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# Excess mortality among essential workers in England and Wales during the COVID-19 pandemic

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## ABSTRACT

**Background** Exposure to SARS-CoV-2, subsequent development of COVID-19 and death from COVID-19 may vary by occupation, and the risks may be higher for those categorised as ‘essential workers’.

**Methods** We estimated excess mortality by occupational group and sex separately for each month in 2020 and for the entire 12 months overall.

**Results** Mortality for all adults of working age was similar to the annual average over the previous 5 years. Monthly excess mortality peaked in April, when the number of deaths was 54.2% higher than expected and was lowest in December when deaths were 30.0% lower than expected.

Essential workers had consistently higher excess mortality than other groups throughout 2020. There were also large differences in excess mortality between the categories of essential workers, with healthcare workers having the highest excess mortality and social care and education workers having the lowest. Excess mortality also varied widely between men and women, even within the same occupational group. Generally, excess mortality was higher in men.

**Conclusions** In summary, excess mortality was consistently higher for essential workers throughout 2020, particularly for healthcare workers. Further research is needed to examine excess mortality by occupational group, while controlling for important confounders such as ethnicity and socioeconomic status. For non-essential workers, the lockdowns, encouragement to work from home and to maintain social distancing are likely to have prevented a number of deaths from COVID-19 and from other causes.

## INTRODUCTION

Over 9.3 million COVID-19 cases have been confirmed in England and Wales as of 3 December 2021, with over 153 000 deaths attributed to the disease.<sup>1–4</sup>

Exposure to SARS-CoV-2, subsequent development of COVID-19 and death from COVID-19 may vary by occupation, and the risks may be higher for those categorised as ‘essential workers’.<sup>5–13</sup> Healthcare, social care and education workers have particularly high infection rates.<sup>12 14 15</sup> In adults of working age, the risk of developing severe COVID-19 is highest for medical support staff, social care workers and transport workers.<sup>6</sup> The risk of death from COVID-19 during 2020 has been shown to be significantly higher in social care

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Essential workers may be at a higher risk of developing severe COVID-19, particularly those working as medical support staff, social care workers and transport workers.

## WHAT THIS STUDY ADDS

⇒ Our analysis is the first to report monthly trends in excess mortality during the pandemic among essential workers in England and Wales. Excess mortality was consistently higher for essential workers throughout 2020, particularly for healthcare workers.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our results show that for non-essential workers, the lockdowns, encouragement to work from home and to maintain social distancing are likely to have prevented a number of deaths from COVID-19 and from other causes. However, further research is needed to examine excess mortality by occupational group for essential workers, while controlling for important confounders such as ethnicity and socioeconomic status.

workers and male healthcare workers than in the general population.<sup>5</sup>

Previous studies showing a higher risk of COVID-19 death in specific occupational groups in England and Wales have counted only deaths following a positive test or where COVID-19 is mentioned on the death certificate.<sup>5 6</sup> These data rely heavily on the availability and reliability of tests. During the early part of the pandemic, COVID-19 tests were not widely available to the public, and only deaths occurring in a hospital after a positive test were counted. Moreover, those death counts will not have included deaths following a false negative test. Similarly, death counts that require a mention of COVID-19 on the death certificate may be subject to bias. In the UK, the definition of a COVID-19 death differs between institutions.<sup>16</sup> Thus, trends in the number of deaths attributed to COVID-19 are a mix of actual changes in the number of people dying from COVID-19, changes in the eligibility criteria for COVID-19 testing and different practices for reporting the cause of death on the death certificate.

An alternative way to monitor and compare deaths during a pandemic is to use excess mortality,



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which was used to examine the impact of the influenza pandemic of 1918–1919.<sup>17–19</sup> This compares the number of deaths from any cause that have occurred each week or month during the pandemic with the average number of deaths during that same week or month in previous years. Excess mortality can be expressed in absolute terms (the excess death count) or in relative terms (as the percentage of the corresponding number of deaths in previous years).

In England and Wales, all-cause mortality in 2020 has been higher than in previous years (excess mortality), both in the population as a whole and in various subgroups. Excess mortality has been particularly high in London, and among men, older adults, ethnic minorities, those living in care homes and those living in the most deprived areas.<sup>10 20–24</sup>

Only two studies to date have examined excess mortality during 2020 by occupation. In California (USA), workers in the food, transportation and manufacturing industries had experienced the highest excess mortality during the first 9 months of the pandemic.<sup>25</sup> In England, Public Health England reported relative increases in mortality (the ratio of the total number of deaths during March to May 2020 to the 5-year average during the same months in 2014–2018) for workers in caring personal services, elementary security operations and road transport.<sup>10</sup>

Our analysis is the first to report monthly trends in excess mortality during the pandemic among essential workers in England and Wales.

## METHODS

We obtained the final official counts of all deaths from any cause that occurred in England and Wales between 1 January 2015 and 31 December 2020 from the Office for National Statistics.

We restricted our analyses to adults living in England and Wales who were aged 20–64 years at the time of death (figure 1). We excluded two records missing the month and day of death. In all, we included 383 704 deaths that occurred between 1 January

and 31 December in 2015–2019 and 75 901 deaths between 1 January and 31 December 2020.

We used the four-digit Standard Occupational Classification 2010 unit group reported on the death certificate and literature to categorise occupations into three broad groups of essential workers: healthcare, social care and education, and other essential occupations (online supplemental table 1).<sup>6</sup> These broad groups were further divided into healthcare professionals, healthcare associate professionals and medical support staff; social care workers and educational staff; and police and protective services, food industry workers and transport industry workers. We included two additional categories: non-essential workers and adults whose occupation was unknown, or who were unemployed at the time of death. Of the 383 704 deaths during 2015–2019, 90 370 (24%) occurred in adults who were unemployed at the time of death, or whose occupation was unknown. The proportion was very similar for deaths during 2020 (16 988, 22%).

We estimated excess mortality by occupational group and sex separately for each month in 2020 and for the entire 12 months overall. To estimate excess mortality, we compared the total number of deaths in each month of 2020 with the average number of deaths occurring in the same month during the previous 5 years ('expected deaths'). We used 5 years of mortality data from 2015 to 2019 to reduce any bias from spikes in the number of deaths in a single month and year (eg, due to an influenza outbreak or a heatwave) and to be consistent with previous analyses conducted. We used the date when the death occurred, rather than the date when it was registered, to avoid any effects of delays in the reporting of deaths. We report excess mortality both as the number of deaths over and above the expected number and as the percentage of the expected number of deaths.

## RESULTS

### Total excess mortality: 1 January 2020–31 December 2020

During 2020, 75 901 deaths occurred among adults aged 20–64 years living in England and Wales. The total number of deaths was similar to the average number of deaths per year during 2015–2019 (expected deaths). There were 840 fewer deaths than expected, representing a decrease of 1.1% (table 1). The total number of deaths in men was 45 574, with 858 or 1.8% fewer deaths than expected (online supplemental table 2). While in women the total number of deaths was 30 327, only 18 (0.1%) more than expected (online supplemental table 3).

Healthcare workers had the highest excess mortality, at 13.3% (table 1). The second highest excess mortality was in adults working in other essential occupations (6.1%), followed by those working in social care and education (4.3%).

For non-essential workers, unemployed or those whose occupation was unknown, mortality was 3%–6% lower than would have been expected if the pandemic had not occurred (table 1).

Further subdividing healthcare workers into healthcare professionals, healthcare associate professionals and medical support staff revealed large differences, with excess mortality highest for medical support staff (22.3%) (table 2). Separating social care workers from those in education revealed that deaths in 2020 were 7.7% higher than expected for social care workers, but 3.4% lower for those working in education (tables 2 and 3). Among other essential workers, transport workers had the highest excess mortality (9.2%), followed by those working for the police and in protective services (5.5%) and food industry (4.0%) (table 3).

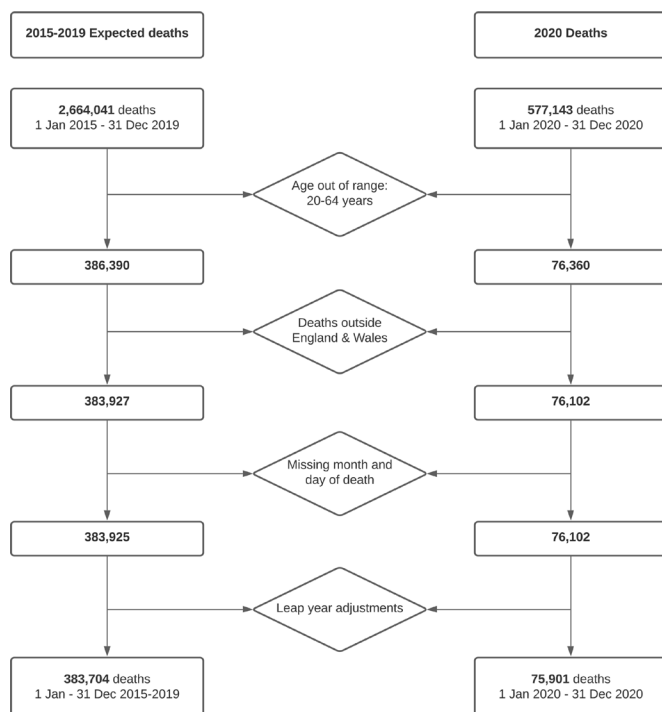


Figure 1 Data exclusion flow chart.

**Table 1** Number of deaths from all causes in 2020, and number (%) of excess deaths\*, adults aged 20–64 years, by broad essential worker occupational group, January 2020–December 2020

	All occupational groups				Healthcare workers				Social and education workers				Other essential workers				Non-essential workers				Unknown/unemployed				
	Deaths in 2020		Excess deaths (%)		Deaths in 2020		Excess deaths (%)		Deaths in 2020		Excess deaths (%)		Deaths in 2020		Excess deaths (%)		Deaths in 2020		Excess deaths (%)		Deaths in 2020		Excess deaths (%)		
	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)	
January	6879	-5.1	254	0.7	524	-21	-3.8	1130	-49	-4.2	3342	-199	-5.6	1629	-104	-6.0									
February	5907	-6.5	227	-2	447	-32	-6.7	989	-50	-4.8	2828	-248	-8.0	1417	-80	-5.3									
March	7657	13.7	303	64	266	82	15.8	1256	196	18.5	3609	312	9.4	1890	268	16.5									
April	9782	3439	442	209	89.9	764	273	55.7	1778	750	73.0	4454	1351	43.5	2344	855	57.4								
May	6767	452	320	97	43.8	536	34	6.7	1173	171	17.1	3227	136	4.4	1511	14	0.9								
June	5722	-254	247	26	11.7	433	-35	-7.5	979	23	2.4	2755	-204	-6.9	1308	-64	-4.7								
July	5643	-504	241	6	2.5	445	-34	-7.1	970	-24	-2.4	2801	-229	-7.6	1186	-223	-15.8								
August	5642	-442	246	26	11.7	495	14	2.9	957	-27	-2.7	2722	-276	-9.2	1222	-179	-12.8								
September	5247	-698	213	-1	-0.3	467	4	0.9	908	-64	-6.6	2571	-326	-11.2	1088	-312	-22.3								
October	5776	-545	246	15	6.4	493	-12	-2.4	983	-40	-3.9	2866	-207	-6.7	1188	-301	-20.2								
November	6006	-333	243	7	2.8	569	68	13.6	1062	68	6.9	2937	-196	-6.2	1195	-280	-19.0								
December	4873	-2092	172	-77	-31.0	445	-87	-16.3	917	-201	-17.9	2329	-1046	-31.0	1010	-682	-40.3								
Total	75901	-840	3154	371	13.3	6217	254	4.3	13102	753	6.1	36441	-1131	-3.0	16988	-1086	-6.0								

\*The total number of deaths in each month of 2020 compared with the average number of deaths occurring in the same month for the previous 5 years. The percentage of excess deaths is the total number of excess deaths expressed as a percentage of the 5-year average.

Excess mortality was higher in men than in women in each broad and detailed occupational group (online supplemental tables 2-5). For example, although healthcare workers had the highest excess mortality among all occupational groups, excess mortality in this group was much higher in men than in women (23.2% vs 9.6%).

**Pre-lockdown: 1 January 2020–22 March 2020**

During the first 2 months of 2020, mortality was similar to or lower than that of the previous 5 years for all broad occupational groups (table 1, figure 2). By the end of March 2020, however, mortality had increased for all groups and exceeded what would have been expected had the pandemic not occurred. Excess mortality followed a similar pattern for both men and women (online supplemental files 6; 7).

Excess mortality for all adults aged 20–64 years was 13.7% in March 2020 (table 1). Excess mortality was highest for healthcare workers (26.6%), followed by those working in other essential occupations (18.5%). There were 268 additional deaths, or 16.5% higher than expected, in adults with no known occupation or who were unemployed at the time of death. Social care and educational workers also experienced higher mortality than in previous years (15.8%). While still higher than expected, non-essential workers had the lowest excess mortality (9.4%) of the broad occupational groups in March 2020.

**First national lockdown: 23 March 2020–3 July 2020**

After the first national lockdown began on 23 March 2020, excess mortality continued to increase, with the peak of the first wave of the pandemic occurring in April, and then decreased rapidly during May and June (figures 2 and 3). Of the 9782 deaths occurring in adults aged 20–64 years in April 2020, there were 3439 more than expected, representing an excess mortality of 54.2% (table 1). By the end of June 2020, mortality had fallen to 4.3% below that expected for working age adults.

During April 2020, excess mortality was higher in men than in women (57.9% vs 48.5%) (online supplemental tables 2; 3). However, by the end of June mortality was 5.6% lower than expected in men and 2.2% lower than expected in women.

Excess mortality was 50% or higher in April 2020 for all essential occupations and those with an unknown occupation or who were unemployed (figures 2 and 3). The highest excess mortality was seen among healthcare workers (89.9%), while the lowest was in non-essential workers (43.5%) (table 1). By the end of June, mortality was lower than expected for those working in social care and education (7.5% lower), non-essential workers (6.9% lower) and those with an unknown occupation or who were unemployed (4.7% lower). Mortality was still higher than expected for healthcare workers (11.7%) and other essential workers (2.4%). There were large differences within each essential occupation (tables 2 and 3) and by sex (online supplemental tables 2; 3).

**Post-lockdown: 4 July 2020–4 November 2020**

During the 4 months following the lifting of the first national lockdown on 4 July 2020, mortality was consistently lower than expected among working age adults for all occupations combined (table 1). Mortality was 11.7% lower than expected in September 2020. Although there was a slight increase in mortality during October, it was still 8.6% lower than the 5-year average. Mortality was similar for men and women in July (8.0% and 8.5% lower, respectively), while in August and September, it was lower in men than in women (online supplemental tables 2;

**Table 2** Number of deaths from all causes in 2020, and number (%) of excess deaths\*, adults aged 20–64 years, by detailed essential worker occupational group, January 2020–December 2020

	Healthcare professionals			Healthcare associate professionals			Medical support staff			Social care		
	Deaths in 2020	Excess deaths		Deaths in 2020	Excess deaths		Deaths in 2020	Excess deaths		Deaths in 2020	Excess deaths	
		No	%		No	%		No	%		No	%
January	33	-3	-7.3	144	1	0.6	77	4	4.9	369	-5	-1.3
February	29	-4	-11.0	130	0	-0.2	68	1	1.6	314	-16	-4.8
March	38	5	15.9	174	45	35.1	91	13	17.0	422	64	17.9
April	72	40	125.0	227	93	69.7	143	76	113.4	551	218	65.4
May	46	15	47.4	185	54	41.7	89	28	46.4	376	28	7.9
June	31	-1	-2.5	121	-5	-3.8	95	31	49.4	307	-14	-4.4
July	37	3	7.6	125	-7	-5.2	79	10	14.5	335	7	2.0
August	25	-7	-22.4	131	7	5.8	90	26	40.2	337	3	1.0
September	21	-9	-29.1	110	-6	-5.0	82	14	20.2	332	10	3.2
October	39	8	26.6	131	0	0.3	76	6	8.9	358	3	0.8
November	22	-13	-36.4	135	6	4.8	86	13	17.8	412	64	18.5
December	21	-8	-28.1	101	-34	-25.2	50	-35	-41.3	320	-46	-12.6
Total	414	27	7.0	1714	156	10.0	1026	187	22.3	4433	316	7.7

\*The total number of deaths in each month of 2020 compared with the average number of deaths occurring in the same month for the previous 5 years. The percentage of excess deaths is the total number of excess deaths expressed as a percentage of the 5-year average.

3). There were slight increases in mortality during October for both men and women.

For other essential workers and for non-essential workers, relative mortality fell steadily from July to September, followed by a slight increase in October (table 1, figure 2). Excess mortality was highest in healthcare workers (11.7%) and adults working in social care and education (2.9%) during August. Those with an unknown occupation or who were unemployed at the time of death had the lowest mortality during this period, reaching the lowest point in September (22.3% lower than expected).

### Second national lockdown: 5 November 2020–2 December 2020

During the second national lockdown, mortality increased slightly though it was still lower than the average for 2015–2019

(5.3% lower) (table 1). Mortality was 7.1% lower in men and 2.6% lower in women (online supplemental tables 2; 3).

In November 2020, mortality in healthcare workers was 2.8% higher than expected, decreasing from the previous month (table 1, figure 2). However, for all other occupational groups, mortality continued to increase, and was highest for social care and education workers (13.6% higher than expected). Mortality for non-essential workers and those who were unemployed or whose occupation was unknown was lower than expected during the second national lockdown.

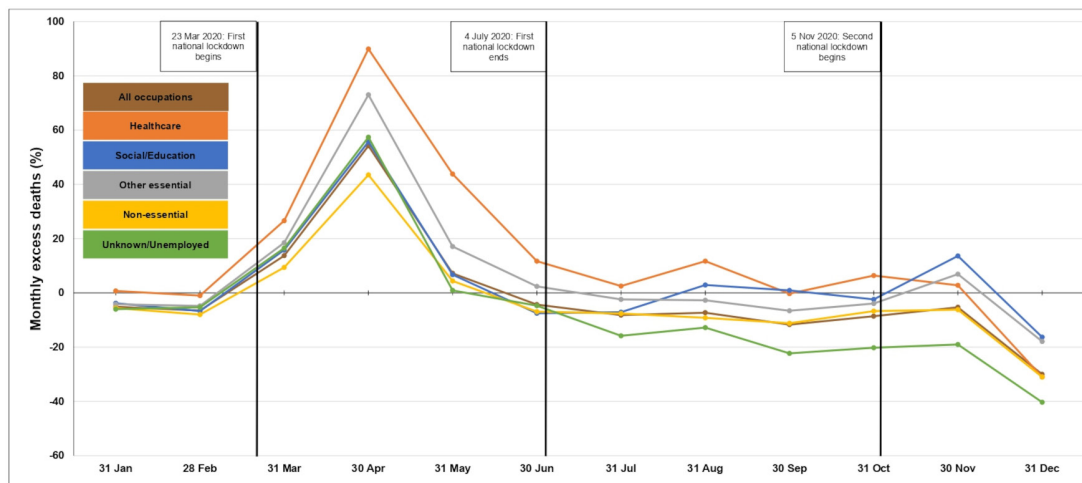
### Post-lockdown: 3 December 2020–31 December 2020

In December 2020, mortality was 30.0% lower than expected for all occupations combined (table 1) and for all broad occupational

**Table 3** Number of deaths from all causes in 2020, and number (%) of excess deaths\*, adults aged 20–64 years, by detailed essential worker occupational group, January 2020–December 2020

	Education			Police and protective			Food			Transport		
	Deaths in 2020	Excess deaths		Deaths in 2020	Excess deaths		Deaths in 2020	Excess deaths		Deaths in 2020	Excess deaths	
		No	%		No	%		No	%		No	%
January	155	-16	-9.3	306	-46	-13.2	424	-32	-7.1	400	29	7.9
February	133	-16	-11.0	291	-22	-6.9	410	13	3.1	288	-41	-12.3
March	177	18	11.2	372	59	19.0	449	30	7.3	435	106	32.2
April	213	55	35.2	534	236	79.0	651	256	64.7	593	259	77.3
May	160	6	3.9	357	58	19.3	457	76	19.9	359	38	11.7
June	126	-21	-14.3	300	13	4.6	347	-27	-7.3	332	37	12.5
July	110	-41	-27.0	283	-20	-6.5	385	-3	-0.7	302	-2	-0.5
August	158	10	7.0	314	26	9.0	337	-40	-10.6	306	-13	-4.1
September	135	-6	-4.4	261	-14	-5.1	363	-21	-5.6	284	-29	-9.2
October	135	-15	-10.0	274	-21	-7.1	393	-9	-2.3	316	-10	-3.1
November	157	4	2.5	307	22	7.8	374	-24	-5.9	381	70	22.4
December	125	-40	-24.4	242	-92	-27.5	403	-24	-5.7	272	-85	-23.7
Total	1784	-62	-3.4	3841	200	5.5	4993	193	4.0	4268	360	9.2

\*The total number of deaths in each month of 2020 compared with the average number of deaths occurring in the same month for the previous 5 years. The percentage of excess deaths is the total number of excess deaths expressed as a percentage of the 5-year average.



**Figure 2** Monthly excess deaths (%) by broad occupational group: adults aged 20–64 years, England and Wales.

groups (figure 2). A similar pattern was seen when examining mortality by detailed occupation groups (figure 3).

## DISCUSSION

This is the first study to examine monthly trends in excess mortality by occupation during the COVID-19 pandemic in England and Wales.

We have used all-cause observed mortality to estimate excess mortality during the COVID-19 pandemic. Excess mortality is not affected by the availability or reliability of COVID-19 tests, or who was eligible for testing. Thus, the number of excess deaths in each month during 2020 comes from the same population at risk—working age adults in England and Wales, rather than a population that changed over time. Excess mortality does not require data on the cause of death, and it is therefore unaffected by the differences in the definition of a COVID-19 death or variations in the practices of doctors reporting COVID-19 as the cause of death on the death certificate.

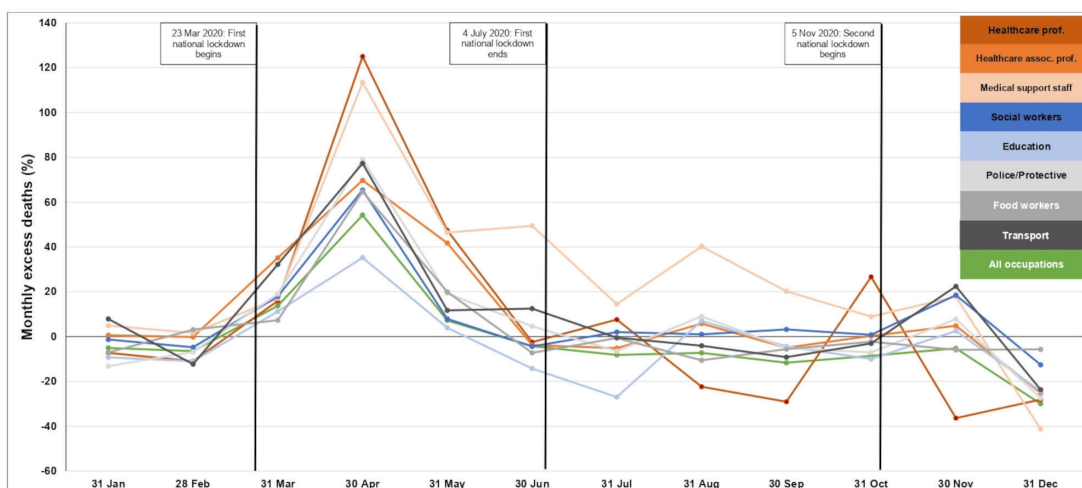
Mortality for the entire year of 2020 for all adults of working age was similar to the annual average over the previous 5 years. However, when trends in excess mortality were examined in successive months, large differences were revealed throughout the pandemic of 2020. Excess mortality peaked in April, when the number of deaths was 54.2% higher than expected and

was lowest in December when deaths were 30.0% lower than expected.

Essential workers had consistently higher excess mortality than other groups throughout 2020. There were also large differences in excess mortality between the categories of essential workers, with healthcare workers having the highest excess mortality and social care and education workers having the lowest. Excess mortality also varied widely between men and women, even within the same occupational group. Generally, excess mortality was higher in men.

These results are consistent with findings from previous studies showing an increased risk of severe COVID-19 infection and death among essential workers in England and Wales.<sup>5 6 10</sup> Healthcare workers have been reported to have a seven-fold increase in the risk of severe COVID-19 compared with non-essential workers, even after controlling for age, sex, ethnicity, deprivation and comorbidities.<sup>6</sup> The risk for social care and education workers was almost twice that of non-essential workers.<sup>6</sup> An analysis of COVID-19-specific mortality showed that men working in healthcare and social care had significantly higher death rates than the general population of the same age.<sup>5</sup> The same was true for women working in social care.

For non-essential workers, excess mortality was consistently lower than expected following the lifting of the first lockdown in



**Figure 3** Monthly excess deaths (%) by detailed occupational group: adults aged 20–64 years, England and Wales.

July 2020. Although most restrictions had been lifted, workers were still encouraged to work from home. This guidance helped to minimise workplace-related exposure and the risk of death from COVID-19. It may also have reduced the risk of death from other causes (eg, road traffic accidents), which may explain why deaths were lower than expected for non-essential workers during the second half of 2020.

Mortality was below the average for the previous 5 years for those who were unemployed or whose occupation was unknown. It is possible that unemployed adults of working age were unemployed because of chronic illness and were, therefore, categorised as 'clinically extremely vulnerable'. Adults in that category were asked to 'shield' (ie, not to leave their homes and to minimise all face-to-face contact) from 23 March 2020 to 31 July 2020 and again from 5 November 2020 to 2 December 2020. More generally, social distancing may have reduced the risk of death from other causes, as well as from COVID-19. In fact, several countries that had few COVID-19 deaths, but implemented social distancing as a preventive measure, showed reduced mortality during the pandemic.<sup>26</sup>

Excess mortality in broad occupational groups often concealed large differences in excess mortality between occupational subgroups within the same industry. Among healthcare workers, medical support staff had higher excess mortality than healthcare professionals and healthcare associate professionals. Excess mortality among social care workers was much higher than for those working in education. In the relatively diverse group of other essential workers, those working in the transport sector had the highest excess mortality, compared with those in the police and protective services, and the food industry.

This attenuation of the impact of COVID-19 on specific occupations has also been reported in previous studies of COVID-19 infection and COVID-19-specific death. Medical support staff had almost a ninefold risk of developing severe COVID-19 compared with non-essential workers during mid-March 2020 to late July 2020, while the risk for healthcare professionals and healthcare associate professionals was 6–7 times that of non-essential workers.<sup>6</sup> The risk of death from COVID-19 has also been shown to differ between specific healthcare occupations.<sup>5 12</sup>

Some of the differences within the same broad occupational group may be explained by potential confounders for which we have not controlled. For example, the risk of death from COVID-19 has been shown to vary by deprivation, with the most deprived group at the highest risk.<sup>27</sup> Excess mortality has also been shown to be highest in the most deprived groups.<sup>10</sup> Within a given broad occupational group, there are varying levels of socioeconomic status (eg, consultants and hospital porters are both in the broad healthcare group). Further defining the groups might reveal differences in excess mortality that could be explained by other factors, such as socioeconomic status, rather than higher levels of exposure.

We did not control for ethnicity, which has been shown to be related to COVID-19 death.<sup>10 27–30</sup> Higher excess deaths in some occupations (eg, nurses and transport workers), in which the proportion of ethnic minorities is higher, may, therefore, be partially explained by the higher risk of death from COVID-19 among those ethnic groups. However, any such bias is likely to be small, since each occupational group is being compared with its own mortality experience in previous years. Thus, confounding by ethnicity is unlikely to explain our findings, although effect modification by ethnicity (ie, ethnic differences in the COVID-19 case fatality rate) may have played a role.

Some of the excess deaths during 2020 may be attributable to other conditions than COVID-19, and indirectly attributable

to the pandemic (eg, delays in seeking care and/or treatment for cancer because of the pressure on healthcare services due to COVID-19).<sup>31 32</sup> However, there is little evidence of this being a major problem internationally, since several countries which implemented social distancing, but few COVID-19 deaths, and cut back on non-COVID-19 healthcare access, actually had reduced mortality during 2020.<sup>26</sup>

Though we have used the final official death counts, some deaths that occurred during 2020 may not have been included in our analyses due to delays in death registration. This may be particularly true for the latter half of 2020, when excess mortality was below the average for the previous 5 years.

In summary, excess mortality was consistently higher for essential workers throughout 2020, particularly for healthcare workers. Further research is needed to examine excess mortality by occupational group, while controlling for important confounders such as ethnicity and socioeconomic status. For non-essential workers, the lockdowns, encouragement to work from home and to maintain social distancing is likely to have prevented a number of deaths from COVID-19 and from other causes.

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**Correction notice** This article has been corrected since it first published. The open access licence type has been updated.

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