

Occupational differences in the prevalence and severity of long-COVID: Analysis of the ONS Coronavirus (COVID-19) Infection Survey

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Abstract

Objectives: To establish whether prevalence and severity of long-COVID symptoms vary by industry and occupation.

Methods: We utilised ONS Coronavirus Infection Survey (CIS) data (February 2021-April 2022) of working-age participants (16-65 years). Exposures were industrial sector, occupation and major Standard Occupational Classification (SOC) group. Outcomes were self-reported: (1) long-COVID symptoms; and (2) reduced function due to long-COVID. Binary (outcome 1) and ordered (outcome 2) logistic regression were used to estimate odds ratios (OR) and prevalence (marginal means) for all exposures.

Results: Public facing industries, including teaching and education, social care, healthcare, civil service, retail and transport industries and occupations had highest odds ratios for long-COVID. By major SOC group, those in caring, leisure and other services (OR 1.44, CIs: 1.38-1.52) had substantially elevated odds than average. For almost all exposures, the pattern of odds ratios for long-COVID symptoms followed that for SARS-CoV-2 infections, except for professional occupations (OR<1 for infection; OR>1 for long-COVID). The probability of reporting long-COVID for industry ranged from 7.7% (financial services) to 11.6% (teaching and education); whereas the prevalence of reduced function by ‘a lot’ ranged from 17.1% (arts, entertainment and recreation) to 22-23% (teaching and education and armed forces) and to 27% (those not working).

Conclusions: The risk and prevalence of long-COVID differs across industries and occupations. Generally, it appears that likelihood of developing long-COVID symptoms follows likelihood of SARS-CoV-2 infection, except for professional occupations. These findings highlight sectors and occupations where further research is needed to understand the occupational factors resulting in long-COVID.

Key messages

What is already known on this topic –

- SARS-CoV-2 infection and COVID-19 mortality in the UK varied by occupational group; yet it is not known if any occupational groups are more susceptible to long-COVID than others.

What this study adds –

- This is the first study to examine how prevalence of long-COVID and its impacts on functional capacity differ by industrial sector and occupational groups.
- Prevalence of self-reported long-COVID increased with time across all exposure groups and mostly followed SARS-CoV-2 infection trends; with the exception of Professional occupations that demonstrated notable differences in the direction of odds of long-covid when compared to odds of SARS-CoV-2 infection.
- Those working in Teaching and education, and social care industries showed the highest likelihood of having long-COVID symptoms. The exact same pattern was observed when analysis was performed using occupational groups. When we used SOC groups the likelihood was higher in Caring, leisure and other services.

How this study might affect research, practice or policy –

- The findings contribute to the evidence base that long-COVID differences occur across industries and occupations, provides insights for employees, employers, occupational and healthcare for the industries and occupations that may need additional support for return-to-work policies and highlights sectors and occupations where further research is needed to understand the mechanisms resulting in long-COVID and how occupational factors influence the risk of developing long-COVID or interact with long-COVID to increase the impact on activities.

Introduction

In the UK, the risk of SARS-CoV-2 infection and COVID-19 mortality has varied by occupational group, although most differences appear to have declined over the duration of the pandemic (1-5). It remains unclear however, whether or not some occupational groups are more susceptible to long-; and if any differences reflect, or are addition to, differential risks in SARS-CoV-2 infection (6). The highest risks of long-COVID are reported amongst workers in education, social care and healthcare sectors (7); all sectors with elevated risks of SARS-CoV-2 infection during the pandemic (8).

Being out of work is associated with poor health (9-11) and the risk unemployment increases with length of sick leave (12). Recent studies have demonstrated the burden of long-COVID, where even after months, many patients report persisting symptoms and have not returned to previous levels of work (13 14). A Danish nationwide registry study demonstrated that of those hospitalised, being female, older age, and having a comorbidity were associated with a lower chance of returning to work (15). Davies *et al*, showed that almost half of the study respondents suffering with long-COVID required a reduced work schedule compared to pre-illness (13). A Swedish national cohort study showed that 13% were on sick leave due to long-COVID from March-August 2020 and 9% were on sick leave for at least four months (16). Those on sick leave due to long-COVID were older, predominantly men, spent more time on sick leave prior to COVID-19, and were more likely to have received inpatient care (16). While we understand some of the factors that predict long-COVID and work ability, little is known about how the prevalence of long-COVID and associated functional capacity differs by occupation and the impact of occupational factors on these patterns.

Long-COVID has a disproportionate impact on groups already disadvantaged in terms of work and health. Returning to work is part of rehabilitation from illness and is important to those recovering from long-COVID (12). Many people with significant illness or disability work effectively if they are provided with suitable support in the workplace (12). Better understanding of the prevalence and severity of long-COVID in different occupational groups will inform the need for rehabilitation, workplace adjustment measures and support (17) and provide evidence about whether or not long-COVID should be considered an occupational disease (7). It may also identify workplaces that need additional support measures to reduce risks of transitioning to long-COVID after SARS-CoV-2 infection.

Our study aims to establish whether the prevalence and severity of long-COVID varied by occupation and if any differences are in excess of differences in the risk of SARS-CoV-2 infection.

399

400 **METHODS AND DATA**

401 **Study design**

402 We used data from the ONS Coronavirus (COVID-19) Infection Survey (CIS) from Feb 2021 (when
403 long-Covid questions were first included in CIS) until the end of April 2022. This longitudinal study
404 began in April 2020, used random sampling and aimed to be representative of the UK population.
405 Repeated PCR testing for all participants was carried out during weekly home visits for the first
406 month of entry to the survey, and then monthly until 30th April 2022 when testing samples were sent
407 and returned by post and survey questions were asked on-line or over the phone (18). CIS uses 4
408 different variables to capture employment status. Participants were coded as employed or not
409 working (Employment status coding section).

410 Analyses were restricted to participants aged ≥ 16 to ≤ 65 years old on the day of their first home visit
411 and to those who turned 16 during the study period and had answered long-COVID questions at
412 least once.

413 We used the first available observation per occupational exposure and other covariates, assuming
414 no change across time. In sensitivity analyses, we estimated panel models to allow for variation
415 across time.

416

417 **Exposure groups**

418 We used three different industry and occupational groupings. Industry was classified based on the
419 ONS sector groupings used within CIS (19). Based on expert judgement and consensus among team
420 members we derived a bespoke set of occupational groupings using 4-digit standard occupational
421 codes (SOC 2010) (Table S1) (20). Groups used in previous studies (2-4 21) focussed on key
422 worker/essential worker groups (i.e., those with highest exposure at the start of the pandemic) and
423 therefore new groupings were needed to capture all occupations and exposures while ensuring
424 adequate group size, as the pandemic progressed. The third exposure category was by major SOC
425 group.

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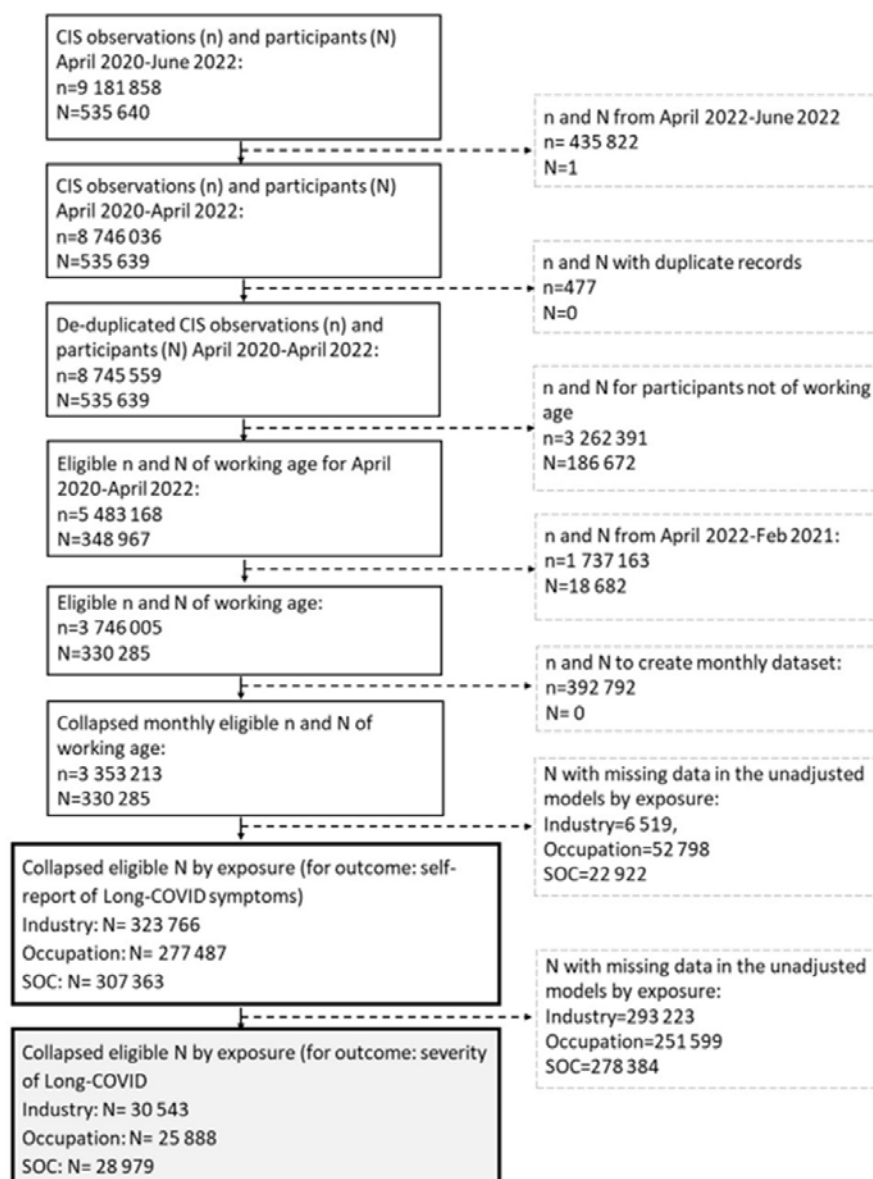


Figure 1. Flow chart of Covid Infection Survey (CIS) participants. N= number of participants, n=number of observations

Analytical sample and ascertainment of outcome

Primary outcome measures were self-reported (i) cases of long-COVID and (ii) reduced function (i.e., severity) due to long-COVID among those reporting long-COVID, using the following CIS questions:

- (i) self-reported long-COVID: *“Would you describe yourself as having 'long-COVID', that is, you are still experiencing symptoms more than 4 weeks after you first had COVID-19, that are not explained by something else?”*. For our primary analysis we reported the n (%) of people who self-reported having long-COVID in at least one survey, irrespective of any COVID-19 test result or previous infection reported.
- (ii) self-reported reduced function (severity) of long-COVID: *‘How much did long-COVID reduce your ability to carry out daily activities?’* Respondents could answer 0: not at all, 1: Yes, a little, 2: Yes, a lot. This analytical sample was restricted to those self-reporting long-covid symptoms.

Statistical analyses

Analysis was completed for the two outcome variables using all three exposure groups, irrespective of whether they have tested or reported being previously infected by SARS-CoV-2. For comparison, we also performed analyses using the outcome ‘SARS-CoV-2 infection (self-reported or positive PCR test).

Sample characteristics were summarised using frequencies and proportions. Descriptive statistics were used to show the change in prevalence of self-reported long-COVID over time. Binary (outcome 1: long-COVID symptoms) and ordered (outcome 2: reduced function due to long-COVID) logistic regression models with robust standard errors to account for heteroskedasticity were used. For the binary logistic regression analyses, data were collapsed by person using the first reported values for exposure and covariates and taking ‘at least one reported episode of long-COVID’ as the outcome. For the ordered logistic regression, the highest reported value for the outcome variable (i.e., severity of long-COVID) was used per person. We used effects coding where ORs are contrasted to each group mean compared to the grand mean showing the likelihood of having long-COVID in each group. To assess for potential confounding or mediating differences we estimated unadjusted and fully adjusted models for all the covariates (age, sex, IMD, rural or urban location, household size, region, pre-existing health conditions) (2).

Weighting was not used as the CIS derived weights are cross sectional. Testing for patterns of missingness in the outcome variable did not show any differences (Table S2). Participants with no measures in our outcome, exposure and covariate variables were excluded (Figure 1; Table S2). We included the non-working group for comparison purposes.

Sensitivity Analyses

Sensitivity analyses based on our main analytical methods was conducted using two additional analytical samples: (i) those with a positive PCR test; and (ii) those with a positive PCR test and/or self-reported infection before entering the CIS. Furthermore, using the specifications of our main sample, multiple participant visits and records were merged where needed to create a dataset with one observation per month per person to allow variation across time (Figure 1). We used multilevel mixed-methods generalised linear models, with a binomial link function for the outcome of having long-COVID symptoms; and a multilevel mixed-effects ordered logistic regression for the outcome of reduced function due to long-COVID and compare with the estimations of our analytical model.

All analyses were calculated using STATA 17 (22).

RESULTS

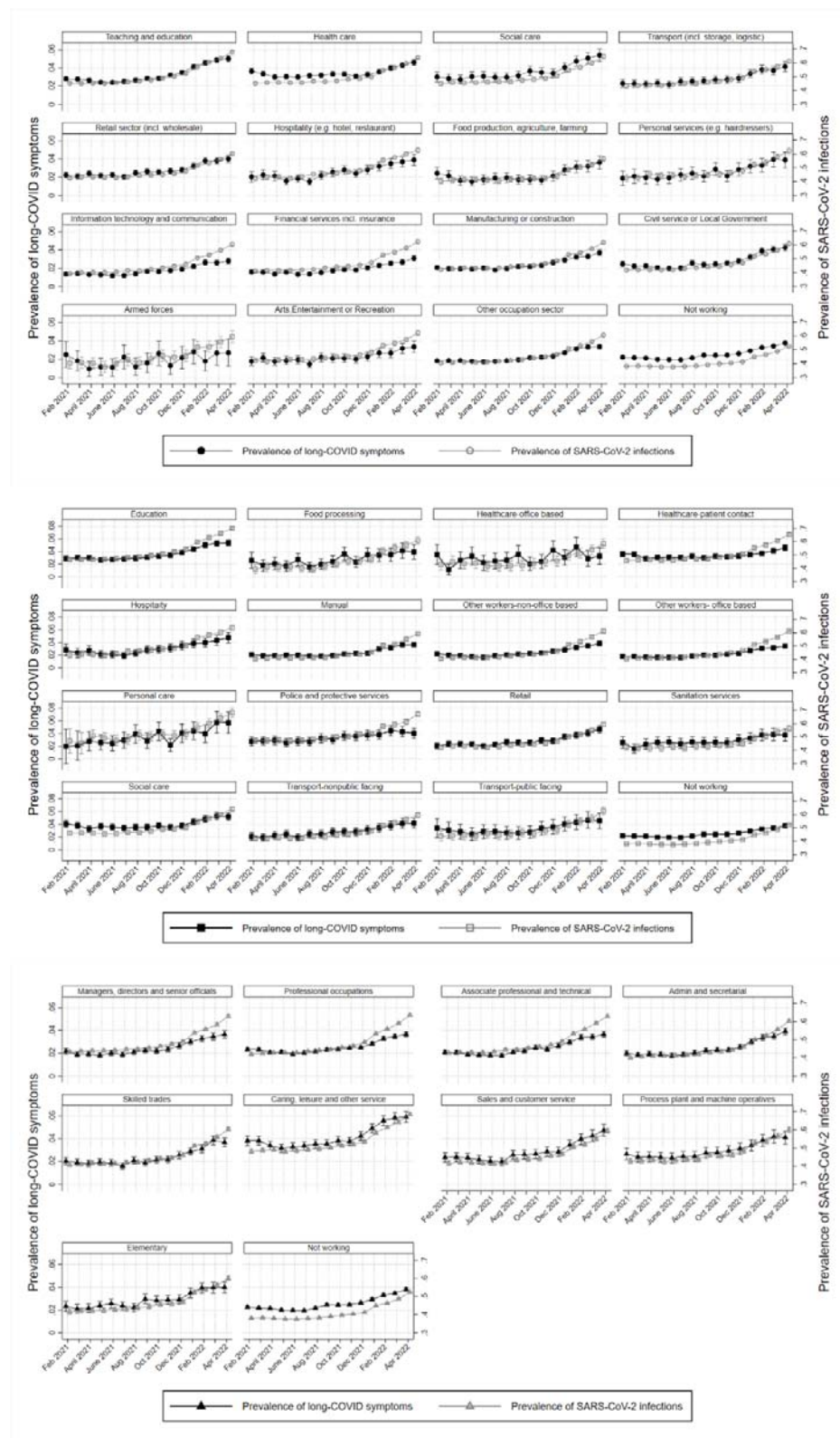
Cohort characteristics

Our final analytical samples included 323 766 individuals by industry, 277 487 individuals by occupational group and 307 363 individuals by major SOC group (Figure 1). Table 1 illustrates descriptive statistics by exposure group. In all cases, the non-working group had approximately twice as high prevalence of underlying health conditions (Table S3) and a higher prevalence of being affected ‘a lot’ by long-COVID. (Tables S4b, S5b, S6b) compared to the working group.

Monthly prevalence of self-reported long-COVID and SARS-CoV-2 infection across time and across all three occupational exposures, demonstrates an increase of the prevalence of self-reported long-COVID with time, following similar trends in SARS-CoV-2 infection (Figure 2). Prevalence of long-COVID by industry ranges from ~2% to almost 6% in April 2022 for social care and education. The healthcare sector also shows relatively high prevalence that increases post-January 2022. Similar patterns in long-COVID prevalence are observed by occupation and major SOC group. Education and social care and hospitality occupations demonstrate the highest prevalence (>4% from Jan 2022). Caring, leisure and other service occupations (SOC group) exhibit the highest prevalence, followed by sales and customer service occupations.

Table 1. Descriptive statistics of all covariates used for adjustment by exposure and self-reported long-covid case- Number and percentages of individuals

Exposure groups		Industry (SIC)						Occupational groups						Major occupational groups (SOC)					
Outcome	Self-reported long-COVID	No	Count Yes	Total	No	% Yes	Total	No	Count Yes	Total	No	% Yes	Total	No	Count Yes	Total	No	% Yes	Total
Age bands	15-19	21 083	1 440	22 523	7.2	4.7	7.0	20 771	1 415	22 186	8.3	5.5	8.0	20 911	1 430	22 341	7.5	4.9	7.3
	20-24	15 820	1 140	16 960	5.4	3.7	5.2	14 149	998	15 147	5.6	3.9	5.5	15 193	1 089	16 282	5.5	3.8	5.3
	25-29	20 191	1 516	21 707	6.9	5.0	6.7	16 607	1 234	17 841	6.6	4.8	6.4	18 864	1 432	20 296	6.8	4.9	6.6
	30-34	24 958	2 168	27 126	8.5	7.1	8.4	20 492	1 780	22 272	8.1	6.9	8.0	23 390	2 045	25 435	8.4	7.1	8.3
	35-39	27 647	2 911	30 558	9.4	9.5	9.4	22 596	2 348	24 944	9.0	9.1	9.0	25 890	2 715	28 605	9.3	9.4	9.3
	40-44	29 224	3 766	32 990	10.0	12.3	10.2	23 787	3 065	26 852	9.5	11.8	9.7	27 315	3 520	30 835	9.8	12.2	10.0
	45-49	30 989	4 032	35 021	10.6	13.2	10.8	25 318	3 323	28 641	10.1	12.8	10.3	28 983	3 807	32 790	10.4	13.1	10.7
	50-54	34 809	4 550	39 359	11.9	14.9	12.2	28 866	3 752	32 618	11.5	14.5	11.8	32 671	4 270	36 941	11.7	14.7	12.0
	55-59	38 180	4 353	42 533	13.0	14.3	13.1	32 773	3 744	36 517	13.0	14.5	13.2	36 252	4 146	40 398	13.0	14.3	13.1
	60-64	39 819	3 819	43 638	13.6	12.5	13.5	36 261	3 435	39 696	14.4	13.3	14.3	38 585	3 694	42 279	13.9	12.8	13.8
	65-69	10 503	848	11 351	3.6	2.8	3.5	9 979	794	10 773	4.0	3.1	3.9	10 329	832	11 161	3.7	2.9	3.6
Sex	Male	135 306	11 759	147 065	46.1	38.5	45.4	114 942	9 826	124 768	45.7	38.0	45.0	127 779	11 075	138 854	45.9	38.2	45.2
	Female	157 917	18 784	176 701	53.9	61.5	54.6	136 657	16 062	152 719	54.3	62.0	55.0	150 604	17 905	168 509	54.1	61.8	54.8
Deprivation	1st Quartile	44 738	5 668	50 406	15.3	18.6	15.6	39 010	4 908	43 918	15.5	19.0	15.8	42 574	5 393	47 967	15.3	18.6	15.6
	2nd Quartile	68 677	7 360	76 037	23.4	24.1	23.5	58 714	6 292	65 006	23.3	24.3	23.4	65 160	7 007	72 167	23.4	24.2	23.5
	3rd Quartile	83 677	8 398	92 075	28.5	27.5	28.4	71 560	7 095	78 655	28.4	27.4	28.4	79 472	7 958	87 430	28.6	27.5	28.5
	4th Quartile	96 131	9 117	105 248	32.8	29.9	32.5	82 315	7 593	89 908	32.7	29.3	32.4	91 177	8 622	99 799	32.8	29.8	32.5
Government office regions	North East	10 033	1 349	11 382	3.4	4.4	3.5	8 563	1 124	9 687	3.4	4.3	3.5	9 540	1 279	10 819	3.4	4.4	3.5
	North West	32 049	3 914	35 963	10.9	12.8	11.1	27 026	3 241	30 267	10.7	12.5	10.9	30 258	3 678	33 936	10.9	12.7	11.0
	Yorkshire & the Humber	23 074	2 692	25 766	7.9	8.8	8.0	19 772	2 264	22 036	7.9	8.8	7.9	21 969	2 571	24 540	7.9	8.9	8.0
	East Midlands	18 474	2 032	20 506	6.3	6.7	6.3	15 832	1 728	17 560	6.3	6.7	6.3	17 544	1 938	19 482	6.3	6.7	6.3
	West Midlands	21 127	2 430	23 557	7.2	8.0	7.3	18 163	2 033	20 196	7.2	7.9	7.3	20 160	2 320	22 480	7.2	8.0	7.3
	East of England	26 605	2 704	29 309	9.1	8.9	9.1	22 254	2 230	24 484	8.9	8.6	8.8	25 298	2 577	27 875	9.1	8.9	9.1
	London	56 565	5 190	61 755	19.3	17.0	19.1	46 784	4 276	51 060	18.6	16.5	18.4	52 959	4 886	57 845	19.0	16.9	18.8
	South East	36 248	3 477	39 725	12.4	11.4	12.3	31 041	2 919	33 960	12.3	11.3	12.2	34 384	3 282	37 666	12.4	11.3	12.3
	South West	22 150	2 147	24 297	7.6	7.0	7.5	19 331	1 861	21 192	7.7	7.2	7.6	21 195	2 021	23 216	7.6	7.0	7.6
	Northern Ireland	8 378	838	9 216	2.9	2.7	2.9	7 431	738	8 169	3.0	2.9	2.9	7 851	785	8 636	2.8	2.7	2.8
	Scotland	24 138	2 266	26 404	8.2	7.4	8.2	22 263	2 110	24 373	8.9	8.2	8.8	23 428	2 205	25 633	8.4	7.6	8.3
	Wales	14 382	1 504	15 886	4.9	4.9	4.9	13 139	1 364	14 503	5.2	5.3	5.2	13 797	1 438	15 235	5.0	5.0	5.0
Urban or Rural	Major urban	110 000	11 547	121 547	37.5	37.8	37.5	92 337	9 624	101 961	36.7	37.2	36.7	103 478	10 918	114 396	37.2	37.7	37.2
	Urban city or town	122 942	13 315	136 257	41.9	43.6	42.1	106 614	11 333	117 947	42.4	43.8	42.5	117 243	12 617	129 860	42.1	43.5	42.3
	Rural town	29 107	2 890	31 997	9.9	9.5	9.9	25 176	2 494	27 670	10.0	9.6	10.0	27 806	2 790	30 596	10.0	9.6	10.0
	Rural village	31 174	2 791	33 965	10.6	9.1	10.5	27 472	2 437	29 909	10.9	9.4	10.8	29 856	2 655	32 511	10.7	9.2	10.6
Household Size	One	38 251	4 202	42 453	13.1	13.8	13.1	32 671	3 562	36 233	13.0	13.8	13.1	36 288	3 975	40 263	13.0	13.7	13.1
	Two	109 005	10 377	119 382	37.2	34.0	36.9	93 306	8 859	102 165	37.1	34.2	36.8	103 553	9 881	113 434	37.2	34.1	36.9
	Three	59 258	6 298	65 556	20.2	20.6	20.3	50 670	5 290	55 960	20.1	20.4	20.2	56 126	5 972	62 098	20.2	20.6	20.2
	Four	59 824	6 646	66 470	20.4	21.8	20.5	51 287	5 627	56 914	20.4	21.7	20.5	56 783	6 303	63 086	20.4	21.8	20.5
	Five plus	26 885	3 020	29 905	9.2	9.9	9.2	23 665	2 550	26 215	9.4	9.9	9.5	25 633	2 849	28 482	9.2	9.8	9.3
Health Condition	No	248 054	23 727	271 781	84.6	77.7	83.9	210 591	19 808	230 399	83.7	76.5	83.0	234 681	22 422	257 103	84.3	77.4	83.7
	Yes	45 169	6 816	51 985	15.4	22.3	16.1	41 008	6 080	47 088	16.3	23.5	17.0	43 702	6 558	50 260	15.7	22.6	16.4
Total		293 223	30 543	323 766	90.6	9.4	100.0	251 599	25 888	277 487	90.7	9.3	100.0	278 383	28 980	307 363	90.6	9.4	100.0



298

299 **Figure 2:** Monthly prevalence of self-reported long-COVID symptoms (Primary y-axis; left) and SARS-
300 CoV-2 infections (secondary y-axis; right) for all workers aged 16-65 for (a) industry; (b) occupational
301 groups: and (c) SOC major groups

302

303 **Relative risk (ORs) and prevalence (marginal means) of long-COVID**

304 In the unadjusted model (Table S7), Teaching and education (OR 1.41; CIs: 1.36-1.46), Social care (OR
305 1.38, CIs: 1.28-1.48), Healthcare (1.19; CIs: 1.14-1.23), Civil service or local government (1.12; CIs:
306 1.06-1.17), retail (1.08; CIs: 1.08; 1.03-1.14) and transport (1.08; CIs: 1.00-1.16) demonstrated
307 increased likelihood of reporting long-COVID symptoms compared to the average working-age
308 population. All other sectors (including the non-working group) showed odds ratios (ORs) less than
309 one or with very wide CIs, with the lowest ORs being in the information technology and
310 communication sector(IT) (0.75; CIs: 0.71-0.79). In the fully adjusted model (Table S7, Figure 3a), ORs
311 for most industries were attenuated and the pattern remained the same with Teaching and
312 education exhibiting the highest odds (1.27; CIs: 1.23-1.31). Exceptions to confounding attenuation
313 were primarily seen for the transport industry (1.12; CIs: 1.04-1.21) and hospitality and
314 manufacturing, albeit with wide confidence intervals. Prevalence of long-COVID (marginal means-
315 predicted probability of having at least one episode of long-COVID symptoms across all groups)
316 ranged from 7.8% (IT, financial services and armed forces) to 11.1% (social care) and 11.6% for
317 teaching and education (Table S9, Figure S1a).

318 By occupational group, in the unadjusted model most demonstrated higher likelihood of having
319 long-COVID; however, for some CIs are wide (Table S7). Similar to analysis by industry, education (OR
320 1.53; CIs: 1.61-1.79) and Social Care (1.53; CIs: 1.45-1.60) occupations showed the highest risk.
321 Manual, other workers-non-office based and office-based occupations, along with the non-working
322 group showed ORs<1. After adjustment (Table S7, Figure 3b), education (1.34; CIs: 1.28-1.41) and
323 social care (1.34; CIs: 1.26-1.43) remained the two groups with the highest relative risk and were
324 closely followed by police and protective services (1.31; CIs 1.18-1.45), hospitality (1.27; CIs 1.13-
325 1.43), and transport- public facing (1.25; CIs 1.03-1.51) or non-public facing (1.16; CIs 1.04-1.29). The
326 group with the lowest ORs was office-based occupations (0.90; CIs: 0.88-0.92). All other groups with
327 ORs≤1 have very wide confidence intervals. Prevalence of long-COVID by occupational group ranged
328 from a low of 8.4% in other workers-office based, to a high of 12% in education (Table S9, Figure
329 S1b).

330 Using major SOC group as the exposure, in the unadjusted model (Table S7), ORs for Caring, Leisure
331 and other services stand out (OR 1.65, CIs: 1.58-1.73), compared to all other groups, followed by the
332 sales and customers service, elementary, and process plant and machine operatives' groups with
333 ORs>1. In the remaining major SOC groups ORs were lower than one. After adjustment the category
334 with the highest ORs remains the same; however, ORs were slightly attenuated. Minor changes were

observed in all other groups (Table S7, Figure 3c). Admin and secretarial, professional occupations and those not working were less likely to report long-COVID symptoms. However, those in caring, leisure and other services (1.44, CIs: 1.38-1.53) still demonstrated substantially higher odds than average, followed by process plant and machine operatives (1.14, CIs: 1.05-1.23), sales and customer service (1.11, CIs: 1.04-1.19) and elementary occupations (1.11, CIs: 1.04-1.19). Finally, estimations for managers, directors and senior officials, and associate professional and technical occupations are uncertain. For most occupational groups prevalence of long-COVID was between 9 and 10%, with the exceptions of caring, leisure and other service occupations with 13% prevalence Analysis by major SOC group (Table S9, Figure S1c).

Comparing the likelihood of long-COVID with the likelihood of SARS-CoV-2 infection (Figures 3a-c) demonstrates similar patterns, i.e., industries with high risk of SARS-CoV-2 infection generally display high likelihood of long-COVID symptoms. In the majority of occupational groups similar patterns exist, with minor discrepancies for healthcare-office based where $OR > 1$ for SARS-CoV-2 infection and $OR < 1$ for long-COVID; and food processing and sanitation services where the opposite pattern is observed (Figure 3b). Using major SOC groups as the exposure displayed similar findings (Figure 3c), with the main exception of professional occupations, where likelihood of long-COVID is proportionally higher compared to SARS-CoV-2 infection. Some indication of different patterns between risk of infection and long-COVID were also observed in managers, directors and senior officials and sales occupations; however, in all cases confidence intervals are wide.

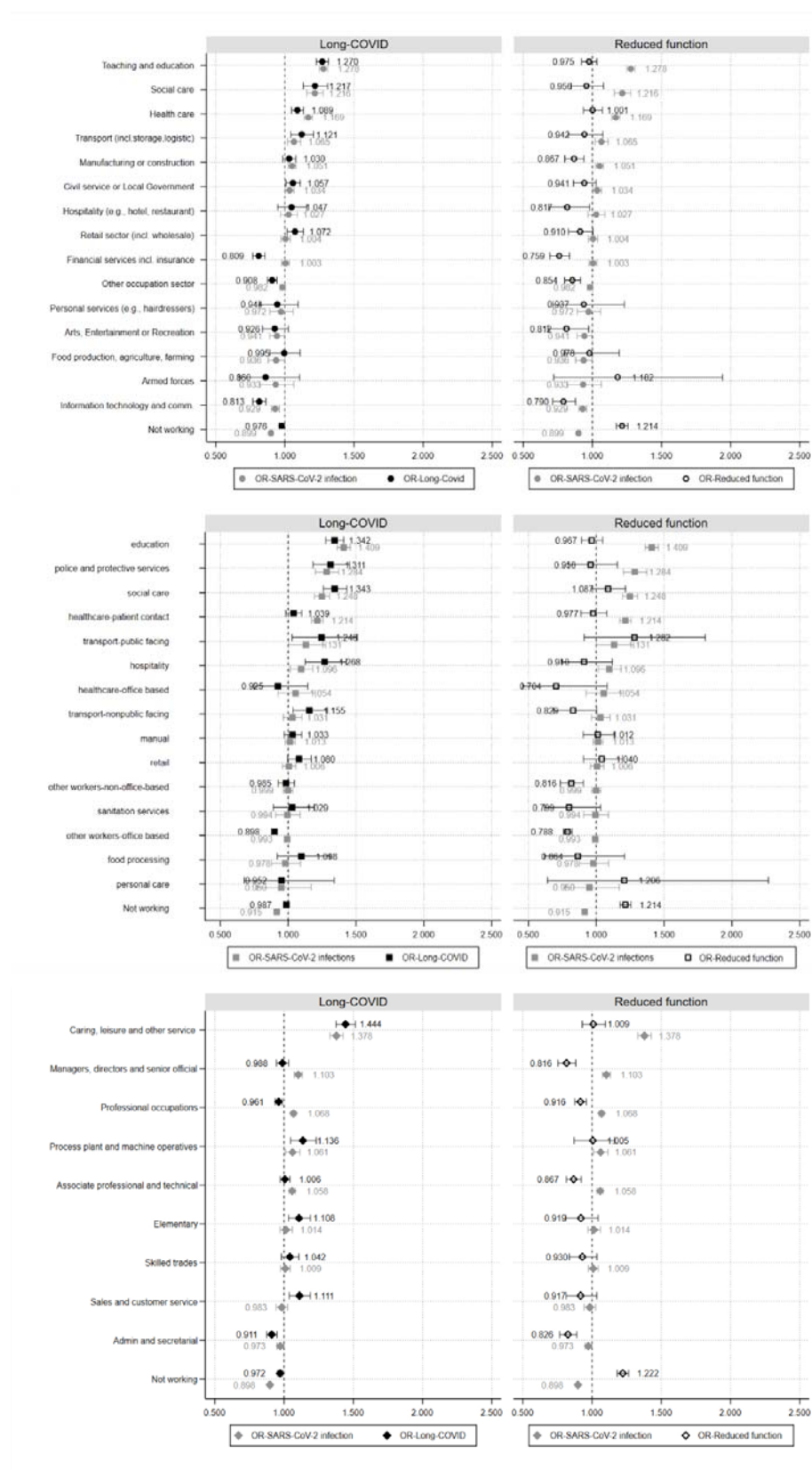


Figure 3. Odds (a-c) of having Long-COVID symptoms (left) and reduced function (right) by industry, occupational groupings and major SOC groups

358

359 **Odds ratios (ORs) and prevalence (margins) of reduced function due to long-COVID**

360 In order to examine the extent to which long-COVID symptoms impacted daily activities (i.e., proxy
361 of severity) we used a reduced sample for all three exposure groups as analyses were restricted to
362 those self-reporting at least one long-COVID symptom over the study period. Final analytical samples
363 were 30 543 participants for industry, 25 888 participants for occupational groups and 28 979
364 participants for major SOC groups (Figure 1).

365 In the unadjusted model (Table S8) all industries, apart from healthcare (ORs 1.07; CIs: 1.00-1.14)
366 and Social Care (1.07; CIs: 0.95-1.14), demonstrated lower odds of experiencing reduced function
367 (i.e., reporting that daily activities were impacted a little or a lot) compared to the grand mean, while
368 those not working had the highest odds (1.26; CIs: 1.23-2.03). Adjusting for all covariates attenuates
369 ORs and in many cases confidence intervals are wide (e.g., Retail sector, food production and
370 personal services); however, the trends remain stable (Table S8, Figure 3a).

371 Analysis by occupational groups (Table S8), similarly demonstrated that those not working have very
372 high odds of reduced function (OR 1.25; CIs: 1.21-1.29); however, the highest odds are observed in
373 the transport-public facing occupational group (1.29; CIs: 0.92-1.81), followed by personal (1.25; CIs:
374 0.67-2.32) and social care (1.23; CIs: 1.10-1.37) occupations. In all other groups ORs are less than
375 one. Adjusting for all confounders generally attenuated the odds, but results retained the same
376 patterns for magnitude and confidence intervals (Table S8, Figure 3a).

377 By major SOC group, in the unadjusted model (Table S8) for almost all groups it is less likely for
378 someone to demonstrate reduced function due to long-COVID. The exceptions were the not working
379 group (OR 1.27; CIs: 1.23-1.31) and the caring, leisure and other services (1.09; CIs: 1.01-1.18).
380 Following adjustment, effect is attenuated for all groups (Table S8, Figure 3a).

381 Prevalence of reduced function by a 'a little' ranged between 47% and 49% for all three exposure
382 groups (Table S9, Figure S2). Prevalence of reduced function by 'a lot', ranged from 17.1% to 21.7%
383 by industry (for the arts, entertainment or recreation and teaching and education sectors,
384 respectively), and 27.3%. for those not working. By occupational group, the lowest prevalence of
385 reduced function by 'a lot' was observed for education (24.1%) and the highest for social care,
386 personal care, and public-facing transport occupations. The latter were comparable to the
387 prevalence for those not working (28.2%) (Table S9, Figure S2). By major SOC group, reduced
388 function by 'a lot' ranged from 20.9% for managers, directors and senior officials and admin and
389 secretarial to 24.4% for caring, leisure and other services and process plant and machine operatives.

390

391 **Sensitivity Panel Analysis - Relative risk (ORs) of long-COVID & reduced function due to long-** 392 **COVID**

393 Analysis run on the specified two additional samples, i.e. (i) confirmed PCR test or (ii) confirmed PCR
394 test or prior report of infection (Figures S3-S4) did not show different patterns, confirming the
395 robustness of our results.

396 For long-COVID odds ratios from the panel analysis were relatively larger compared to our main
397 analysis for almost all industrial and occupational groups. The opposite was observed for major SOC
398 groups, although the magnitude of the odds ratios were closer to those in our main sample. Similar
399 patterns were observed for the outcome of reduced daily function (Tables S10-S12), suggesting
400 assumptions about changes in occupation/occupational status over time are valid.

401

402

403 **Discussion**

404 *Summary of findings*

405 The prevalence of self-reported long-COVID increased through the study period. The social care and
406 education industry (~6%) and hospitality (~4%) occupations recorded the highest prevalence.
407 Industries and occupations with high levels of office-based working (e.g., IT), displayed lowest odds
408 of long-COVID compared to more public facing industries, including teaching and education, social
409 care, healthcare, civil service, retail and transport industries and occupations. By major SOC group,
410 those in caring, leisure and other services (OR 1.44; CIs: 1.38-1.52) and education displayed (1.34;
411 CIs: 1.28-1.41) substantially higher odds than average. The likelihood of reporting long-COVID
412 symptoms followed the trend of risk of infection for most industries, occupational groups and SOC
413 groups. The exception was for professional occupations, where relative risk of reporting long-COVID
414 symptoms was higher than that of infections. Indication of differing patterns between infection and
415 long-COVID were also observed in other occupational groups, but results uncertainty was high. Long-
416 COVID symptoms impacted almost half of all affected participants' ability to do daily activities by 'a
417 little'. Participants in healthcare and social care industries were most impacted by 'a lot'. Similarly,
418 occupational groups most affected were public-facing occupations with those working in transport
419 occupations having the highest prevalence of all (30%), followed by the not working (28.1%) and

personal care (27.4%). For SOC groups the highest prevalence (24%) was observed in caring, leisure and other services and process plant and machine operatives.

Findings in context with previous literature

To our knowledge, no other studies examine long-COVID across industries and/or occupational groups for direct comparisons. However, previous work estimated that ~10% of people infected with Covid-19 may have significant post-acute or chronic symptoms persisting >12 weeks (23) and that a substantial proportion of these will have symptoms that are disabling and involve prolonged absence from work (24). These findings are in line with our results (23 24). A study in adult patients with COVID-19 attending a hospital showed that post-acute COVID-19 syndrome was detected in a half of COVID-19 survivors (25). These are higher than our results but were an older cohort and probably represent a group with severe COVID-19 infection (25). Vulnerable groups are disproportionately represented among essential workers (e.g., bus drivers, allied health professionals) (26 27). In addition to being at a greater risk of infection (3 4 28), they may also face a disproportionate burden of long-COVID. Our findings suggest that workers in social care, education, hospitality, food production and transport have increased odds of long-COVID. Moreover, groups likely to have high levels of long-COVID include those with a high risk of SARS-CoV2 infection (26), with the exception of professional occupations.

Strengths & Limitations

Our study has several strengths. We used a large nationally representative dataset to examine prevalence and risk of long-COVID across industries, and occupations, which fills an important gap in the literature. Our analysis included a relatively long study period (Feb2021-Apr2022), allowing us to examine trends of over time. Some limitations should be noted. Any analysis by occupation/sector requires aggregation of different types of workers in groups. It is possible that analyses mask differences within particular sectors or occupations. In our main analyses we utilised occupational status at the beginning of the study period, which may mask effects due to changes in employment status. However, our sensitivity analysis using a panel dataset addressed this. At the time of data collection, there was no universal definition of long-COVID, and the results reported rely on self-reported measures which are prone to bias. It is possible that bias in this measure is related to occupation – for example healthcare workers increased health knowledge may mean that they self-diagnose long-COVID differently. The CIS recording of COVID-19 infections does not include infections occurring between visits and missed visits may be related to occupation e.g., shift-

workers being unavailable at the CIS visit. It is not possible to assess the reason(s) participant are not working. Therefore, we cannot examine or exclude the possibility that some participants are not working due to long-COVID symptoms.

Conclusions

The SARS-CoV-2 pandemic created new challenges for workers, employers, occupational and public health. Long-COVID is compounding to these challenges, mainly related to sustaining employment and return-to-work for those affected. Our findings show that long-COVID differences are evident across industries and occupations. Professional occupations, including jobs in teaching and education, IT, welfare and healthcare showed that the risk of infection may not be the only driving force. Our findings of increased risk of long-COVID in the health and social care industries support the findings that some health conditions are prescribed as industrial diseases (7) and highlight other sectors and occupations that require further attention. Scientific evidence is essential to understand the mechanisms resulting in long-COVID, how occupation influences prevalence and severity and whether working conditions affect the risk of developing long-COVID or interact with long-COVID to increase the impact on activities.

Contributors

SR is the principal investigator. All authors contributed to the design of the proposal and study. TK lead and conducted the statistical analysis and was supported by ED and SR. TK and ED drafted the manuscript. All authors contributed to the interpretation of the results, critically revised the paper and agreed on the final version for submission.

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Disclaimer

This work contains statistical data from ONS which is Crown Copyright. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Competing interests

SVK was co-chair of the Scottish Government’s Expert Reference Group on Ethnicity and COVID-19 and a member of the UK Scientific Advisory Group on Emergencies subgroup on ethnicity.

Ethics approval

The COVID-19 Infection Survey received ethical approval from the South-Central Berkshire B Research Ethics Committee (20/SC/0195). All participants provided informed consent. For use of this data for this project statistics authority self-assessment classified the study as low risk. This assessment was approved by the Office for National Statistics (ONS) Research Accreditation Panel.

Data availability statement

ONS CIS data can be accessed only by researchers who are Office of National Statistics (ONS) accredited researchers. Researchers can apply for accreditation through the Research Accreditation Service. Access is through the Secure Research Service (SRS) and approved on a project basis. For further details see:

<https://www.ons.gov.uk/aboutus/whatwedo/statistics/requestingstatistics/approvedresearcherscheme>.

Patient and public involvement: Participants were not involved in the design and implementation of the study or in setting research questions and the outcome measures. No participants were asked to advise on interpretation or writing up of results.

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