instytut badań strukturalnych

IBS WORKING PAPER 05/2020
JUNE 2020

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Abstract

We study the gender dimension of occupational exposure to contagious diseases spread by the respiratory or close-contact route. We show that in Europe, women are more exposed to contagion, as they are more likely than men to work in occupations that require contact with diseases, frequent contact with clients, and high levels of physical proximity at work. Women are also more likely than men to be unable to work from home, which contributes to their increased exposure. Gender is a more important factor in workers' exposure to contagion than their education or age. This gender difference in exposure can be largely attributed to patterns of sectoral segregation, and to the segregation of women within sectors into occupations that require more interpersonal interactions. While workers in Southern European countries are the most exposed to contagion, the gender differences in exposure are greatest in the Nordic and Continental European countries.

Keywords: COVID-19, contagion, exposure to disease, gender, occupations, working from home.

JEL: J01, I10, J44

• This paper uses Eurostat, Eurofound, and Occupational Information Network data. Eurostat, Eurofound, Occupational Information Network have no responsibility for the results and the conclusions, which are those of the authors. The usual disclaimers apply. All errors are ours.

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ISSN 2451-4373 | IBS ®

1. Introduction and motivation

The COVID-19 pandemic has been spreading rapidly around the world. By June 8, 2020, 7 million people had been infected, and 400,000 people had died (according to the Johns Hopkins University data). It has quickly emerged that the SARS-CoV-2 virus has profoundly different effects on men and women. Sex and gender are important drivers of both the infection risk and its outcomes. Compared to women, men are more likely to die from COVID-19, and tend to have worse clinical results (Purdie et al. 2020). These differences in outcomes may be attributable to sex-based immunological differences, or to gender differences in the prevalence of comorbidities or behaviors that turn out to be risk factors for COVID-19 (Wenham, Smith, and Morgan 2020). However, on a global basis, women are as likely as men to be infected; and in the 25 European countries with available data, women make up the majority (56%) of those infected (according to the Global Health 50/50 data). Among the social factors that contribute to this gender gap are gender differences in the likelihood of being engaged in workplace interactions that are critical for the spread of infectious diseases transmitted by the respiratory or close-contact route, such as COVID-19 (Mossong et al., 2008, Klepac et al., 2018). Indeed, it has been shown that the cross-country differences in levels of exposure to contagion at work predict the growth in COVID-19 cases, in and the number of deaths from COVID-19 (Lewandowski, 2020). Such findings clearly indicate that workplace interactions represent an important transmission channel that can influence the severity of the COVID-19 epidemic in various countries. However, little is known about the gender differences in levels of work-related exposure to contagion that result from gender disparities in the frequency of social contacts at work. We seek to contribute to this strand of literature by providing empirical evidence for a large number of European countries.

Why does the intensity of social contacts at work differ between men and women? The first reason is the persistence of occupational and sectoral segregation by gender. As Lewandowski (2020) has shown, the frequency of social contacts differs across occupations, with health professionals and personal service, personal care, and other service workers facing the highest levels of exposure to contagion. Women make up the majority of workers in these occupations, with most being low-paid "essential workers." The second reason is that because of institutional and cultural factors, there are substantial cross-country differences in levels of exposure to contagion in comparable occupations in Europe. Therefore, we can expect to find that the gender gaps in exposure to contagion differ across countries. Moreover, the consequences of exposure to contagion at work are likely to go beyond facing immediate health risks. It is generally expected that non-pharmaceutical interventions, such as social distancing and regulatory limits on mobility and economic activity, will be in place, at least periodically, until a vaccine or a cure is developed (Kissler et al., 2020, Leung et al., 2020). It has been estimated that more than 20% of all jobs in EU-27 could be disrupted by the COVID-19 pandemic, and that a majority of those jobs are performed by women (Pouliakas and Branka 2020). Thus, exposure to contagion at work can lead to increased stress, uncertainty, risk of joblessness, and economic hardship.

We aim to contribute to the knowledge on the gendered dimension of the COVID-19 pandemic in the following four ways. First, we examine whether there is a gender gap in levels exposure to contagion due to differences in patterns of workplace interactions. Second, we explore cross-country differences in the size of the gender gap in exposure to contagion. Third, we investigate which factors, related to the organization and location of work, as well as to physical proximity and work-related social contacts, contribute to this gender gap. Fourth, we assess whether occupational and sectoral segregation by gender influence the gender gap in exposure to contagion.

We find that in Europe, women are more exposed to contagion in the workplace than men. Compared to men, women are more likely to work in jobs that are more exposed almost by definition, such as jobs in health and care; and are more likely to be employed in personal services, which require frequent interpersonal interactions. In 23 out of 28 European countries we study, we observe that women are overrepresented in occupations that are highly exposed to contagion. There are substantial cross-country differences in the average occupational exposure to contagion in European countries, with workers in Central Eastern European countries being the least exposed, and workers in Southern European countries being the most exposed. However, the size of the gender gap in exposure is not related to the average exposure in a country. Countries with a large gender gap in exposure levels (above 10 pp) include countries with high overall levels of workplace exposure to contagion, such as Germany, the Netherlands or the United Kingdom; as well as countries with low overall exposure levels, such as Latvia and Lithuania. We show that female workers are disproportionately likely to be exposed to contagion largely because women are more likely than men to work in sectors that require contact with diseases, frequent contact with clients, and high levels of physical proximity at work. Women are also less likely than men to be able to work from home, even though they perform more unpaid care and household work. As a consequence, we find that gender is a more important factor than education or age in determining workers' levels of exposure to contagion. We show that this gender gap can be largely attributed to patterns of sectoral segregation, and to the segregation of women within sectors into occupations that require more interpersonal interactions.

2. Methodology and Data

In order to measure the occupational exposure to contagious diseases, we use the index proposed by Lewandowski (2020), based on the most recent Occupation Information Network ('O*NET' 2018) and the European Working Conditions Survey ('EWCS' 2015) data. The O*NET database provides detailed and periodically updated descriptions of the specific work activities and job demands associated with each occupation. Although the O*NET data are available only for the US, and are based on expert assessments or small survey samples, they are often applied to European countries as well. The EWCS data include broader definitions of occupations (two-digit ISCO-08 codes), but are collected in a large number of European countries. Hence, they allow for the measurement of cross-country differences in the nature of work in comparable occupations.

The index we use here is based on six variables that measure critical factors in the spread of infectious diseases transmitted by the respiratory or close-contact route: i.e., social contacts, the mixing patterns of people in the workplace, and occupational hazards related to contact with disease. These variables are occupational (1) exposure to disease or infections (O*NET); (2) physical proximity at work (O*NET); (3) dealing with clients, pupils, or patients (at least around half of the time, EWCS); (4) working in public spaces (at least several times a month, EWCS); (5) working at the clients' premises (at least several times a month, EWCS); and (6) not working from home (working from home no more than a few times a year; EWCS). Each indicator, E_{ic}^{k}, as well as the synthetic index calculated as their average, ETC_{ic}, are measured at the level of occupation i and country c. They range from 0 to 1, with higher values indicating higher levels of exposure. Next, we merge the index of occupational exposure to contagion with the worker-level EU-Labor Force Survey ('EU-LFS' 2018) data that provide the most accurate estimates of occupational structures in European countries. Our final sample includes 28 countries for which reliable EWCS and LFS data are available.

We define workers who are highly exposed to infectious diseases, $HETC_c$, as workers in occupations and countries in which the value of ETC_{ic} is above the European median (calculated with standardized weights that give every country the same total weight).

In order to analyze the differences between women and men in levels of exposure to contagion and in the probability of working in a highly exposed occupation, we estimate linear OLS (2 and 3) and logistic (4) regressions:

$$E_{jic}^{k} = \beta_0 + \beta_1 X_j + \lambda_r + \gamma_s + \varepsilon_{ijc} \quad (2)$$

$$ETC_{jic} = \beta_0 + \beta_1 X_j + \lambda_r + \gamma_s + \varepsilon_{ijc} \quad (3)$$

$$\Pr(HETC_{jic} = 1) = F(\beta_0 + \beta_1 X_j + \lambda_r + \gamma_s + \varepsilon_{ijc}) \quad (4)$$

where $F(Z) = \frac{e^Z}{1+e^Z}$, *j* stands for individual, *i* for occupation, and *c* for country; X_j is a vector of personal and workplace characteristics (sex, age, education, contract type, and firm size); and λ_r are fixed effects pertaining to five geographical groups into which we aggregate countries: Anglo-Saxon (Ireland & United Kingdom), Southern (Italy, Portugal, Spain), Continental (Austria, Belgium, Germany, Luxembourg, France, the Netherlands, Switzerland), Eastern (Bulgaria, Croatia, Czechia, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovakia, Slovenia), and Nordic countries (Denmark, Finland, Iceland, Norway, Sweden). Finally, γ_s stands for sector fixed effects (21 NACE sectors). We estimate two variants of models (2)-(4). In the first variant, we don't control for sector fixed effects, but we add these effects in the second variant. This allows us to assess to what extent the effects associated with gender are related to sectoral segregation.

Next, we use the coefficients estimated in models (2) and (3) to decompose the variance of each dependent variable, e_{jic}, into the contributions of particular individual, job, and regional characteristics. In particular, the decomposition allows us to evaluate the contributions of gender differences to the overall differences in workers' levels of exposure to contagion, as well as to assess the role sectoral segregation by gender plays in these gender gaps. We use the covariance-based decomposition proposed by Morduch and Sicular (2002). Formally, the contribution of a variable, x, to the cross-country variance of e_{jic} is defined as follows:

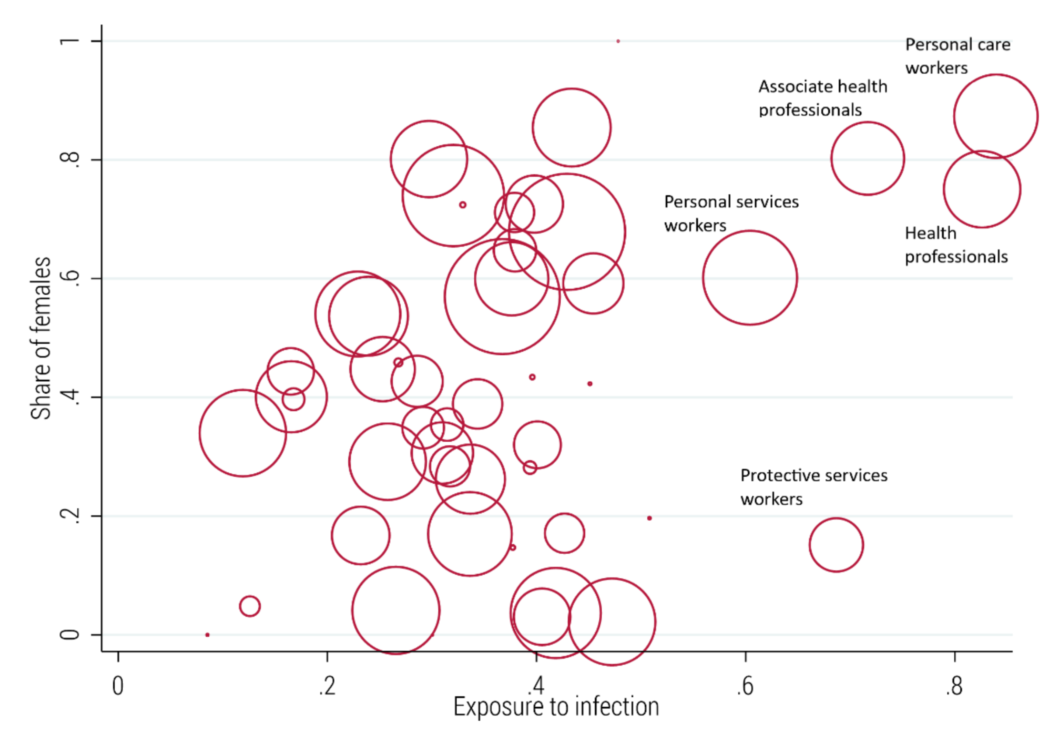
$$\sigma_{x\, e_{jic}} = \frac{cov(\beta_x x_{jic}, e_{jic})}{var(e_{jic})} \quad (5)$$

3. Results

Descriptive results

In Europe, women are more likely than men to work in occupations that are more exposed to contagion. Among the five occupations that are most exposed to contagion in Europe, four are dominated by women (Figure 1). These female-dominated occupations are either directly involved in health or personal care (health professionals, associate health professionals, personal care workers) or in services that inherently require social contacts (personal services workers). Only one of the occupations that have the highest levels of exposure (protective services workers) is dominated by men. By contrast, occupations with low levels of exposure to contagion – such as agricultural workers, plant and machine operators, assemblers, as well as information and communications technology professionals – are usually dominated by men (Figure 1).

Figure 1. Differences in levels of exposure to contagion across two-digit ISCO occupations in Europe.

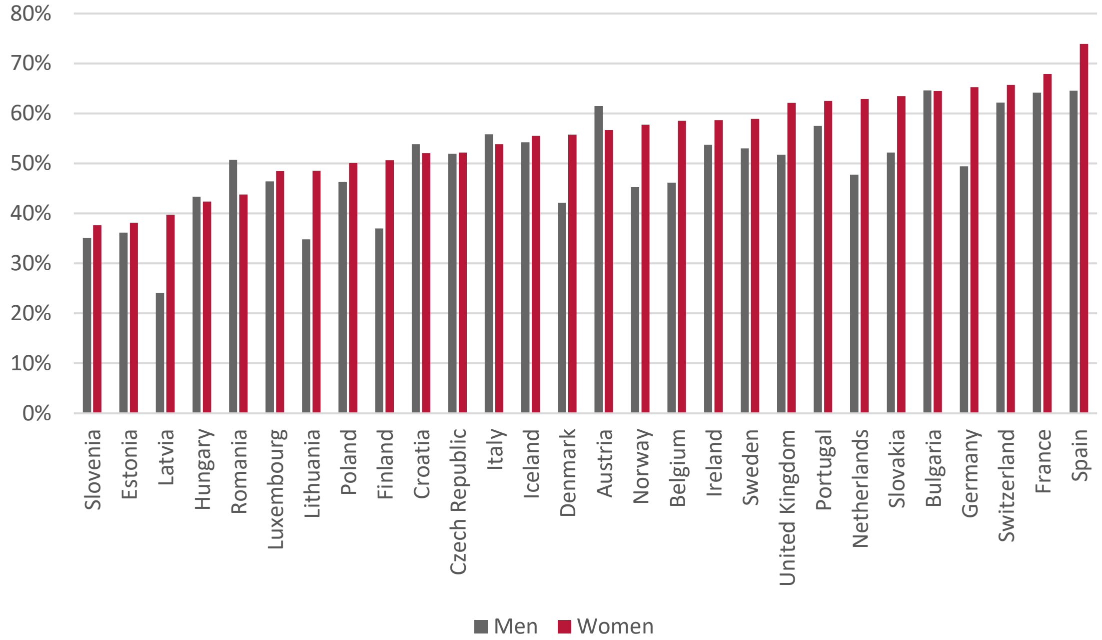


Note: *The bubble size indicates the average share of a given occupation in total employment in our sample of 28 European countries, calculated with standardized weights. Exposure to infection is measured with the synthetic index ETC_{ic} presented in the methodology section. Sample size is 1,457,381.*

*Source: Own calculations on the basis of EU-LFS, EWCS, and O*NET data.*

There are noticeable cross-country differences in the shares of jobs that are highly exposed to contagion. The shares of highly exposed workers are largest in Southern European countries, France, and the UK, while they are smallest in the Central and Eastern European countries (Lewandowski 2020). Importantly, in the vast majority of countries (23 out of 28), the shares of highly exposed workers are larger among women than among men (on average, by 7.8 pp). These gender differences are particularly large in the Nordic countries, Germany, Belgium, and the Netherlands; as well as in Latvia and Lithuania, where they exceed 12 pp. The shares of highly exposed workers are larger for men than for women (on average, by 2.7 pp) in only five of the countries studied (Austria, Croatia, Hungary, Italy, Romania).

Figure 2. The share of workers highly exposed to contagion in Europe, by gender.



Note: *countries are sorted by the share of female workers who are highly exposed to contagion at work, as measured by index $HETC_c$, presented in the methodology section*

*Source: Own calculations on the basis of EU-LFS, EWCS and O*NET data.*

Econometric results

Our econometric results show that, on average, female workers face higher levels of exposure to contagion than men, and are also 26% more likely than men to work in highly exposed occupations (column 1 of Table 1). Moreover, these effects are especially pronounced for younger women: compared to their male counterparts, women aged 15-24 are 70% more likely, and women aged 25-34 are 21% more likely to work in a highly exposed occupation. This is mainly because younger women tend to work in environments that require close proximity, and they are more likely than men to be dealing with clients, pupils, or patients. However, both male and female workers aged 45 or older are less exposed to contagion, and are less likely to be employed in a highly exposed occupation than younger workers. In terms of education, the largest gap is between workers with college (or higher) education and those with no college education – the former group are by almost 50% less likely than the latter group to be employed in a highly exposed occupation, and are thus less exposed to contagion. These effects are found both for women and men, although women with lower secondary education face less exposure, and are less likely to be employed in a highly exposed occupation than women with upper secondary education.

The gender differences in levels of occupational exposure to contagion are largely driven by patterns of sectoral segregation; i.e., by women being more likely than men to work in certain sectors of the economy, such as health, care, education, and hospitality (Weichselbaumer and Winter-Ebmer, 2005, Borrowman and Klasen, 2020). When we control for the economic sector in which an individual works, the effect of sex is not statistically significant (column 2 of Table 1). Hence, within particular sectors, prime-aged women are not more likely than men to be employed in more exposed occupations. However, the within-sector differences between age groups remain significant: younger women are more exposed to contagion than prime-aged women and young men, whereas older women are significantly less exposed.

Table 1. The individual and workplace correlates of working in a highly exposed occupation, occupational exposure to contagion index and its components

	Probability of working in a highly exposed occupation		Occupational exposure to contagion		Exposure to disease or infections		Physical proximity at work		Dealing with clients, pupils, or patients		Working at the clients' premises		Working in public spaces		Unable to work from home	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Gender																
Female	1.261** (0.149)	1.018 (0.111)	0.039*** 0.009	-0.003 (0.005)	0.110*** (0.014)	0.026*** (0.006)	0.060*** (0.013)	-0.004 (0.008)	0.121*** (0.013)	0.054*** (0.010)	-0.105*** (0.014)	-0.070*** (0.009)	-0.024*** (0.008)	-0.030*** (0.006)	0.005 (0.006)	0.010** (0.004)
Age group:																
15-24	1.177** (0.081)	1.142** (0.074)	0.007 (0.005)	0.004 (0.003)	0.005 (0.005)	0.004 (0.004)	0.033*** (0.007)	0.025*** (0.005)	0.027*** (0.009)	0.012* (0.007)	-0.048*** (0.008)	-0.033*** (0.006)	-0.016*** (0.005)	-0.020*** (0.004)	0.030*** (0.005)	0.029*** (0.004)
25-34	1.026 (0.027)	1.009 (0.029)	0.001 (0.002)	0.000 (0.001)	0.004** (0.002)	0.003* (0.001)	0.013*** (0.002)	0.010*** (0.002)	0.000 (0.003)	-0.003 (0.002)	-0.016*** (0.003)	-0.013*** (0.002)	-0.009*** (0.002)	-0.010*** (0.002)	0.014*** (0.002)	0.014*** (0.002)
45-54	0.945*** (0.020)	0.977 (0.021)	-0.003* (0.002)	-0.001 (0.001)	0.002 (0.002)	-0.001 (0.001)	-0.006*** (0.002)	-0.003 (0.002)	0.001 (0.002)	0.003 (0.002)	-0.003 (0.002)	0.000 (0.002)	-0.001 (0.001)	0.000 (0.001)	-0.006*** (0.002)	-0.002 (0.002)
55-64	0.898*** (0.033)	0.941* (0.032)	-0.004 (0.003)	-0.001 (0.002)	0.014*** (0.003)	0.001 (0.002)	-0.006 (0.004)	-0.002 (0.002)	0.005 (0.004)	0.006** (0.003)	-0.013*** (0.004)	-0.006** (0.003)	-0.004 (0.002)	-0.002 (0.002)	-0.012*** (0.003)	-0.002 (0.002)
Female *age group:																
15-24	1.695*** (0.124)	1.591*** (0.118)	0.035*** (0.006)	0.029*** (0.004)	0.001 (0.010)	0.012** (0.006)	0.052*** (0.009)	0.046*** (0.007)	0.050*** (0.008)	0.044*** (0.007)	0.016* (0.009)	0.010 (0.007)	0.023*** (0.006)	0.016*** (0.005)	0.008* (0.005)	-0.001 (0.004)
25-34	1.213*** (0.041)	1.183*** (0.042)	0.014*** (0.003)	0.012*** (0.002)	0.003 (0.004)	0.006** (0.003)	0.015*** (0.004)	0.014*** (0.003)	0.015*** (0.004)	0.015*** (0.003)	0.013*** (0.004)	0.009*** (0.003)	0.013*** (0.003)	0.011*** (0.002)	0.002 (0.003)	-0.004* (0.002)
45-54	0.997 (0.029)	0.941** (0.028)	0.004* (0.002)	-0.004** (0.002)	0.012*** (0.003)	-0.001 (0.002)	0.010*** (0.003)	-0.003 (0.003)	-0.002 (0.003)	-0.010*** (0.002)	0.002 (0.003)	0.000 (0.002)	-0.004** (0.002)	-0.004** (0.002)	-0.000 (0.002)	0.000 (0.002)
55-64	1.007 (0.048)	0.916* (0.043)	0.010** (0.004)	-0.004 (0.003)	0.022*** (0.006)	0.001 (0.004)	0.014** (0.006)	-0.007 (0.004)	-0.002 (0.006)	-0.014*** (0.004)	0.012*** (0.005)	0.007* (0.004)	-0.005 (0.003)	-0.005* (0.003)	-0.000 (0.003)	0.002 (0.003)

Education:																
Primary or less	1.076 (0.235)	1.210 (0.259)	-0.017 (0.015)	-0.005 (0.010)	-0.001 (0.015)	0.004 (0.009)	-0.030 (0.019)	-0.017 (0.013)	-0.069*** (0.020)	-0.045*** (0.017)	0.037 (0.039)	0.027 (0.028)	-0.032*** (0.012)	-0.027** (0.011)	0.023 (0.014)	0.036*** (0.010)
Lower secondary	1.051 (0.096)	1.154* (0.099)	-0.012 (0.008)	-0.001 (0.004)	-0.004 (0.006)	0.003 (0.004)	-0.017* (0.009)	-0.002 (0.005)	-0.025*** (0.009)	-0.011* (0.007)	-0.003 (0.010)	-0.004 (0.008)	-0.010* (0.006)	-0.006 (0.005)	0.005 (0.013)	0.014** (0.006)
College or higher	0.558*** (0.062)	0.553*** (0.057)	-0.032*** (0.008)	-0.037*** (0.006)	0.006 (0.009)	-0.016*** (0.006)	-0.107*** (0.010)	-0.105*** (0.008)	0.101*** (0.011)	0.067*** (0.007)	-0.016 (0.013)	-0.004 (0.009)	0.010 (0.008)	0.002 (0.007)	-0.132*** (0.007)	-0.102*** (0.006)
Female * education:																
Primary or less	1.152 (0.348)	1.273 (0.339)	-0.022 (0.020)	-0.020 (0.014)	0.032 (0.031)	0.008 (0.016)	-0.085** (0.039)	-0.069** (0.031)	-0.101*** (0.034)	-0.069*** (0.025)	0.036 (0.051)	0.030 (0.036)	0.011 (0.023)	0.009 (0.021)	0.011 (0.013)	0.004 (0.011)
Lower secondary	0.825* (0.093)	0.843 (0.098)	-0.013 (0.008)	-0.010 (0.006)	0.011 (0.013)	0.010 (0.007)	-0.028* (0.014)	-0.021** (0.011)	-0.065*** (0.013)	-0.052*** (0.010)	0.013 (0.013)	0.014 (0.010)	0.007 (0.008)	0.005 (0.007)	0.006 (0.007)	0.003 (0.006)
College or higher	0.956 (0.111)	1.004 (0.106)	-0.000 (0.010)	0.003 (0.007)	-0.027* (0.015)	-0.024** (0.009)	0.018 (0.014)	0.018* (0.010)	-0.034*** (0.013)	-0.022** (0.009)	0.038*** (0.012)	0.024*** (0.008)	0.006 (0.008)	0.013* (0.007)	-0.001 (0.008)	0.005 (0.006)
Country group																
Anglo-Saxon	0.994 (0.313)	0.942 (0.306)	0.020 (0.027)	0.017 (0.019)	0.008 (0.043)	0.006 (0.027)	0.023 (0.043)	0.018 (0.032)	0.050* (0.030)	0.043* (0.024)	-0.025 (0.030)	-0.023 (0.025)	0.023 (0.024)	0.021 (0.023)	0.006 (0.025)	0.007 (0.022)
Southern	1.120	1.232	0.021	0.028**	0.006	0.017	0.024	0.029	0.030	0.036*	-0.070**	-0.061***	0.011	0.013	0.090***	0.087***
	(0.310)	(0.343)	(0.020)	(0.014)	(0.030)	(0.019)	(0.033)	(0.024)	(0.028)	(0.022)	(0.027)	(0.023)	(0.024)	(0.021)	(0.019)	(0.016)
Central Eastern	0.617** (0.124)	0.758 (0.156)	-0.056*** (0.015)	-0.025** (0.011)	-0.046** (0.021)	-0.007 (0.013)	-0.030 (0.023)	0.004 (0.017)	-0.097*** (0.021)	-0.066*** (0.017)	-0.093*** (0.020)	-0.082*** (0.017)	-0.035** (0.014)	-0.023* (0.013)	0.060*** (0.017)	0.068*** (0.013)
Nordic	0.765 (0.195)	0.711 (0.182)	0.021 (0.025)	0.016 (0.018)	0.017 (0.037)	0.006 (0.022)	0.023 (0.036)	0.014 (0.025)	0.031 (0.025)	0.027 (0.019)	0.025 (0.025)	0.025 (0.021)	0.047** (0.019)	0.051*** (0.019)	-0.063*** (0.024)	-0.061*** (0.021)
Sector controls	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
R^2 / pseudo R^2	0.035	0.160	0.068	0.360	0.072	0.437	0.070	0.342	0.174	0.384	0.099	0.257	0.042	0.135	0.207	0.358
No. of obs.	1474320	1474320	1474320	1474320	1474320	1474320	1474320	1474320	1474320	1474320	1474320	1474320	1474320	1474320	1474320	1474320

Note: *The coefficients estimated in pooled regressions are estimated in a worker-level model with standardized weights that give each country equal importance. All models include controls for firm size and type of contract. (Results for coefficients pertaining to these variables, and coefficients pertaining to sector fixed effects, are available upon request). Reference groups: male, ages 34-45, upper secondary education, firm size up to 10 workers, permanent contract, Continental region of Europe. Standard errors clustered at country x occupation level.*

*Source: Own estimation based on EU-LFS, EWCS, and O*NET data.*

Finally, there are differences in exposure patterns between groups of countries. In particular, workers in Eastern European countries are less exposed to contagion, and are less likely to be employed in highly exposed occupations. Workers in Southern European countries, where the impact of COVID-19 has been particularly severe, are significantly more exposed to contagion than their peers working in comparable sectors in other Continental countries. However, there are no statistically significant differences in exposure levels by gender across the groups of countries. Thus, it appears that the raw differences in levels of exposure between men and women in different countries (presented in Figure 2) are due to differences in gender-specific employment structures in various countries.[1] At the same time, the cross-country differences in workers' levels of exposure result from international differences in both occupational structures and in the nature of work in particular occupations, which are, in turn, related to differences in the complexity of economic networks and in culture (Charles, 1992, Lewandowski, 2020).

Next, we investigate which dimensions of work that determine levels of occupational exposure to contagion (namely, exposure to diseases or infections; physical proximity at work; dealing with clients, pupils, or patients; working in public spaces; working at the clients' premises; not being able to work from home) are behind the significantly higher levels of exposure to contagion among female workers.

We find that compared to men, women are significantly more exposed to diseases and infections (column 3 of Table 1); are more likely to be dealing with clients, pupils, or patients (column 9 of Table 1); and have significantly higher levels of physical proximity at work (column 7 of Table 1). In general, these effects are robust to the inclusion of sector fixed effects. Thus, the findings indicate that these gender differences are partly attributable to sectoral segregation (e.g., to women being overrepresented in health care, personal care, education), but are also present within particular sectors, as women are more likely than men to be employed in occupations that require interpersonal skills and social contact. Importantly, we find that women aged 45 or older are more likely to be exposed to infections for a reason that that entirely attributable to sectoral segregation (column 6 of Table 1): i.e., that women aged 45 or older make up a disproportionate share of health and care personnel (from 68% in Italy to 93% in Estonia). At the same time, younger women are more likely than older women to have high levels of physical proximity at work (columns 7-8 of Table 1), and to have frequent interactions with clients, pupils, or patients (columns 9-10 of Table 1).

Importantly, our results show that women are more likely than men to be unable to work from home, which also contributes to the gender gap in occupational exposure to diseases. This effect is observable within particular sectors, and is strongest for young workers and for workers with primary education only (column 16 of Table 1). This finding is striking given that during pandemic lockdowns, women are expected to juggle work and family by working from home while also bearing most of burden of unpaid household chores and care work, which now includes homeschooling children (Sayer, 2005, Gausman and Langer, 2020). Working from home is easier for both male and female college-educated workers. Moreover, access to working from home is likely to improve for women in the future, as they become better educated. In 2019, the share of young women (aged 25-34) with tertiary education exceeded that of young men in all 28 European countries in our sample. But for the moment, working from home is a privilege that is mainly enjoyed by highly educated, well-paid male workers.

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[1] We estimated models (2)-(4) by additionally including interactions between the female fixed effect and the country groups fixed effects. As the coefficients pertaining to these interactions are insignificant, we do not show them here. They are available upon request.

We also find some workplace-related factors that mediate the gender gap in the exposure to contagion. First, women are less likely than men to be working at clients' premises (columns 11-12 of Table 1). Second, women are less likely than men to be working in public spaces (columns 13-14 of Table 1). Although the incidence of such work is slightly higher among young women than among prime-aged women, it is lower than among men with the same educational levels, ages, and sectors of employment. Moreover, while the incidence of working at clients' premises is significantly higher among college-educated women than among women with no college education, it is nevertheless lower than among comparable men. Again, these differences can be attributed to occupational segregation. For example, working at clients' premises is most common in managerial and professional jobs, which are more likely to be held by men than by women.

Next, we discuss the results of variance decompositions, which allow us to assess the relative contributions of gender and other individual and workplace characteristics to the observed differences in levels of exposure to contagion among European workers. We find that gender plays a key role. The contribution of gender to the variance of exposure to contagion (column 1 of Table 2), as well as to the variance of several dimensions of this exposure – namely, levels of exposure to infections (column 3 of Table 2), to dealing with clients (column 7 of Table 2), and to working at clients' premises (column 9 of Table 2) – is greater than that of other individual characteristics. The contribution of gender to the differences in levels of physical proximity at work is also large (column 5 of Table 2), although it is slightly smaller than that of education. However, these contributions are mainly driven by sectoral segregation, and are much smaller when we control for the effects of sectors. Of the sectors, human health and social work activities account for most of the variance of exposure to contagion and of its abovementioned dimensions.[2] In other words, it is the fact that women are much more likely than men to work in the sectors of the economy associated with human health and social work that drives women's higher risk of exposure to infections.

When we look at the effect of working at clients' premises (columns 9-10 of Table 2), we see that the contribution of gender is largely driven by the within-sector differences, and that the component associated with sectoral segregation is spread across multiple sectors. This effect can be attributed to occupational segregation (Blau and Kahn 2017), and to the underrepresentation of women in professional and managerial positions. In the pandemic, this underrepresentation can be interpreted as a silver lining of the glass ceiling, as there is evidence of SARS-CoV-2 transmission clusters related to professional meetings (Hijnen et al., 2020, Rothe et al., 2020).

Finally, we find that the contribution of gender to the differences in working from home, and to differences in the frequency of working in public spaces, is tiny. In the case of working from home, education has the greatest impact. In the case of working in public spaces, most of the differences are attributable to differences between country groups, rather than to personal or workplace characteristics. Thus, these differences are likely related to differences in the organization of work and cultural factors. The contributions of country group effects are also large for the two dimensions related to contact with clients, and they are driven by the Central and Eastern European countries, where the incidence of such work-related social contacts is much lower than it is in other European countries.

[2] The results for particular sectors are available upon request.

Table 2. Results of variance decomposition of the occupational exposure to contagion index and its components (in % of total variance)

	Occupational exposure to contagion		Exposure to disease or infections		Physical proximity at work		Dealing with clients, pupils, or patients		Working at the clients' premises		Working in public spaces		Unable to work from home	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Female	1.99	0.21	5.58	1.10	2.05	0.21	5.60	2.42	4.17	2.78	0.44	0.55	0.09	-0.28
Education	0.49	0.57	0.01	-0.04	3.28	3.24	5.03	3.28	0.07	0.07	0.21	0.08	12.63	10.13
Other workplace factors	0.31	0.16	0.31	0.09	0.77	0.58	0.64	0.36	0.32	0.21	0.11	0.05	0.622	0.53
Region	3.93	2.19	1.28	0.31	0.71	0.20	6.06	4.47	5.33	4.77	3.41	2.93	7.23	7.43
Sector	-	32.88	-	42.19	-	29.98	-	27.92	-	17.83	-	9.84	-	17.90
Share of variance explained	6.67	36.02	7.18	43.66	6.81	34.21	17.33	38.44	9.89	25.67	4.17	13.44	20.57	35.71

Note: *variance decomposition calculated in line with equation (5) based on the estimation results presented in Table 1.*

*Source: Own estimation based on EU-LFS, EWCS, and O*NET data.*

4. Discussion and conclusions

We have shown that in Europe, women are more likely than men to work in occupations that are more exposed to the risk of being infected by contagious diseases spread by the respiratory or close-contact route. This is primarily because women are more likely than men to be employed in sectors that require contact with diseases, frequent contact with large numbers of people, and high levels of physical proximity at work, such as health, care, education, and hospitality. On average, women account for 73% of workers in these sectors in European countries. We have also found that across all sectors of the economy, women are more likely than men to be employed in occupations that require workers to deal frequently with clients, pupils, or patients. Moreover, women are less likely than men to work from home, even though they spend more time on unpaid care and household work. However, certain workplace-related factors narrow the gender gap in levels of exposure to contagion: compared to men, women are less likely to be working at clients' premises, or to be working in public spaces. In general, we find that gender is a more important factor in workers' levels of exposure to contagion than their education or age.

We have also shown that the gender gaps in the exposure to contagion in the workplace have heterogenous cross-country patterns. In the vast majority of countries, the shares of highly exposed workers are larger among women than among men. The Nordic countries, the Continental countries, (e.g., Germany, Belgium, and the Netherlands), and the Baltic countries have relatively large gender gaps in exposure levels to the disadvantage of women, but the shares of highly exposed workers in these countries are slightly larger for men. The shares of highly exposed workers are slightly larger among men than among women in only a handful of countries (e.g., Austria, Hungary, and Italy). However, when other individual and workplace factors are adjusted for, we find that the Eastern European countries have the lowest levels of exposure to contagion at work, while the Southern European countries have the highest. However, our results also show that these effects apply to both men and women, and that there are no systematic differences between country groups in the gender differences in exposure levels.

To sum up, we find that although there are several individual-, workplace-, and country-level characteristics that influence workers' levels of exposure to contagious diseases such as COVID-19, workers' gender appears to be the one with the greatest impact.

Our results have important policy and research implications. Women are disadvantaged by their greater exposure to diseases in the workplace. Indeed, women make up the majority of people who are infected with COVID-19, although they are less likely than men to die from it. This adds to the list of women's disadvantages in pandemic conditions, which already include the unequal division of home production, care, and educational duties. Any labor market policies aimed at lowering the risks of contagion in the workplace should take the gender dimension into account. There is also a pressing need to incorporate more women into local and global health policy-making, as there are currently very few women managing health surveillance, detection, or prevention schemes. The gender lenses could be applied to design more effective pandemic-related health policies, including those focused on the risk of workplace contagion. Currently, we know very little about the impact of pandemics on labor markets, and on men's and women's employment. However, the finding that women are more exposed than men to contagion is likely to be a strong predictor that women will have worse labor market opportunities during pandemics. If women are more likely than men to lose their jobs or to drop out of the labor market due to disease contagion, gender income gaps are likely to widen, and the unequal division of home production is likely to be further consolidated. These risks require further study. More research is also needed on the cultural factors, gender norms, and gender roles that might affect differences in women's and men's vulnerability to infection exposure.

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