

COVID-19 AND MUSCULOSKELETAL DISORDERS: A DOUBLE BURDEN OF RISK FOR MIGRANT WORKERS IN EUROPE?

Introduction

The spread of COVID-19 in 2020 was the world's most serious health threat since the so-called Spanish Flu in 1918. With almost all countries affected worldwide, 100 million confirmed cases, more than 2 million deaths and a significant contraction in the global gross domestic product (GDP), the pandemic has brought huge human and economic costs.

As all of us rapidly understood, virus transmission largely occurs in closed environments with reduced spatial distance between individuals (WHO, 2020). Therefore, workplaces, as well as households, schools and other enclosed public spaces, were soon identified as environments in which the contagion could spread rapidly. Sharing transport or accommodation was also identified as a factor that could increase the risk of contagion.

The policy advice followed by many governments was to implement lockdowns affecting selected economic activities in parallel with school closures and the restriction of movement (Ferguson et al., 2020). This early advice was later supported by reports of COVID-19 outbreaks that were registered in workplaces. The European Centre for Disease Prevention and Control (ECDC) studied 1,376 COVID-19 clusters in occupational settings in more than 15 European Union (EU) countries and the United Kingdom (UK) between March and July 2020 (ECDC, 2020). Those working in occupations characterised by physical proximity, especially in indoor settings, reported the highest number of infections. In terms of economic activity, food packaging and processing plants, factories, manufacturing plants and office settings reported high numbers of outbreaks. Recent figures from the UK show that the highest death rates were reported in elementary occupations, process, plant, and machine operation, and caring, leisure and other service occupations (ONS, 2021).

The European Agency for Safety and Health at Work (EU-OSHA) provided guidelines that leveraged this evidence — as well as advice from the World Health Organisation (WHO), the Centers for Disease Control and Prevention (CDC) and the ECDC — to recommend the introduction of collective measures (e.g. the reorganisation of workplaces to reduce contagion) and individual measures (e.g. physical barriers between colleagues or customers and the introduction of personal protective equipment) to protect workers from contagion (EU-OSHA, 2020a). Parallel to that, and beyond preventive interventions such as compulsory facemask wearing and constraints on individual mobility and social interactions, use of telework was one of the most widespread measures adopted at company level.

However, soon after the virus began to spread, empirical evidence started to show that COVID-19 infection risk was not homogeneous across workers, but largely dependent on the characteristics of the job and the workplace, with vulnerable groups being more at risk (Public Health England, 2020; Fasani and Mazza, 2021).

During the peaks of virus circulation, many economic sectors across Europe were (and periodically still are) closed, with the aim of reducing the spread of infection; however, some essential economic activities still needed to be performed, even during shutdown periods. So-called essential workers or frontline workers, such as nurses, doctors, medical researchers, blue-collar workers in key production sectors, drivers and refuse collectors, continued (and continue) to go to their workplaces, even during the periods of rapid spread of the virus, with these workers facing higher infection risks than those who could perform their tasks at home.

In addition to not being able to suspend these types of job or perform them through teleworking, most of them also involve a high degree of social interactions with, and physical proximity to, other people (e.g. co-workers, clients, pupils, patients), thus entailing a higher COVID-19 infection risk than other jobs. This is a feature shared by many low-paid activities in the hospitality sector and low-paid blue-collar jobs that are impossible or very difficult to carry out at home (ECDC, 2020).

Consequently, warnings soon emerged that the COVID-19 crisis would reinforce existing inequalities by hitting already vulnerable individuals harder — with women and poor and migrant populations bearing the brunt of the fallout from the pandemic (Golding and Muggah, 2020).

Globally, migrant workers represent a large share of 'essential workers'. Gelatt (2020) reports that migrants make up 29 % of physicians, 38 % of home health aides and 23 % of retail-store pharmacists, compared with an average share of 17 % for the United States economy. Fasani and Mazza (2021) estimate that, for the EU-14 + UK¹, 38 % of EU migrants and 42 % of migrants from outside the EU are essential workers, compared with 35 % of natives. Moreover, these authors show that in all of the 15 countries analysed (except Greece) migrants tend to be over-represented in essential occupations compared with natives. Migrant workers are also over-represented in jobs in which physical distancing is difficult and in jobs that cannot be performed by teleworking (Borjas and Cassidy 2020; Basso et al., 2020; OECD, 2020; Fasani and Mazza, 2021).

For the above-mentioned reasons, and also because migrants are more likely to live in overcrowded or informal housing, or housing that is unsuitable for quarantine and isolation, concerns about the higher risk of COVID-19 infection and mortality among migrants were raised in the early phases of the pandemic (OECD, 2020).

Migrants' greater vulnerability was later confirmed by observational data (IOM, 2020a). Hayward et al. (2020), through a large meta-analysis, found that *'migrants are at increased risk of infection and are disproportionately represented among COVID-19 cases. Available datasets suggest a similarly disproportionate representation of migrants in reported COVID-19 deaths, as well as increased all-cause mortality in migrants in some countries in 2020. Undocumented migrants, migrant health and care workers, and migrants housed in camps and labour compounds may have been especially affected.'* Proto and Quintana-Domeque (2020) found that male members of ethnic minorities in the UK were experiencing more deterioration in their mental health than white individuals, and Platt and Warwick (2020) observed that most minority groups suffered excess mortality compared with the majority group².

The aim of this article is to quantify and analyse in depth the incidence and distribution of COVID-19 contagion risk among migrant workers as an additional burden on top of the already existing vulnerabilities in the workplace for this group of workers.

Being a migrant worker in Europe is associated with poorer employment and working conditions, especially for those who were born in low-income countries or those known as 'economic migrants' (UNHCR, 2006; Sterud et al., 2018). Migrant workers are often over-represented in so-called 3D jobs — those that are dirty, dangerous and demeaning — namely manual, tiring and dangerous activities often characterised by high intensity and pace. Migrant workers are more likely to work in low-income activities, poor-quality jobs and elementary occupations. They are also more likely to work fewer hours and in more precarious jobs than native workers, and are therefore more likely to experience job insecurity and have difficulty making ends meet (Eurofound, 2019; Mucci et al., 2019).

Specifically with regard to working conditions and health-related risks, recently collected evidence reported by Isusi et al. (2020) has shown that 'compared with native workers, migrant workers are more frequently exposed to physical risk factors and environmental hazards at work, particularly vibrations, painful/awkward positions and the handling of heavy loads. The findings also show that migrant workers are more exposed than native workers to work-related organisational and psychosocial risk factors, including bullying/harassment practices, threats, verbal abuse, discrimination and poorer working conditions'.

The following section provides an estimation of the extent to which the risk of COVID-19 contagion represents an additional burden of health risk for migrant workers. Specifically, with regard to a

¹ EU-14: Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Sweden.

² The uneven effect of the pandemic on migrant workers is not limited to health, but includes many economic aspects as well. Couch et al. (2020) observe disproportionately negative impacts on US unemployment among black (either native or immigrants) and immigrants from Latin America, further widening pre-existing gaps with the native population. Fasani and Mazza (2021) found that extra-EU migrants are exposed to a higher risk of unemployment than natives, and estimate that more than nine million immigrants in the EU-14 + UK area are exposed to a high risk of becoming unemployed because of the pandemic crisis, 1.3 million of whom are facing a very high risk.

previously existing health risk, we will focus on the risk of musculoskeletal disorders (MSDs)³, as these are prominent among the many existing work-related health risk factors and are particularly prevalent among migrant workers compared with natives (Isusi et al., 2020).

The purpose of this article, therefore, is to make available to policy-makers and other interested users empirical evidence about the existence of a **double burden of risk** (i.e. MSD and COVID-19 risks) for migrants in the workplace and to help policy-makers and companies manage occupational safety and health (OSH) needs among migrant workers in the EU.

The article is structured as follows. We first present the methodology used, which follows a task-based approach and combines information from two sources of data, the *Indagine Campionaria sulle Professioni* (ICP) survey and the European Union Labour Force Survey (EU-LFS). The ICP survey provides extremely detailed information on tasks, skills and work content for a whole spectrum of occupations, allowing us to map jobs that are associated with: (i) high COVID-19 exposure risks and (ii) high MSD risks. The EU-LFS dataset allows us to analyse how different worker categories, in particular workers with a migrant background, are distributed in such jobs throughout Europe. The subsequent section reports on the distribution of MSD and COVID-19 risks among migrant workers in Europe, with an in-depth analysis of the COVID-19 exposure risk and an assessment of the presence of a double burden of risk for migrant workers. The last section concludes and provides a review of possible policy responses to address the multifaceted OSH needs of migrant workers in light of the COVID-19 pandemic.

Methodology

The task-based approach

To identify and map jobs (in terms of occupation/sector) that are associated with higher MSD and COVID-19 risks, we followed a task-based approach. According to this approach, to better understand labour market phenomena, the unit of analysis should be the specific activity that workers perform in their job (the tasks) rather than their occupations⁴. The task-based approach uses occupational surveys that describe job content, aspects, skill requirements and organisational characteristics at a very detailed level for occupations. It was first developed in the United States by using the Occupation Information Network (O*NET) database⁵.

This approach is particularly appropriate for our analysis. Workplace health risks, in fact, largely depend on the content and the specific features of the tasks performed by workers in their daily jobs. On the one hand, MSDs are correlated with specific physical aspects of tasks such as working in awkward positions, making repetitive movements, lifting high loads, being exposed to vibrations and so on. On the other hand, COVID-19 risks are also linked to aspects of specific job tasks or characteristics such as those requiring social contact and physical proximity to other people.

To apply this approach in a European context and establish an analytical framework that is able to appropriately reflect the characteristics of the occupations, tasks and work organisation of the European economy, we refer to the Italian occupational survey ICP⁶. The ICP survey is similar to the US O*NET survey, but, as it was carried out in a European context, it better reflects the characteristics of the

³ Work-related musculoskeletal disorders are impairments of bodily structures, such as muscles, joints, tendons, ligaments, nerves, bones and the localised blood circulation system, that are caused or aggravated primarily by work and by the effects of the immediate environment in which work is carried out (EU-OSHA, 2007).

⁴ For instance, starting from the work of Autor et al. (2003), the literature has shown that technological change might affect routine tasks more than non-routine or cognitive ones.

⁵ The O*NET database — https://www.onetonline.org/find/descriptor/browse/Work_Context/4.C.2/ — provides detailed descriptions of the specific work activities associated with each occupation and has been used to identify routine jobs (Frey and Osborne, 2017), teleworkable jobs (Dingel and Neiman, 2020) and also jobs with higher COVID-19 contagion risk (Gamio, 2020).

⁶ The ICP is a survey of occupations conducted by the National Institute for Public Policy Analysis (INAPP) in collaboration with the Italian National Institute of Statistics (ISTAT). It closely follows the structure of the US O*NET database, and thus incorporates very detailed information on tasks, skills, work contexts and organisational characteristics, collected at the five-digit level of occupations (*Codici Professionali*, or CP). The 2012 wave, used in this article, surveyed about 16,000 Italian workers representing sectoral, occupational and geographical heterogeneity. On average, 20 workers for each five-digit occupation were interviewed face to face for about 1 hour, providing a large spectrum with which to measure the content of work across occupations.

European economy. For this reason, it has been used by Sostero et al. (2020) to build indexes of the teleworkability of jobs in Europe.

In this article, we compute from the ICP survey synthetic indicators of job exposure to MSD and COVID-19 risks by using specific features of job tasks, as illustrated in Table 1.

Indexes of MSD and COVID-19 risks

As widely documented, MSDs, understood as impairments of bodily structures, are the most common work-related health problem across Europe, affecting workers in all sectors and occupations (EU-OSHA, 2019).

MSDs can be caused by many different (combinations of) factors and may have many different consequences. According to the framework developed by EU-OSHA, the main determinants of MSDs can be grouped by sociodemographic and individual factors and organisation of work. The latter includes numerous conditions that may increase the risk of workers suffering from MSDs, such as physical factors, organisational factors and psychosocial factors.

While there is comprehensive research available regarding physical risk factors, research on psychosocial and organisational factors, which are related to 'the way the work is designed, organised and managed, as well as to the economic and social context of work' (EU-OSHA, 2007), is more limited, particularly because of the difficulties in defining and measuring these factors⁷. In what follows, we focus primarily on physical risk factors, which are well mapped by the ICP survey.

The risk of COVID-19 exposure at work is a new and emerging work-related health risk that depends on specific task features such as the degree of proximity to other people, on interactions with clients/customers and on exposure to disease in performing one's job (Barbieri et al., 2020). The ICP survey provides us with the elements to build an indicator of risk exposure for COVID-19 risk as well.

Table 1 summarises the components used to build the two indexes. They are features of job tasks that expose workers to the risk of developing an MSD or COVID-19.

Table 1: MSD and COVID-19 risk indicator components

Features of job tasks associated with:	
MSD risk	COVID-19 risk
<ul style="list-style-type: none"> • <i>Vibration</i>: being exposed to vibrations in performing job tasks. • <i>Awkward positions</i>: working in tiring or painful positions. • <i>Heavy loads</i>: requiring worker to apply muscular strength to pull, push, lift or carry heavy loads. • <i>Standing</i>: standing for a long time in performing job tasks. • <i>Bending</i>: kneeling, squatting in performing job tasks. • <i>Repetitions</i>: repeating hand or arm movements. • <i>VDU</i>: working with visual display units. 	<ul style="list-style-type: none"> • <i>Proximity</i>: degree of physical proximity to other people in performing job tasks. • <i>Contact with others</i>: working in direct contact with customers/clients in performing job tasks. • <i>Care</i>: taking care of others in performing job tasks. • <i>Disease exposure</i>: degree of exposure to diseases or illness in performing job tasks.

Source: Authors' elaboration

For each of the 798 five-digit occupations⁸, the features listed in Table 1 are ranked in the ICP survey according to an importance scale ranging from 0 (least intense) to 100 (most intense).

⁷ According to EU-OSHA (2007), psychosocial factors include anxiety, overall fatigue and sleeping problems; job-related stress; heavy mental load; lack of (decision-making) autonomy; lack of support from line managers; lack of support from colleagues; lack of recognition for work done; lack of knowledge of results; sexual or verbal harassment; and discrimination. In addition, organisational factors may also increase the risk of MSDs: working under time pressure; short cycle times (for more than 50 % of the working time); lack of time to recover; inflexibility of procedures and checks; lack of individual/collective leeway; lack of resources to carry out high-quality work; gender-based division of work; lack of control options; and monotonous tasks/lack of variety.

⁸ According to the Italian ISTAT CP 2011 classification.

For analytical clarity and simple reading, and similarly to other studies (Barbieri et al., 2020; Sostero et al., 2020; Quaranta et al., 2021), we chose to build the synthetic indicators for MSD and COVID-19 risks as binary indicators (low/high). In both cases, we set a threshold in the 0- to 100-point scale representing a critical value for dividing an occupation into a different risk group. For MSD risk, we set the threshold at the eighth decile of the distribution for each feature. Therefore, each occupation is classified as having low (or high) MSD risk if any of the seven features listed in Table 1 is below (or above) the eighth decile. Similarly, for COVID-19 risk, the threshold chosen for each job feature is a fixed value of 59, and any occupation is classified as having a low (or high) COVID-19 risk if any of the four features is lower (or higher) than 59. Although the choice of the threshold is an arbitrary decision, the values chosen are able to rather clearly separate occupations with different levels of exposure risk for MSDs and COVID-19 (see the annex for additional details on the operationalisation of the two indexes).

To allow for an international analysis, we need to link this information to the EU-LFS, as in the EU-LFS occupations are recorded at a three-digit level. Thus, we first had to aggregate the occupational classification from the 798 five-digit units into 120⁹ three-digit International Standard Classification of Occupations (ISCO) units, using the official mapping published by the Italian National Institute of Statistics (ISTAT)¹⁰.

With this procedure, we were then able to partition the occupations into four categories according to the level of exposure risk for MSDs and COVID-19. Specifically, we ended up with 85 occupations out of 120 that have a comparatively high MSD exposure risk, and 48 occupations out of 120 that have a comparatively high COVID-19 exposure risk.

By comparing the exposure risks for MSDs and COVID-19⁹, we identify 30 occupations that present higher exposure risks for both COVID-19 and MSDs, while the other occupations display a combination of the two risks. Table 2 illustrates some examples of occupations in each category. Table 10 in the annex reports the full list of occupations for each category of risk.

Table 2: Examples of occupations with low/high levels of MSD and COVID-19 exposure risks

		MSD exposure risk	
		Low	High
COVID-19 exposure risk	Low	Managing directors and chief executives Legal professionals Administrative and specialised secretaries Clerical support workers Handicraft workers	Engineering professionals General office clerks Secretaries Forestry and related workers Building finishers and related trades workers Hotel and office cleaners and helpers
	High	Medical doctors Teachers: primary school, vocational and secondary education Medical and pharmaceutical technicians Client information workers Building and housekeeping supervisors Shop salespersons	Nursing and midwifery associate professionals Waiters and bartenders Street and market salespersons Childcare workers and teachers' aides Personal care workers in health services Food processing and related trades workers Car, van and motorcycle drivers Domestic cleaners and helpers

Source: Authors' calculations based on ICP data

⁹ Armed forces occupations are excluded.

¹⁰ To aggregate from five-digit into three-digit occupations, we weighted each five-digit occupation by its relative share of employment among the three-digit group, based on recent Italian Labour Force Statistics.

Distribution of workers by MSD and COVID-19 exposure risk

Having assessed the methodology for categorising occupations according to their level of MSD and COVID-19 exposure risk, we now measure the share of workers falling into each occupation and thus compute how many workers in EU Member States face different combinations of MSD and COVID-19 exposure risks, and their main characteristics.

In what follows, the analysis refers to 30 countries: the 27 EU Member States (EU-27), with the exception of Malta for data issues, plus the Iceland, Norway, Switzerland and the UK.

On average, the high MSD exposure risk affects about 61 % of workers in these countries, while about 41 % of workers are exposed to the high COVID-19 risk. About 19 % of workers face simultaneously a high risk of MSD and COVID-19 exposure (see Table 3).

Table 3: Proportions of workers with high or low MSD and COVID-19 exposure risk in the EU-27 (excluding Malta), Switzerland, Norway, Iceland and UK

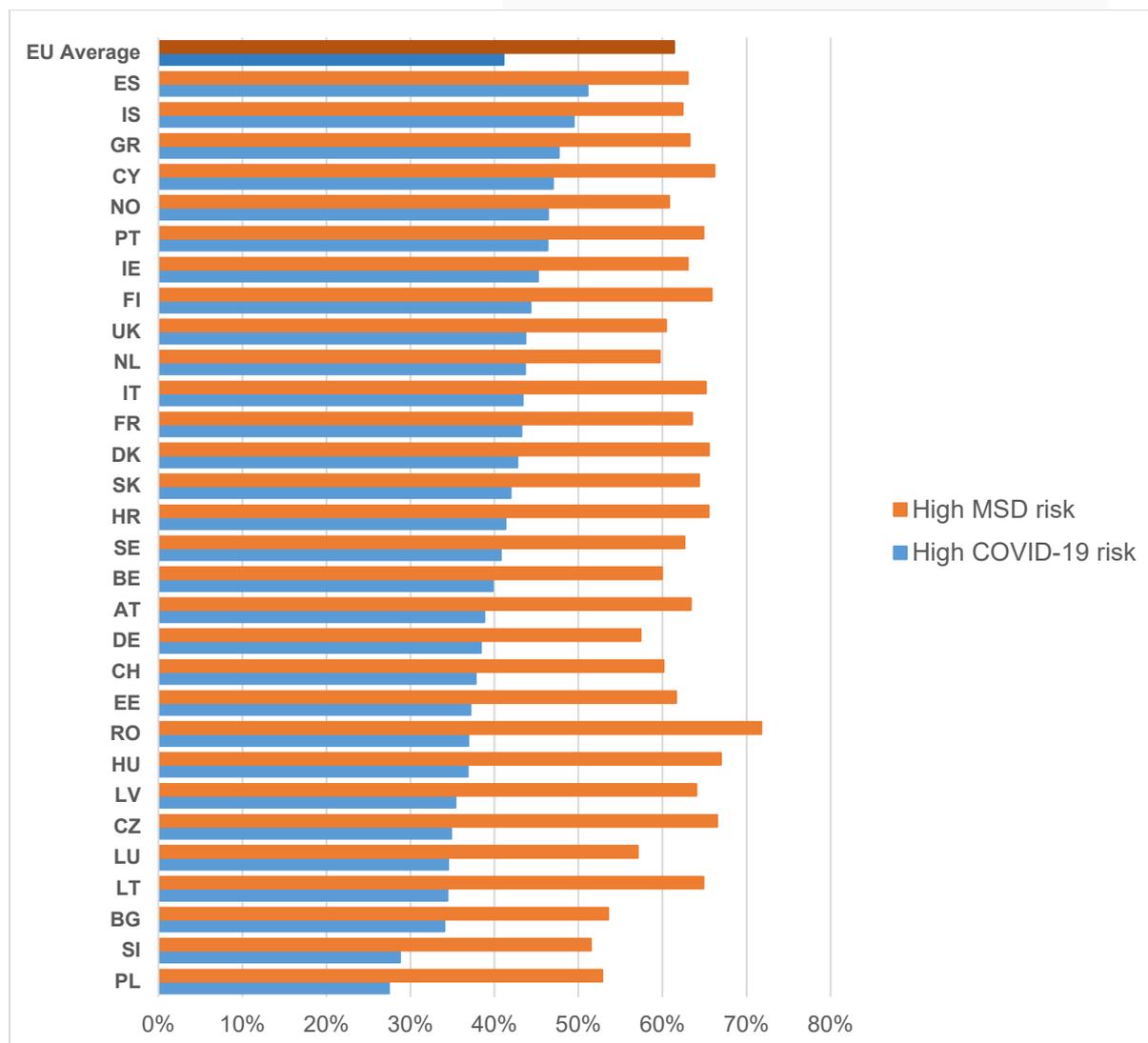
		MSD exposure risk	
		Low	High
COVID-19 exposure risk	Low	16.3 %	42.6 %
	High	22.3 %	18.8 %

Source: Authors' calculations based on ICP and 2019 EU-LFS data

As the occupational structure greatly affects the distribution of workers into different risk categories, there is significant cross-country variability, as highlighted by Figure 1 and Figure 2.

MSD exposure risk is above average in eastern European countries such as Romania, Hungary, Czechia, Latvia and Lithuania, but in some eastern European countries the MSD exposure risk is below average: Poland, Bulgaria and Slovenia. Workers' COVID-19 exposure risk ranges from about 50 % in Spain, Iceland and Greece to about 30 % in Poland and Slovenia.

Figure 1: Proportions of workers in jobs with high MSD and COVID-19 risk by country (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)

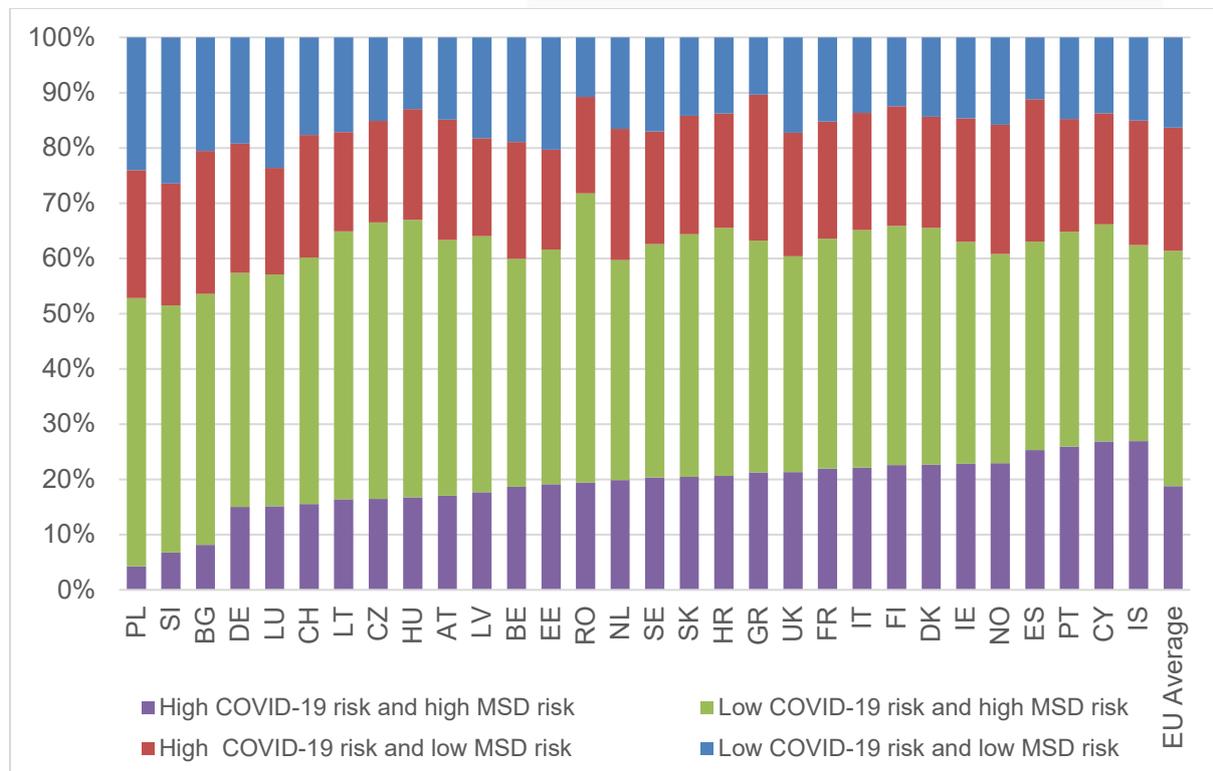


Source: Authors' calculations based on 2019 EU-LFS data

By comparing the two risk dimensions, it is possible to see that in Spain, Portugal, Cyprus and Iceland about one worker out of five (20 %) faces simultaneously high MSD and COVID-19 risks, compared with a European average of less than 19 %. On the other hand, in Poland, Bulgaria and Slovenia, although the proportion of workers exposed to MSD risk is higher than in other countries, the proportion of workers exposed to both MSD and COVID-19 risks is below average (respectively 4.3 %, 6.7 % and 8.1 %).

The explanation for this cross-country variability lies mainly in each country's industry specialisation and the relevance of specific sectors and occupations in each country.

Figure 2: Proportions of workers with high or low MSD and COVID-19 exposure risk by country (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)



Source: Authors' calculations based on 2019 EU-LFS data

Table 4 shows, for some job and sociodemographic characteristics, workers with high MSD and COVID-19 exposure risks — considered separately — as a proportion of the total number of workers in employment in each category.

Concerning the MSD risk, the results are similar to those already found in the literature, confirming the validity of the methodological approach followed here: the exposure to MSD risk is higher for men and younger workers than other groups of workers. The sectors most exposed to MSD risks are agriculture and construction, while MSD exposure risk decreases as workers' skill level increases¹¹.

Moving to COVID-19 risk, Table 4 shows that the workers who face higher exposure risk are mainly female, young and semi-skilled workers, while the higher percentage of risky jobs is found in two economic macro-sectors, that is public services (including education, human health and social work activities) and trade, transport, accommodation and food service activities¹².

¹¹ Following ILO (2012), we define skilled labour ISCO-08 major groups 1, 2 and 3; semi-skilled labour ISCO-08 major groups 4, 5, 6, 7 and 8; and unskilled labour ISCO-08 major group 9.

¹² For the sake of simplicity, economic sectors in Table 4 are aggregated according to Eurostat A*10 industry breakdowns.

Table 4: Proportions of workers in jobs with high MSD and COVID-19 exposure risks by worker characteristic and sector (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)

Worker characteristics	Proportion of workers with high MSD exposure risk	Proportion of workers with high COVID-19 exposure risk
All	61.4 %	41.1 %
Female	54.4 %	55.2 %
Male	67.3 %	32.6 %
Age 15-19	73.0 %	58.5 %
Age 20-29	63.5 %	46.7 %
Age 30-39	60.4 %	41.7 %
Age 40-49	60.5 %	41.3 %
Age 50-59	61.3 %	41.9 %
Age 60+	60.1 %	42.8 %
A — Agriculture, forestry and fishing	96.6 %	4.5 %
B-E — Industry (except construction)	71.8 %	15.5 %
F — Construction	83.1 %	32.5 %
G-I — Wholesale and retail trade, transport, accommodation and food service activities	57.2 %	54.8 %
J — Information and communication	78.6 %	9.8 %
K — Financial and insurance activities	58.3 %	18.1 %
L — Real estate activities	36.7 %	23.0 %
M-N — Professional, scientific and technical activities; administrative and support service activities	62.4 %	20.6 %
O-Q — Public administration, defence, education, human health and social work activities	43.9 %	72.0 %
R-U — Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organisations and bodies	69.0 %	61.9 %
Skilled labour	42.2 %	39.3 %
Semi-skilled labour	71.4 %	48.1 %
Unskilled labour	100.0 %	32.2 %

Source: Authors' calculations based on 2019 EU-LFS data

Assessment of MSD and COVID-19 risks among migrant workers in Europe

According to 2019 Eurostat European Union Labour Force Survey data, there were 45,579,000 workers in the EU-27 plus the UK aged 15-64 who were born in a different country from the one where they currently reside, representing 14 % of the total population of these countries aged 15-64. Of those people, more than 30 million were born outside the EU (9.4 %) and 15 million were born in a different Member State (4.5 %). The largest non-national workforce was found in Germany (10,904,298 persons, equal to 20.4 %); the UK (7,627,826 persons, equal to 18.1 %); France (5,544,429 persons, equal to 13.6 %); Spain (5,503,477 persons, equal to 17.8 %) and Italy (5,352,746 persons, equal to 13.9 %). The employed non-national workforce accounted for 30,478,157 workers, equal to 13.5 % of workers in the EU-27 plus the UK.

Definition of migrant workers for the purposes of this study

Migrant workers are defined based on their country of birth. We define native workers as those workers who were born in their current country of residence, whereas migrant workers are those who were born abroad. For some of the research, we also further distinguish between extra-EU migrants, i.e. those born outside the EU, and EU migrants, i.e. those were born in a Member State other than the one where they currently reside.

As reported in the introduction, previous studies have already highlighted the fact that migrant workers are particularly vulnerable in the labour market in many ways. Specifically, with regard to MSD exposure risk, Isusi et al. (2020) show that migrant workers report a higher prevalence of MSDs than native workers, as they are more frequently exposed to physical risk factors and environmental hazards at work, such as exposure to vibrations, painful positions and carrying heavy loads.

Our analysis confirms that migrant workers are particularly vulnerable with respect to MSD exposure risk. It also shows that being a migrant increases significantly the COVID-19 exposure risk. In fact, migrant workers, particularly extra-EU migrants, are at higher risk of exposure risk to both MSDs and COVID-19 (Table 5). Extra-EU migrants display a more than 12 percentage point higher MSD exposure risk and a 7 percentage point higher COVID-19 exposure risk than natives. EU migrants lie between these two extremes.

Table 5: Proportions of workers in jobs with higher MSD and COVID-19 exposure risks by origin (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)

Worker origin	Workers with high MSD exposure risk	Workers with high COVID-19 exposure risk
Native	59.8 %	42.2 %
EU migrant	69.8 %	43.1 %
Extra-EU migrant	72.2 %	49.3 %

Source: Authors' calculations based on 2019 EU-LFS data

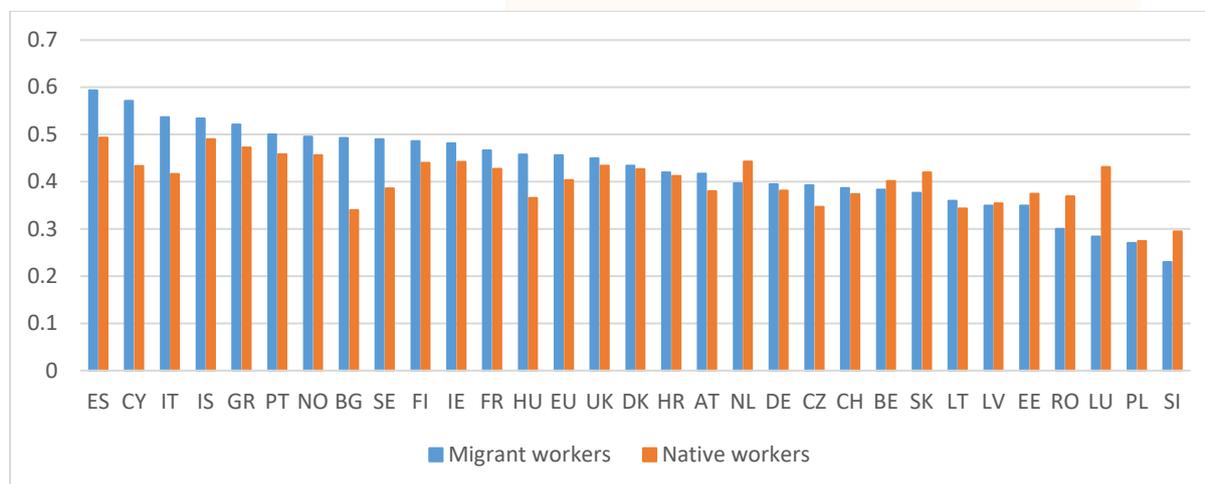
COVID-19 exposure risk among native and migrant workers

As less literature is available on the native-migrant exposure differential and COVID-19 risks, in this section we give further details on the increased exposure of migrants to this new work-related health risk and on how it is distributed among the migrant workforce, with respect to the native one.

As displayed in Figure 3, in most European countries, the proportion of migrant workers in jobs with elevated risk of exposure to COVID-19 is higher than the proportion of native workers in jobs with the

same exposure risk. There are a few exceptions: in 7 out of 30 countries, native workers face a higher COVID-19 exposure risk than migrant workers, and in three countries the proportions are almost equal (Switzerland, Latvia and Poland). We explain these cross-country variations by differences in industry structure and in migrant workers' concentration in different sectors and occupations across countries.

Figure 3: Proportions of workers in jobs with high COVID-19 risk by origin and country (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)



Source: Authors' calculations based on 2019 EU-LFS data

For both native and migrant workers, female workers face the highest risk of COVID-19 exposure (Table 6). However, because of the strong presence in Europe of male migrant workers in low-skilled jobs in the trade, transport and service sectors — which are also sectors that have a high COVID-19 exposure risk — the gap in exposure between migrant and native workers is larger among male workers than female workers. In fact, the proportion of male migrants employed in jobs associated with a high COVID-19 exposure risk is 7 percentage points higher than the proportion of male native workers (39 % versus 32 %), and this gap increases to 10 percentage points when considering extra-EU migrants. The gap between migrant and native female workers in jobs associated with a high COVID-19 exposure risk is only about 2 percentage points, and is negative when considering female EU migrant workers (-2 percentage points); however, the gap is 5 percentage points when comparing female native and extra-EU migrant workers.

Table 6: Proportions of workers in jobs with high COVID-19 exposure risk by origin and gender (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)

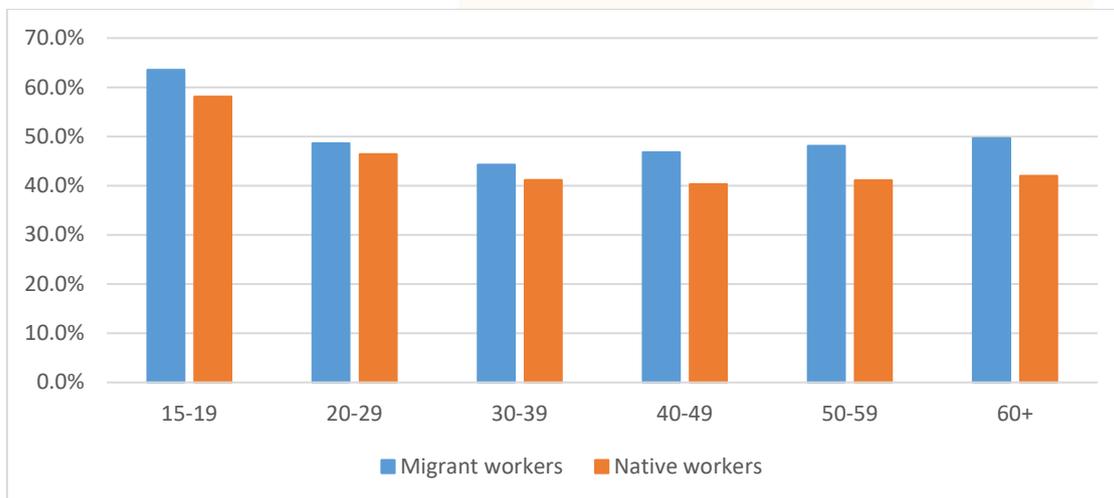
Workers' origin	Female	Male
Native workers	54.9 %	31.5 %
Migrant workers:	56.8 %	38.9 %
EU migrants	52.7 %	34.5 %
Extra-EU migrants	59.5 %	41.4 %

Source: Authors' calculations based on 2019 EU-LFS data

Table 4 shows that the prevalence of COVID-19 exposure risk declines quite significantly as the age of the worker increases, reaching a minimum for the 40-49 age group, and then increases, but at a slower pace. Distinguishing between native and migrant workers (Figure 4), we can see that for the latter group the U-shape is more pronounced and the minimum prevalence is reached earlier, in the 30-39 age group. In addition, the native-migrant risk gap increases with age.

These results are most probably connected with the concentration of migrant workers of all age groups in specific job typologies that entail a higher COVID-19 infection risk, while for native workers the presence in jobs associated with a high COVID-19 exposure risk is particularly diffuse among younger workers.

Figure 4: Proportions of workers in jobs with high COVID-19 exposure risk by origin and age group (EU-27 (excluding Malta), Switzerland, Norway, Iceland and UK)



Source: Authors' calculations based on 2019 EU-LFS data

Considering workers' skill level¹³, for both native and migrant workers, a higher exposure risk is found among the semi-skilled workforce, including workers in both the low-skilled non-manual category (such as clerks and sales workers) and skilled manual workers. This is also the skill category in which the migrant-native risk gap is highest (Figure 5). The COVID-19 exposure risk is similar for native and migrant workers in the skilled labour category — which includes highly skilled non-manual workers such as professionals and technicians; however, a significant gap, with migrant workers being more likely to be at high risk, is found in the low-skilled category, involving low-educated workers employed in elementary occupations.

Figure 5: Proportions of workers in jobs with high COVID-19 exposure risk by origin and skill level (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)



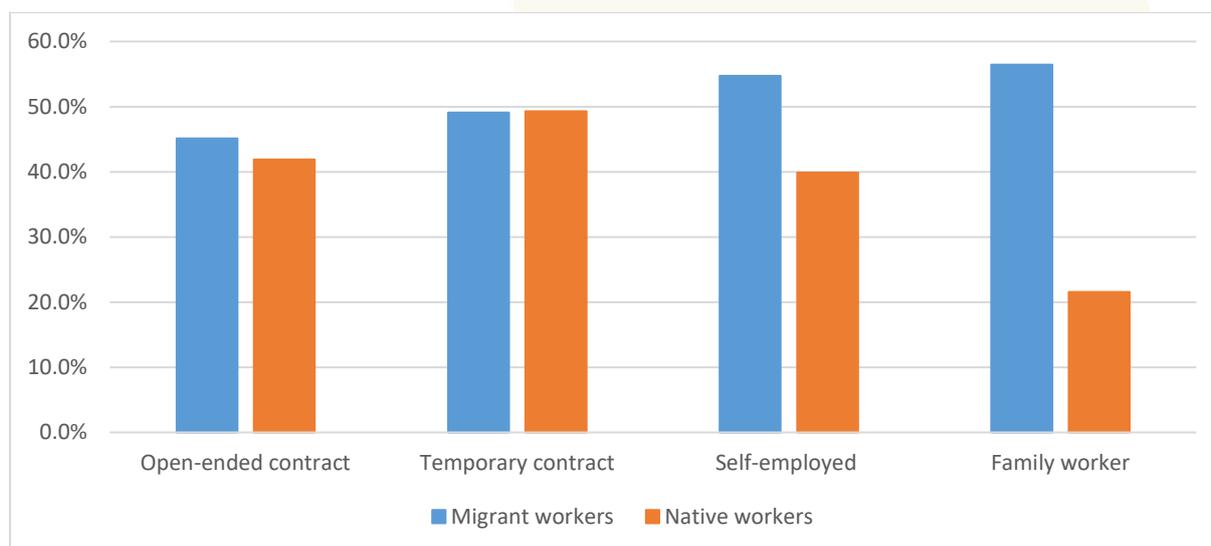
Source: Authors' calculations based on 2019 EU-LFS data

¹³ See footnote 11. We define skilled labour ISCO-08 major groups 1, 2 and 3; semi-skilled labour ISCO-08 major groups 4, 5, 6, 7 and 8; and unskilled labour ISCO-08 major group 9.

Looking at the contract type as a measure of employment conditions, we find that larger gaps between migrant and native workers are found among the self-employed (with and without employees) and family workers, among whom more than half of migrant workers are employed in jobs with high COVID-19 exposure risk. A possible explanation for these findings is that a larger proportion of self-employed and family migrant workers are employed in the hospitality and trade sectors, which have a comparatively high COVID-19 exposure risk. For instance, 10 % of self-employed and family migrant workers are employed in accommodation and food service activities, compared with 4.7 % of native workers employed in these activities.

Interestingly, the proportions of native and migrant workers holding a temporary contract and working in jobs with high COVID-19 exposure risk are similar (Figure 6), further confirming the fact that COVID-19 mostly poses a risk to the already vulnerable groups of workers, such as precarious workers.

Figure 6: Proportions of workers in jobs with high COVID-19 exposure risk by origin and type of contract of employment (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)



Source: Authors' calculations based on 2019 EU-LFS data

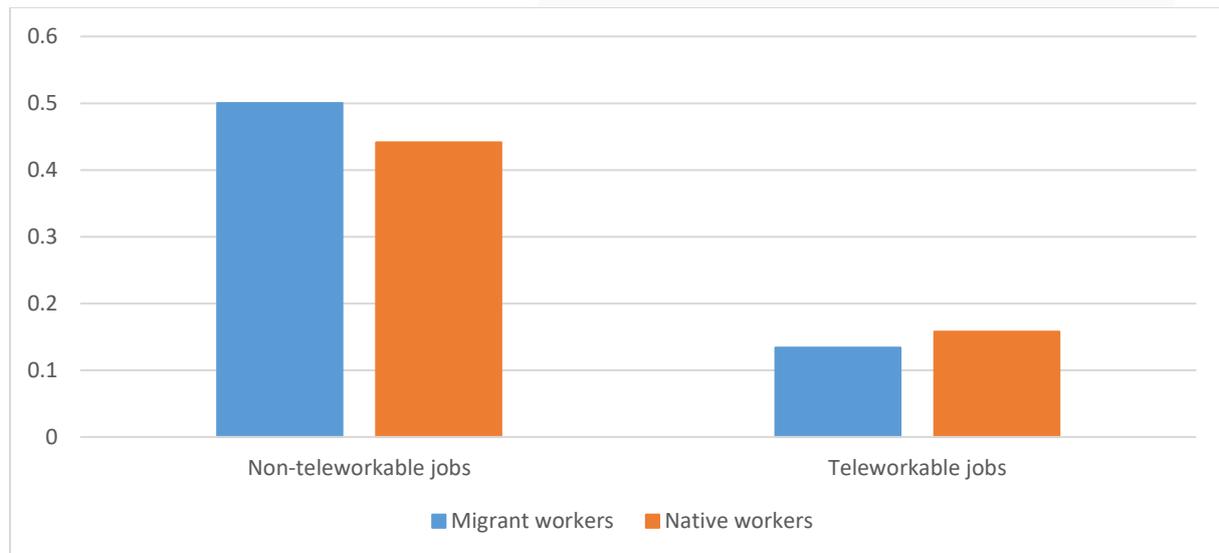
Since the outbreak of the COVID-19 pandemic, working from home has become the most widespread solution for preserving jobs and production and minimising the infection risk. However, the nature of many occupations makes it difficult if not impossible to perform them in places other than the usual workplace. Crucially, this is the case for many activities involving direct contact with the public, which also put workers at higher risk of exposure to the virus.

Adopting the definition of 'teleworkability' used by Sostero et al. (2020)¹⁴, in Figure 7 we plot the proportions of workers in jobs with high exposure risk separately from those employed in jobs that cannot be performed at home (non-teleworkable jobs) and those that are employed in fully or partially teleworkable jobs. Note that the two types of job, jobs with high COVID-19 exposure risk and teleworkable jobs, are not mutually exclusive, as the latter identifies a conceptual category of jobs that can be performed at home and that, when performed at home, are associated with a lower exposure risk. The COVID-19 exposure risk index, instead, identifies those jobs that, when performed under ordinary circumstances, are associated with a higher risk of COVID-19 infection.

The proportion of migrant workers is higher than the proportion of native workers in jobs with a high COVID-19 exposure risk that cannot be performed at home, while the proportion of migrant workers in teleworkable jobs is lower. Again, the higher level of vulnerability of migrant workers emerges in this respect.

¹⁴ Sostero et al. (2020) provide values, ranging from 0 to 1, of the index of technical teleworkability for the 120 three-digit ISCO-08 occupations. We consider the occupations with index value equal to 1 teleworkable, and occupations with index value below 1 not teleworkable.

Figure 7: Proportion of workers in jobs with high COVID-19 exposure risk by origin and job teleworkability (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)



Source: Authors' calculations based on 2019 EU-LFS data

Migrant workers and the double burden of risk

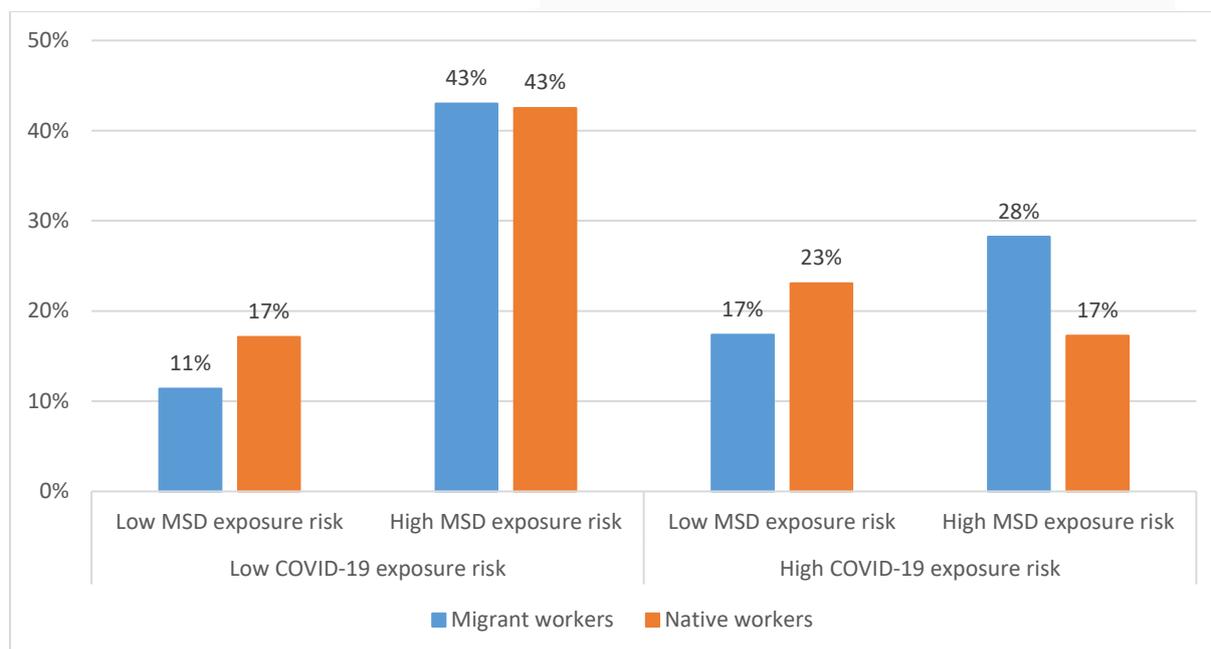
As the last step of our analysis, we report in Figure 8 the distribution of native and migrant workers in jobs characterised by different combinations of MSD and COVID-19 exposure risks.

Focusing on the most worrying category, namely the category represented by jobs associated with both a high MSD and a high COVID-19 exposure risk, we find that migrant workers are over-represented with respect to native workers. More than one out of four migrant workers is employed in jobs with this 'double burden of risk', whereas less than one out of six native workers is employed in such jobs (28 % compared with 17 %).

Conversely, migrant workers are under-represented in the most favourable category of jobs that have low exposure risks in terms of both MSDs and COVID-19. In this case, 11 % of migrant workers are employed in these jobs compared with 17 % of native workers. No differences are found in the 'low COVID-19, high MSD' exposure risk category, which is also the category employing the largest proportion of native and migrant workers; a gap against natives is found in jobs displaying low MSD and high COVID-19 exposure risks.

Interestingly, the largest migrant-native gap is found in the worst situation, i.e. in jobs with high exposure risks for both dimensions. The proportion of native workers employed in these jobs is 11 percentage points lower than the proportion of migrant workers employed in these jobs (17 % native versus 28 % migrant workers).

Figure 8: Proportions of workers in jobs with high and low COVID-19 and MSD exposure risks by origin (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)



Source: Authors' calculations based on 2019 EU-LFS data

Further distinguishing by country of origin, Table 7 shows that the most at risk are the extra-EU migrant workers. Nearly one out of three migrant workers from non-EU countries is employed in a job associated with a high MSD exposure risk and a high COVID-19 exposure risk.

Table 7: Proportions of workers in jobs with high COVID-19 and MSD exposure risk by origin (EU-27 (excluding Malta), Switzerland, Norway, Iceland and the UK)

Worker origin	Workers with high COVID-19 and MSD exposure risks
Native workers	17.3 %
EU migrant workers	24.6 %
Extra-EU migrant workers	30.5 %

Source: Authors' calculations based on 2019 EU-LFS data

Studies have already recognised migrant workers as one of the most vulnerable groups in Europe: they are frequently employed in low-paid, precarious jobs; often work longer or unsocial working hours; and often work in unsafe working conditions with little OSH training. Because of the jobs in which they are often segregated and the sectors in which they are most frequently employed, COVID-19 adds to the already existing serious health risks experienced by migrant workers in Europe. Our results confirm preliminary evidence that the pandemic is reinforcing existing inequalities, hitting one of the most vulnerable groups in the labour market even harder.

Furthermore, additional aspects of migrant workers' lives contribute to their vulnerability to the virus. Their higher exposure to COVID-19 risk is, in fact, not confined to the employment domain, but is also related many other domains, among which overcrowded accommodation is undoubtedly one of the most important in terms of amplifying the health impacts of the pandemic. The following box presents some evidence on this issue.

BOX — COVID-19 risk beyond the workplace: housing conditions among migrant and native workers

Work environments are the source of many of the direct social interactions that make up an employed person's daily life. As shown above, COVID-19 infection risk depends on job-specific characteristics, including physical proximity to other workers and how intense and frequent social interactions are in the workplace. Nevertheless, workplaces are not the only shared environment in everyday life. Indeed, housing is another important aspect of personal living arrangements that can affect exposure to infectious diseases. In addition to the workplace and job characteristics analysed in above, poor housing conditions such as overcrowding and high density are other important determinants of COVID-19 exposure risk.

Using 2018 data from the Eurostat European Survey on Income and Living Conditions (SILC), in this box we provide evidence that migrant workers' living arrangements¹⁵ also contribute to their vulnerability with regard to COVID-19 infection risk.

First, large households (measured as the number of members living in the same house) are more common among migrant workers. In fact, a lower proportion of migrant workers live in individual households than native workers (13.8 % compared with 14.2 %), while a higher proportion of migrant workers live in households with five or more members (13.6 % compared with 10.2 %).

Although it can give an approximation of the likelihood of within-household COVID-19 transmission, the household dimension is not a sufficient indicator of the housing situation in terms of the possibility for self-isolating and reducing the spread of the virus when someone becomes infected.

EU-SILC data provide a computed variable on overcrowding¹⁶ that suits our analytical purposes. We find that in Europe 13.3 % of the employed population (a little less than 30 million European workers) live in an overcrowded household. Prevalence is higher among migrant workers, 18.2 % of which live in an overcrowded household (around 5 million persons). Migrants represent more than 11 % of all workers, but represent 16 % of workers affected by overcrowding.

Finally, the composition of households also differs greatly between natives and migrants in Europe. The prevalence of families with at least one child is larger among migrants (48 %) than among native families (40.9 %).

Table 8: Indicators of overcrowded living arrangements for workers by origin

	Migrant workers	Native workers
Individual households	13.8 %	14.2 %
Households with five or more members	13.6 %	10.2 %
Overcrowded households (Eurostat definition)	18.2 %	12.6 %
Households with at least one child	48.0 %	40.9 %

Source: Authors' calculations based on EU-SILC 2018 cross-section microdata, November 2020 release

¹⁵ We focus on the living arrangements of the employed population, to address the same population as the rest of the analysis. We use the 2018 cross-sectional microdata, as data on 2019 are not available for all the countries in the November 2020 release. We exclude Serbia (RS) from the analysis for consistency with the countries available in the EU-LFS. We identify employed individuals by means of the variable called 'activity status' (PX050), which assigns the prevailing labour market status observed in the income reference period for each surveyed person. We classify the individuals as native or immigrant based on the country of birth (PB210).

¹⁶ Eurostat (2017) defines a 'person as living in an overcrowded household if the household does not have at its disposal a minimum number of rooms equal to: one room for the household; one room per couple in the household; one room for each single person aged 18 or more; one room per pair of single people of the same gender between 12 and 17 years of age; one room for each single person between 12 and 17 years of age and not included in the previous category; one room per pair of children under 12 years of age'.

These three factors — the household dimension, overcrowding and household diversity — may contribute to a higher risk of contagion for migrant workers in Europe, adding to the already observed higher exposure to COVID-19 on the job.

Conclusions and policy recommendations

The main findings in this discussion paper show that, with equal occupational characteristics, prevalence of high COVID-19 exposure risk is higher among migrant workers than among native workers. The largest gaps by migratory status were found in older workers (age ≥ 40), semi- or unskilled, family or self-employed workers, and for the combination of high COVID-19 and MSD exposure risks. These results are in line with, and further strengthen, available studies showing that the COVID-19 pandemic is likely to have a disproportionate effect on the health, economic and social outcomes for the migrant population.

Evidence suggests that poor working conditions, precarious employment, seasonal work, possibly with informal arrangements and involving debts to employers, have a negative impact on the health status and quality of life of migrant workers, increasing the risk of negative outcomes including serious illness and death (WHO 2015).

In addition, migrants are exposed to higher levels of many risk factors and vulnerabilities relevant to COVID-19, including increased exposure to the virus due to high-risk occupations and overcrowded accommodation. The present analysis highlights how the characteristics of the jobs mostly performed by migrants in Europe, jobs requiring high levels of physical proximity with other workers, clients or patients, expose them to a higher COVID-19 infection risk than native workers. Sub-groups such as extra-EU migrants, women migrants and low-skilled workers are those with the highest COVID-19 exposure risk, which adds to pre-existing vulnerabilities and inequalities, also because migrant workers are more likely to continue to work while ill, for fear of losing their job, or not getting paid, worsening and prolonging infections. Higher vulnerability of migrants translates into higher prevalence of serious illness and death for this specific group of workers, as suggested by ONS data showing increased risk of death for elementary occupations and workers from minority ethnic groups (ONS, 2021).

Moreover, these factors combine with poorer access to healthcare services and to health information because of language barriers, and with a reduced entitlement to healthcare coverage related to their immigration status. Migrant workers are also more likely to live in overcrowded households, with a larger number of members, including children. The combination of these factors puts migrant families at an even higher risk and makes it more difficult to implement effective quarantine measures for selected members of the household if needed.

We have also provided evidence that the COVID-19 pandemic is likely to exacerbate other existing vulnerabilities with regard to migrant workers' health-related risks and, specifically, MSD risks.

Based on our analysis, we estimate that approximately 9,200,000 migrant workers in 30 European countries are at very high risk of both COVID-19 and MSD exposure, 60 % of whom are extra-EU migrants. Thus, about one out of three extra-EU migrants and one out of four EU migrants are employed in jobs with double the exposure risk, compared with one out of six native workers in such jobs.

According to the Organisation for Economic Co-operation and Development (OECD, 2020), in many EU countries 'migrants have paid a higher toll with respect to the incidence of COVID-19, with higher infection risk and higher mortality, despite having a younger age on average'. In view of the current COVID-19 pandemic that is still affecting Europe, it is important to implement policy responses to mitigate its health and employment impact on migrants. According to WHO (2015) if relevant policies do not exist or are ineffective migrants' health can deteriorate rapidly.

However, considering the negative effect of COVID-19 alone on workers' health may not be appropriate or sufficient. As already pointed out, in fact, to better understand the complex exposure and health risks and improve safety and health risk management overall, a cumulative risk assessment (CRA) framework appears to be more appropriate (Alahmad et al., 2020). This framework recognises that exposure to a single chemical or non-chemical stressor rarely occurs in isolation (Fox et al., 2018). In light of the above results, the CRA framework appears to be particularly relevant for an occupational exposure to a contagion such as COVID-19, which does not occur from other stressors, especially in the migrant population.

With the persistence of the COVID-19 pandemic, employers and authorities should prioritise addressing the job and health needs of migrant workers for whom the COVID-19 exposure risk adds to the existing serious health risks they experience. However, no single intervention can solve all of the problems outlined; rather, a set of interventions that address all domains is in order. We briefly highlight some of them below¹⁷.

Migrants' occupational health and safety. Although migrants may be healthier than their receiving community (the so-called 'healthy worker effect — HWE'), being employed in jobs with poor working conditions (dirty, dangerous and demeaning jobs) in most European countries adversely affects their workplace safety and health. According to Simon et al. (2015), migrant workers' health status is affected by poor working conditions, high exposure to occupational risk (dangerous jobs, insufficient safety training), lower salaries, limited legal rights and limited access to healthcare services. The risk of work-related injuries is higher among labour migrants than in the non-migrant population, and the most common work-related health problems reported among labour migrants include musculoskeletal, respiratory and mental health problems. In the absence of specific measures implemented for the migrant workforce, the current COVID-19 pandemic may further exacerbate their vulnerability. It is important that employers, when putting in place measures to eliminate or minimise worker exposure to COVID-19, take into account the specificity of the migrant workforce, in particular the existence of language barriers. Poor language knowledge may in fact negatively affect the enforcement of both collective and individual measures and their ability to take preventive measures against COVID-19. For instance, most of the suggested measures developed at national or international level¹⁸ could not easily be followed by the migrant population if they were not also available in their own language. Furthermore, the suggested measure of limiting physical interaction with customers through remote orders (online or phone) could not be implemented by workers with a low level of language knowledge. Therefore, employers should make all possible efforts to remove existing language barriers to ensure full healthcare and safety access for workers speaking different languages. In addition, and in view of the availability of COVID-19 vaccines, according to WHO's Strategic Advisory Group of Experts' suggestions, governments should prioritise low-income migrant workers, irregular migrants and those unable to physically distance, including those living in camps and camp-like settings, for the allocation of the COVID-19 vaccination (WHO, 2021).

Communication. To limit the spread of the virus, employers (and governments) need to provide migrants with timely and accurate information on the pandemic and the spreading of the virus. It is particularly important that migrants can access communications on COVID-19, including locally available health measures and medical services, in their own language. The OECD (2020) lists some examples of information campaigns targeting the migrant population through multilingual websites and other online platforms and tools.

Economic and employment support measures. Migrant workers are particularly vulnerable in the labour market: their contracts, often temporary, offer a lower level of social protection than that available to native workers (Fasani and Mazza, 2021; Quaranta et al., 2021); they earn lower wages than native workers; and they are less likely to be able to carry out their activities from home during the pandemic (Sostero et al., 2020). The effect of these (and eventually other) combined vulnerabilities means that migrant workers are exposed to a high level of income risk because of the COVID-19 economic crisis, as they risk losing their jobs and being unable to rely on personal savings. The United Nations estimates that nearly 30 % of the workforce in sectors highly affected by job losses resulting from the crisis in OECD countries is foreign born (UN, 2020). It is therefore extremely important to ensure that economic support measures reach migrant workers, both by widening migrants' access to existing welfare programmes and creating new schemes that specifically target foreign workers (Moroz et al., 2020¹⁹).

Housing conditions. As documented in this paper, migrants tend to be over-represented in crowded living environments, affecting the implementation of preventive measures such as social distancing. It should be ensured that housing conditions respect sanitary norms, particularly in the case of migrants in collective housing, such as asylum seekers, seasonal workers and workers in migrant labour camps

¹⁷ An interesting list of examples of reforms, new initiatives and campaigns from across the world on migrants' contributions to the COVID-19 response, in health care and beyond, is provided by the Overseas Development Institute (ODI) (<https://www.odi.org/>).

¹⁸ See for instance EU-OSHA's COVID-19 resources for the workplace: <https://osha.europa.eu/en/themes/covid-19-resources-workplace>

¹⁹ A list of interventions implemented in various countries is also presented in this report.

(OECD, 2020; IOM, 2020b). Housing conditions are particularly relevant in the context of COVID-19 prevention, as one of the measures widely suggested is the shift to telework. Remote work, if not prevented by the content of the activity itself, could be difficult if not impossible to carry out by migrants with unsuitable housing arrangements.

Anti-discrimination measures. The COVID-19 pandemic risks increasing discrimination against migrants through fake news, misinformation and politicisation of issues, all of which tend to be pervasive in times of uncertainty and anxiety (IOM, 2020a). In addition, although migrant workers have proven to be essential in keeping European economies running (Fasani and Mazza, 2021), there is the risk that the economic impact of the COVID-19 crisis will exacerbate exclusion and inequalities in the labour market, affecting the most vulnerable, including workers with a migrant background.

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Annex — Details on the procedure used to compute COVID-19 and MSD exposure risks

As described above, the indexes for the COVID-19 and the MSD exposure risks are based on the *Indagine Campionaria sulle Professioni*, an Italian occupation survey that closely follows the structure of the US O*Net survey. We used the detailed information on tasks in this survey to classify fine-grained occupations (over 750 five-digit occupations in the Italian professional classification) as exposed to COVID-19 and MSDs or not, based on the level reported by the variables described in Table 1.

To allow for an international analysis, we needed to link this information to the EU-LFS. As occupations are recorded at a three-digit level in the EU-LFS, we first had to aggregate the occupational classification from the 798 five-digit units into 119²⁰ three-digit ISCO units, using the official mapping published by ISTAT. To aggregate from five-digit into three-digit occupations, we weighted each three-digit group by its relative share of employment in each five-digit occupation, according to recent Italian Labour Force Statistics.

For each three-digit occupation, to build a dichotomic indicator (low/high) for both the MSD and COVID-19 exposure risk, we proceeded as follows. For MSD exposure risk we plotted the distribution of the seven components listed in Table 1, obtaining the values reported in Table 9. As shown in the table, the distribution of values across the seven job aspects is quite widespread and varied, making it difficult to find a single threshold that is meaningful for all of them. Therefore, we opted for setting the threshold at the eighth decile of the distribution for each item, which is a critical value for dividing occupations into two different risk groups.

Thus, with this procedure, we ended up classifying all 120 three-digit ISCO occupations into two categories: (i) those with higher MSD exposure risk if any of the seven job components is over the eighth decile threshold; and (ii) those with lower MSD exposure risk, i.e. the remaining occupations.

Table 9: Distribution of the ICP variables used to characterise MSD exposure risk

ICP variables to identify MSDs	1st Decile	Mean	Median	8th Decile	9th Decile	Std Dev
Being exposed to vibrations in performing job tasks	0.0	7.6	0.6	7.6	29.6	155.9
Working in tiring or painful positions	2.8	34.3	33.5	59.9	72.4	255.5
Requiring worker to apply muscular strength to pull, push, lift or carry heavy loads	1.3	28.7	22.9	47.5	66.9	241.3
Standing for long periods	13.4	48.6	49.7	79.3	82.2	272.6
Kneeling, squatting	2.0	29.4	25.5	48.0	65.0	246.4
Repetitive hand or arm movements	12.5	44.1	44.7	67.7	74.9	220.2
Working with visual display units (VDUs)	11.2	43.1	44.2	68.0	73.3	248.2

Source: Authors' calculations based on ICP data

For the COVID-19 exposure risk, we were able to classify occupations based on a single threshold. In particular, for each three-digit occupation, whenever any indicator of the four components presented in Table 1 was higher than a threshold of 59, we classified the corresponding occupation as having a higher COVID-19 exposure risk. In this way, we ended up having two macro-categories of occupations:

²⁰ Armed forces occupations are excluded.

those for which there is a low risk on all four dimensions (professions with low risk of contagion exposure) and those that instead have high values on at least one of the four parameters listed above (professions with high risk of contagion exposure). This procedure has already been applied with consistent and interesting results for the Italian case in Quaranta et al. (2021).

Table 10 displays the full list of occupations according to the four risk typologies.

Table 10: Classification of occupations by MSD and COVID-19 exposure risk level

MSD exposure risk = low COVID-19 risk = low		MSD exposure risk = low COVID-19 risk = high	
ISCO-08 code	Occupation	ISCO-08 code	Occupation
111	Legislators and senior officials	143	Other services managers
112	Managing directors and chief executives	221	Medical doctors
122	Sales, marketing and development managers	226	Other health professionals
132	Manuf., mining, construction, and distrib. manag.	232	Vocational education teachers
134	Professional services managers	233	Secondary education teachers
241	Finance professionals	234	Primary school and early childhood teachers
261	Legal professionals	235	Other teaching professionals
265	Creative and performing artists	263	Social and religious professionals
332	Sales and purchasing agents and brokers	312	Mining, manufacturing and construction superv.
333	Business services agents	313	Process control technicians
334	Administrative and specialised secretaries	321	Medical and pharmaceutical technicians
335	Regulatory government associate professionals	325	Other health associate professionals
432	Material-recording and transport clerks	341	Legal, social and religious associate prof.
441	Other clerical support workers	343	Artistic, cultural and culinary associate prof.
731	Handicraft workers	422	Client information workers
732	Printing trades workers	515	Building and housekeeping supervisors
753	Garment and related trades workers	522	Shop salespersons
		541	Protective services workers
MSD exposure risk = high COVID-19 risk = low		MSD exposure risk = high COVID-19 risk = high	
ISCO-08 code	Occupation	ISCO-08 code	Occupation
121	Business services and administration managers	141	Hotel and restaurant managers
131	Production managers in agric., forestry and fish	142	Retail and wholesale trade managers

133	Info. and commun. technology service managers	225	Veterinarians
211	Physical and earth science professionals	315	Ship and aircraft controllers and technicians
212	Mathematicians, actuaries and statisticians	322	Nursing and midwifery associate professionals
213	Life science professionals	324	Veterinary technicians and assistants
214	Engineering professionals	342	Sports and fitness workers
215	Electro-technology engineers	352	Telecommunications and broadcasting technicians
216	Architects, planners, surveyors and designers		
231	University and higher education teachers	421	Tellers, money collectors and related clerks
242	Administration professionals	511	Travel attendants, conductors and guides
243	Sales, marketing and public relations prof.		
251	Software and applications developers	512	Cooks
252	Database and network professionals	513	Waiters and bartenders
262	Librarians, archivists and curators	514	Hairdressers, beauticians and related workers
264	Authors, journalists and linguists	521	Street and market salespersons
311	Physical and engineering science technicians	523	Cashiers and ticket clerks
314	Life science techn. and related ass. professionals	524	Other sales workers
331	Financial and mathematical ass. professionals	531	Child care workers and teachers' aides
351	Info. and comm. tech. operations and support	532	Personal care workers in health services
411	General office clerks	622	Fishery workers, hunters and trappers
412	Secretaries (general)	711	Building frame and related trades workers
413	Keyboard operators	751	Food processing and related trades workers
431	Numerical clerks	814	Rubber, plastic and paper products machine op.
516	Other personal services workers		
611	Market gardeners and crop growers	817	Wood processing and papermaking plant operators
612	Animal producers		
613	Mixed crop and animal producers	832	Car, van and motorcycle drivers
621	Forestry and related workers	835	Ships' deck crews and related workers
712	Building finishers and related trades workers	911 ²¹	Domestic cleaners and helpers
713	Painters, building structure cleaners and related	912	Vehicle, window, laundry and other hand cleaning
721	Sheet and structural metal workers	931	Mining and construction labourers
722	Blacksmiths, toolmakers and related workers		
723	Machinery mechanics and repairers	941	Food preparation assistants
741	Electrical equipment installers and repairers	952	Street vendors (excluding food)
742	Electronics and telecomm. installers and repairers		
752	Wood treaters, cabinet-makers and related		
754	Other craft and related workers		

²¹ To separate within ISCO code 911 'Domestic cleaners and helpers' who have a high level in the job feature 'care', correlated with a high COVID-19 exposure risk, from 'Cleaners and helpers in offices, hotels and other establishments', we checked the sector of economic activity of workers' employment and considered sector 'T — Activities of households as employers' and 'Q — Human health and social work activities' for the former.

811	Mining and mineral processing plant operators		
812	Metal processing and finishing plant operators		
813	Chemical and photographic products plant operat.		
815	Textile, fur and leather products machine op.		
816	Food and related products machine operators		
818	Other stationary plant and machine operators		
821	Assemblers		
831	Locomotive engine drivers and related workers		
833	Heavy truck and bus drivers		
834	Mobile plant operators		
9112	Hotel and office cleaners and helpers		
921	Agricultural, forestry and fishery labourers		
932	Manufacturing labourers		
933	Transport and storage labourers		
951	Street and related service workers		
961	Refuse workers		
962	Other elementary workers		

Source: Authors' calculations based on 2019 EU-LFS and ICP data