofar as given the complexity of the relationships between work, age, and health, as well as their multifactorial nature and their changes over time, it is difficult to set an “at risk for health” exposure duration. After all, their pathogenic effects can be delayed. However, our analysis based on the 2017 SUMER survey provides a degree of insight regarding this issue: in 2017, 8% of French employees were affected by having to repeatedly carry heavy loads (10 hours/week or more), 44% by work duties that involved at least one awkward body posture (2 hours/week or more), 7.6% by exposure to vibrations (2 hours/week or more for arm/hand vibrations and 10 hours/week or more for vibration caused by fixed machinery), and 9% by exposure to harmful noise levels (noise > 85 dB: 10 hours/week or more, or impulse noise: 2 hours/week or more). Despite technical developments that have reduced some arduous work duties [22] and the implementation of

occupational risk prevention policies (Law on Public Health Policy in 2004, Occupational Health Plans, National Health and Environment Plans), prevalence of exposure to physically demanding working conditions remains high in France. That much said, the exposure rates for lifting of heavy loads, harmful noise levels, and extreme temperatures have decreased significantly compared to the 2003 SUMER survey, while postural constraints (particularly kneeling and other postures) have increased [12-13]. The situation in France is similar to that in other European countries. The European Foundation for the Improvement of Living and Working Conditions has shown that in 2015, 32% of the workers in the European Union reported that at least a ¼ of their working hours involved carrying heavy loads, for 43% their work involved tiring or painful positions, and that for 20% their work involved exposure to vibrations [23]. Based on comparable data, France had prevalence of exposure to these physical conditions reaching 36%, 49%, and 19% respectively [23].

Beyond these general figures, there were significant disparities between employees. All categories combined, blue-collar workers and employees in the construction and manufacturing sectors remained the most exposed to physically demanding working conditions, in addition to exposure to carcinogenic, mutagenic, and reprotoxic (CMR) agents [17] and to night/shift work [9]. These occupational risks continue to be unevenly distributed among the various socio-professional categories, and they contribute strongly to social inequalities in health. Executives were more exposed to painful neck postures and psychosocial suffering at work. Employees in large companies (> 500 employees) appear to be less exposed to occupational risks: in addition to being less exposed to CMR agents [17], we found that they were less exposed to physically demanding working conditions. Although prevention can be effective at the individual level, large companies have a greater ability to commit financial resources to implementation of collective and preventive adaptation

policies in regard to occupational health factors throughout the employees' working lives, as is generally considered to be more effective.

Our analyses highlighted that, in addition to the construction sector, service activities such as personal care and administrative and support services were strongly affected by various physical working conditions and hence warrant being prioritized for preventative actions.

Although women were less likely to face physically demanding working conditions, they were nonetheless subject to a significant degree of exposure. Gender differences were largely due to differences in employment or companies. For example, men were predominant in skilled and unskilled blue-collar jobs, which are the two socio-professional categories most heavily exposed to physically demanding working conditions (except for neck constraints). Similarly, the occupational duties with the highest exposures were overwhelmingly male, and shift workers, in particular, tended to be men and had above-average exposure rates for the majority of physical constraints. However, once potential gender differences in jobs and company characteristics were controlled by multivariate regressions, men were significantly more likely to be exposed only to the lifting of heavy loads, vibration, noise, and cold temperatures. All other things being equal, women were more prone to painful postures (arms held high, neck constraints, and others). These results confirm that above and beyond gender segregation of occupations in the labor force, there exists a split within jobs/sectors regarding physical working conditions. Women are less often assigned to tasks where the physical requirements are known to be high, such as the handling of heavy loads or using machines that generate vibrations in the upper limbs (grinders, chainsaws, jackhammers, etc.) or in the whole body (handling trolleys, construction and earthmoving machinery, etc.). Our results are consistent with the division of labor that Eng et al. (2011) [24] and Messing (2004) [25] highlighted based on North

American data. However, given the strong postural constraints to which they are subjected, women are not exempt from physical hardship. Preventive actions will be called upon to take into account these gender differences and, more specifically, raise awareness among women and their employer on the need to improve their posture at work.

The likelihood of exposure to physically demanding working conditions tended to decrease slightly with age. This finding confirms the conclusion of Pailhé (2004) [26] who, based on older French surveys (1984, 1988, 1991 *Working Conditions* surveys), found that more aged employees were relatively less exposed to occupational risks than their younger counterparts. Lower exposure is not due to the fact that, as they get older, employees move away from the most exposed socio-professional categories; our multivariate regressions seem to neutralize this type of structure effect. It can be assumed that the division is to a greater extent created as pertains to the tasks assigned within the different jobs. Employers may assign less strenuous tasks to older workers in order to avoid work-related strain and extended periods of sick leave, especially if they have been exposed to physically demanding working conditions throughout their careers. In addition, the quest for increased productivity exacerbates this phenomenon, as older workers may be less productive in tasks that require physical effort.

Our regression analyses suggest that night work and shift work are associated with greater exposure to certain specific physical working conditions. Occupational risk prevention policies should focus their action plans primarily on noise and vibration exposures for night workers and on noise, extreme temperatures, and heavy load exposures for shift workers. Our results are in line with previous studies, which suggested that atypical work schedules tend to be cumulative with other risk factors related to emotionally and physically arduous

work [17, 27]. The human body's greater vulnerability at night makes it exceptionally sensitive, however, to arduous physical conditions (noise, temperature, vibrations, etc.) [28]. In particular, the strain caused by night/shift work can be significantly increased when there exist other stress factors related to a harsh physical environment in the workplace [29].

Accumulated hardship appears to be particularly pronounced in night/shift workers, as in and of itself, night/shift work entails an inherent occupational health risk. Rather unfortunately, a 2017 reform of the French Labor Code (ordinance n°2017-1389-22) has led to the abolition of the contribution for prevention paid for by companies and, in particular, a supplementary contribution in the event of multiple exposures of employees to occupational risks. Future surveys on the latter will help to determine the extent to which this reform may have affected companies' prevention behavior and possibly contributed to a widening of occupational and health inequalities.

Our study has several limitations. Firstly, given the number of investigators, inter-physician variability in determination of exposure prevalence and duration with regard to identical occupations arose due to their differing levels of knowledge. Furthermore, data collection was based on an employee's exposure during the previous week; no information was available with regard to his or her prior work and exposure history, and cumulative exposure could not be determined. That said, there is no reason to suspect differential under- or over-estimation of exposures.

In summary, our study confirms the hypothesis that discrepancies in exposure to physically demanding working conditions occur at different levels in the workplace (i.e., at the individual, job, and company level). Our results identify high-priority targets (e.g., young

employees, blue-collar workers, night/shift workers) for prevention measures to help reduce the adverse impacts of demanding physical working conditions and associated musculoskeletal disorders. This is especially important insofar as exposure inequalities overlap with the existing social gradient of health inequalities. Gender should be taken into account in the drafting of policies and preventive measures regarding occupational exposures. In addition to the construction sector, a number of service activities warrant being prioritized for preventative actions.

**Acknowledgments:** This study was funded by the French Directorate of Research, Studies and Statistics Coordination (*Direction de l'animation de la recherche, des études et des statistiques* - DARES) of the French Ministry of Labour, in the framework of funding for “Social inequalities in Health” projects. This research received support from the Chair “Prevent’Horizon”, under the aegis of the Risk Foundation in partnership with UCLB, ACTUARIS, AG2R LA MONDIALE, G2S, COVEA, GROUPAMA GAN VIE, GROUPE PASTEUR MUTUALITE, HARMONIE MUTUELLE, HUMANIS PREVOYANCE, LA MUTUELLE GENERALE. The funding partners had no involvement in analysis and interpretation of the data, writing of the manuscript, and the decision to submit the paper for publication. The authors are grateful to Sophie Domingues for helping with the final editing of the manuscript.

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**Table 1.** Prevalence of exposure to physically demanding working conditions in the 2017 national survey of occupational hazards (SUMER)

	Postural constraints					Harmful noise			Extreme temperatures	
	Handling of heavy loads	Holding one's arms up	Kneeling	Neck constraints	Other postural constraints	Vibration	Noise > 85 dB	Impulse noise	< 15 °C	> 24 °C
<b>In the survey sample</b>	7.8%	8.6%	10.5%	20.3%	26.4%	7.6%	4.6%	6.3%	1.6%	1.5%
<b><i>n</i> exposed at work</b>	1,755,359	1,980,448	2,414,156	4,655,895	5,994,752	1,772,949	1,071,779	1,469,179	371,341	355,946
<b>Gender</b>										
Women	4.8%	6.4%	7.5%	22.0%	25.3%	1.1%	0.9%	2.1%	0.9%	1.0%
Men	10.9%	10.7%	13.4%	18.7%	27.4%	15.9%	8.4%	10.7%	2.3%	2.1%
<b>Occupational status</b>										
Intellectual professionals, managers	0.6%	1.3%	0.6%	24.3%	12.4%	0.7%	1.0%	1.6%	0.2%	0.3%
Technicians and associate professionals	2.4%	3.7%	5.7%	20.2%	17.0%	3.0%	2.3%	4.0%	0.7%	0.9%
Clerks	0.9%	0.8%	0.8%	34.1%	17.7%	0.2%	0.1%	1.0%	0.0%	0.3%
Service workers	11.0%	11.4%	13.8%	11.7%	33.8%	2.3%	0.9%	2.5%	1.2%	1.9%
Skilled blue-collar workers	18.1%	19.5%	25.6%	20.9%	41.5%	30.4%	15.2%	19.9%	3.7%	3.3%
Unskilled blue-collar workers and agricultural workers	18.2%	16.9%	16.8%	13.6%	39.3%	20.6%	12.4%	11.9%	6.0%	3.0%

**Main occupational duties**

Production, manufacturing, and construction	16.7%	16.9%	20.7%	20.1%	37.1%	23.2%	18.5%	17.9%	5.2%	5.1%
Installation, repair, and maintenance	9.2%	23.4%	39.9%	17.0%	39.0%	37.3%	13.4%	27.1%	2.8%	1.9%
Cleaning, childcare, and home management	6.3%	13.9%	17.0%	5.2%	35.8%	6.1%	1.4%	3.0%	0.7%	1.7%
Handling, logistics, and warehousing	28.2%	10.0%	8.2%	18.7%	38.2%	13.6%	2.2%	7.6%	4.5%	1.0%
Administrative assistance, typing, receptionist	0.1%	0.1%	0.6%	38.3%	16.1%	0.2%	0.1%	0.8%	0.1%	0.2%
Management and accounting	0.1%	0.0%	0.2%	30.0%	18.2%	0.2%	0.0%	0.6%	0.0%	0.2%
Commerce and sales, marketing	7.2%	7.2%	5.1%	19.8%	21.6%	1.4%	0.4%	1.1%	1.1%	0.6%
Engineering, research and development activities	0.3%	0.2%	0.4%	26.1%	12.2%	0.2%	0.6%	1.0%	0.1%	0.3%
Education	1.7%	7.6%	5.6%	12.2%	14.5%	1.2%	2.9%	3.4%	0.6%	0.2%
Personal care	11.6%	7.6%	15.0%	12.3%	36.6%	0.5%	0.3%	3.4%	0.0%	0.5%
Other	4.0%	5.5%	4.8%	21.1%	19.4%	6.6%	3.0%	3.2%	0.8%	1.7%
<b>Activity sector</b>										
Agriculture	12.5%	7.4%	20.4%	9.7%	43.2%	25.7%	7.4%	5.1%	8.9%	3.6%
Industry	8.3%	7.8%	8.7%	23.8%	21.1%	11.9%	12.0%	11.4%	2.0%	3.3%

Construction	18.5%	26.7%	38.8%	22.3%	38.5%	36.2%	14.6%	22.5%	3.3%	1.2%
Services	6.9%	7.4%	8.6%	19.8%	26.1%	5.8%	2.7%	4.4%	1.3%	1.2%
<b>Company size</b>										
1 to 9 employees	7.1%	11.9%	12.6%	19.7%	28.3%	11.5%	4.9%	6.4%	1.7%	1.8%
10 to 49 employees	9.0%	10.5%	13.1%	21.2%	28.2%	10.4%	4.7%	7.9%	1.6%	1.5%
50 to 199 employees	9.5%	7.0%	8.6%	20.5%	27.1%	7.8%	5.5%	6.5%	1.8%	1.5%
200 to 499 employees	7.4%	7.0%	8.2%	22.7%	25.7%	5.9%	5.2%	5.5%	2.5%	2.0%
500 or more employees	5.1%	4.2%	7.4%	18.5%	20.2%	4.3%	2.7%	4.3%	0.8%	1.1%
<b>Employment contract</b>										
Apprentices, trainees, agency workers	13.6%	12.4%	13.4%	15.3%	44.0%	14.0%	10.6%	13.3%	2.0%	1.8%
Fixed-term contract, seasonal and occasional workers	6.6%	8.8%	10.5%	20.7%	25.7%	7.4%	3.9%	4.1%	2.7%	2.1%
Undetermined contract	8.0%	8.7%	10.4%	20.4%	26.6%	8.7%	4.5%	6.4%	1.7%	1.5%
Workers with a specific status	1.4%	4.1%	6.0%	38.9%	20.7%	13.4%	3.2%	7.9%	0.7%	0.6%
Civil servants	6.6%	7.1%	10.7%	18.4%	21.5%	6.4%	4.3%	4.9%	0.7%	1.7%
<b>Shift work</b>										
No	6.8%	8.6%	10.0%	21.3%	25.2%	8.3%	3.8%	5.2%	1.4%	1.2%
Yes	14.7%	8.3%	13.6%	13.9%	34.0%	10.1%	10.2%	13.6%	3.37%	3.7%
<b>Night work</b>										

No	7.6%	8.7%	10.4%	20.8%	26.3%	8.1%	4.1%	6.0%	1.5%	1.3%
Yes	9.2%	7.6%	10.8%	17.4%	26.6%	11.2%	8.1%	8.6%	2.7%	3.0%

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**Table 2.** Results of the multivariate logistic regressions of exposure to physically demanding working conditions

	Heavy loads	Arms up	Knees	Neck	Other postures	Vibration	Noise (> 85dB)	Impulse Noise	< 15 °C	> 24 °C
Adjusted <sup>a</sup> odds ratio [95% CI]										
<b>Gender (Ref = Women)</b>										
Men	1.25*** [1.07 - 1.44]	0.75*** [0.65 - 0.86]	1.01 [0.87 - 1.16]	0.78*** [0.72 - 0.84]	0.85*** [0.79 - 0.92]	3.56*** [2.89 - 4.38]	2.90*** [2.30 - 3.63]	1.75*** [1.46 - 2.10]	1.34** [1.01 - 1.78]	0.93 [0.70 - 1.24]
Age	0.99** [0.99 - 1.00]	0.99*** [0.90 - 0.99]	0.99*** [0.98 - 0.99]	0.99*** [0.99 - 1.00]	0.99*** [0.99 - 1.00]	0.99*** [0.98 - 0.99]	0.99 [0.98 - 1.01]	0.99*** [0.98 - 0.99]	1.009 [0.99 - 1.01]	0.99** [0.98 - 0.99]
<b>Seniority (Ref = more than 10 years)</b>										
Less than 1 year	0.87 [0.66 - 1.17]	0.65*** [0.48 - 0.85]	0.99 [0.77 - 1.27]	0.95 [0.79 - 1.14]	0.76*** [0.64 - 0.91]	0.94 [0.71 - 1.24]	0.92 [0.65 - 1.30]	0.72* [0.52 - 1.00]	0.95 [0.57 - 1.60]	0.93 [0.54 - 1.60]
1 to 3 years	0.87 [0.72 - 1.06]	0.78*** [0.65 - 0.94]	1.09 [0.92 - 1.30]	0.87** [0.77 - 0.98]	0.91 [0.81 - 1.02]	1.00 [0.83 - 1.22]	0.77** [0.61 - 0.98]	0.98 [0.80 - 1.19]	1.10 [0.78 - 1.55]	1.07 [0.74 - 1.55]
3 to 10 years	0.99 [0.86 - 1.14]	0.92 [0.81 - 1.05]	1.14* [1.00 - 1.29]	0.91** [0.84 - 0.99]	0.97 [0.89 - 1.05]	1.07 [0.93 - 1.24]	0.88 [0.75 - 1.04]	1.00 [0.86 - 1.15]	1.01 [0.285 - 0.445]	1.07 [0.81 - 1.41]
<b>Working hours (Ref = Part-time)</b>										

Full-time	1.73*** [1.41 - 2.13]	1.27*** [1.6 - 1.53]	1.17* [0.99 - 1.39]	1.21*** [1.09 - 1.34]	1.02 [0.93 - 1.13]	1.61*** [1.23 - 2.11]	2.34*** [1.56 - 3.52]	2.10*** [1.52 - 2.89]	1.96*** [1.22 - 3.15]	1.64** [1.02 - 2.64]
<b>Shift work (Ref = No)</b>										
Yes	1.27*** [1.10 - 1.47]	1.05 [0.91 - 1.22]	1.09 [0.96 - 1.26]	1.02 [0.92 - 1.13]	1.07 [0.97 - 1.17]	1.07 [0.93 - 1.24]	1.81*** [1.53 - 2.14]	1.85*** [1.59 - 2.15]	1.15 [0.88 - 1.51]	1.82*** [1.38 - 2.38]
<b>Night work (Ref = No)</b>										
Yes	1.04 [0.90 - 1.20]	0.80*** [0.69 - 0.93]	0.84** [0.73 - 0.96]	0.95 [0.86 - 1.06]	0.91** [0.83 - 1.00]	1.20** [1.03 - 1.38]	1.32*** [1.11 - 1.57]	1.06 [0.91 - 1.23]	1.13*** [0.86 - 1.48]	1.21 [0.92 - 1.60]
<b>Sunday/Holiday work (Ref = No)</b>										
Yes	0.84** [0.73 - 0.96]	0.94 [0.83 - 1.06]	0.81*** [0.72 - 0.92]	1.17*** [1.07 - 1.27]	0.95 [0.88 - 1.03]	0.89 [0.78 - 1.02]	1.04 [0.88 - 1.22]	1.09 [0.95 - 1.27]	0.80* [0.63 - 1.03]	0.37*** [0.28 - 0.48]
<b>Employment contract (Ref = Indefinite contract)</b>										
Apprentices, agency workers and fixed-term contract	0.7 [0.68 - 1.1]	1.34*** [1.08 - 1.67]	1.07 [0.87 - 1.33]	1.09 [0.94 - 1.26]	1.08 [0.94 - 1.24]	1.15 [0.90 - 1.46]	1.08 [0.80 - 1.47]	1.01 [0.78 - 1.33]	1.15 [0.76 - 1.72]	1.4 [0.91 - 2.09]
Workers with a specific status	0.36*** [0.25 - 0.52]	0.68*** [0.52 - 0.90]	0.75** [0.58 - 0.95]	1.55*** [1.36 - 1.76]	1.10 [0.95 - 1.26]	1.19 [0.96 - 1.48]	0.53 [0.40 - 0.71]	0.73*** [0.58 - 0.92]	0.49** [0.27 - 0.90]	0.5*** [0.31 - 0.81]

Civil servants	1.28**	1.26**	1.47***	0.89*	0.98	1.051	1.15	0.88	0.57**	1.01
	[1.05 - 1.55]	[1.05 - 1.51]	[1.24 - 1.74]	[0.80 - 0.98]	[0.89 - 1.08]	[0.84 - 1.31]	[0.88 - 1.50]	[0.70 - 1.11]	[0.36 - 0.89]	[0.67 - 1.51]

**Occupational status (Ref = Technicians and associate professionals)**

Intellectual professionals, managers	0.34***	0.34***	0.16***	1.04	0.80***	0.71**	0.51***	0.56***	0.42***	0.59**
	[0.23 - 0.48]	[0.25 - 0.46]	[0.11 - 0.23]	[0.95 - 1.15]	[0.71 - 0.89]	[0.54 - 0.95]	[0.37 - 0.70]	[0.43 - 0.73]	[0.24 - 0.73]	[0.37 - 0.93]

Clerks	1.02	1.07	0.29***	1.12*	1.23***	0.21***	0.78	0.73	0.16**	0.48*
	[0.65 - 1.58]	[0.73 - 1.56]	[0.16 - 0.51]	[0.99 - 1.26]	[1.07 - 1.41]	[0.09 - 0.48]	[0.43 - 1.39]	[0.47 - 1.15]	[0.04 - 0.67]	[0.21 - 1.11]

Service workers	3.69***	3.13***	2.84***	0.61***	2.16***	1.13	0.83	1.02	1.60**	1.15
	[3.02 - 4.50]	[2.57 - 3.82]	[2.39 - 3.38]	[0.54 - 0.70]	[1.93 - 2.41]	[0.84 - 1.53]	[0.56 - 1.22]	[0.76 - 1.37]	[1.03 - 2.49]	[0.76 - 1.75]

Skilled blue-collar workers	3.46***	3.65***	2.84***	1.32***	3.35***	6.03***	2.33***	2.62***	1.79***	1.64***
	[2.85 - 4.20]	[3.06 - 4.35]	[2.44 - 3.33]	[1.18 - 1.48]	[3.01 - 3.73]	[5.07 - 7.16]	[1.93 - 2.79]	[2.23 - 3.08]	[1.29 - 2.48]	[1.21 - 2.23]

Unskilled blue-collar workers and agricultural workers	5.04***	3.40***	2.47***	0.97	3.55***	5.41***	2.00***	1.99***	3.96***	1.02
	[4.04 - 6.28]	[2.75 - 4.20]	[2.03 - 3.00]	[0.82 - 1.14]	[3.09 - 4.08]	[4.38 - 6.69]	[1.59 - 2.52]	[1.61 - 2.46]	[2.78 - 5.64]	[0.68 - 1.54]

**Main occupational duties (Ref = Production, manufacturing, and construction)**

Installation, repair, and maintenance	0.63*** [0.50 - 0.78]	1.91*** [1.61 - 2.27]	3.47*** [2.95 - 4.08]	0.91 [0.79 - 1.06]	1.17*** [1.02 - 1.33]	1.60*** [1.36 - 1.87]	0.82** [0.67 - 0.99]	1.38*** [1.17 - 1.62]	0.51*** [0.34 - 0.75]	0.77 [0.53 - 1.11]
Cleaning, childcare, and home management	0.44*** [0.33 - 0.60]	0.76 [0.59 - 0.98]	0.93 [0.72 - 1.19]	0.35*** [0.26 - 0.46]	0.93 [0.78 - 1.11]	0.84 [0.61 - 1.15]	0.45*** [0.29 - 0.72]	0.48*** [0.33 - 0.70]	0.22*** [0.11 - 0.44]	0.46** [0.25 - 0.88]
Handling, logistics, and warehousing	2.24*** [1.86 - 2.71]	0.81* [0.65 - 1.01]	0.76** [0.61 - 0.96]	0.79** [0.67 - 0.95]	0.94 [0.80 - 1.09]	0.55*** [0.44 - 0.68]	0.25*** [0.17 - 0.35]	0.38*** [0.29 - 0.49]	1.01 [0.72 - 1.40]	0.30*** [0.16 - 0.55]
Administrative secretary, typing, and receptionist	0.04*** [0.01 - 0.12]	0.03*** [0.01 - 0.07]	0.15*** [0.08 - 0.27]	2.01*** [1.70 - 2.38]	0.68*** [0.56 - 0.82]	0.20*** [0.08 - 0.51]	0.04*** [0.01 - 0.17]	0.168*** [0.09 - 0.31]	0.17*** [0.05 - 0.56]	0.18*** [0.06 - 0.53]
Management and accounting	0.01*** [0.00 - 0.11]	0.01*** [0.00 - 0.06]	0.04*** [0.01 - 0.14]	1.73*** [1.48 - 2.03]	0.84** [0.70 - 1.00]	0.14*** [0.06 - 0.34]	0.02*** [0.00 - 0.12]	0.06*** [0.02 - 0.14]	0.05*** [0.01 - 0.38]	0.11*** [0.03 - 0.45]
Commerce and sales, marketing	0.76** [0.59 - 0.99]	0.46*** [0.36 - 0.59]	0.43*** [0.34 - 0.56]	1.06 [0.91 - 1.23]	0.73*** [0.63 - 0.85]	0.18*** [0.12 - 0.27]	0.07*** [0.04 - 0.14]	0.15*** [0.10 - 0.22]	0.25*** [0.15 - 0.43]	0.22*** [0.13 - 0.39]

Engineering, research, development activities, and education	0.17*** [0.10 - 0.28]	0.53*** [0.39 - 0.71]	0.43*** [0.31 - 0.60]	1.22*** [1.05 - 1.40]	0.72*** [0.62 - 0.84]	0.09*** [0.05 - 0.16]	0.24*** [0.16 - 0.35]	0.26*** [0.18 - 0.36]	0.18*** [0.08 - 0.38]	0.21*** [0.10 - 0.41]
Personal Care	1.49*** [1.15 - 1.94]	0.47*** [0.35 - 0.62]	1.30** [1.02 - 1.66]	0.70*** [0.58 - 0.85]	1.56*** [1.32 - 1.83]	0.17*** [0.08 - 0.35]	0.08*** [0.03 - 0.20]	0.174*** [0.10 - 0.29]	0.04*** [0.01 - 0.17]	0.11*** [0.05 - 0.25]
Other	0.34*** [0.26 - 0.43]	0.39*** [0.31 - 0.49]	0.47*** [0.38 - 0.58]	1.23*** [1.08 - 1.39]	0.81*** [0.2 - 0.92]	0.82** [0.68 - 0.99]	0.37*** [0.29 - 0.47]	0.36*** [0.29 - 0.45]	0.45*** [0.31 - 0.64]	0.54*** [0.38 - 0.77]
<b>Activity sector (Ref = Agriculture and industry)</b>										
Construction	1.82*** [1.47 - 2.25]	3.06*** [2.51 - 3.72]	4.25*** [3.54 - 5.12]	1.08 [0.92 - 1.28]	1.91*** [1.65 - 2.22]	2.37*** [1.96 - 2.85]	0.87 [0.70 - 1.09]	1.50*** [1.23 - 1.83]	0.64** [0.42 - 0.99]	0.32*** [0.18 - 0.59]
Services	1.13 [0.95 - 1.33]	1.54*** [1.31 - 1.81]	1.17** [1.00 - 1.37]	1.28*** [1.16 - 1.40]	1.61*** [1.46 - 1.78]	1.30*** [0.574 - 0.845]	0.68*** [0.57 - 0.81]	1.04 [0.88 - 1.21]	1.43** [1.08 - 1.88]	0.11* [0.04 - 0.33]
<b>Company size (Ref = More than 500 employees)</b>										
1 to 9 employees	0.70** [0.54 - 0.92]	0.96 [0.74 - 1.23]	1.16 [0.92 - 1.47]	0.85** [0.73 - 0.99]	1.23*** [1.06 - 1.43]	1.86*** [1.43 - 2.42]	0.85 [0.61 - 1.19]	0.69** [0.52 - 0.92]	1.82 [1.11 - 2.99]	1.33 [0.79 - 2.24]

10 to 49 employees	0.87 [0.69 - 1.09]	0.95 [0.76 - 1.18]	1.13 [0.92 - 1.38]	1.06 [0.94 - 1.20]	1.32*** [1.17 - 1.49]	1.52*** [1.22 - 1.90]	1.13 [0.86 - 1.48]	1.12* [0.88 - 1.41]	1.79*** [1.17 - 2.73]	1.17 [0.75 - 1.81]
50 to 249 employees	1.16 [0.97 - 1.39]	0.372*** [0.292 - 0.475]	1.13 [0.96 - 1.34]	1.08 [0.98 - 1.19]	1.31*** [1.19 - 1.45]	1.25** [1.03 - 1.51]	1.47*** [1.20 - 1.80]	1.24** [1.03 - 1.48]	1.39* [0.96 - 1.99]	1.21 [0.85 - 1.71]
250 to 499 employees	1.37*** [1.09 - 1.69]	1.22* [0.98 - 1.54]	1.06 [0.85 - 1.32]	1.02 [0.91 - 1.16]	1.20*** [1.05 - 1.36]	1.13 [0.90 - 1.42]	1.10 [0.86 - 1.41]	1.06 [0.85 - 1.33]	1.74*** [1.17 - 2.58]	0.85 [0.55 - 1.32]
No. of observations	23,531	24,067	24,009	23,761	23,664	24,079	24,017	24,057	23,997	24,016

<sup>a</sup>Odds ratio adjusted for all of the variables in the model, including the geographical location of the company, the presence of trade union representatives and/or a committee for health, safety, working conditions, and intervention by occupational health and safety officers in the past 12 months.

\* Significant at 10%, \*\* significant at 5%, \*\*\*significant at 1%.