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Short Communication

Potential Work-related Exposure to SARS-CoV-2 by Standard Occupational Grouping Based on Pre-lockdown Working Conditions in France

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ABSTRACT

This study aims to ascertain occupations potentially at greatest risk of exposure to SARS-CoV-2 based on pre-lockdown working conditions in France. We combined two French population-based surveys documenting workplace exposures to infectious agents, face-to-face contact with the public, and working with colleagues just before the pandemic. Then, for each 87-level standard French occupational grouping, we estimated the number and percentage of the French working population reporting these occupational exposure factors, by gender, using survey weights. As much as 40% (11 million) of all workers reported at least two exposure factors. Most of the workers concerned were in the healthcare sector. However, army/police officers, firefighters, hairdressers, teachers, cultural/sports professionals, and some manual workers were also exposed. Women were overrepresented in certain occupations with potentially higher risks of exposure such as home caregivers, childminders, and hairdressers. Our gender-stratified matrix can be used to assign prelockdown work-related exposures to cohorts implemented during the pandemic.

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1. Introduction

The risk of contracting COVID-19 is not uniform across occupations. Work-related exposures to SARS-CoV-2 are greater in certain jobs that are in contact with diseases and infections or working face-to-face with the public and colleagues [1,2], some without appropriate personal protective equipment [3]. These occupational factors are likely to translate into differential disease risk by occupation, as US aggregate data suggests [4].

Quantifying the number of workers potentially exposed to SARS-CoV-2 in the different occupational groups may help understand the work-related mechanisms behind COVID-19 disparities in incidence and mortality among working-age adults. This information is essential for public health risk response and management of COVID-19 and similar infectious disease outbreaks in the workplace. From the Occupational Information Network (O*NET) database, the risk of work-related exposure to SARS-CoV-2 by occupation has been assessed in the USA [2,5] and the UK [1]. In the absence of accurate and detailed real-world data, some COVID-19 job exposure matrices (JEM) were developed, in which occupational hygiene/medicine experts assigned a risk score to each job title. COVID-19-JEM, for example, is the result of an iterative process involving experts from three countries (Denmark, the Netherlands, and the UK) to categorize occupations according to eight workplace factors believed to be associated with COVID-19: four determinants of risk of transmission; number of contacts; nature of contacts (co-workers, general public, or patients with COVID-19); contaminated workspaces and location (indoors or outdoors); two mitigation measures; social distancing and face covering; and two precarious work factors; income insecurity and proportion of migrants [6]. This JEM has been validated by comparing risk scores assigned by the COVID-19-JEM with self-reported data among the Dutch

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workers [7] and by estimating the associations between the COVID-19-JEM risk scores and COVID-19 in the UK [8], Denmark [9], and the Netherlands [7].

In France, a job-exposure matrix, "Mat-O-Covid", was constructed to attribute a probability of direct contact with other persons (colleagues and/or public) and infected patients to the French classification of occupations and socioprofessional categories (PCS2003) based on expert assessments rather than real-world data [10].

Our analysis is based on questionnaire surveys conducted just before the first lockdown in France (before March 16, 2020). Many studies on work-related exposure to SARS-CoV-2 focused on the working conditions of essential workers during the national lockdowns [11]. However, the definition of essential worker groups is highly contextual and time-sensitive, varying from country to country, sometimes even within the same country, and throughout the COVID-19 pandemic [12]. In this study, we aimed to go beyond the notion of essential workers and provide a more systematic description of potential occupational exposure to SARS-CoV-2 and other respiratory infectious diseases under pre-lockdown working conditions. This description could fill the information gap in the early stages of the pandemic, before the implementation of occupational protective measures. Our analyses were stratified by gender to account for the possible task-level differences in similar job categories [13].

2. Materials and methods

We combined two recent cross-sectional surveys conducted by the French Ministry of Labor: the 2019 round of "working conditions" (CT) and the 2017 round of "medical surveillance of occupational risk exposure" (SUMER). Those surveys describe many work-related exposures and characterize their duration, intensity, and eventual change over time [14,15]. Working participants aged 18 to 64 years and living in metropolitan France were included in the study (N = 23,231 for CT and N = 26,297 for SUMER).

We decided to choose CT as the main database because it represents both public and private sector employees and the self-employed, whereas SUMER only includes employees. In addition, there is an overrepresentation of employees from the three levels of the public health service (state, territorial, and hospital) and the private hospital sector, where workers were among the most exposed during the COVID-19 crisis.

Based on the literature and available data, we selected "exposure to infectious agents," "face-to-face contact with the public," and "working with colleagues" as the work-related exposure factors to SARS-CoV-2. We then used the 2009 version of the French Ministry of Labor standard grouping of occupations in 87-level occupational families (FAmilles Professionnelles: FAP) [16] to report the percentage of workers exposed to each exposure factor by FAPs. FAP is a national job classification that groups occupations with similar work-related exposures in a better way because it classifies those that share common skills based on similar occupational activities [16]. We chose the 87-level FAP because there were not enough observations in the more detailed FAP stratum to use the survey weights and stratify by gender. To assign a FAP to each participant, we used the cross-walk table linking FAPs to the standard French classification of occupations and socioprofessional categories (PCS 2003).

To code exposure to infectious agents, we relied on the questions "At your workplace, are you exposed to infectious risks?" in CT and "Are you working in contact with a human reservoir?" in SUMER. Because the question's wording in SUMER was more likely to capture viral exposure and the results obtained were closer to the literature on jobs with high exposure to SARS-CoV-2, we corrected "exposure to infectious agents" in CT based on SUMER. To do so, we recoded their exposures to zero if a participant was coded as exposed in CT but belonged to a FAP with less than 1% of exposed workers in SUMER. For example, more than 10% of agricultural workers, seafarers, fishermen, fish farmers, and skilled construction, concrete, and mining workers reported exposure to infectious agents in CT. In contrast, their exposure to SUMER was less than 1%. We assumed that they were exposed to nonhuman and nonviral infectious agents and re-coded their exposure to zero in the CT database. For the other two work-related exposure factors, we relied on CT. For face-to-face contact with the public, we used two questions: "Are you in direct contact with the public? (users, patients, students, travelers, customers, suppliers, etc.)" and in case they were "Is the contact face-to-face"? For physical contact with colleagues, we used the question, "Do you work alone?". All of the exposure factors were coded as binary variables.

Exposure levels were then constructed to identify the most likely exposed occupations before the first lockdown in France. Participants exposed to at least two SARS-CoV-2 occupational exposure factors were coded as "highly exposed", those exposed to only one exposure factor as "moderately exposed", and those not exposed to any as "not exposed".

We then stratified our matrix by gender and reported a gender-specific exposure prevalence when there were at least 30 observations in a stratum and, if not, a percentage for the two genders combined. The data were weighted to be nationally representative of the workforce in metropolitan France. A detailed description of the sampling and weighting methods used in the CT periodic surveys can be found elsewhere [17]. The analyses were carried out using SAS Studio version 3.6.

3. Results

According to the CT survey, as much as 40% of the working population reported exposure to at least two of the three SARS-CoV-2 occupational exposure factors, representing 11 million workers in metropolitan France. This exposure was greater for women (47%) than for men (34%) (Table 1). When looking at exposure to infectious agents, most at-risk occupations were in the healthcare sector. However, when considering contact with the public and colleagues, other occupational groups such as the army and police officers, firefighters, hairdressers, teachers, culture and sports professionals, and some low-skilled manual workers also had a high proportion of exposed workers (Table 2).

The percentage of the workforce who reported exposure to infectious agents, face-to-face contact with the public, and working with colleagues was 27%, 63%, and 41%, respectively. Women were more likely to be exposed to the first two exposure factors, whereas men reported working with colleagues more often. Women were also overrepresented in some occupations with potentially higher risks of exposure to SARS-CoV-2 such as home caregivers and domestic helpers, childminders, and hairdressers. Within some occupational families, a higher proportion of work-related exposure was reported by women workers (e.g. cleaning agents and teachers). For others, it was the other way around, with a higher proportion of work-related exposure reported by male workers (e.g. caregivers and vegetable growers, gardeners, and wine-growers) (Supplementary Table 1).

4. Discussion

In the French working population, under pre-lockdown working conditions, we observed the highest proportion of exposed workers among healthcare workers and also in some other occupations, such as social workers, hotel/restaurant employees, army/police

Table 1
Distribution of SARS-CoV-2 occupational exposure levels in the working population and the top five occupational families (FAPs) with the highest proportion of workers reporting high exposure level (France, pre-pandemic)

	Weighted N			Highly exposed (%)			Moderately exposed (%)			Not exposed (%)		
	All	Men	Women	All	Men	Women	All	Men	Women	All	Men	Women
All workers	26,180,000	13,490,000	12,690,000	40.3	34.2	46.7	40.9	45.5	35.9	18.5	19.9	17.1
Caregivers	770,54	65,499	705,041	95.9	98.3	95.7	3.9	1.7	4.1	0.2	0.0	0.2
Nurses, midwives	655,616	96,256	559,361	94.5	92.1	94.9	4.7	6.3	4.4	0.9	1.7	0.7
Doctors and related professions	366,912	143,311	223,601	89.6	89.5	89.7	6.8	4.5	8.3	3.6	6.0	2.0
Armies, police officers, firefighters	191,063	158,496	32,567	75.0	77.1	64.6	15.6	16.6	10.9	9.4	6.3	24.5
Hotel and restaurant employees and supervisors	369,53	88,986	280,543	75.0	65.9	77.9	23.3	34.0	20.0	1.7	0.1	2.2

Highly exposed: exposed to at least two COVID-19 occupational exposure factors (exposures to infectious agents, face-to-face contact with the public, and working with colleagues); moderately exposed: exposed to only one exposure factor; Not exposed: not exposed to any exposure factor.

officers, firefighters, hairdressers, and teachers. The gender-stratified analysis showed that women are overrepresented in occupations with potentially greater risks of exposure to SARS-CoV-2 than men. This result is in line with similar works in the United States and the United Kingdom [1,2].

The CT and SUMER surveys are large, well-established national surveys providing generalizable information on the working conditions of the metropolitan French workforce. Based on data collected right before the outbreak and hence prior to lockdown measures that have altered later exposure patterns, our occupational family-exposure matrix can be used to assign a baseline level of work-related exposure to SARS-CoV-2 to the French cohorts implemented in the heart of the pandemic. It may also be used to assess potential workplace exposures to other infectious diseases of respiratory origin. Gender stratification is a key strength of this matrix, as it brings a gender perspective to the assessment of exposure to workplace hazards based on existing data [13].

Starting from the baseline levels we provide, adjustments could be made to reflect the work arrangements made during the lockdown and after, depending on the feasibility of a remote working arrangement [18] and the means of commuting to and from work [19]. Other aspects need to be considered such as the specificities of the healthcare sector, which has better policies and protection against infectious agents [12].

On the other hand, the main limitation of our study lies in the quantification of "working with colleagues". We used "not working alone" as the closest indicator of physical contact with coworkers. However, working alone, in the context of a survey not designed to study SARS-CoV-2 exposures, could imply working autonomously and without collaboration with coworkers rather than having no physical contact with them. Secondly, our matrix is limited by rather broad occupational groupings—the standard 87-level occupational families—which could sometimes group occupations with different levels of exposure in the same category. Thirdly, it is important to note that the three work-related exposure factors examined in our study are not an exhaustive list of occupational exposures to SARS-CoV-2. Some workers not identified as high-risk in our study may in fact be at increased risk of contamination due to other workplace conditions such as poor ventilation, high humidity, and droplet transmission. Meatpacking/food processing workers are one example of this potential underestimation. We were also unable to include nonbinary workers in our analysis due to the binary nature of the only sex/gender question in the CT survey, which asked respondents to select "male" or "female" as their sex, which may have masked some gendered heterogeneity.

Finally, another limitation of this study is that the work-related exposure factors are self-reported. Workers' perceptions of their work could also be socially patterned, and diverse social groups might experience and assess identical jobs differently. For example, immigrants are found to be less likely than other employees to declare certain physical strains, probably in part because they come from a cultural universe where such constraints appear to be "natural", inherent to all work, and not worth reporting [20]. It may also be because, as sociological studies have shown, immigrants often feel bound by a kind of "social hypercorrection" that reduces their propensity to complain about their condition [21]. Self-reported

Table 2
Top five occupational families (FAPs) with the highest proportion of workers reporting the three occupational exposure factors to SARS-CoV-2 (France, pre-pandemic)

Exposure factors	Occupational family	Exposed					
		All		Men		Women	
		N*	%	N*	%	N*	%
Exposure to infectious agents	Nurses, midwives	601,593	91.8	84,416	87.7	517,129	92.5
	Caregivers	689,248	89.5	63,836	97.5	625,442	88.7
	Doctors and related professions	323,213	88.1	125,254	87.4	197,932	88.5
	Home carers and domestic helpers	397,736	69.5	13,852	69.5†	391,011	70.8
	Armies, police officers, firefighters	118,268	61.9	98,775	62.3	19,488	59.8
Face-to-face contact with the public	Hairdressers, beauticians	137,915	100.0	13,800	100.0†	124,116	100.0
	Caregivers	757,287	98.3	64,831	99.0	692,421	98.2
	Teachers	871,708	98.1	309,678	99.0	562,040	97.5
	Nurses, midwives	642,438	98.0	93,705	97.4	548,733	98.1
	Cultural and sports professionals and supervisors	366,938	97.5	125,896	96.6	241,045	98.0
Working with colleagues	Seafarers, fishermen, fish farmers	22,326	90.5	13,455	90.5†	8,871	90.5†
	Low-skilled construction, concrete, and mining workers	161,546	80.8	158,927	81.9	4,810	80.8†
	Low-skilled woodworking and furniture workers	11,462	79.0	10,345	79.0†	1,117	79.0†
	Armies, police officers, firefighters	134,031	70.2	116,938	73.8	17,088	52.5
	Skilled construction, concrete, and mining workers	77,480	69.8	77,185	69.7	206	69.8†

* Weighted N.
† The percentage of exposed workers for the two genders combined, since there were less than 30 observations in the gender-specific stratum.

exposure may also be more common among workers trained in infectious diseases and their transmission such as health care workers, than among other workers such as manual laborers. This differential reporting may be reduced in subsequent waves of CT, SUMER, or similar surveys as a result of COVID-19 awareness campaigns.

Further studies are needed to capture the real-time dynamics of workplace SARS-CoV-2 exposure among different socio-occupational groups throughout the COVID-19 pandemic.

5. Conclusion

Surveillance of work-related exposures and the socio-demographic characteristics of the workers vulnerable to this virus based on a gender perspective is key to implementing an occupation-specific public health response to Covid-19.

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Data statement

The National Archive of Data from Official Statistics (ADISP) provided the data supporting this study's findings for secondary analysis (request numbers 23905 & 25798). Restrictions apply to the availability of these data, which were used under license for this study. Requests for access to anonymized data can be made to: http://www.progedo-adisp.fr/enquetes/XML/lil.php?lil=lil-1459 (accessed on 23 June 2021).

Conflicts of interest

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.shaw.2023.10.012.

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