

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 five 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 socio-economic 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.

What we already know on this topic

Essential workers may be 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 socio-economic status.

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.¹⁻⁴

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”.⁵⁻¹³ Healthcare, social care and education workers have particularly high infection rates.^{12,14,15} In adults of working age, the risk of developing severe COVID-19 is highest for medical support staff, social care workers and transport workers.⁶ The risk of death from COVID-19 during 2020 has been shown to be significantly higher in social care workers and male healthcare workers than in the general population.⁵

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.^{5,6} 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.¹⁶ 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, which was used to examine the impact of the influenza pandemic of 1918-1919.¹⁷⁻¹⁹ 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 sub-groups. 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.^{10,20-24}

Only two studies to date have examined excess mortality during 2020 by occupation. In California (US), workers in the food, transportation and manufacturing industries had experienced the highest excess mortality during the first nine months of the pandemic.²⁵ 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 five-year average during the same months in 2014-2018) for workers in caring personal services, elementary security operations and road transport.¹⁰

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 (ONS).

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 (SOC) 2010 unit group reported on the death certificate and literature to categorise occupations into three broad groups of essential workers: health care, social care and education, and other essential occupations (Supplementary Table 1).⁶ 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 five years (“expected deaths”). We used five 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 (e.g., 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 – 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 (Supplementary Table

Table 1. Number of deaths from all causes in 2020, and number (%) of excess deaths^a, 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.	(%)
January	6,879	-371	-5.1	254	2	0.7	524	-21	-3.8	1,130	-49	-4.2	3,342	-199	-5.6	1,629	-104	-6.0
February	5,907	-411	-6.5	227	-2	-1.0	447	-32	-6.7	989	-50	-4.8	2,828	-248	-8.0	1,417	-80	-5.3
March	7,657	921	13.7	303	64	26.6	599	82	15.8	1,256	196	18.5	3,609	312	9.4	1,890	268	16.5
April	9,782	3,439	54.2	442	209	89.9	764	273	55.7	1,778	750	73.0	4,454	1,351	43.5	2,344	855	57.4
May	6,767	452	7.2	320	97	43.8	536	34	6.7	1,173	171	17.1	3,227	136	4.4	1,511	14	0.9
June	5,722	-254	-4.3	247	26	11.7	433	-35	-7.5	979	23	2.4	2,755	-204	-6.9	1,308	-64	-4.7
July	5,643	-504	-8.2	241	6	2.5	445	-34	-7.1	970	-24	-2.4	2,801	-229	-7.6	1,186	-223	-15.8
August	5,642	-442	-7.3	246	26	11.7	495	14	2.9	957	-27	-2.7	2,722	-276	-9.2	1,222	-179	-12.8
September	5,247	-698	-11.7	213	-1	-0.3	467	4	0.9	908	-64	-6.6	2,571	-326	-11.2	1,088	-312	-22.3
October	5,776	-545	-8.6	246	15	6.4	493	-12	-2.4	983	-40	-3.9	2,866	-207	-6.7	1,188	-301	-20.2
November	6,006	-333	-5.3	243	7	2.8	569	68	13.6	1,062	68	6.9	2,937	-196	-6.2	1,195	-280	-19.0
December	4,873	-2,092	-30.0	172	-77	-31.0	445	-87	-16.3	917	-201	-17.9	2,329	-1,046	-31.0	1,010	-682	-40.3
Total	75,901	-840	-1.1	3,154	371	13.3	6,217	254	4.3	13,102	753	6.1	36,441	-1,131	-3.0	16,988	-1,086	-6.0

^a The total number of deaths in each month of 2020 compared to the average number of deaths occurring in the same month for the previous five years. The percentage of excess deaths is the total number of excess deaths expressed as a percentage of the five-year average.

2), while in women it was 30,327, only 18 (0.1%) more than expected (Supplementary 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 sub-dividing 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. 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%).

Excess mortality was higher in men than in women in each broad and detailed occupational group (Supplementary Tables 2, 3, 4 and 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-22 March 2020

During the first two months of 2020, mortality was similar to or lower than that of the previous five 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 (Supplementary Figures 1 and 2).

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-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 9,782 deaths occurring in adults aged 20-64 years in April 2020, there were 3,439 more than

Table 2. Number of deaths from all causes in 2020, and number (%) of excess deaths^a, 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	1,714	156	10.0	1,026	187	22.3	4,433	316	7.7

^a The total number of deaths in each month of 2020 compared to the average number of deaths occurring in the same month for the previous five years. The percentage of excess deaths is the total number of excess deaths expressed as a percentage of the five-year average.

Table 2. Number of deaths from all causes in 2020, and number (%) of excess deaths^a, 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	1,784	-62	-3.4	3,841	200	5.5	4,993	193	4.0	4,268	360	9.2

^a The total number of deaths in each month of 2020 compared to the average number of deaths occurring in the same month for the previous five years. The percentage of excess deaths is the total number of excess deaths expressed as a percentage of the five-year average.

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%) (Supplementary Tables 2 and 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 (Table 2) and by sex (Supplementary Tables 2 and 3).

Post-lockdown: 4 July-4 November 2020

During the four 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 five-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 (Supplementary Tables 2 and 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-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 (Supplementary Table 2 and 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: 3-31 December 2020

In December 2020, mortality was 30.0% lower than expected for all occupations combined (Table 2) and for all broad occupational 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 five 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.^{5,6,10} Healthcare workers have been reported to have a seven-fold increase in the risk of severe COVID-19 compared to non-essential workers, even after controlling for age, sex, ethnicity, deprivation and comorbidities.⁶ The risk for social care and education workers was almost twice that of non-essential workers.⁶ An analysis of COVID-19-specific mortality showed that men working in health care and social care had significantly higher death rates than the general population of the same age.⁵ 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 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 (e.g., 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 five 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” (i.e., not to leave their homes and to minimise all face-to-face contact) from 23 March until 31 July 2020 and again from 5 November until 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.²⁶

Excess mortality in broad occupational groups often concealed large differences in excess mortality between occupational sub-groups 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 to 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 nine-fold risk of developing severe COVID-19 compared to non-essential workers during mid-March to late July 2020, while the risk for healthcare professionals and healthcare associate professionals was 6-7 times that of non-essential workers.⁶ The risk of death from COVID-19 has also been shown to differ between specific healthcare occupations.^{5,12}

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.²⁷ Excess mortality has also been shown to be highest in the most deprived groups.¹⁰ Within a given broad occupational group, there are varying levels of socio-economic status (e.g., 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 socio-economic status, rather than higher levels of exposure.

We did not control for ethnicity, which has been shown to be related to COVID-19 death.^{10,27-30} Higher excess deaths in some occupations (e.g., 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 (i.e., 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 (e.g., delays in seeking care and/or treatment for cancer because of the pressure on healthcare services due to COVID-19).^{31,32} 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 health care access, actually had reduced mortality during 2020.²⁶

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 five 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 socio-economic 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.

Contributions

MM had access to the data, conducted the formal analysis and wrote the original manuscript. MM, CA, MPC and NP reviewed the results. MM, CA, MVT, VN, SR, KVH, LP, MPC and NP reviewed the draft manuscript.

Data sharing

The data used in this manuscript are held by the Office for National Statistics and not available to be shared publicly.

Ethical approval

Following assessment using the NSDEC's tool, we engaged with the UK Statistics Authority Data Ethics team and it was decided that ethical approval was not required.

Transparency statement

The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported and no important aspects of the study have been omitted.

Role of the funding source

The funders played no role in the analysis or writing of this manuscript.

Patient and Public Involvement

It was not appropriate to involve the public in these formal analyses.

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Figure 1. Data exclusion flowchart

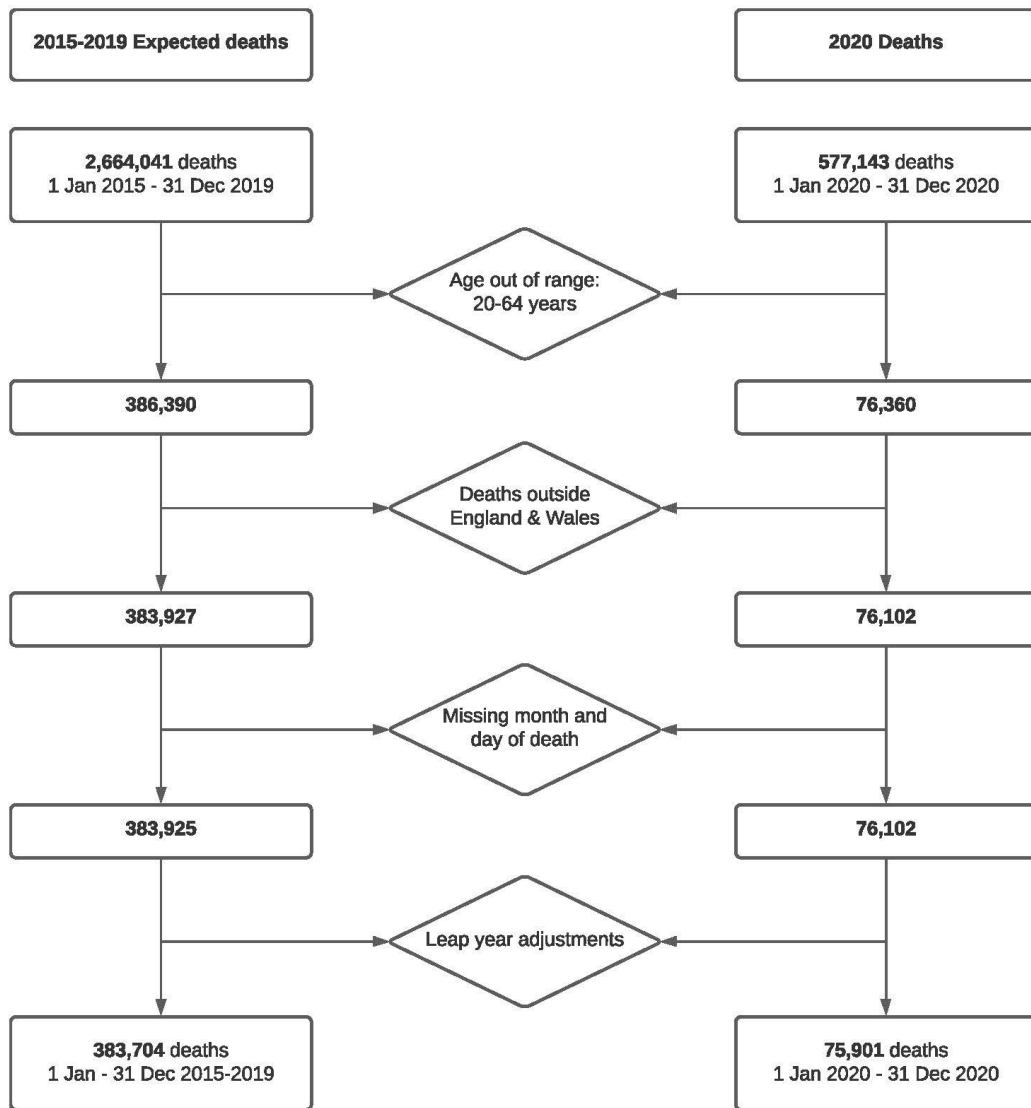


Figure 2. Monthly excess deaths (%) by broad occupational group: adults aged 20-64 years, England and Wales

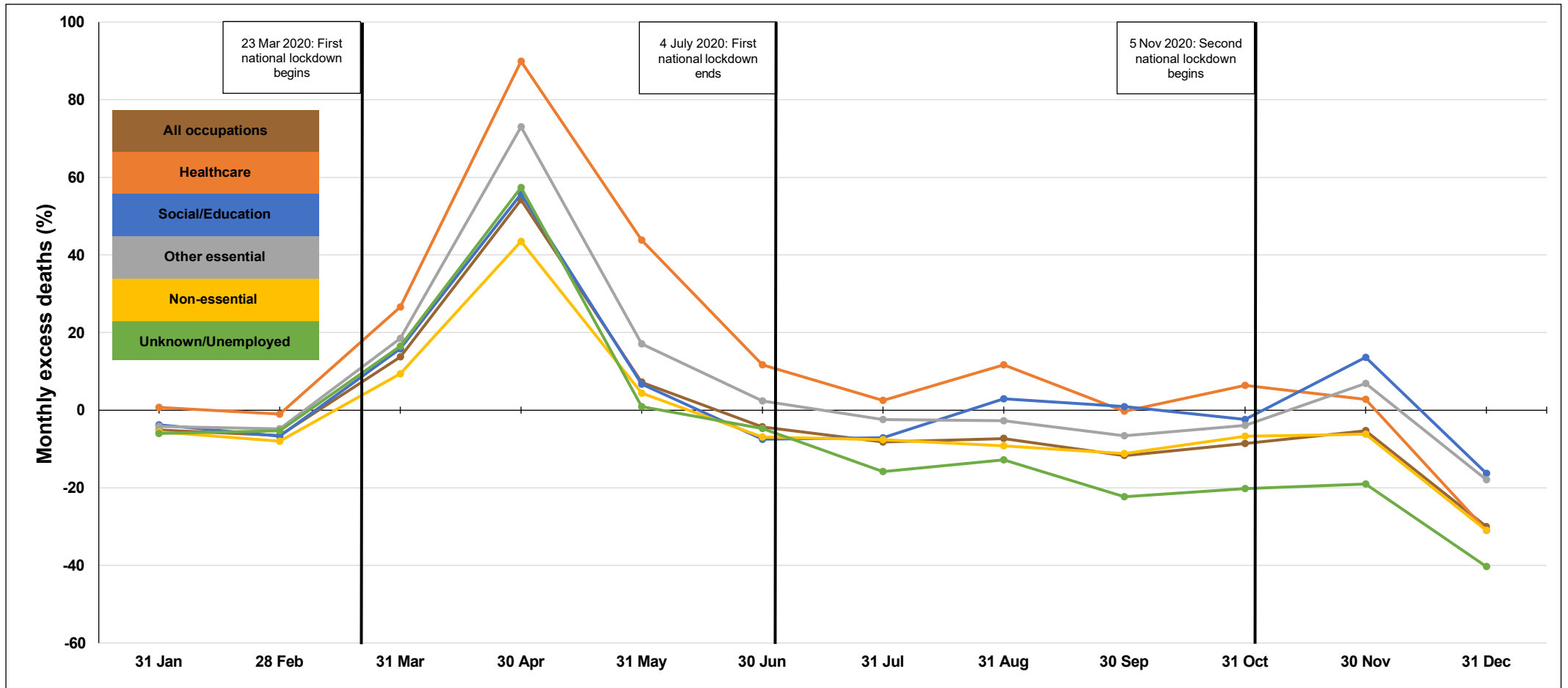
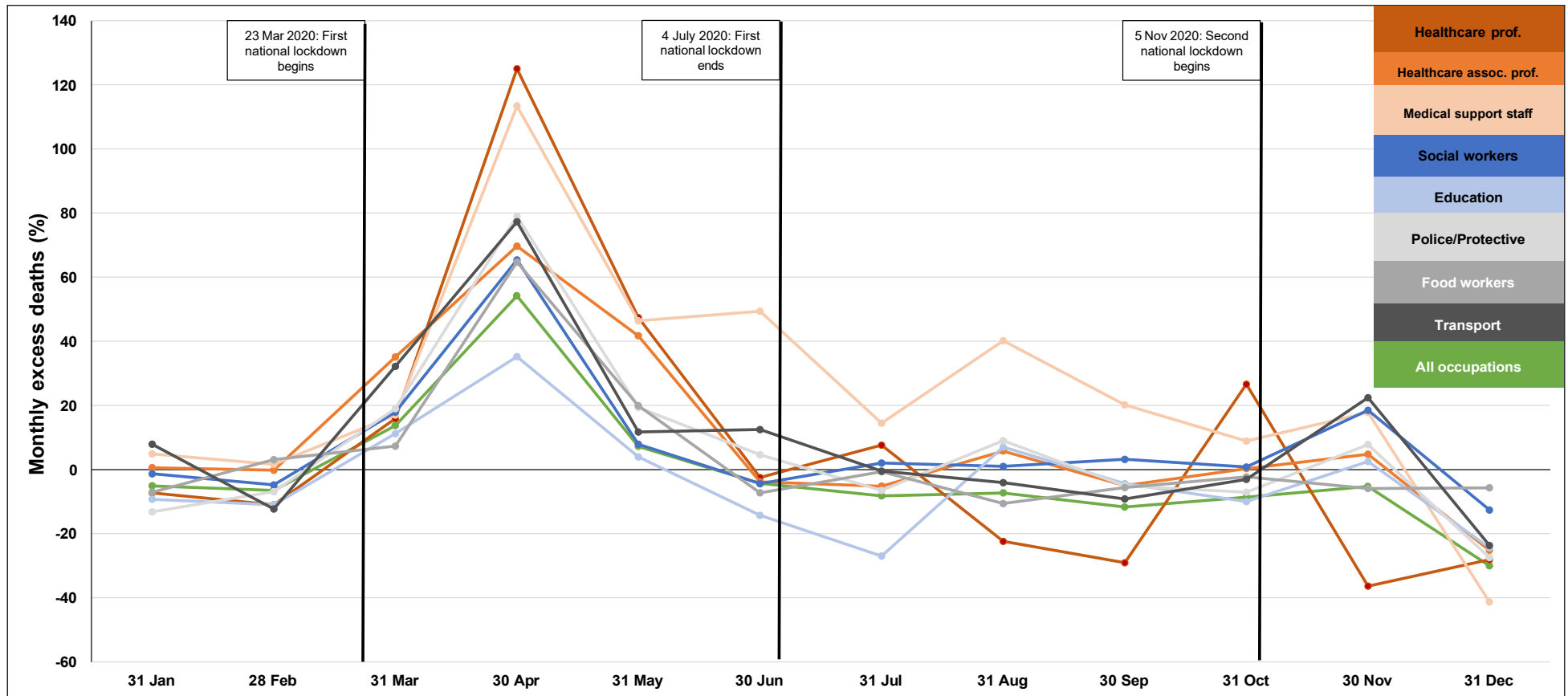
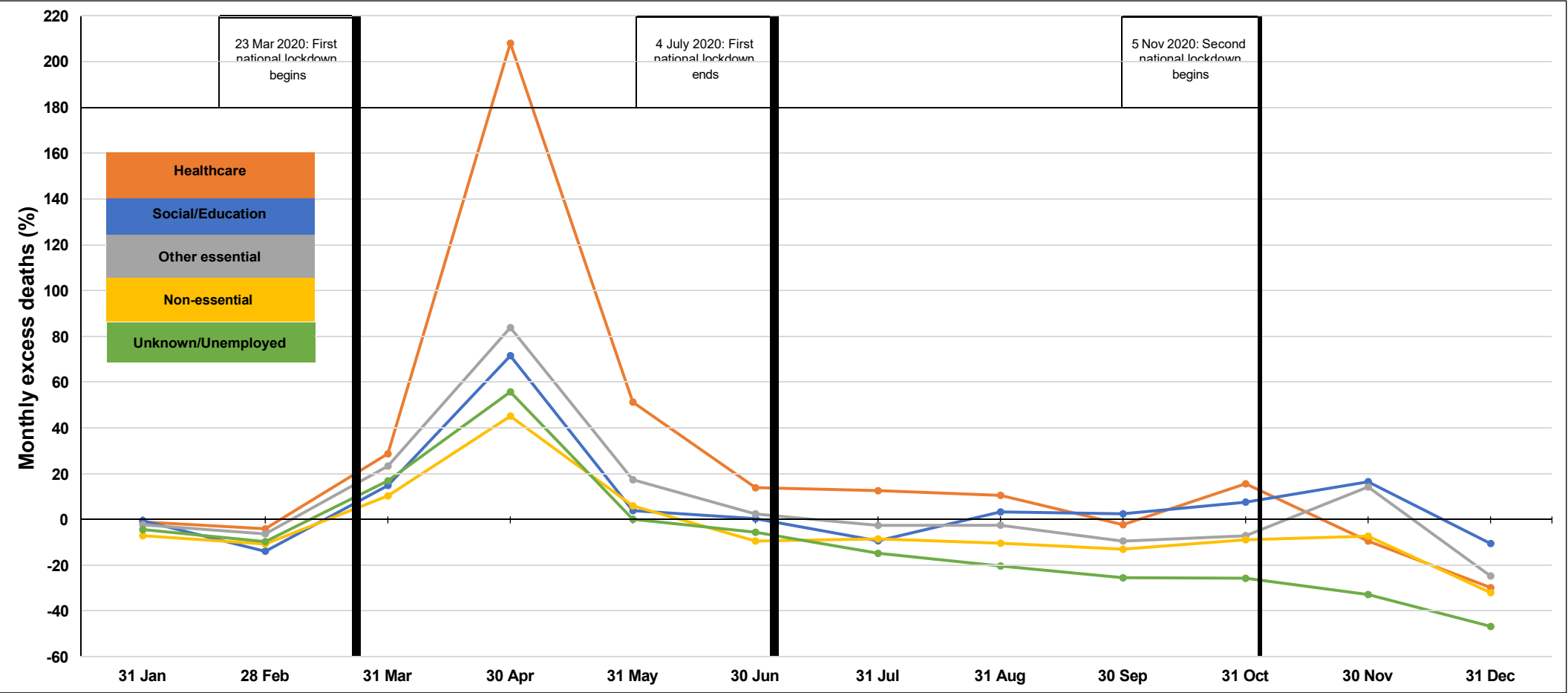


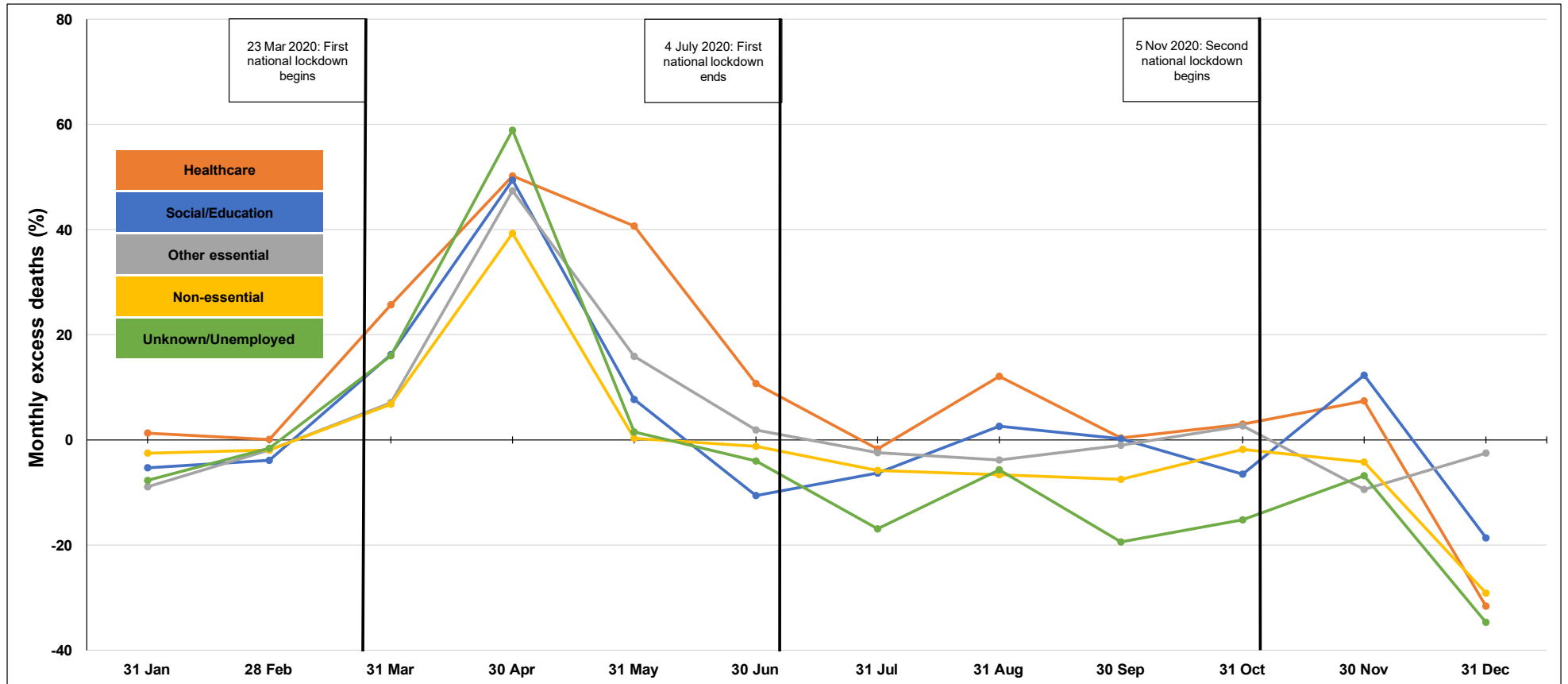
Figure 3. Monthly excess deaths (%) by detailed occupational group: adults aged 20-64 years, England and Wales



Supplementary Figure 1. Monthly excess deaths (%) by broad occupational group: men aged 20-64 years, England and Wales



Supplementary Figure 2. Monthly excess deaths (%) by broad occupational group: women aged 20-64 years, England and Wales



Supplementary Table 1. Broad and detailed essential groups

Broad	Detailed	SOC 2010 Code	Occupation
Healthcare			
Healthcare professionals			
		2211	Medical practitioners
		2212	Psychologists
		2213	Pharmacists
		2214	Ophthalmic opticians
		2215	Dental practitioners
		2217	Medical radiographers
		2218	Chiropodists
		2219	Health professionals n.e.c.
Other health professionals and healthcare associate professionals			
		1181	Health services and public health managers and directors
		1241	Healthcare practice managers
		2221	Physiotherapists
		2222	Occupational therapists
		2223	Speech and language therapists
		2229	Therapy professionals n.e.c
		2231	Nurses
		2232	Midwives
		3213	Paramedics
		3216	Dispensing opticians
		3217	Pharmaceutical technicians
		3218	Medical and dental technicians
		3219	Health associate professionals n.e.c.
Medical support staff			
		4211	Medical secretaries
		6141	Nursing auxiliaries and assistants
		6142	Ambulance staff (excl paramedics)
		6143	Dental nurses
		7114	Pharmacy and other dispensing assistants
		9271	Hospital porters
Social and education			
Social care			
		1184	Social service managers and directors
		1242	Residential, day and domiciliary care managers
		2442	Social workers
		2444	Clergy
		2449	Welfare professionals n.e.c.
		3231	Youth and community workers
		3233	Child and early years officers
		3234	Housing officers
		3235	Counsellors
		3239	Welfare and housing associate professionals n.e.c.
		6144	Houseparents and residential wardens
		6145	Care assistants and home carers
		6146	Senior care workers
		6147	Care escorts
		6232	Caretakers
		6148	Undertakers, mortuary and crematorium assistants
		9279	Other elementary services occupations n.e.c.

Supplementary Table 1. Broad and detailed essential groups

Broad	Detailed	SOC 2010 Code	Occupation
	Education		
		2314	Secondary education teaching professionals
		2315	Primary and nursery education teaching professionals
		2316	Special needs education teaching professionals
		2319	Teaching and other educational professionals n.e.c.
		6121	Nursery nurses and assistants
		6125	Teaching assistants
		6126	Educational support assistants
	Other essential		
	Police and protective services		
		1172	Senior police officers
		1173	Senior officers in fire, ambulance, prison and related services
		2443	Probation officers
		3311	NCOs and other ranks
		3312	Police officers (sergeant and below)
		3313	Fire service officers (watch manager and below)
		3314	Prison service officers (below principal officer)
		3315	Police community support officers
		3319	Protective service associate professionals n.e.c.
		6240	Cleaning and housekeeping managers and supervisors
		9231	Window cleaners
		9232	Street cleaners
		9233	Cleaners and domestics
		9235	Refuse and salvage occupations
		9239	Elementary cleaning occupations n.e.c.
		9241	Security guards and related occupations
		9242	Parking and civil enforcement occupations
		9249	Elementary security occupations n.e.c.
	Food		
		1162	Managers and directors in storage and warehousing
		1190	Managers and directors in retail and wholesale
		1211	Managers and proprietors in agriculture and horticulture
		1213	Managers and proprietors in forestry, fishing and related services
		1254	Shopkeepers and proprietors – wholesale and retail
		5111	Farmers
		5112	Horticultural trades
		5119	Agricultural and fishing trades n.e.c.
		5431	Butchers
		5432	Bakers and flour confectioners
		5433	Fishmongers and poultry dressers
		7111	Sales and retail assistants
		7112	Retail cashiers and checkout operators
		7130	Sales supervisors
		8111	Food, drink and tobacco process operators
		9111	Farm workers
		9119	Fishing and other elementary agriculture occupations n.e.c.
		9134	Packers, bottlers, canners and fillers
		9251	Shelf fillers
		9259	Elementary sales occupations n.e.c.

Supplementary Table 1. Broad and detailed essential groups

Broad	Detailed	SOC 2010 Code	Occupation
	Transport		
		1161	Managers and directors in transport and distribution
		6215	Rail travel assistants
		8211	Large goods vehicle drivers
		8212	Van drivers
		8213	Bus and coach drivers
		8214	Taxi and cab drivers and chauffeurs
		8231	Train and tram drivers
		8234	Rail transport operatives
		9211	Postal workers, mail sorters, messengers and couriers

Supplementary Table 2. Number of deaths from all causes in 2020, and number (%) of excess deaths^a, men 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 No.	(%)	Deaths in 2020	Excess deaths No.	(%)	Deaths in 2020	Excess deaths No.	(%)	Deaths in 2020	Excess deaths No.	(%)	Deaths in 2020	Excess deaths No.	(%)	Deaths in 2020	Excess deaths No.	(%)
January	4,175	-227	-5.2	68	-1	-0.9	157	0	-0.3	801	-17	-2.1	2,352	-174	-6.9	797	-35	-4.2
February	3,464	-363	-9.5	62	-3	-3.9	118	-19	-13.7	675	-44	-6.1	1,971	-231	-10.5	639	-67	-9.5
March	4,679	595	14.6	83	19	28.9	169	22	15.0	905	172	23.5	2,605	248	10.5	917	134	17.1
April	6,073	2,228	57.9	180	122	208.2	237	99	71.7	1,322	603	84.0	3,206	999	45.3	1,128	405	55.9
May	4,104	295	7.8	96	33	51.4	151	6	4.1	811	122	17.6	2,321	133	6.1	725	2	0.3
June	3,422	-203	-5.6	71	9	14.1	130	1	0.6	674	17	2.6	1,911	-193	-9.2	636	-36	-5.4
July	3,426	-299	-8.0	76	9	12.8	128	-13	-9.1	666	-16	-2.4	1,969	-178	-8.3	587	-100	-14.6
August	3,355	-362	-9.7	66	6	10.7	143	5	3.5	674	-16	-2.3	1,923	-220	-10.2	549	-138	-20.1
September	3,086	-492	-13.7	55	-1	-2.1	135	4	2.7	603	-61	-9.2	1,788	-262	-12.8	505	-171	-25.3
October	3,422	-403	-10.5	72	10	15.8	155	11	7.8	659	-49	-6.9	1,997	-191	-8.7	539	-184	-25.5
November	3,535	-268	-7.1	59	-6	-9.2	172	25	16.7	777	98	14.4	2,057	-157	-7.1	470	-227	-32.6
December	2,833	-1,359	-32.4	48	-20	-29.6	134	-15	-10.3	592	-192	-24.5	1,630	-759	-31.8	429	-372	-46.5
Total	45,574	-858	-1.8	936	176	23.2	1,829	125	7.3	9,159	617	7.2	25,730	-985	-3.7	7,921	-791	-9.1

^a The total number of deaths in each month of 2020 compared to the average number of deaths occurring in the same month for the previous five years. The percentage of excess deaths is the total number of excess deaths expressed as a percentage of the five-year average.

Supplementary Table 3. Number of deaths from all causes in 2020, and number (%) of excess deaths^a, women 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 No.	Excess deaths (%)	Deaths in 2020	Excess deaths No.	Excess deaths (%)	Deaths in 2020	Excess deaths No.	Excess deaths (%)	Deaths in 2020	Excess deaths No.	Excess deaths (%)	Deaths in 2020	Excess deaths No.	Excess deaths (%)	Deaths in 2020	Excess deaths No.	Excess deaths (%)
January	2,704	-144	-5.1	186	2	1.3	367	-20	-5.3	329	-32	-8.9	990	-25	-2.5	832	-69	-7.7
February	2,443	-48	-1.9	166	0	0.1	329	-14	-3.9	314	-6	-1.9	858	-17	-1.9	778	-12	-1.6
March	2,978	326	12.3	220	45	25.7	430	60	16.2	351	23	7.1	1,004	64	6.8	973	134	16.0
April	3,709	1,211	48.5	262	88	50.2	527	174	49.4	456	147	47.4	1,248	352	39.3	1,216	451	58.9
May	2,663	157	6.2	224	65	40.7	385	28	7.7	362	50	15.9	906	3	0.3	786	12	1.5
June	2,300	-51	-2.2	176	17	10.7	303	-36	-10.6	305	6	1.9	844	-10	-1.2	672	-28	-4.0
July	2,217	-205	-8.5	165	-3	-1.7	317	-21	-6.3	304	-7	-2.4	832	-51	-5.8	599	-122	-16.9
August	2,287	-80	-3.4	180	19	12.1	352	9	2.6	283	-11	-3.8	799	-57	-6.6	673	-41	-5.7
September	2,161	-206	-8.7	158	1	0.4	332	1	0.2	305	-3	-1.0	783	-64	-7.5	583	-140	-19.4
October	2,354	-143	-5.7	174	5	3.0	338	-23	-6.5	324	8	2.7	869	-16	-1.8	649	-117	-15.2
November	2,471	-65	-2.6	184	13	7.4	397	43	12.3	285	-29	-9.4	880	-38	-4.2	725	-53	-6.8
December	2,040	-733	-26.4	124	-57	-31.6	311	-71	-18.6	325	-8	-2.5	699	-287	-29.1	581	-309	-34.7
Total	30,327	18	0.1	2,219	195	9.6	4,388	129	3.0	3,943	136	3.6	10,712	-147	-1.4	9,067	-295	-3.2

^a The total number of deaths in each month of 2020 compared to the average number of deaths occurring in the same month for the previous five years. The percentage of excess deaths is the total number of excess deaths expressed as a percentage of the five-year average.

Supplementary Table 4. Number of deaths from all causes in 2020, and number (%) of excess deaths^a, men aged 20-64 years, by detailed essential worker occupational group, January 2020 - December 2020

	Healthcare professionals			Healthcare associate professionals			Medical support staff			Social care			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		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.	%	No.	No.	%	No.	No.	%
January	18	-2	-8.2	29	-1	-3.3	21	2	10.5	123	4	3.4	34	-4	-11.5	200	-18	-8.3	228	-18	-7.5	373	19	5.4
February	13	-3	-19.8	29	3	10.7	20	-2	-9.9	90	-12	-11.8	29	-6	-16.7	180	-9	-4.9	224	8	3.8	271	-42	-13.5
March	18	2	15.4	29	0	0.7	36	16	80.0	128	20	18.7	41	2	4.6	253	61	31.6	235	9	3.8	417	103	32.8
April	47	32	221.9	65	40	155.9	68	50	269.6	188	88	88.8	49	11	27.6	345	151	78.2	398	189	90.6	579	263	83.1
May	21	3	19.3	45	16	53.1	30	14	82.9	104	-7	-6.0	47	13	36.6	216	38	21.2	247	40	19.4	348	44	14.3
June	19	2	9.2	26	-1	-4.4	26	8	47.7	100	2	2.0	30	-1	-3.8	187	12	7.0	176	-25	-12.4	311	30	10.6
July	22	4	22.2	26	-3	-9.1	28	7	34.6	102	-3	-2.9	26	-10	-27.4	164	-24	-12.8	219	14	6.7	283	-6	-2.1
August	12	-5	-29.4	28	3	10.2	26	9	51.2	112	5	5.1	31	-1	-1.9	195	13	7.4	187	-18	-8.6	292	-12	-3.8
September	12	-2	-14.3	20	-3	-12.3	23	4	18.6	103	3	3.2	32	0	1.3	163	-4	-2.3	173	-27	-13.6	267	-30	-10.2
October	19	3	20.3	30	5	21.0	23	1	6.5	119	6	5.1	36	5	17.6	166	-19	-10.1	192	-19	-8.8	301	-11	-3.6
November	9	-9	-50.5	26	-2	-8.5	24	6	30.4	134	21	18.6	38	4	10.5	196	18	10.4	213	4	2.1	368	75	25.5
December	9	-5	-35.7	25	-6	-18.8	14	-9	-40.2	95	-18	-15.9	39	3	7.1	134	-75	-36.0	199	-34	-14.7	259	-82	-24.1
Total	219	21	10.6	378	50	15.3	339	105	44.6	1,398	110	8.6	432	15	3.6	2,399	145	6.4	2,691	123	4.8	4,069	349	9.4

^a The total number of deaths in each month of 2020 compared to the average number of deaths occurring in the same month for the previous five years. The percentage of excess deaths is the total number of excess deaths expressed as a percentage of the five-year average.

Supplementary Table 5. Number of deaths from all causes in 2020, and number (%) of excess deaths^a, women aged 20-64 years, by detailed essential worker occupational group, January 2020 - December 2020

	Healthcare professionals			Healthcare associate professionals			Medical support staff			Social care			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		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.	%	No.	No.	%	No.	No.	%
January	15	-1	-6.2	115	2	1.6	56	2	2.9	246	-9	-3.5	121	-11	-8.6	106	-28	-21.0	196	-14	-6.7	27	10	60.7
February	16	0	-2.4	102	-3	-2.9	48	3	7.1	224	-4	-1.7	105	-10	-8.5	111	-12	-9.9	187	4	2.4	18	3	23.3
March	20	3	16.3	145	45	45.0	55	-3	-4.8	294	44	17.5	136	16	13.3	119	-1	-1.2	214	22	11.3	18	3	20.0
April	25	8	43.7	162	54	49.4	75	26	54.3	363	129	55.4	164	45	37.6	189	84	80.3	253	67	35.7	14	-4	-23.1
May	25	11	83.8	140	39	38.3	59	15	32.9	272	34	14.4	113	-7	-5.5	141	20	16.5	210	36	20.4	11	-6	-35.3
June	12	-2	-16.7	95	-4	-3.7	69	23	50.0	207	-16	-7.3	96	-20	-17.1	113	1	0.9	171	-2	-1.3	21	7	50.0
July	15	-1	-8.5	99	-4	-4.1	51	3	5.8	233	10	4.3	84	-31	-26.8	119	4	3.8	166	-16	-9.0	19	5	31.9
August	13	-2	-14.5	103	5	4.7	64	17	36.2	225	-2	-0.9	127	11	9.5	119	13	11.8	150	-22	-13.0	14	-1	-9.1
September	9	-7	-42.3	90	-3	-3.2	59	10	20.9	229	7	3.2	103	-7	-6.0	98	-10	-9.4	190	6	3.1	17	1	9.0
October	20	5	33.3	101	-5	-4.5	53	5	10.0	239	-3	-1.2	99	-20	-17.1	108	-2	-2.0	201	9	4.8	15	1	10.3
November	13	-3	-20.7	109	9	8.6	62	7	13.6	278	43	18.4	119	0	0.2	111	4	3.5	161	-28	-14.8	13	-5	-28.6
December	12	-3	-21.1	76	-28	-27.1	36	-26	-41.7	225	-28	-11.1	86	-43	-33.3	108	-16	-13.0	204	10	5.2	13	-2	-14.5
Total	195	6	3.3	1,337	106	8.6	687	82	13.6	3,035	205	7.3	1,353	-76	-5.3	1,442	56	4.0	2,303	70	3.1	200	12	6.4

^a The total number of deaths in each month of 2020 compared to the average number of deaths occurring in the same month for the previous five years. The percentage of excess deaths is the total number of excess deaths expressed as a percentage of the five-year average.