Public Health England

Protecting and improving the nation's health

Disparities in the risk and outcomes of COVID-19

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Executive summary

This is a descriptive review of data on disparities in the risk and outcomes from COVID-19. This review presents findings based on surveillance data available to PHE at the time of its publication, including through linkage to broader health data sets. It confirms that the impact of COVID-19 has replicated existing health inequalities and, in some cases, has increased them. These results improve our understanding of the pandemic and will help in formulating the future public health response to it.

The largest disparity found was by age. Among people already diagnosed with COVID-19, people who were 80 or older were seventy times more likely to die than those under 40. Risk of dying among those diagnosed with COVID-19 was also higher in males than females; higher in those living in the more deprived areas than those living in the least deprived; and higher in those in Black, Asian and Minority Ethnic (BAME) groups than in White ethnic groups. These inequalities largely replicate existing inequalities in mortality rates in previous years, except for BAME groups, as mortality was previously higher in White ethnic groups. These analyses take into account age, sex, deprivation, region and ethnicity, but they do not take into account the existence of comorbidities, which are strongly associated with the risk of death from COVID-19 and are likely to explain some of the differences.

When compared to previous years, we also found a particularly high increase in all cause deaths among those born outside the UK and Ireland; those in a range of caring occupations including social care and nursing auxiliaries and assistants; those who drive passengers in road vehicles for a living including taxi and minicab drivers and chauffeurs; those working as security guards and related occupations; and those in care homes. These analyses do not take into account the existence of comorbidities, which are strongly associated with the risk of death from COVID-19 and could explain some of these differences.

When this data was analysed, the majority of testing had been offered to those in hospital with a medical need. Confirmed cases therefore represent the population of people with severe disease, rather than all of those who get infected. This is important because disparities between diagnoses rates may reflect differences in the risk of getting the infection, in presenting to hospital with a medical need and in the likelihood of being tested.

Some analyses outlined in this review are provisional and will continue to be improved. Further work is planned to obtain, link and analyse data that will complement these analyses.

The results of this review need to be widely discussed and considered by all those involved in and concerned with the national and local response to COVID-19. However, it is already clear that relevant guidance, certain aspects of recording and reporting of data, and key policies should be adapted to recognise and wherever possible mitigate or reduce the impact of COVID-19 on the population groups that are shown in this review to be more affected by the infection and its adverse outcomes.

As the numbers of new COVID-19 cases decrease, monitoring the infection among those most at risk will become increasingly important. It seems likely that it will be difficult to control the spread of COVID-19 unless these inequalities can be addressed.

Age and sex

COVID-19 diagnosis rates increased with age for both males and females. When compared to all cause mortality in previous years, deaths from COVID-19 have a slightly older age distribution, particularly for males.

Working age males diagnosed with COVID-19 were twice as likely to die as females. Among people with a positive test, when compared with those under 40, those who were 80 or older were seventy times more likely to die. These are the largest disparities found in this analysis and are consistent with what has been previously reported in the UK.

These disparities exist after taking ethnicity, deprivation and region into account, but they do not account for the effect of comorbidities or occupation, which may explain some of the differences.

Geography

The regional pattern in diagnoses rates and death rates in confirmed cases among males were similar. London had the highest rates followed by the North West, the North East and the West Midlands. The South West had the lowest. For females the North East and the North West had higher diagnosis rates than London, while London had the highest death rate.

Local authorities with the highest diagnoses and death rates are mostly urban. Death rates in London from COVID-19 were more than 3-times higher than in the region with the lowest rates, the South West. This level of inequality between regions is much greater than the inequalities in all cause mortality rates in previous years.

Deprivation

People who live in deprived areas have higher diagnosis rates and death rates than those living in less deprived areas. The mortality rates from COVID-19 in the most deprived areas were more than double the least deprived areas, for both males and females. This is greater than the inequality seen in mortality rates in previous years, indicating greater inequality in death rates from COVID-19.

High diagnosis rates may be due to geographic proximity to infections or a high proportion of workers in occupations that are more likely to be exposed. Poor outcomes from COVID-19 infection in deprived areas remain after adjusting for age, sex, region and ethnicity, but the role of comorbidities requires further investigation.

Ethnicity

People from Black ethnic groups were most likely to be diagnosed. Death rates from COVID-19 were highest among people of Black and Asian ethnic groups. This is the opposite of what is seen in previous years, when the mortality rates were lower in Asian and Black ethnic groups than White ethnic groups. Therefore, the disparity in COVID-19 mortality between ethnic groups is the opposite of that seen in previous years.

An analysis of survival among confirmed COVID-19 cases and using more detailed ethnic groups, shows that after accounting for the effect of sex, age, deprivation and region, people of Bangladeshi ethnicity had around twice the risk of death than people of White British ethnicity. People of Chinese, Indian, Pakistani, Other Asian, Black Caribbean and Other Black ethnicity had between 10 and 50% higher risk of death when compared to White British.

These analyses did not account for the effect of occupation, comorbidities or obesity. These are important factors because they are associated with the risk of acquiring COVID-19, the risk of dying, or both. Other evidence has shown that when comorbidities are included, the difference in risk of death among hospitalised patients is greatly reduced.

Occupation

A total of 10,841 COVID-19 cases were identified in nurses, midwives and nursing associates registered with the Nursing and Midwifery Council. Among those who are registered, this represents 4% of Asian ethnic groups, 3.1% of Other ethnic groups, 1.7% of White ethnic groups and 1.5% of both Black and Mixed ethnic groups. This analysis did not look at the possible reasons behind these differences, which may be driven by factors like geography or nature of individuals' roles.

ONS reported that men working as security guards, taxi drivers and chauffeurs, bus and coach drivers, chefs, sales and retail assistants, lower skilled workers in construction and processing plants, and men and women working in social care had significantly high rates of death from COVID-19. Our analysis expands on this and shows that nursing auxiliaries and assistants have seen an increase in all cause deaths since 2014 to 2018. For many occupations, however, the number of deaths is too small to draw meaningful conclusions and further analysis will be required.

Inclusion health groups

When compared to previous years, there has been a larger increase in deaths among people born outside the UK and Ireland. The biggest relative increase was for people born in Central and Western Africa, the Caribbean, South East Asia, the Middle East and South and Eastern Africa. This may be one of the drivers behind the differences in mortality rates seen between ethnic groups.

There were 54 men and 13 women diagnosed with COVID-19 with no fixed abode, likely to be rough sleepers. We estimate that this represents 2% and 1.5% of the known population of women and men who experienced rough sleeping in 2019. Data is of poor quality, but this suggests a much higher diagnoses rate when compared to the general population.

People in care homes

Data from the Office for National Statistics (ONS) shows that deaths in care homes accounted for 27% of deaths from COVID-19 up to 8 May 2020. The number of deaths in care homes peaked later than those in hospital, in week ending 24 April.

Our analyses show that there have been 2.3 times the number of deaths in care homes than expected between 20 March and 7 May when compared to previous years, which equates to around 20,457 excess deaths. The number of COVID-19 deaths over this period is equivalent to 46.4% of the excess suggesting that there are many excess deaths from other causes or an under-reporting of deaths from COVID-19.

Comorbidities

Among deaths with COVID-19 mentioned on the death certificate, a higher percentage mentioned diabetes, hypertensive diseases, chronic kidney disease, chronic obstructive pulmonary disease and dementia than all cause death certificates.

Diabetes was mentioned on 21% of death certificates where COVID-19 was also mentioned. This finding is consistent with other studies that have reported a higher risk of death from COVID-19 among patients with diabetes. This proportion was higher in all

BAME groups when compared to White ethnic groups and was 43% in the Asian group and 45% in the Black group. The same disparities were seen for hypertensive disease.

Several studies, although measuring the different outcomes from COVID-19, report an increased risk of adverse outcomes in obese or morbidly obese people.

Acknowledgements

All the analyses in this document were done by scientists working in the Epi cell, Surveillance cell and Health Intelligence team at Public Health England. A draft of this document was reviewed by the individuals and teams below, to whom we are extremely grateful:

- John Pullinger
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- Professor Keith Neal
- The Race Disparity Unit (Cabinet Office)
- PHE topic experts

1. Age and sex

1.1 Main messages

Diagnosis rates are higher among females under 60, and higher among males over 60. Despite making up 46% of diagnosed cases, men make up almost 60% of deaths from COVID-19 and 70% of admissions to intensive care units.

The rate of diagnosed cases increases with age, but the age profile is markedly different among those in critical care. The largest number of patients in critical care come from age groups between 50 and 70 for both males and females and only small numbers aged over 80.

When compared to all cause mortality in previous years, deaths from COVID-19 have a slightly older age distribution, particularly for males. Between the ages of 40 to 79, the age specific death rates from COVID-19 among males were around double the rates in females compared with 1.5 times for all cause mortality in previous years.

A survival analysis looked at people with a positive test, and those 80 or older, when compared with those under 40, were seventy times more likely to die. These are the largest disparities found in this analysis. Working age males diagnosed with COVID-19 were twice as likely to die as females.

The majority of excess deaths (75%) occurred in those aged 75 and over. COVID-19 deaths were equivalent to 80% of the excess in every age group, except the oldest age group where this proportion is lower. There have been fewer deaths than expected in children under 15 years of age.

These findings are consistent with what has been previously reported by ONS (1) and ICNARC (2).

1.2 Background

Male sex and increasing age are known factors associated with COVID-19-related mortality. This was apparent from early on in the pandemic among patients in Wuhan, China (3) and evidence has since accumulated from multiple other countries (4).

Data from the Intensive Care National Audit and Research Centre (ICNARC) has consistently reported that COVID-19 admissions to critical care are mostly among men, making up 71.0% of admissions reported as of 21 May (2). Similarly, ONS reported COVID-19 age-standardised mortality rate for males (781.9 deaths per 100,000) is significantly higher than that for females (439.0 deaths per 100,000) (1). This difference in risk is also observed in the hospitalised population; data from 16,649 COVID-19 positive patients in 166 UK hospitals between February and April 2020 showed that even after controlling for age, comorbidities and obesity, female sex was associated with a reduced risk of death (HR=0.80 (95%CI 0.72-0.89)) compared to male sex (5).

COVID-19-related mortality rates reported by ONS also increase across age groups. For males the increase is significant from 35 to 39 years and above, and for females from 40 to 44 years and above (1). This increase in mortality by age is also observed among hospitalised patients; data from the same study of 16,649 COVID-19 positive patients showed that, even after adjusting for comorbidities, sex and obesity, the risk of dying among those over 80 was almost 14 times higher than those under 50 years old (5).

It is not yet fully clear what drives the differences in outcomes between males and females. Some could be driven by different risks of acquiring the infection – for example due to behavioural and occupational factors – and by differences in how women and men develop symptoms, access care and are diagnosed, or by biological and immune differences that put men at greater risk.

1.3 Cases

This section presents laboratory confirmed cases under Pillar 1 testing. The majority of testing under this pillar has been offered to those in hospital with a medical need as well as NHS key workers, rather than the general population. Confirmed cases therefore represent the population of people with severe disease, rather than all of those who get infected.

As of 13 May, there had been 63,661 cases in males (46.4%) and 73,529 cases in females (53.6%). Figure 1.1 shows the distribution of these cases by age groups and sex.

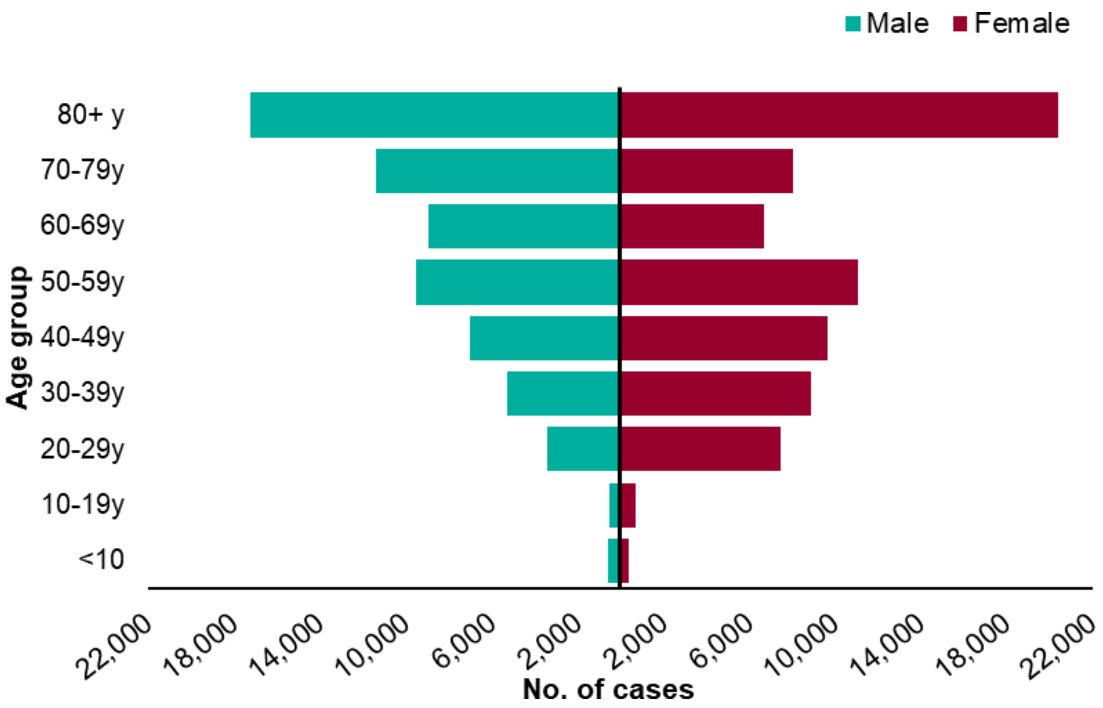


Figure 1.1. Age sex pyramid of laboratory confirmed COVID-19 cases as of 13 May 2020, England. Source: Public Health England Second Generation Surveillance System.

The age standardised diagnosis rates per 100,000 population were similar in males (256.0) and females (252.0). Among people under 60, diagnosis rates were higher in females than males, and among people aged 60 years and older, diagnosis rates were higher in males (Figure 1.2).

PHE has reported previously that among those who were tested, males were more likely to have a positive test (6). This may suggest that females were tested more often and possibly with milder disease. This could be a reflection of the higher number of females working in occupations that expose them to the infection and could explain higher diagnoses rates in working age females. Higher diagnosis rates among males over 60 may reflect worse clinical outcomes in this group.

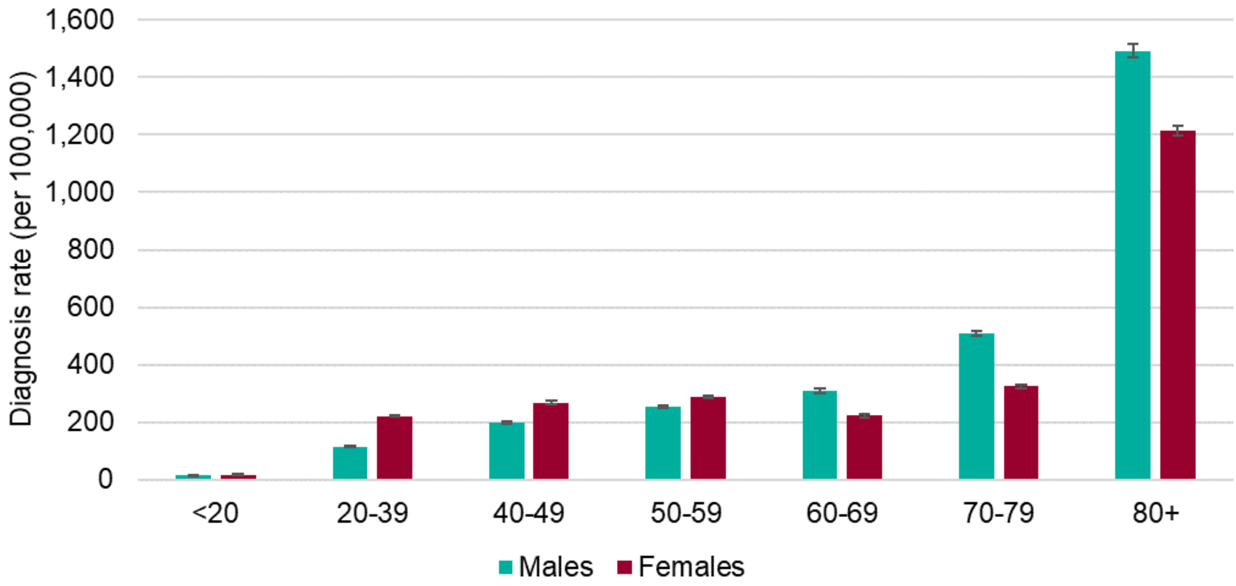


Figure 1.2. Diagnosis rates by sex and age as of 13 May 2020, England. Source: Public Health England Second Generation Surveillance System.

1.4 Hospitalisations

As of 19 of May, 42 trusts had reported lower level of care patients (defined as admission to any hospital ward, excluding intensive care units (ICU) or high dependency units (HDU)), and 94 trusts contributed ICU/HDU (critical care) patient data to the COVID-19 Hospitalisation in England Surveillance System (CHESS). Reporting varies by trusts and the majority of trusts in London do not consistently report to CHESS which will impact on the representativeness of the hospitalised cases. The data presented in this section have not been adjusted for this, which means findings must be interpreted with caution.

Figure 1.3 shows the age and sex distribution of COVID-19 confirmed cases in 'lower level of care' and in critical care. Males make up 54.4% of patients in lower level of care and 70.4% of patients in critical care.

For both sexes, the patient population is younger in critical care. Cases aged over 70 make up 65.5% and 67.6% of the patients in lower level of care among males and females, respectively; in critical care, those over 70 make up only 22.0% and 17.9% of the male and female patients, respectively. The overrepresentation of younger patients in critical care does not necessarily reflect increased severity in this group of patients alone but may also reflect critical care admission criteria.

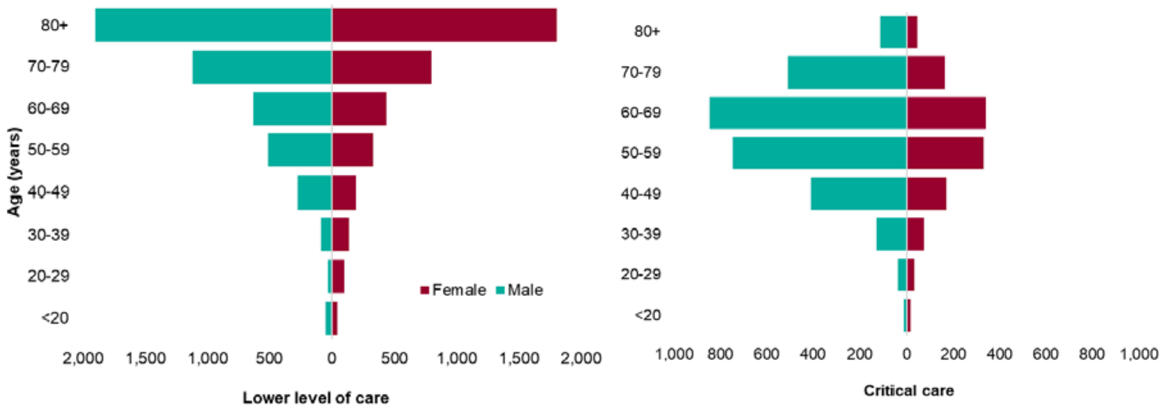


Figure 1.3. Age sex pyramids of admissions for laboratory confirmed COVID-19 to acute trusts, for lower level of care and critical care, as of 19 May 2020, England. Source: Public Health England COVID-19 Hospitalisations in England surveillance system (CHESS).

1.5 Deaths in confirmed cases

As of 13 May, there had been 17,598 deaths in confirmed cases among males (59.3%) and 12,075 in females (40.7%). 56.3% of deaths were among people 80 years and older. Figure 1.4 shows the distribution of deaths by age groups and sex.

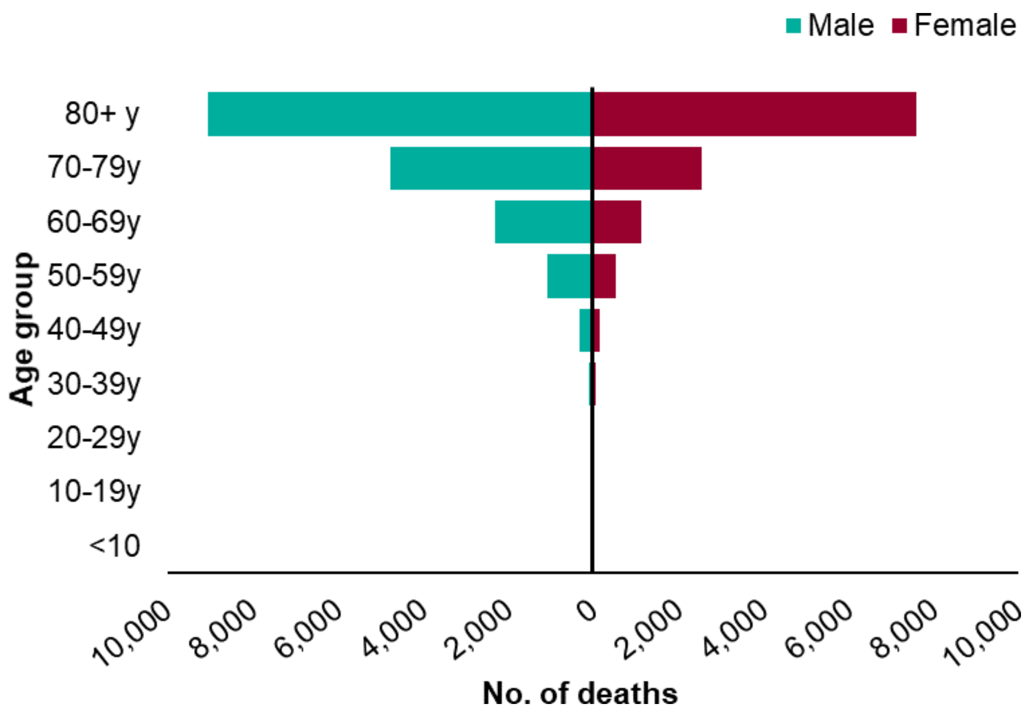


Figure 1.4. Age sex pyramid of laboratory confirmed COVID-19 deaths as of 13 May 2020, England. Source: Public Health England COVID-19 Specific Mortality Surveillance System.

Overall, the mortality rates among confirmed cases per 100,000 population among males were 1.3 to 2.1 higher than among females for all age groups (Figure 1.5). Overall the age standardised mortality rate in males (76.1 per 100,000) was twice that of females (38.8 per 100,000).

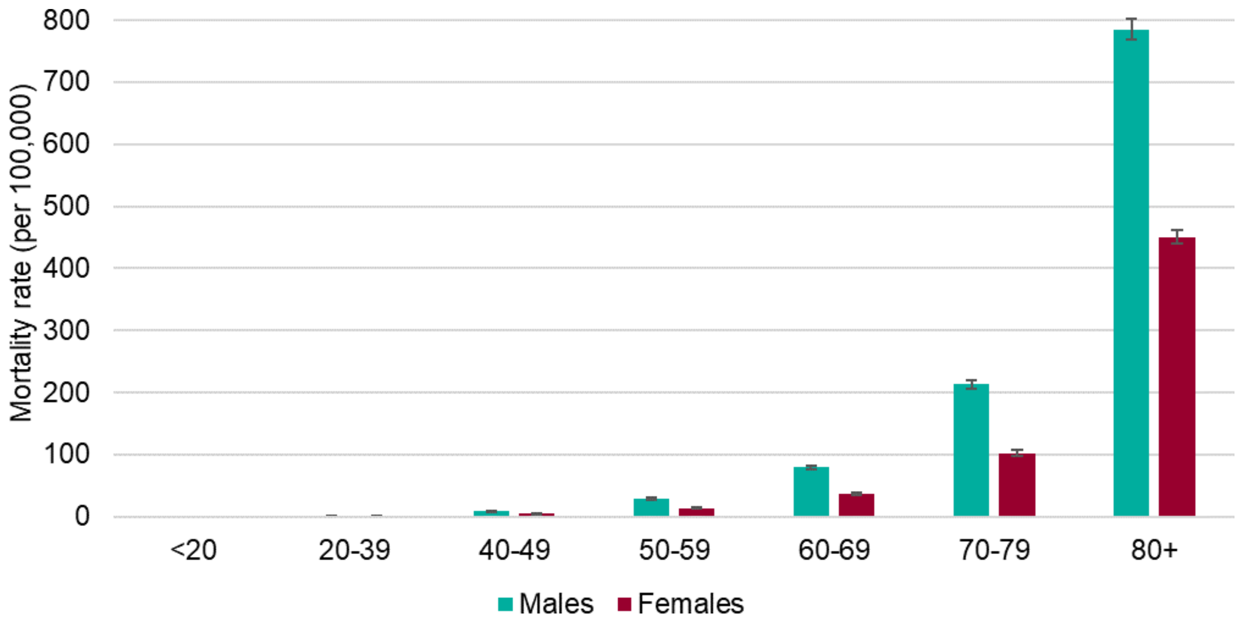


Figure 1.5. Crude mortality rates of laboratory confirmed COVID-19 deaths per 100,000 population by age group and sex, as of 13 May 2020, England. Source: Public Health England COVID-19 Specific Mortality Surveillance System.

An analysis of survival among people with confirmed COVID-19 adjusted for sex, ethnicity, deprivation and region, shows that, compared with people under 40, the probability of death was about 3-times higher among those aged 40 to 49, 9-times higher among those aged 50 to 59, 26 times higher among those aged 60 to 69, 50 times higher among those aged 70 to 79 and 70 times higher among those aged 80 and over. These are the largest disparities by far found in this analysis (Appendix A, table A1).

This analysis also showed that working age males diagnosed with COVID-19 were twice as likely to die than females (Appendix A, table A2). For older adults (65 and over) the disparity remains significant but is much lower, with males in this age group having approximately 50% higher risk of death when compared to females (Appendix A, table A3).

1.6 Comparison with inequalities in previous years

This section uses deaths reported by the Office for National Statistics (ONS) to compare inequalities in death rates from COVID-19 between 21 March and 8 May 2020 with inequalities in all cause death rates for previous years (the ‘baseline all cause’ figure). COVID-19 deaths in this section include all those where COVID-19 was mentioned on the death certificate. These can include cases where the doctor thought it likely that the person had COVID-19, even when there was no positive test result. The deaths reported by ONS will include deaths that are not included in the ‘deaths in confirmed cases’ because they did not have a positive test result confirmed by a PHE or NHS laboratory, and may not include all ‘deaths in confirmed cases’.

There were 35,425 deaths registered between 21 March and 8 May 2020 that mentioned COVID-19 on the death certificate. This is equivalent to 31% of all deaths over this period.

Males accounted for 57% of deaths from COVID-19 and females 43%, while the baseline all cause figures were 49% and 51%. This indicates that males make up a larger percentage of COVID-19 deaths than all causes.

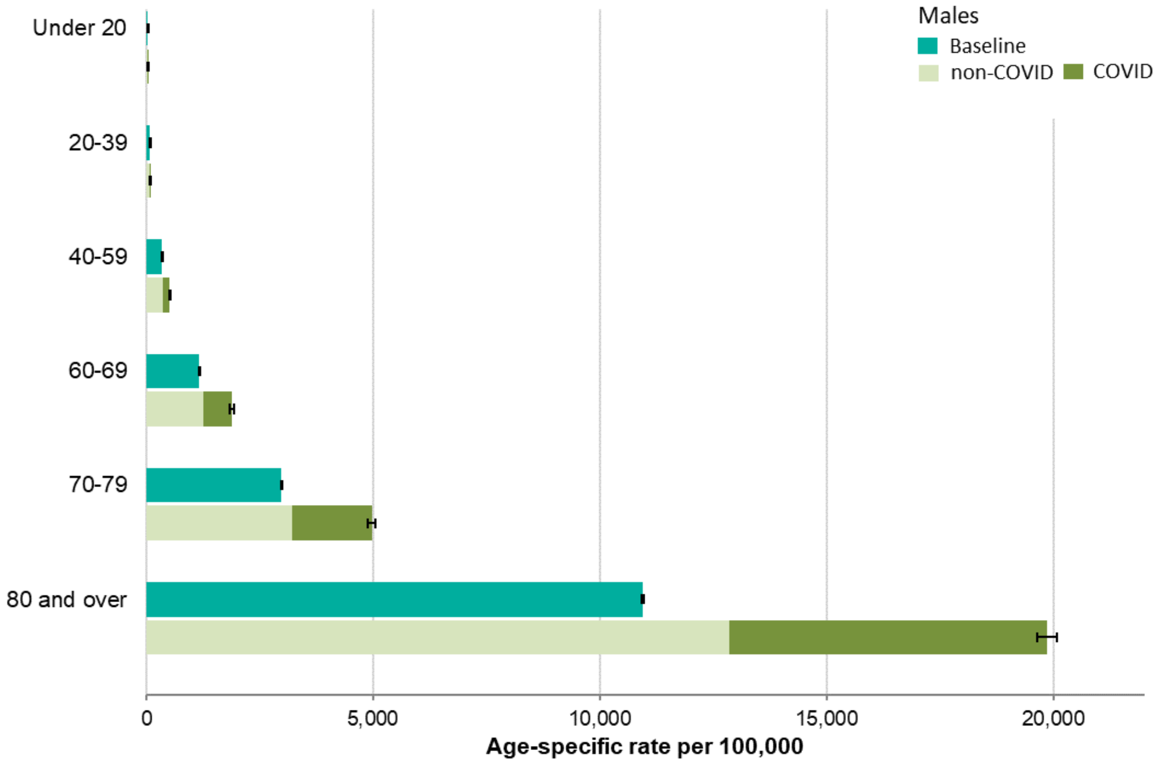
Among males, 54% of COVID-19 deaths were in those aged 80+ compared with 67% of deaths among females. This compares with 48% and 64% for the baseline all cause deaths respectively. 8% of deaths from COVID-19 among males were in those under 60 years of age compared with 6% of females. This compares with 13% and 8% for baseline all cause deaths respectively.

Figures 1.6A and 1.6B show age specific mortality rates for all causes of death and for deaths mentioning COVID-19 between 21 March 2020 and 8 May 2020. They also show the baseline all cause rate using the average annual all cause mortality rates for 2014 to 2018.

Between the ages of 40 to 79, the age specific death rates among males were around double the rates in females, compared with 1.5 times for baseline all causes (Figure 1.6A and 1.6B).

Age specific death rates from COVID-19 increase with age and were highest in those aged 80+ where they were 4.0 times higher than in those aged 70 to 79 in males and 5.1 times higher in females. This ratio is slightly higher than the baseline all cause data for 2014 to 2018 (3.7 and 4.8 in males and females respectively) (Figure 1.6A and 1.6B). Deaths from COVID-19 have a slightly older age distribution than baseline all cause deaths, particularly for males.

The age and sex distribution of ONS deaths from COVID-19 and deaths in confirmed cases were also broadly similar, but ONS deaths had a slightly higher proportion in older ages.



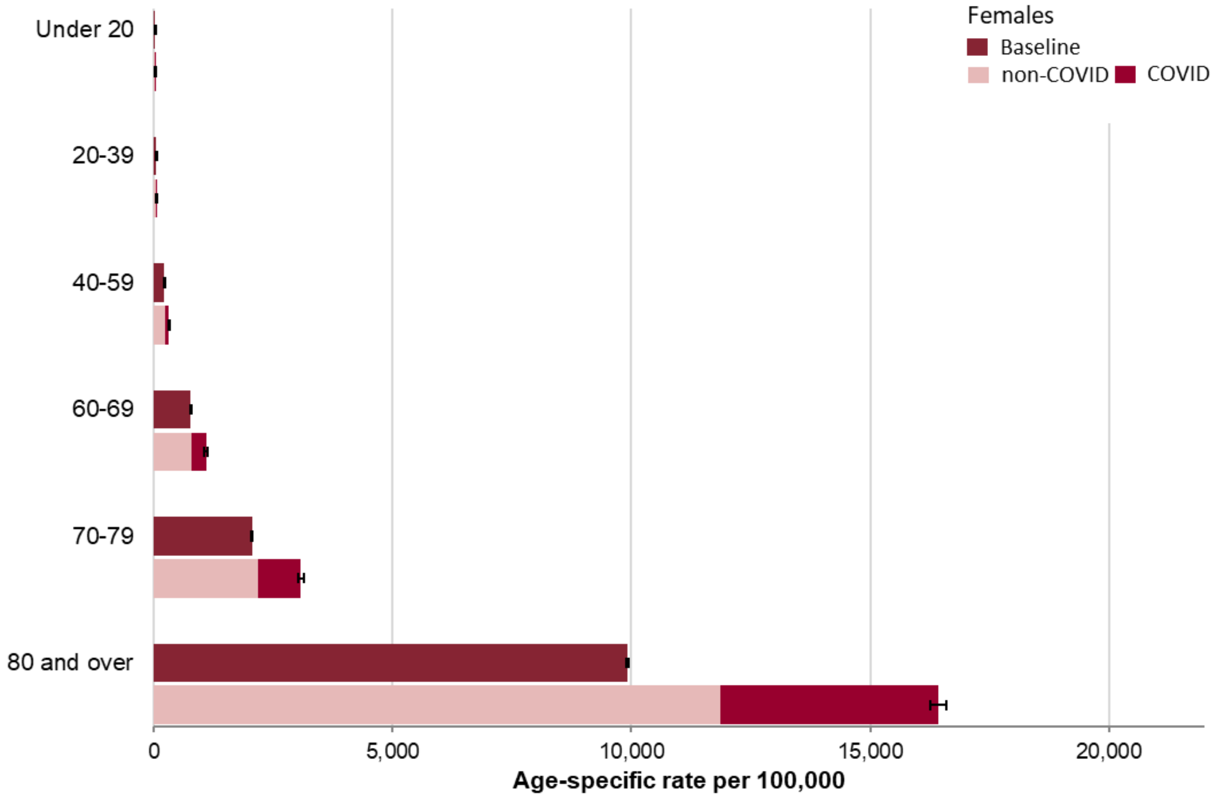


Figure 1.6A and 1.6B. Age specific death rates for all cause deaths and deaths mentioning COVID-19, compared with baseline, by sex, 21 March to 8 May 2020, England. Source: Public Health England analysis of ONS death registration data

1.7 Excess mortality

PHE has developed a model to estimate all cause excess mortality in the population. Figure 1.7 shows the number of excess deaths by age and sex in the period 20 March to 7 May against the number of deaths that would be expected for corresponding dates in 2015 to 2019. It also illustrates how many deaths have COVID-19 mentioned on the death certificate.

The model suggests there have been 46,056 excess deaths between 20 March 2020 and 7 May 2020, 24,731 in males and 21,324 in females. This is similar to the number of excess deaths reported by ONS for England and Wales up until 8 May 2020 (7). ONS compared deaths in 2020 with the simple average for the years 2015 to 2019. However, this will not adjust for ageing of the population or the effect of Easter or bank holidays on the number of deaths registered. The PHE model does adjust for this. More details are provided in the data sources and methodologies section.

The majority of excess deaths have occurred in those aged 75 and over, with 20,841 (45%) in those aged 85+ and 13,921 (30%) in those aged 75 to 84.

There have been fewer deaths than expected in children under 15 years of age. Accidents are a leading cause of death in children and these may have reduced over this period, following social distancing measures, or there could be a delay in the registration of these deaths. Among those age groups where there were excess deaths, the number of deaths with COVID-19 mentioned on the death certificate is equivalent to more than 80% of all excess deaths in each age group, except those aged 85+ where this proportion is lower.

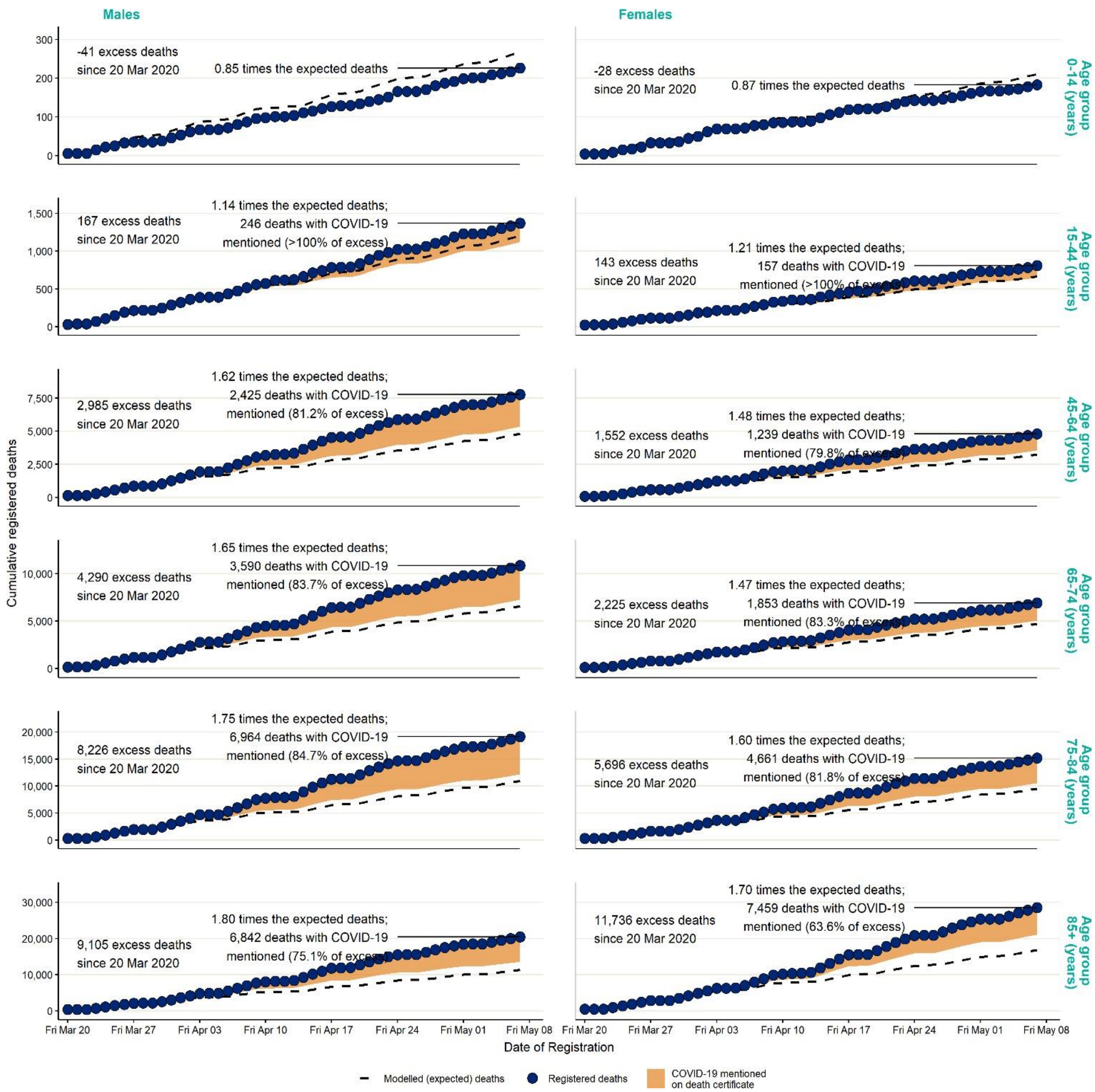


Figure 1.7. Cumulative all cause deaths by date of registration by age and sex, 20 March to 7 May 2020, England. Source: Public Health England excess mortality model based on ONS death registration data.

2. Geography

2.1 Main messages

At 13 May 2020, the regional pattern in diagnoses rates and death rates in confirmed cases among males were similar. London had the highest rates followed by the North West, the North East and the West Midlands. The South West had the lowest.

For females the North East and the North West had higher diagnosis rates than London while London had the highest death rate in confirmed cases.

Diagnosis rates by local authority were highly clustered. Authorities, which are mostly urban, in London, the North West, the West Midlands and the North East had the highest rates. A similar geographic pattern is seen for death rates.

The peak in the number of diagnosed cases happened first in London, the East Midlands and the West Midlands in week ending 4 April. Diagnosed cases peaked latest in South East and Yorkshire and Humber in week ending 18 April. The number of deaths in confirmed cases peaked in week ending 11 April in all regions except North West and Yorkshire and Humber, where it peaked in week ending 18 April.

Death rates in London from COVID-19 were more than 3-times higher than in the region with the lowest rates, the South West. This level of inequality between regions is much greater than the inequality between all cause mortality rates in previous years.

The excess mortality model suggests there have been 9,035 excess deaths in London between 20 March and 7 May, compared with 2,900 in the South West.

2.2 Background

The burden of disease and mortality from COVID-19 is not evenly spread in the population. The UK coronavirus dashboard (8) presents data on the number of cases and deaths in people who have tested positive for SARS-CoV-2 and shows considerable variation in the number of cases by region across the UK. As at 21 May 2020, the number of cases was highest in London and lowest in the South West. The PHE weekly COVID-19 surveillance report as at 13 May 2020 shows the North East and North West regions to have the highest diagnosis rates per 100,000 population, however, London had the highest crude mortality rate in confirmed cases (6).

ONS analysis shows that between 1 March and 17 April 2020, local authorities in London had the highest mortality rates from COVID-19 in England when the age structure of the population was taken into account (9).

Findings from other studies have demonstrated that people living in urban areas versus rural areas have increased odds of testing positive for COVID-19 (10). At the local authority level in England, population density, deprivation and other factors associated with urban areas such as an ethnically diverse population may also be associated with higher mortality from COVID-19 (11).

2.3 Cases

This section presents laboratory confirmed cases under Pillar 1 testing. The majority of testing under this pillar has been offered to those in hospital with a medical need as well as NHS key workers, rather than the general population. Confirmed cases therefore represent the population of people with severe disease, rather than all of those who get infected.

Data reported to PHE up to 13 May 2020 shows that London had the highest number of diagnosed cases (26,024) and the South West the lowest (7,155) and that there was considerable variation among local authorities in England (Table 2a in the data pack).

The highest weekly number of diagnosed cases was reported in week ending 4 April in the East Midlands, London and West Midlands; in week ending 11 April in the East of England, North East, North West and South West; and in week ending 18 April in the South East and Yorkshire and Humber (Figure 2.1).

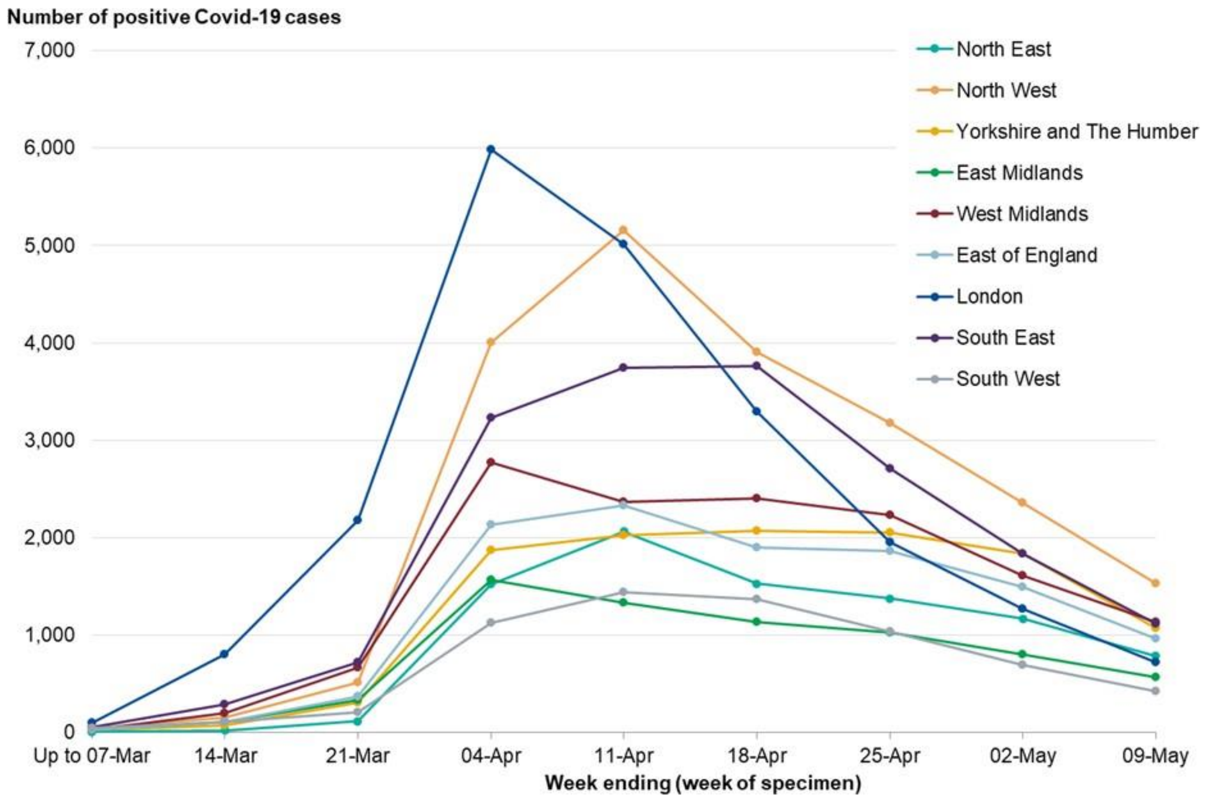


Figure 2.1. Number of positive cases by week by region, as of 9 May 2020, England. Source: Public Health England Second Generation Surveillance System. Note: The last week of data was removed as it was an incomplete week.

The age standardised diagnosis rates (which are adjusted for the population size of the areas and to account for the difference in their age structure) were highest in London (423.9 per 100,000 population) followed by the North West (307.7) and the North East (294.7) for males. For females the rate was highest in the North East (405.0) followed by the North West (335.3) and London (318.5) (Figure 2.2). The South West region had the lowest standardised diagnosis rate for both males and females.

In the North East, North West, Yorkshire and the Humber, and the South East the female diagnosis rates were higher than males, whereas in the East Midlands, East of England and London the opposite was true. In England as a whole the rates were broadly similar for males and females.

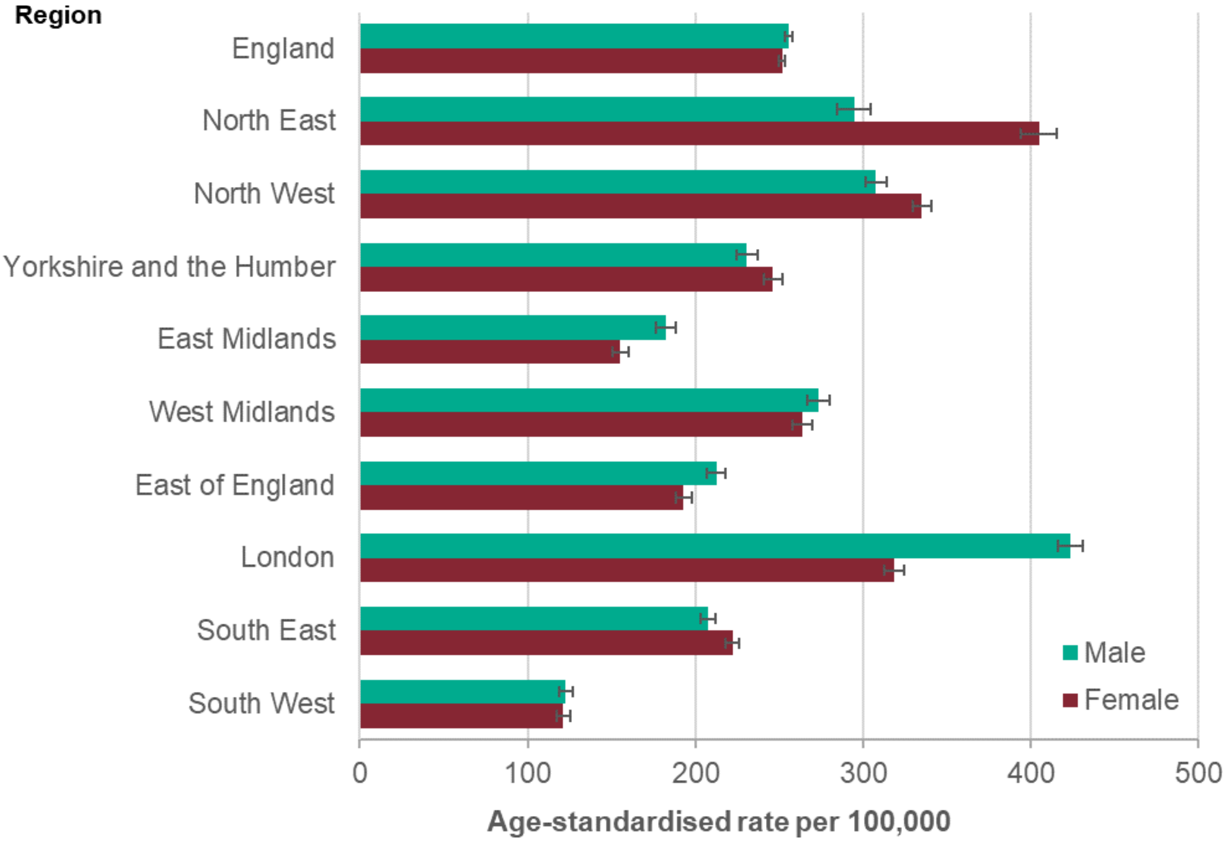
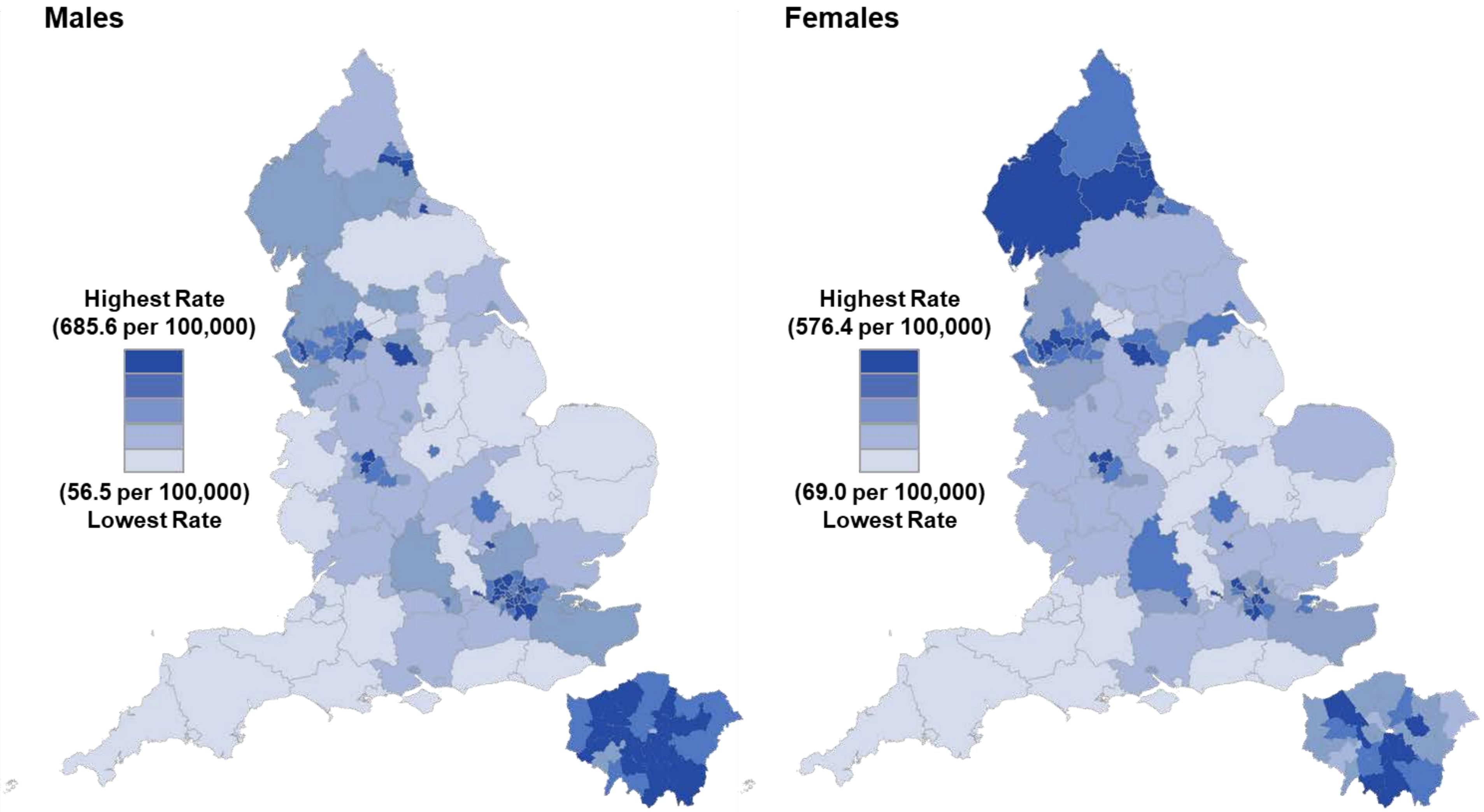


Figure 2.2. Age standardised diagnosis rates by region and sex, as of 13 May 2020, England. Source: Public Health England Second Generation Surveillance System.

Maps 2.1A and 2.1B show age standardised diagnosis rates by upper-tier local authority in England. Among males there is a 12-fold difference in the rates between local authorities and an 8-fold difference in the rates among females. Variation in diagnosis rates will be partly influenced by variation in testing practices between areas.

The maps show diagnosis rates are highly clustered. Authorities which are mostly urban areas, in London, the North West, the West Midlands and the North East had the highest rates. For males, the ten local authorities with the highest diagnosis rates are in London. For females, Cumbria has the sixth highest rate which is a predominately rural area in the North West. These data are also presented in the data pack in Table 2a.



Map 2.1A and 2.1B. Age standardised diagnosis rates by local authority and sex, as of 13 May 2020, England. Source: Public Health England Second Generation Surveillance System.

2.4 Hospitalisations

This section presents data reported to the COVID-19 Hospitalisations in England surveillance system (CHESS). Reporting varies by trusts and the majority of trusts in London do not consistently report to CHESS which will impact on the representativeness of the hospitalised cases. Therefore, rather than providing number of hospitalised patients, daily rates are reported in this section and are analysed using the reporting trusts' catchment area population (rather than regional population denominator) to account for this issue.

Figure 2.3 shows the 3 day moving average rate of hospital admissions to all levels of care (critical and lower level of care) for laboratory confirmed COVID-19 between 15 March and 19 May 2020 by NHS region. The highest rate of hospital admissions occurred between 3 and 9 of April for all regions.

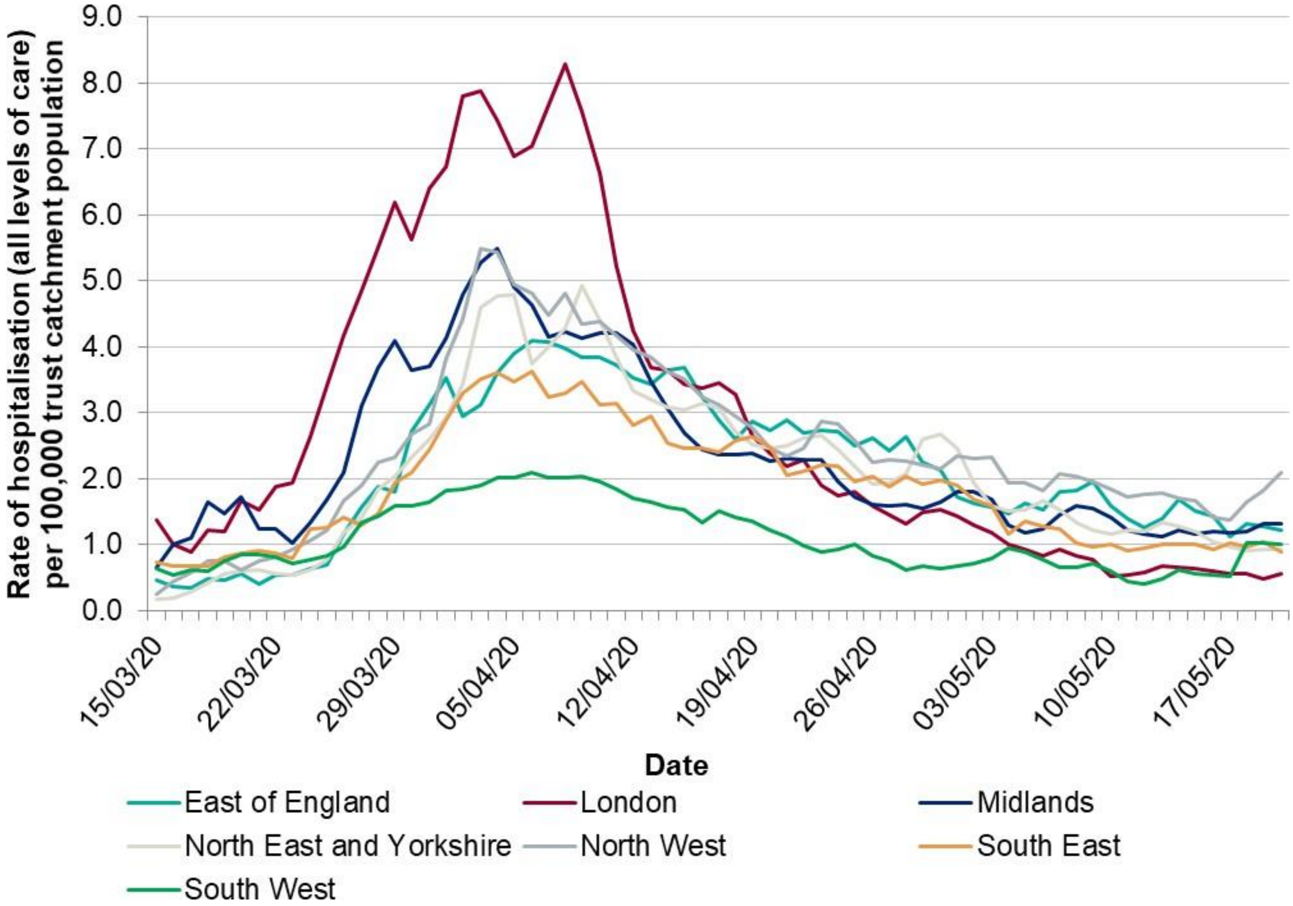


Figure 2.3. 3-day moving average rate of hospital admission to all levels of care for laboratory confirmed COVID-19, by NHS region, as of 19 May 2020, England. Source: Public Health England COVID-19 Hospitalisations in England surveillance system (CHESS).

2.5 Deaths in confirmed cases

The trend in the number of deaths in confirmed cases by week in each region shows that London had the highest number of deaths every week up until week ending 18 April after which the North West had the highest number of deaths. The highest weekly number of deaths in confirmed cases was reported in week ending 11 April in all regions except the North West and Yorkshire and Humber, where it was reported in week ending 18 April (Figure 2.4).

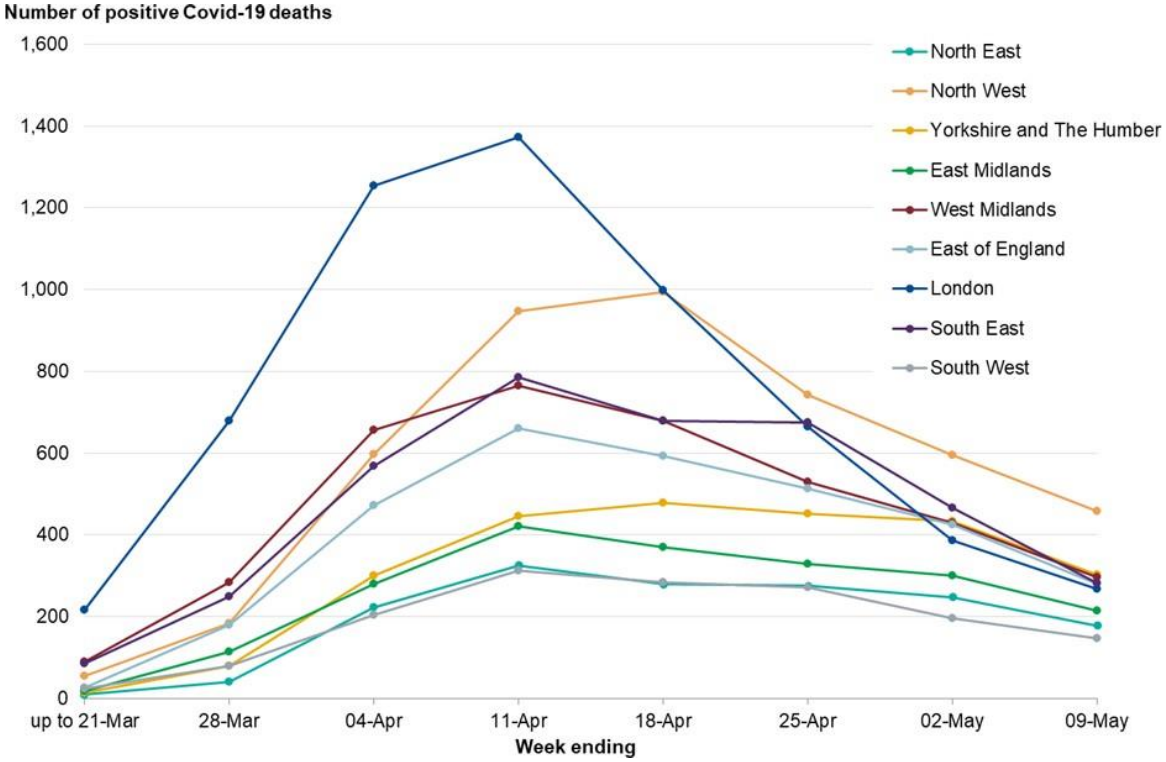


Figure 2.4. Number of deaths in laboratory confirmed COVID-19 cases by region and week, as of 9 May 2020, England. Source: Public Health England COVID-19 Specific Mortality Surveillance System. Note: The last week of data was removed as it was an incomplete week.

Up to 13 May 2020, the age standardised death rate among confirmed cases, per 100,000 population, was highest in London for both males (140.3) and females (66.8) (Figure 2.5) and were also high in the North East, North West and West Midlands. The South West had the lowest standardised death rate among confirmed cases for both males and females. In all regions the death rate in males was higher than females.

Among males, the regional pattern in diagnoses rates and death rates in confirmed cases were similar. However, for females the North East and the North West had the highest diagnosis rates while London had the highest death rate in confirmed cases. This may be explained by different testing strategies and capacity at different times of the pandemic.

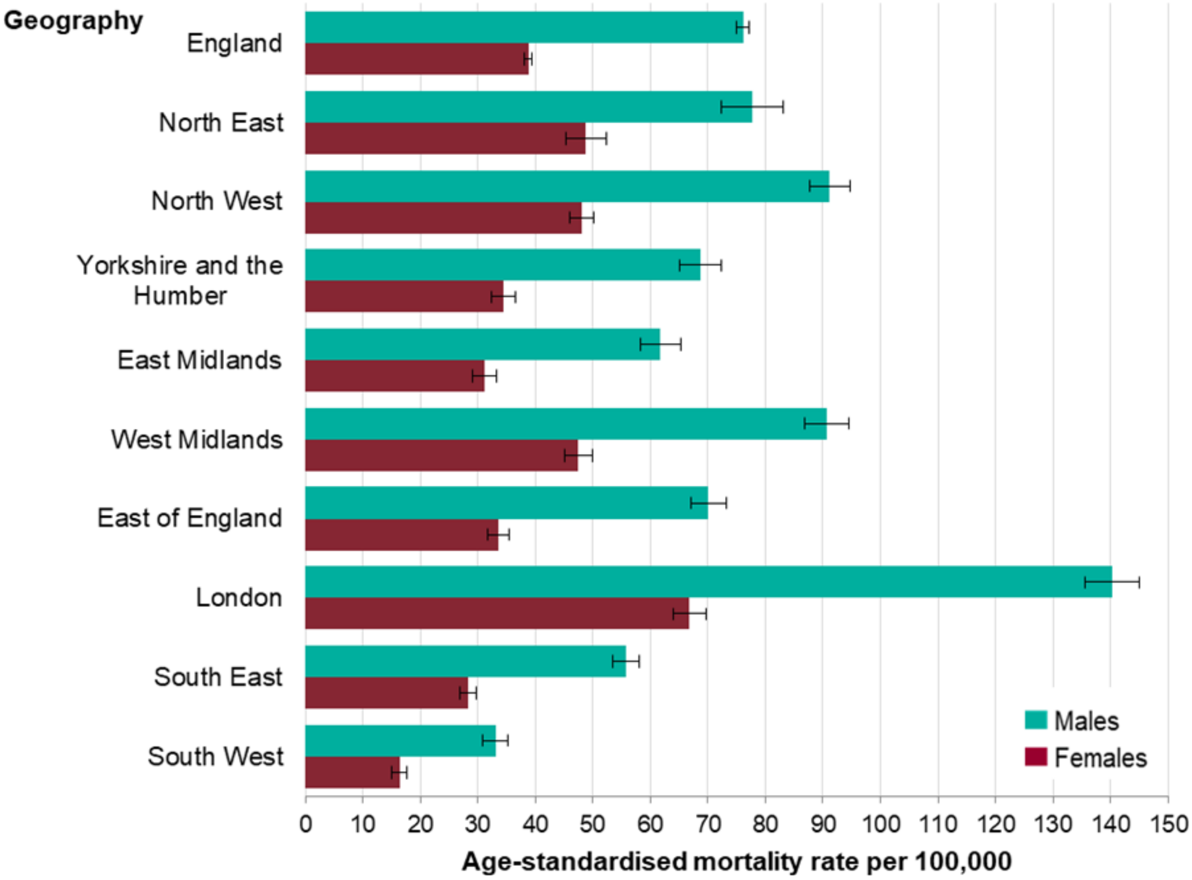
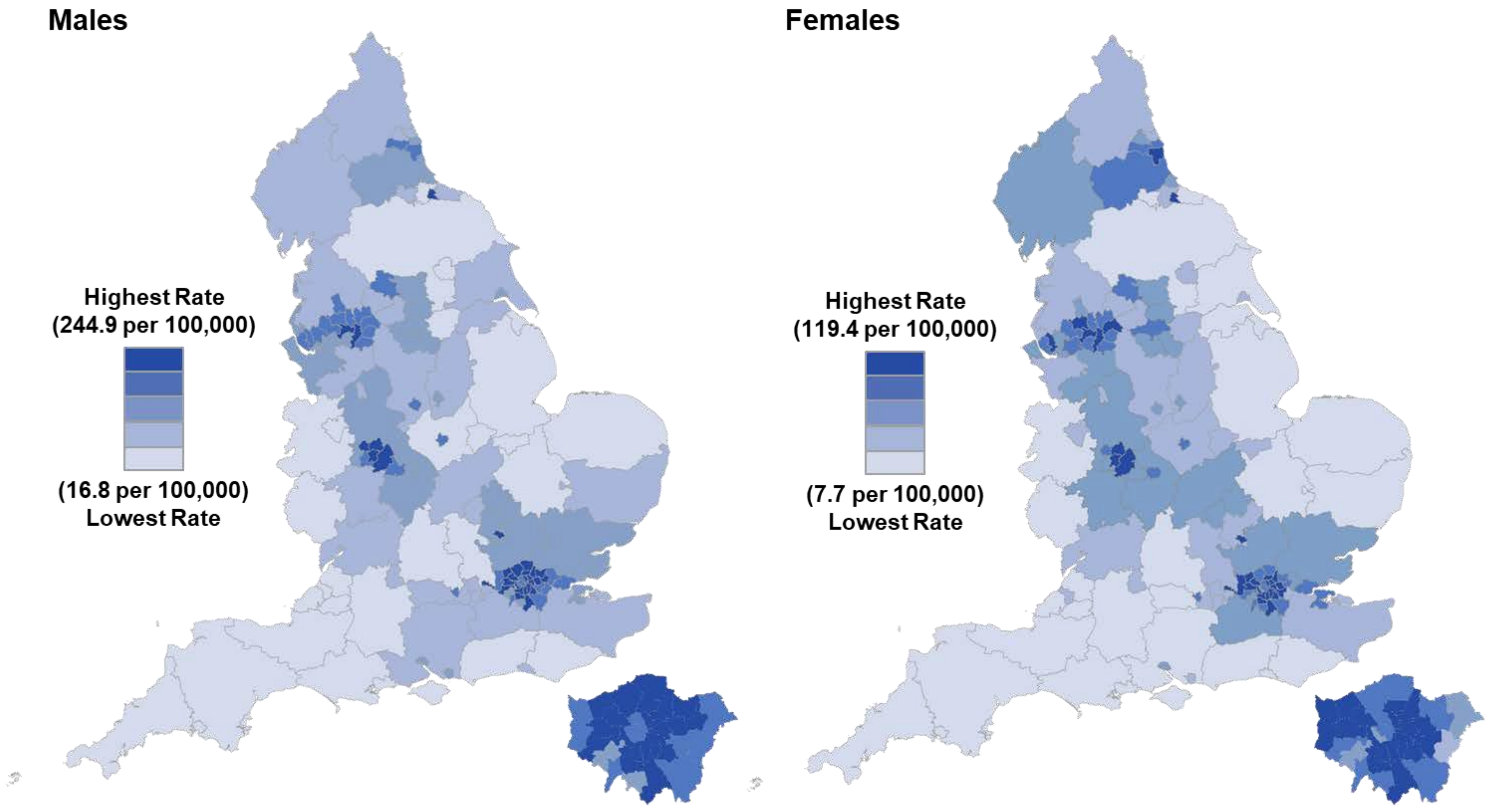


Figure 2.5. Age standardised death rates in laboratory confirmed COVID-19 cases, per 100,000 population, by region and sex, as of 13 May 2020, England. Source: Public Health England COVID-19 Specific Mortality Surveillance System.

Maps 2.2A and 2.2B show age standardised death rates among confirmed cases, per 100,000 population, by upper-tier local authority in England. The maps show that death rates were highly clustered. Authorities, which are largely urban areas, in London, the North West, the West Midlands and the North East had the highest death rates. For males, the 8 authorities with the highest death rates among confirmed cases are in London. (Table 2b in the data pack).

An analysis of survival among people with confirmed COVID-19 by sex, age group, ethnicity, deprivation and region, showed that among people of working age (aged 20 to 64) those living outside of London had a slightly lower risk of death, except for East Midlands and the East of England where the risk was similar. In older ages (65 and over) people living in the North East had a slightly lower risk of death while those in the East of England a higher risk of death compared with London. (Appendix A, tables A2 and A3). However, the magnitude of these inequalities was not as great as that seen for population based death rates for confirmed cases.

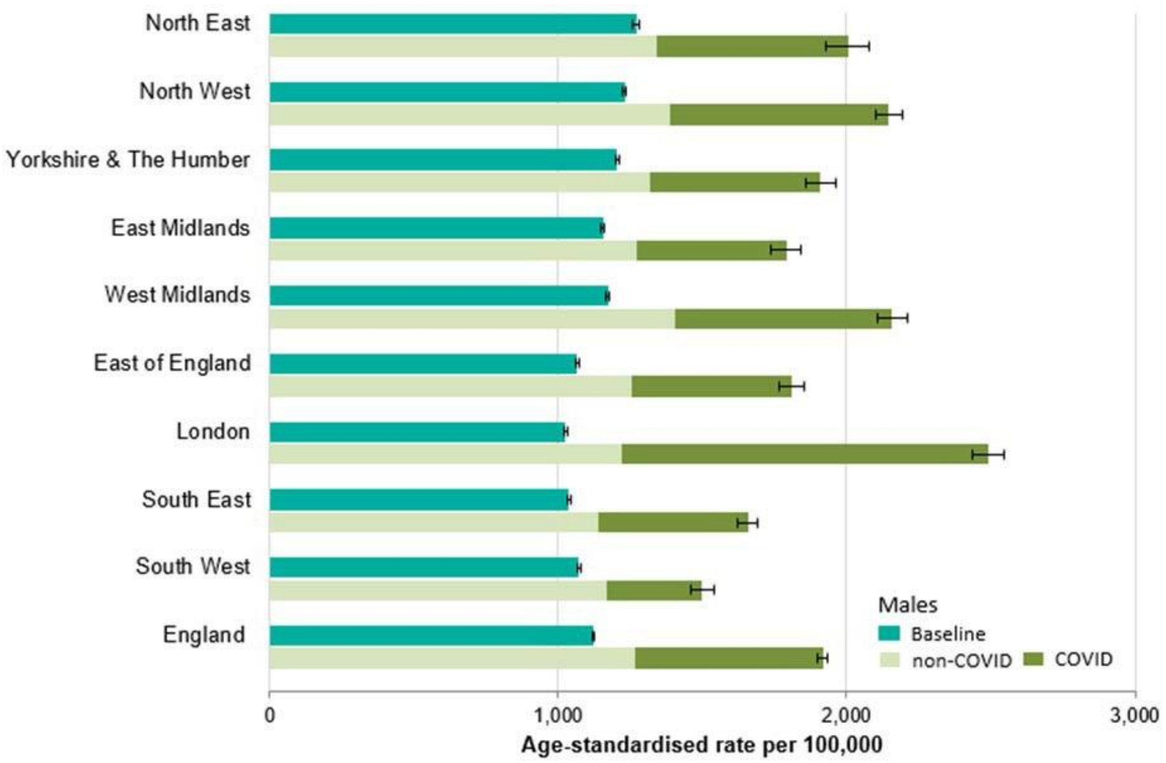


Map 2.2A and 2.2B. Age standardised death rates in laboratory confirmed COVID-19 cases, per 100,000 population, by local authority and sex, as of 13 May 2020, England. Source: Public Health England COVID-19 Specific Mortality Surveillance System.

2.6 Comparison with inequalities in previous years

This section uses deaths reported by the Office for National Statistics (ONS) to compare inequalities in death rates from COVID-19 between 21 March and 8 May 2020 with inequalities in all cause death rates for previous years (the 'baseline all cause' figure).

Figures 2.6A and 2.6B show age standardised mortality rates for all causes of death and for deaths mentioning COVID-19 by region between 21 March 2020 and 8 May 2020. They also show the baseline all cause rate using the average annual all cause mortality rates for 2014 to 2018. The same information is presented by local authority in Table 2c in the data pack.



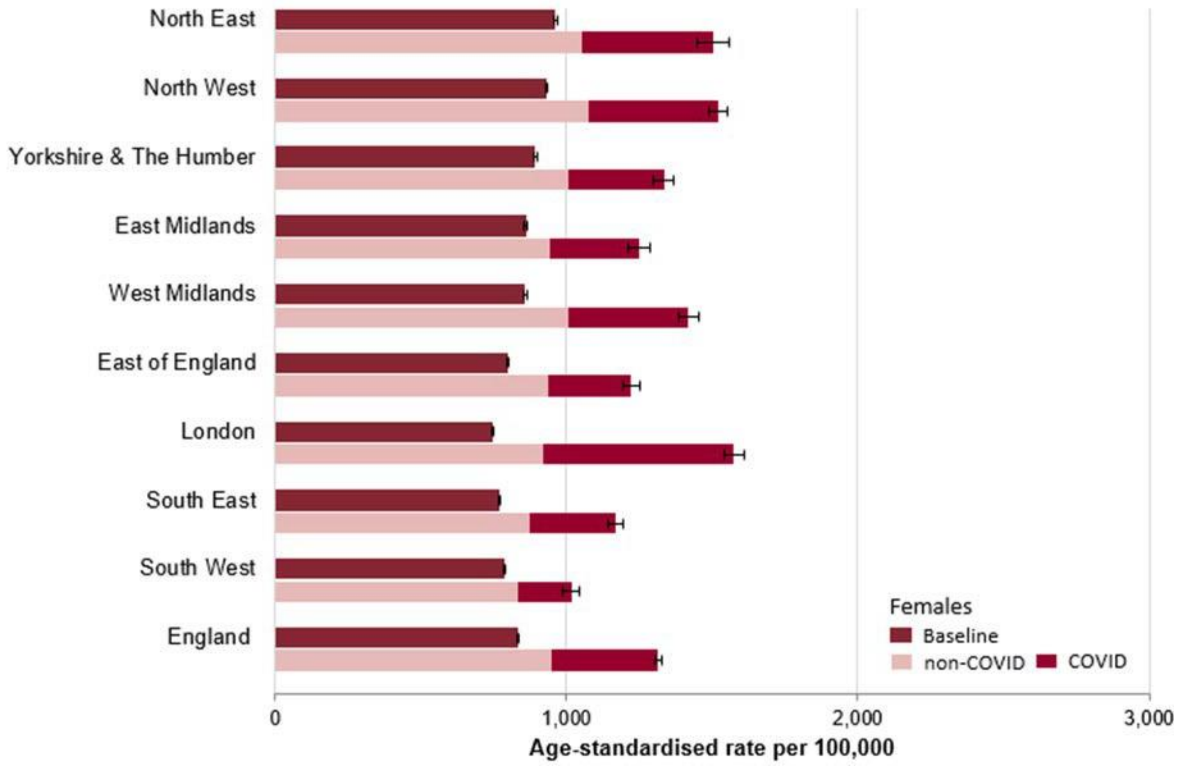


Figure 2.6A and 2.6B. Age standardised mortality rates for all cause deaths and deaths mentioning COVID-19, 21 March to 8 May 2020, compared with baseline mortality rates (2014 to 2018), by region and sex, England. Source: PHE analysis of ONS death registration data

The age standardised death rates from COVID-19 were highest in London for both males and females but were lowest in the South West (Figure 2.6A and 2.6B). This is consistent with the pattern seen for deaths in confirmed cases. The ratio of these rates for males was 3.8 and for females 3.5, indicating that mortality in London from COVID-19 was more than 3-times higher than the South West.

The baseline all cause mortality rates were highest in the North East and were 1.2 times higher in males and 1.3 times higher in females than London, the region with the lowest rates. Therefore, regional inequalities in COVID-19 mortality are greater than those seen previously for all cause mortality and the geographic gradient is different. London had the highest COVID-19 mortality rates, but the lowest baseline all cause mortality rates.

2.7 Excess mortality

PHE has developed a model to estimate all cause excess mortality in the population. Table 2.1 shows results from the excess mortality model and includes the number of excess deaths by sex and region in the period 20 March to 7 May against the number of deaths that would be expected for corresponding dates in 2015 to 2019. It also highlights how many deaths have COVID-19 mentioned on the death certificate.

Overall the model suggests deaths in London have been 2.3 times higher than expected in this period, compared with 1.4 times higher in the South West.

Table 2.1. Cumulative all cause deaths by date of registration and region, 20 March to 7 May 2020 England. Source: Public Health England excess mortality model based on ONS death registration data

	Observed deaths	Expected deaths	Ratio observed/ expected	Excess deaths	COVID-19 deaths	COVID-19 deaths as % excess
North East	6196	3932	1.6	2264	1906	84.2%
North West	17133	10050	1.7	7083	5460	77.1%
Yorkshire and The Humber	11346	7321	1.5	4025	3086	76.7%
East Midlands	9659	6394	1.5	3265	2531	77.5%
West Midlands	13548	7731	1.8	5817	4293	73.8%
East of England	13170	8133	1.6	5037	3513	69.7%
London	16073	7038	2.3	9035	7383	81.7%
South East	18205	11575	1.6	6630	5079	76.6%
South West	10939	8039	1.4	2900	2188	75.4%
Total	116269	70213	1.7	46056	35439	76.9%

3. Deprivation

3.1 Main messages

The trend in the number of diagnosed cases by deprivation quintile shows that cases in the least deprived group peaked earlier and lower than other groups and at 13 May, the cumulative number of cases and diagnosis rate was highest in the most deprived quintile.

The mortality rates from COVID-19 in the most deprived areas were more than double the least deprived areas, for both males and females. This is greater than the ratio for all cause mortality between 2014 to 2018 indicating greater inequality in death rates from COVID-19 than all causes.

Survival among confirmed cases, after adjusting for sex, age group, ethnicity and region was lower in the most deprived areas, particularly among those of working age where the risk of death was almost double the least deprived areas.

In summary, people in deprived areas are more likely to be diagnosed and to have poor outcomes following diagnosis than those in less deprived areas. High diagnosis rates may be due to geographic proximity to infections or a high proportion of workers in occupations that are more likely to be exposed. Poor outcomes remain after adjusting for ethnicity, but the role of underlying health conditions requires further investigation.

3.2 Background

Evidence from previous analysis suggests that there is some association between area based deprivation levels and incidence and mortality from COVID-19. However, this may be weaker once other factors such as ethnicity are taken into consideration (11) (12).

Deprivation is classified using the Index of Multiple Deprivation and encompasses a wide range of aspects of an individual’s living conditions including income, employment, education, health, crime, housing and the living environment (13). Deprived areas can be found in both urban and rural areas of England.

ONS analysis shows that between 1 March and 17 April 2020 the deprived areas in England had more than double the mortality rate from COVID-19 than the least deprived areas (9). Other sources have shown that people living in more deprived areas were more likely to test positive for COVID-19 (10) and to have higher mortality rates (14).

The latest report from the Intensive Care National Audit and Research Centre (ICNARC) used data up to 21 May 2020 and showed that a larger proportion of patients critically ill in intensive care units (ICU) with COVID-19 were from the most deprived quintile of areas (25.0%) than the least deprived (14.7%), however, this pattern was similar to the pattern seen previously among patients admitted for viral pneumonia between 2017 and 2019 (2). Patient outcomes from COVID-19 across deprivation categories were similar.

3.3 Cases

This section presents laboratory confirmed cases under Pillar 1 testing. The majority of testing under this pillar has been offered to those in hospital with a medical need as well as NHS key workers, rather than the general population. Confirmed cases therefore represent the population of people with severe disease, rather than all of those who get infected.

The trend in the number of diagnosed cases by deprivation quintile shows that cases in the least deprived group (quintile 5) peaked earlier and lower than other groups (Figure 3.1). As of 13 May the cumulative number of cases was highest in the most deprived quintile (quintile 1). Deprivation quintiles are roughly equal in population size and are defined in section 10.

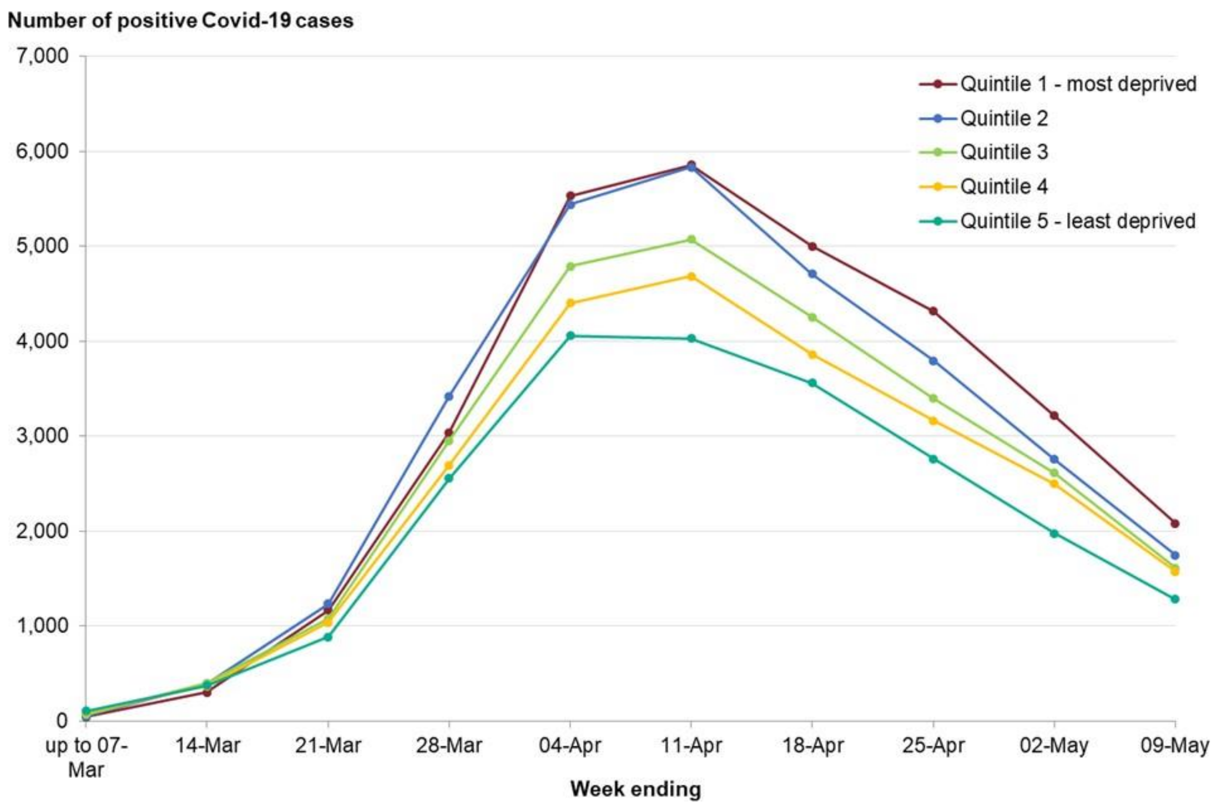


Figure 3.1. Number of positive confirmed cases by deprivation quintile and week, as of 9 May 2020, England. Source: Public Health England Second Generation Surveillance System. Note: The last week of data was removed as it was an incomplete week.

The age standardised diagnosis rates were highest in the most deprived quintile in both males and females, and lowest in the least deprived quintile. The rate in the most deprived quintile was 1.9 times the rate in the least deprived quintile among males and 1.7 times among females. In quintiles 1 and 2 (the most deprived) the male diagnosis rates were significantly higher than females, whereas in all other quintiles the rates in the sexes were very similar (Figure 3.2).

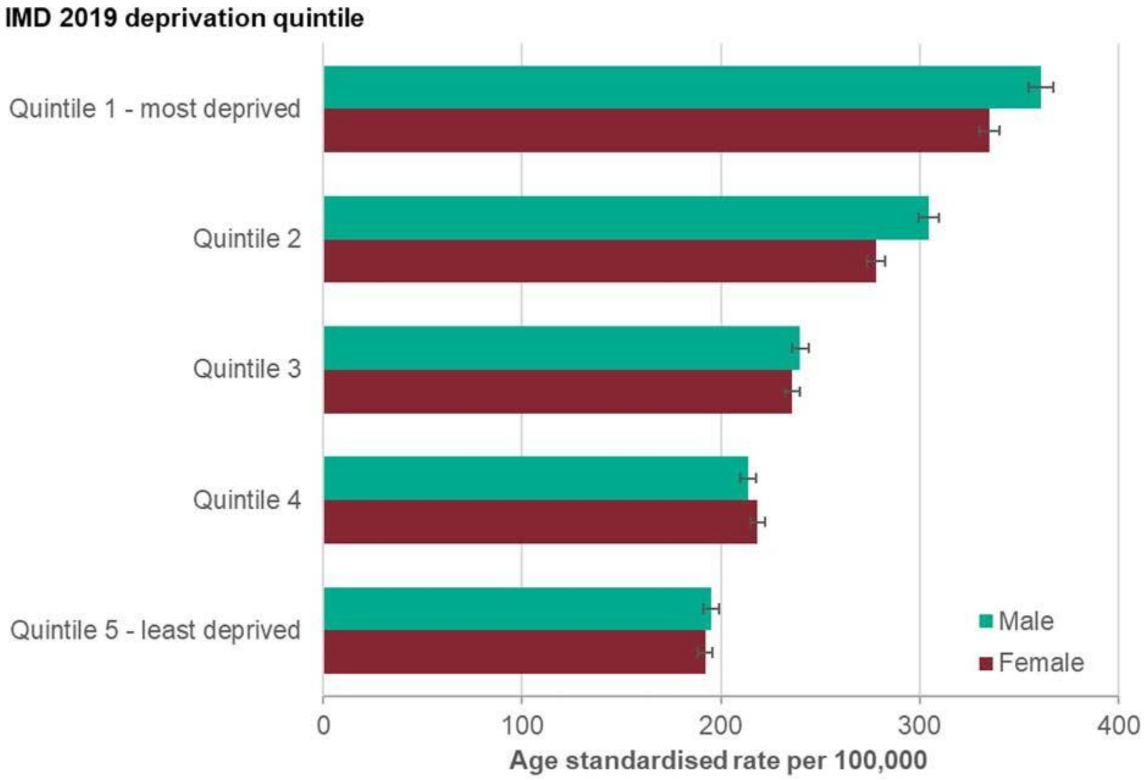


Figure 3.2. Age standardised diagnosis rates by deprivation quintile and sex, as of 13 May 2020, England. Source: Public Health England Second Generation Surveillance System.

3.4 Deaths in confirmed cases

The trend in the number of deaths in confirmed cases by week in each quintile shows that by week ending 11 April the number of weekly deaths was highest in the most deprived quintile (quintile 1) and remained so for every following week. For all quintiles, the week with the peak number of deaths in confirmed cases was week ending 11 April 2020 (Figure 3.3). By 13 May the cumulative number of deaths was highest in the most deprived quintile (quintile 1) (6,894) and lowest in the least deprived (quintile 5) (4,672).

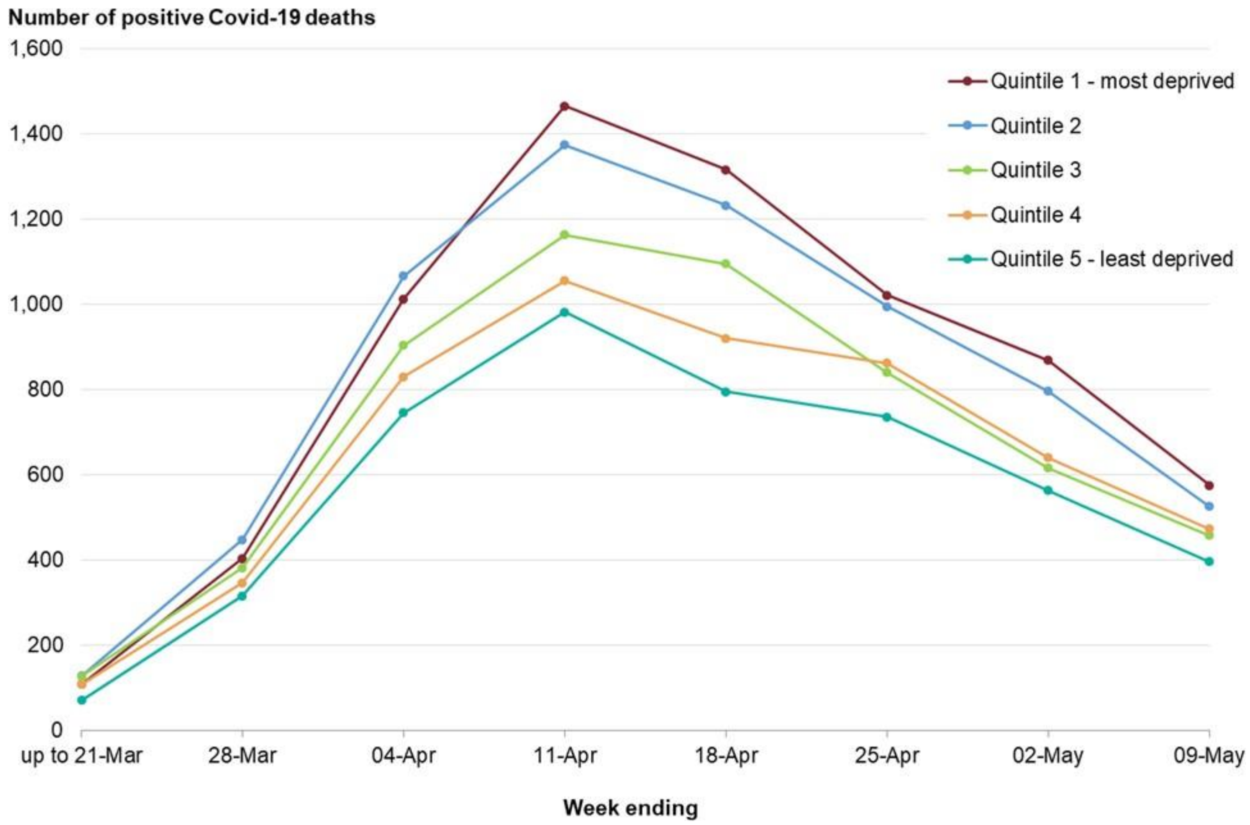


Figure 3.3. Number of deaths in laboratory confirmed COVID-19 cases by deprivation quintile and week, as of 9 May 2020, England. Source: Public Health England COVID-19 Specific Mortality Surveillance System. Note: The last week of data was removed as it was an incomplete week.

The age standardised death rates in confirmed cases, per 100,000 population, were highest in the most deprived quintile in both males and females, and lowest in the least deprived quintile. The rate in the most deprived quintile was 2.3 times the rate in the least deprived quintile among males and 2.4 times among females. In all quintiles the male death rates were significantly higher than females (Figure 3.4).

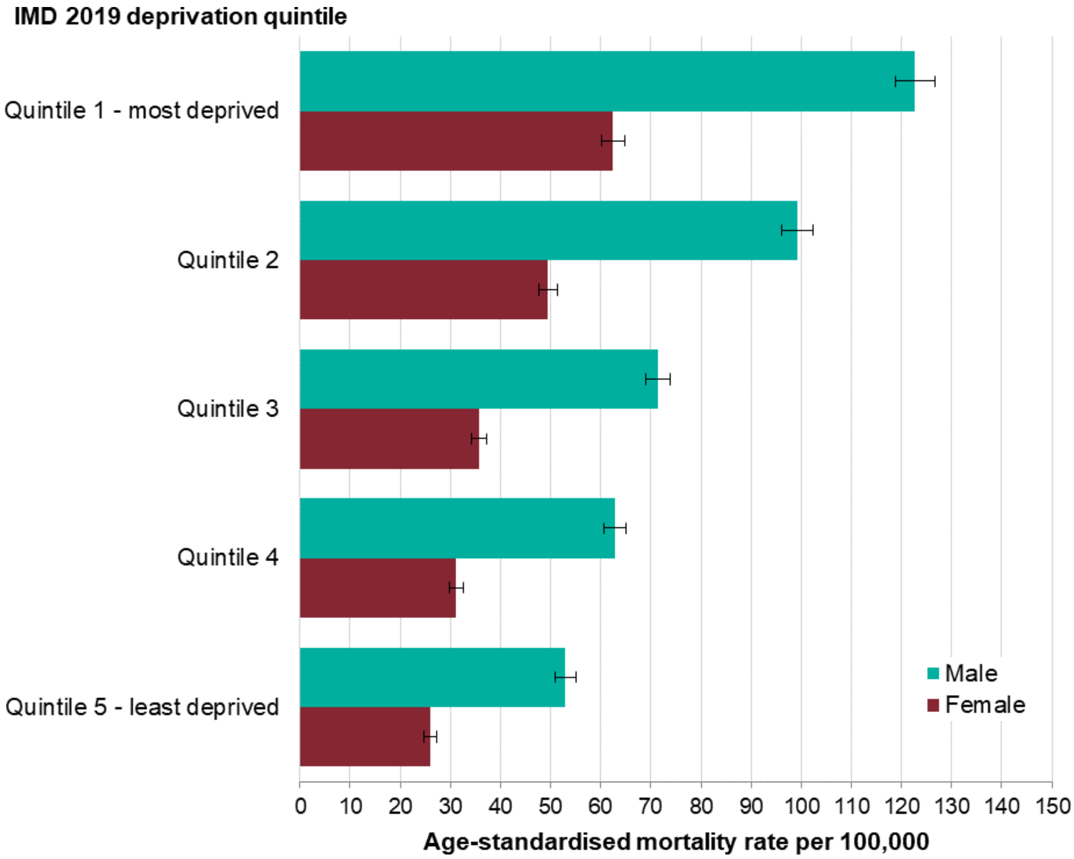


Figure 3.4. Age standardised death rates in laboratory confirmed COVID-19 cases by deprivation quintile and sex, as of 13 May 2020, England. Source: Public Health England COVID-19 Specific Mortality Surveillance System.

An analysis of survival among people with confirmed COVID-19 by sex, age group, ethnicity, deprivation and region, showed that, among people of working age (20 to 64), people living in the most deprived areas of the country were almost twice as likely to die than those living in the least deprived (Appendix A, table A2). For older adults (65 and over) the disparity remains significant but is much lower, with people in the most deprived areas having approximately 9% higher risk of death when compared to people in the least deprived areas (Appendix A, table A3).

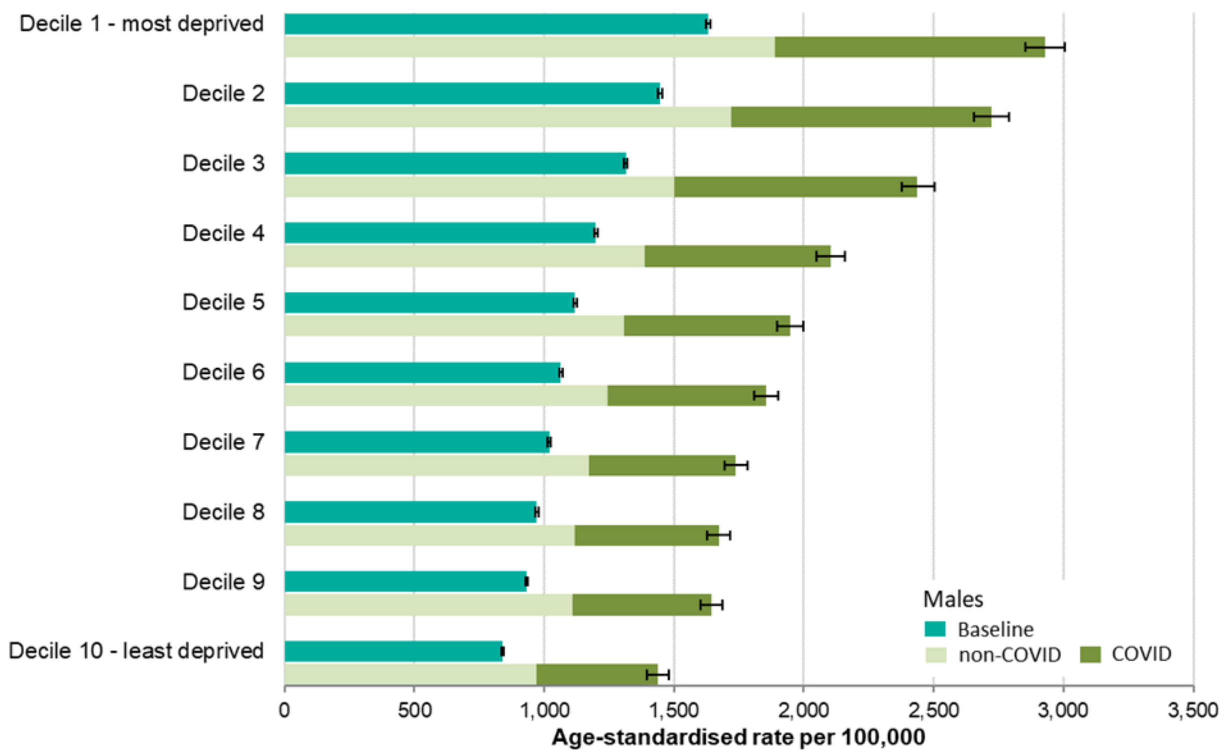
3.5 Comparison with inequalities in previous years

This section uses deaths reported by the Office for National Statistics (ONS) to compare inequalities in death rates mentioning COVID-19 on the death certificate with inequalities in all cause death rates for previous years (the ‘baseline all cause’ figure).

Figure 3.5A and 3.5B show age standardised mortality rates for all causes of death and for deaths mentioning COVID-19 by deprivation decile between 21 March 2020 and 8 May 2020. They also show the baseline all cause rate using the average annual all cause mortality rates for 2014 to 2018.

The age standardised death rate from COVID-19 was highest in the most deprived decile in males, but in the second most deprived decile in females (Figure 3.5A and 3.5B). The rate in the most deprived decile was 2.2 times the rate in the least deprived decile among males and females. In all deciles the male death rates were significantly higher than females. This analysis is consistent with the analysis by ONS (9).

From 2014 to 2018 the baseline all cause mortality rate in the most deprived decile was 1.9 times that in the least deprived decile in both males and females. This is smaller than the ratio for COVID-19 mortality rates indicating that the level of inequality in COVID-19 mortality rates is greater than that for all cause mortality in previous years.



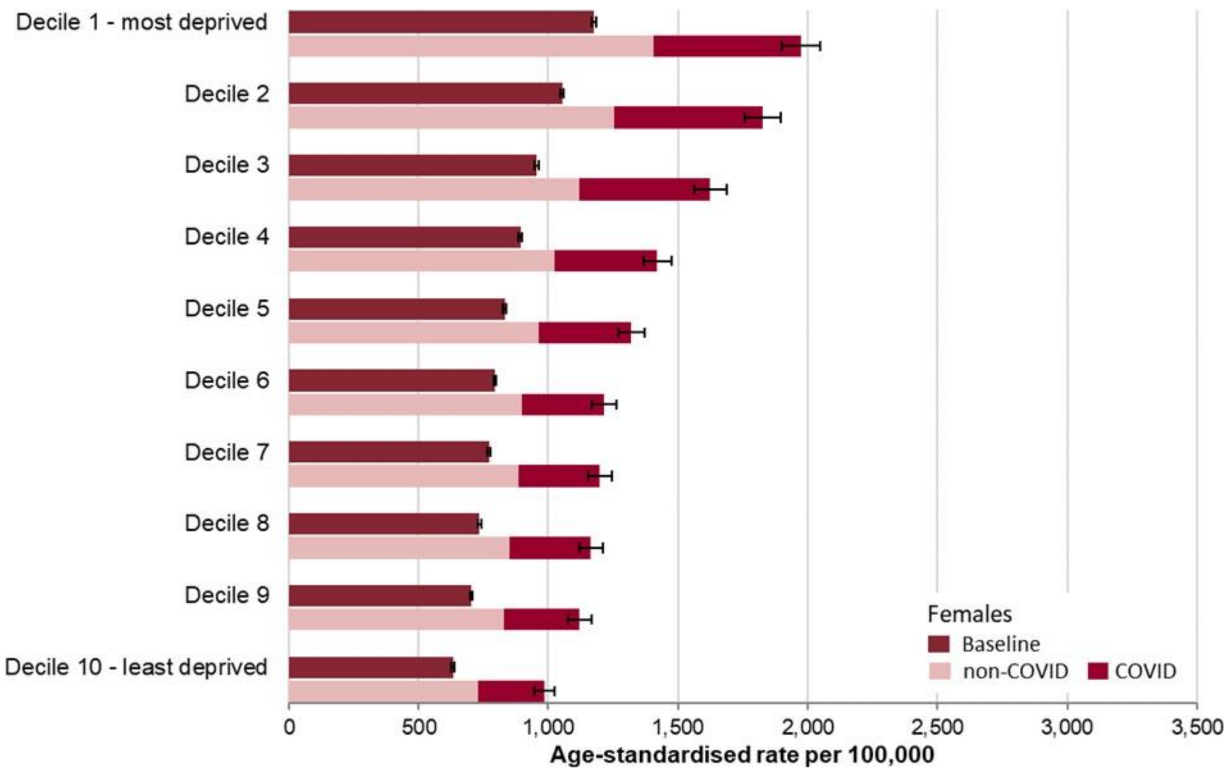


Figure 3.5A and 3.5B. Age-standardised mortality rates for all cause deaths and deaths mentioning COVID-19, 21 March to 8 May 2020, compared with baseline mortality rates (2014 to 2018), by deprivation decile and sex, England. Source: Public Health England analysis of ONS death registration data

3.6 Excess mortality

The PHE excess mortality model shows that between 20 March and 7 May 2020, there was excess mortality among all 5 deprivation quintiles. The crude number of excess deaths ranges from 10,678 in the most deprived quintile areas to 8,621 in the least deprived. This is a slightly larger relative increase in the most deprived quintile. The number of deaths with COVID-19 mentioned as a percentage of these excess deaths ranges from 72-77% across the quintiles.

4. Ethnicity

4.1 Main messages

The highest age standardised diagnosis rates of COVID-19 per 100,000 population were in people of Black ethnic groups (486 in females and 649 in males) and the lowest were in people of White ethnic groups (220 in females and 224 in males).

An analysis of survival among confirmed COVID-19 cases shows that, after accounting for the effect of sex, age, deprivation and region, people of Bangladeshi ethnicity had around twice the risk of death when compared to people of White British ethnicity. People of Chinese, Indian, Pakistani, Other Asian, Black Caribbean and Other Black ethnicity had between 10 and 50% higher risk of death when compared to White British.

Death rates from COVID-19 were higher for Black and Asian ethnic groups when compared to White ethnic groups. This is the opposite of what is seen in previous years, when the all cause mortality rates were lower in Asian and Black ethnic groups. Therefore, the inequality in COVID-19 mortality between ethnic groups is the opposite of that seen for all causes of death in previous years.

Comparing to previous years, all cause mortality was almost 4 times higher than expected among Black males for this period, almost 3 times higher in Asian males and almost 2 times higher in White males. Among females, deaths were almost 3 times higher in this period in Black, Mixed and Other females, and 2.4 times higher in Asian females compared with 1.6 times in White females.

These analyses were not able to include the effect of occupation. This is an important shortcoming because occupation is associated with risk of being exposed to COVID-19 and we know some key occupations have a high proportion of workers from BAME groups.

These analyses were also not able to include the effect of comorbidities or obesity. These are also important factors because they are associated with the risk of death and are more commonly seen in some BAME groups. Other evidence has shown that when these are included, the difference in risk of death among hospitalised patients is greatly reduced.

4.2 Background

Evidence suggests that COVID-19 may have a disproportionate impact on people from Black, Asian and minority ethnic (BAME) groups. The Intensive Care National Audit and

Research Centre (ICNARC) report published on 22 May found that Black and Asian patients were over-represented among those critically ill with confirmed COVID-19 receiving advanced respiratory support. The report found that 15.2% and 9.7% of critically ill patients were from Asian and Black ethnic groups respectively (2).

Some evidence also suggests the risk of death from COVID-19 is higher among people of BAME groups (15) and an ONS analysis showed that, when taking age into account, Black males were 4.2 times more likely to die from a COVID-19-related death than White males (16). The risk was also increased for people of Bangladeshi and Pakistani, Indian and Mixed ethnic groups. However, an analysis of over 10,000 patients with COVID-19 admitted to intensive care in UK hospitals suggests that, once age, sex, obesity and comorbidities are taken into account, there is no difference in the likelihood of being admitted to intensive care or of dying between ethnic groups (17).

The relationship between ethnicity and health is complex and likely to be the result of a combination of factors. Firstly, people of BAME communities are likely to be at increased risk of acquiring the infection. This is because BAME people are more likely to live in urban areas (18), in overcrowded households (19), in deprived areas (20), and have jobs that expose them to higher risk (21). People of BAME groups are also more likely than people of White British ethnicity to be born abroad (22), which means they may face additional barriers in accessing services that are created by, for example, cultural and language differences.

Secondly, people of BAME communities are also likely to be at increased risk of poorer outcomes once they acquire the infection. For example, some co-morbidities which increase the risk of poorer outcomes from COVID-19 are more common among certain ethnic groups. People of Bangladeshi and Pakistani background have higher rates of cardiovascular disease than people from White British ethnicity (23), and people of Black Caribbean and Black African ethnicity have higher rates of hypertension compared with other ethnic groups (24). Data from the National Diabetes Audit suggests that type II diabetes prevalence is higher in people from BAME communities (25).

Most analyses in this section of the review look at 5 broad ethnic groups: White / White British, Black / Black British, Asian / Asian British, Mixed / Multiple Ethnic groups and Other ethnic groups. The survival analysis looks at sixteen smaller ethnic groups. These are based on the data available from different sources. Appendix B and the data sources and methodologies section outline these groups and how they were collapsed.

4.3 Cases

This section presents laboratory confirmed cases under Pillar 1 testing. The majority of testing under this pillar has been offered to those in hospital with a medical need as well as NHS key workers, rather than the general population. Confirmed cases therefore represent the population of people with severe disease, rather than all of those who get infected.

It was possible to assign ethnicity to 127,821 (91.9%) of the 139,086 individuals who had tested positive for SARS-CoV-2 by 13 May 2020. Figure 4.1 shows the weekly number of positive cases by ethnic group since the start of the pandemic. For Black and Other ethnic groups, the highest weekly number of cases was reported in week ending 4 April and for all other ethnic groups the highest weekly number of cases was reported in week ending 11 April.

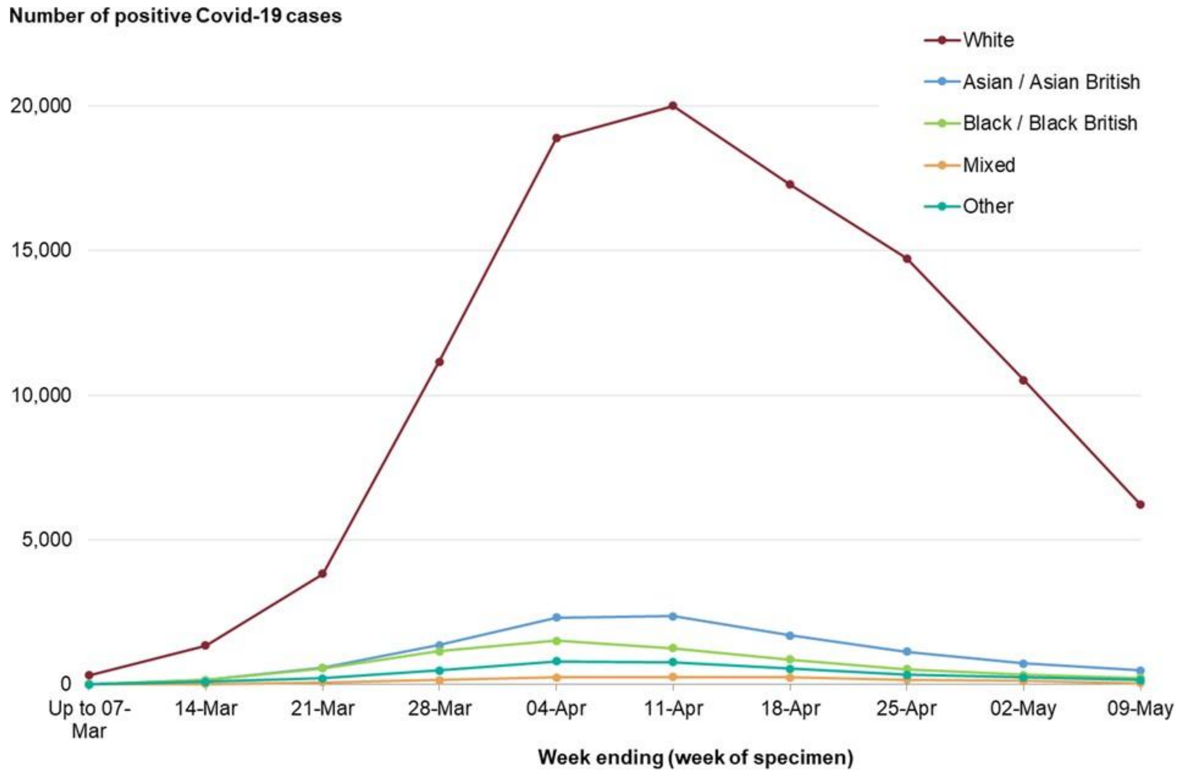


Figure 4.1. Number of positive confirmed cases by ethnic group and week, as of 9 May 2020, England. Source: Public Health England Second Generation Surveillance System. Note: The last week of data was removed as it was an incomplete week.

Figure 4.2 shows the age standardised diagnoses rates by ethnic group. After adjustment by age, the highest diagnosis rates of COVID-19 per 100,000 population were in people of Other ethnic groups (1,076 in women and 1,101 in men) followed by people of Black ethnic groups (486 in females and 649 in males). This compared to 220 per 100,000 among White females and 224 among White males.

These results are not adjusted for some factors that may influence the likelihood of becoming infected, such as geographical location. The rates in the Other ethnic group are likely to be an overestimate due to the difference in the method of allocating ethnicity codes to the cases data and the population data used to calculate the rates.

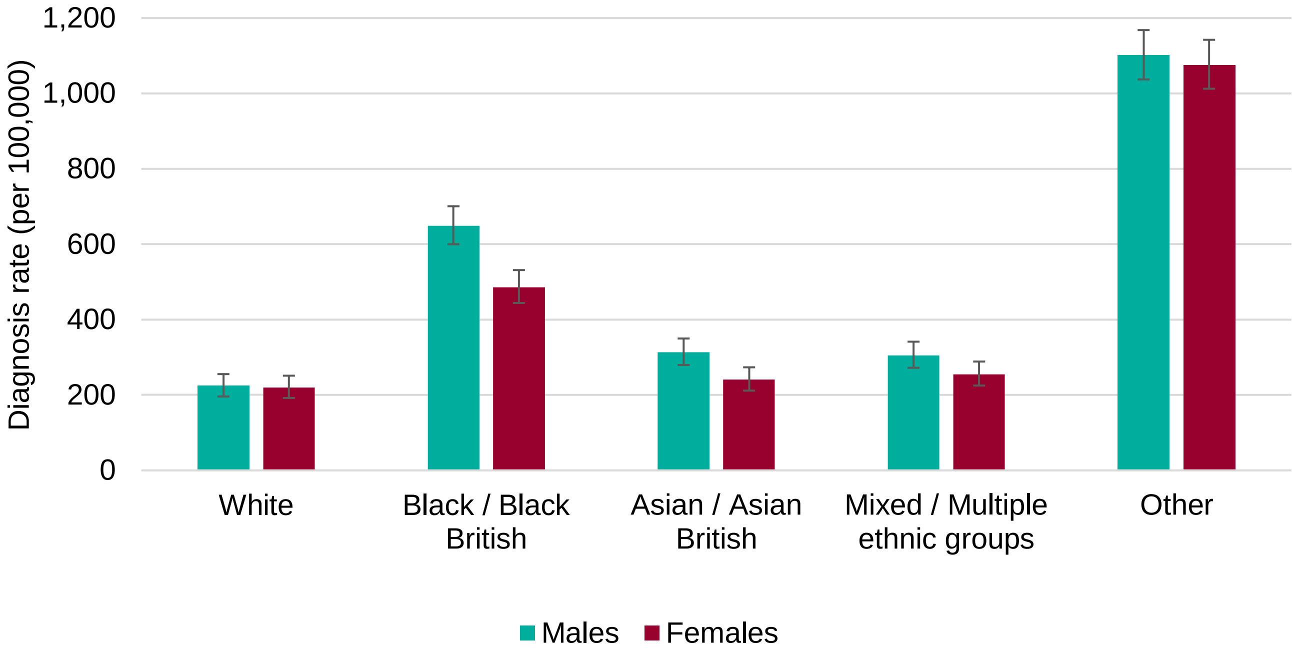


Figure 4.2. Age standardised diagnosis rates by ethnicity and sex, as of 13 May 2020, England. Source: Public Health England Second Generation Surveillance System.

4.4 Hospitalisations

As of 19 May, 42 trusts had reported lower level of care patients (defined as admission to any hospital ward, excluding ICU or HDU), and 94 trusts contributed ICU/HDU (critical care) patient data to the COVID-19 Hospitalisations in England surveillance system (CHESS). Reporting varies by trusts and the majority of trusts in London do not consistently report to CHESS which will impact on the representativeness of the hospitalised cases. The data presented in this section have not been adjusted for this, which means findings must be interpreted with caution.

The lower level of care subset contained 8,508 cases of which 7,617 (89.5%) could be linked to Hospital Episode Statistics (HES) to assign ethnicity. The critical care subset contained 3,978 cases of which 3,219 (80.9%) could be linked to HES to assign ethnicity.

Among cases hospitalised in lower level of care, 11% were of Black, Asian and other Minority Ethnic (BAME) groups; however, this proportion was 36% of those admitted to critical care (Figure 4.3). Confirmed cases among BAME groups tend to be younger than White ethnic groups, which is likely to explain some of this difference, as might other factors such as comorbidities.

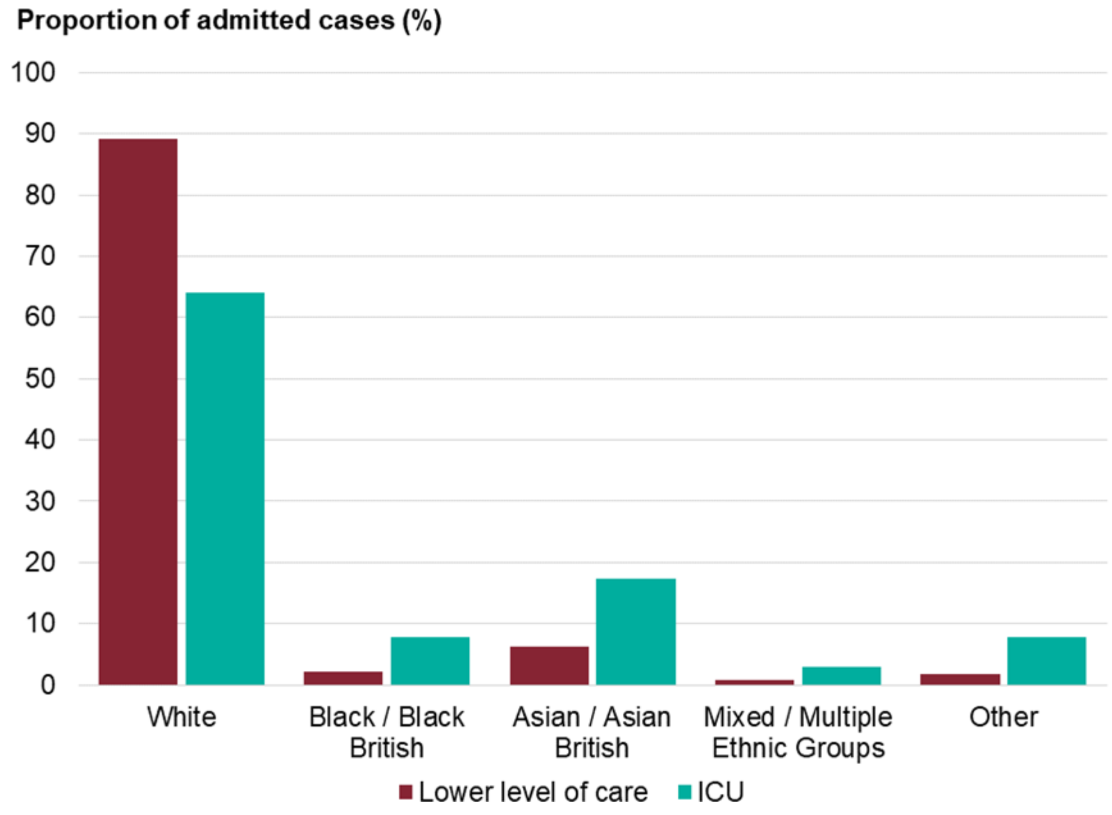


Figure 4.3. Laboratory confirmed admissions for COVID-19 to acute trusts, by level of care and ethnicity, England, as of 19 May 2020. Source: Public Health England COVID-19 Hospitalisations in England surveillance system (CHESS).

4.5 Deaths in confirmed cases

There were 29,673 deaths reported to PHE by 13 May 2020 of which it was possible to obtain ethnicity for 29,500 (99.4%). For all ethnic groups, the highest weekly number of deaths was recorded on week ending 11 April, except for Mixed / Multiple ethnic groups who had an equally high number on week ending 18 April (Figure 4.4).

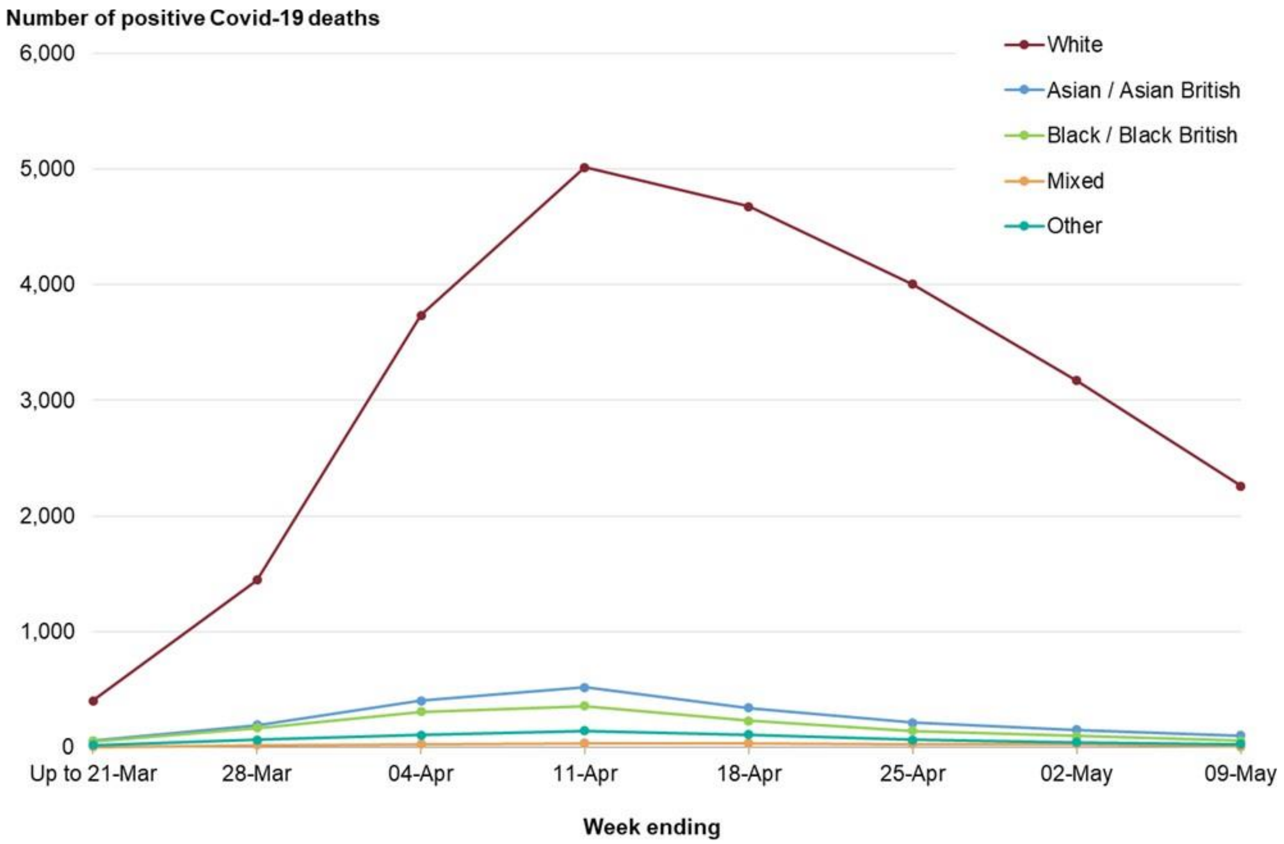


Figure 4.4. Number of deaths in laboratory confirmed COVID-19 cases by ethnicity and week, as of 9 May 2020, England. Source: Public Health England COVID-19 Specific Mortality Surveillance System. Note: The last week of data was removed as it was an incomplete week.

The highest age standardised deaths rates in confirmed cases per 100,000 population were among people of Other ethnic groups (234 in females and 427 in males) followed by people of Black ethnic groups (119 in females and 257 in males), Asian ethnic groups (78 in females and 163 in males), Mixed ethnic groups (58 in females and 116 in males) and White ethnic groups (36 in females and 70 in males) (Figure 4.5).

The rates in the Other ethnic group are likely to be an overestimate due to the difference in the method of allocating ethnicity codes to the cases/mortality data and the population data used to calculate the rates.

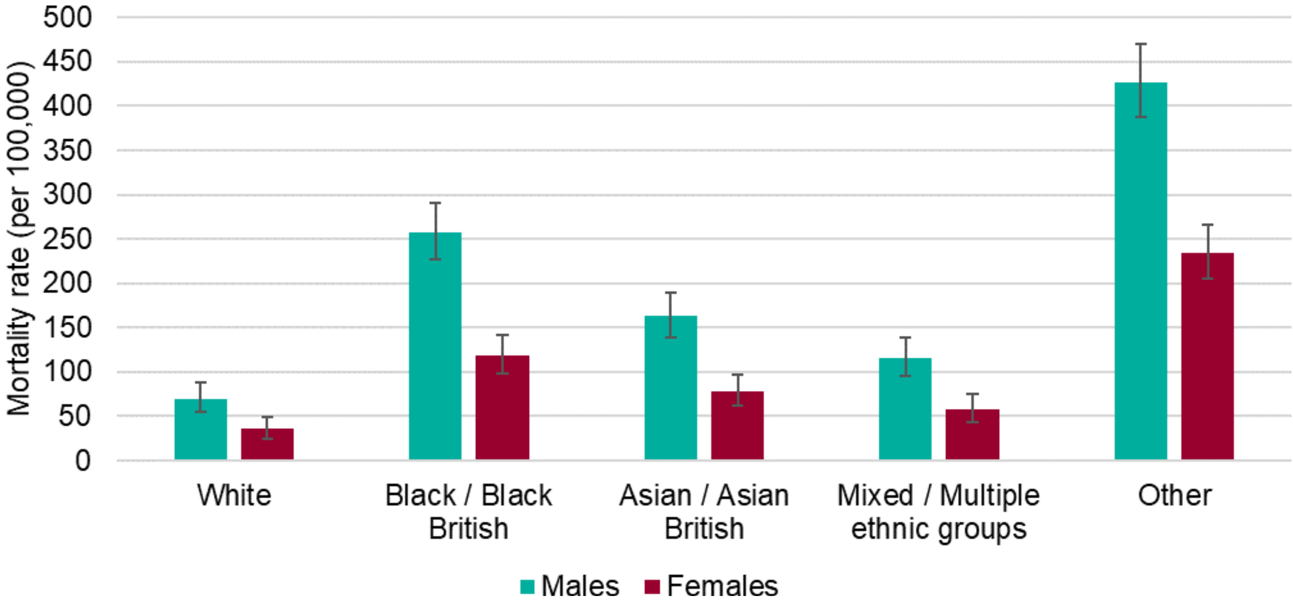


Figure 4.5. Age standardised mortality rates in laboratory confirmed COVID-19 cases by ethnicity and sex, as of 13 May, England. Source: Public Health England: COVID-19 Specific Mortality Surveillance System.

An analysis of survival among people with confirmed COVID-19 by sex, age group, ethnicity, deprivation and region, shows that, after taking these factors into account, some ethnic groups still had a higher risk of death than others (Appendix A). This analysis looked at 16 ethnicity categories and found that, when compared to White British ethnicity, people of Bangladeshi ethnicity had twice the risk of death. People of Chinese, Indian, Pakistani, Other Asian, Black Caribbean and Other Black ethnicity had between 10 and 50% higher risk of death when compared to White British (Appendix A, table A1).

When looking only at the working age population (between 20 and 64 years old), the increased risk of death is seen among people of Bangladeshi ethnicity (80% higher risk than White British ethnicity), Black Other ethnicity, Pakistani ethnicity (both 50% higher) and Black Caribbean ethnicity (30% higher) (Appendix A, table A2).

While this analysis adjusts for many important factors such as age and deprivation, it does not adjust for factors such as comorbidities and obesity, which are likely to have an important impact on the different risk of dying between ethnic groups.

4.6 Comparison with inequalities in previous years

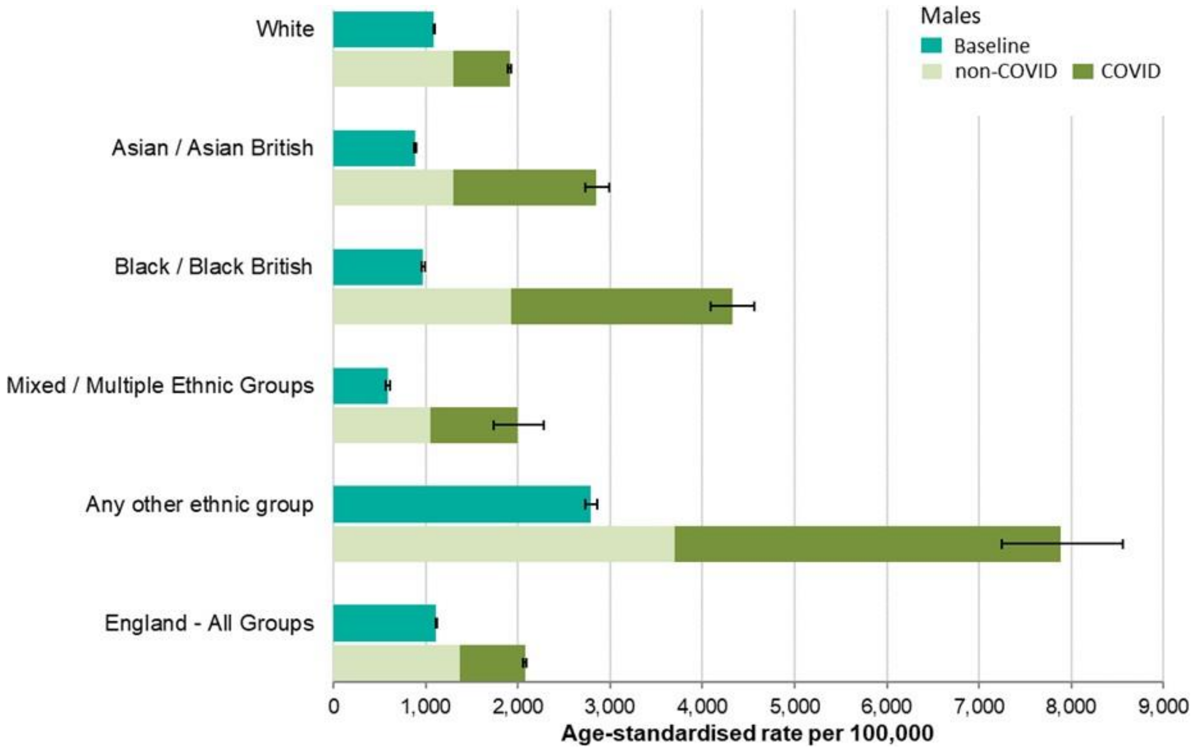
This section uses deaths reported by the Office for National Statistics (ONS) to compare inequalities in death rates mentioning COVID-19 on the death certificate with inequalities in all cause death rates for previous years (the ‘baseline all cause’ figure). Ethnicity is not recorded at death registration, so this information was obtained through linkage to Hospital Episode Statistics. It was possible to obtain ethnicity information for 97% of all cause deaths.

Figures 4.6A and 4.6B show age standardised mortality rates for all causes of death and for deaths mentioning COVID-19 by ethnic group between 21 March 2020 and 1 May 2020. They also show the baseline all cause rate using the average annual all cause mortality rates for 2014 to 2018.

Death rates from COVID-19 were higher in people of Asian, Black, Mixed and Other ethnic groups than White ethnic groups (Figure 4.6A and 4.6B). Black males were 3.9 times more likely to die than the White group, compared with 2.5 times in Asian males. Among females, death rates were 3.3 times higher in the Black ethnic group, and 2.3 times higher in the Asian ethnic group than the White group. These inequalities are broadly consistent with the pattern of deaths in confirmed cases and the findings from ONS before adjustment for other factors (16).

However, the baseline all cause rates show lower mortality in Asian and Black ethnic groups than the White group, therefore the inequality in COVID-19 mortality between these groups is the opposite of that seen for all causes of death in previous years.

The Other ethnic group also had higher mortality rates from both all causes and COVID- 19 than the White group. The rates in the Other ethnic group are likely to be an overestimate due to the difference in the source of allocating ethnicity codes to the mortality data and the population data used to calculate the rates. This may explain the high mortality rates in the Other group, which cannot be interpreted and requires further investigation.



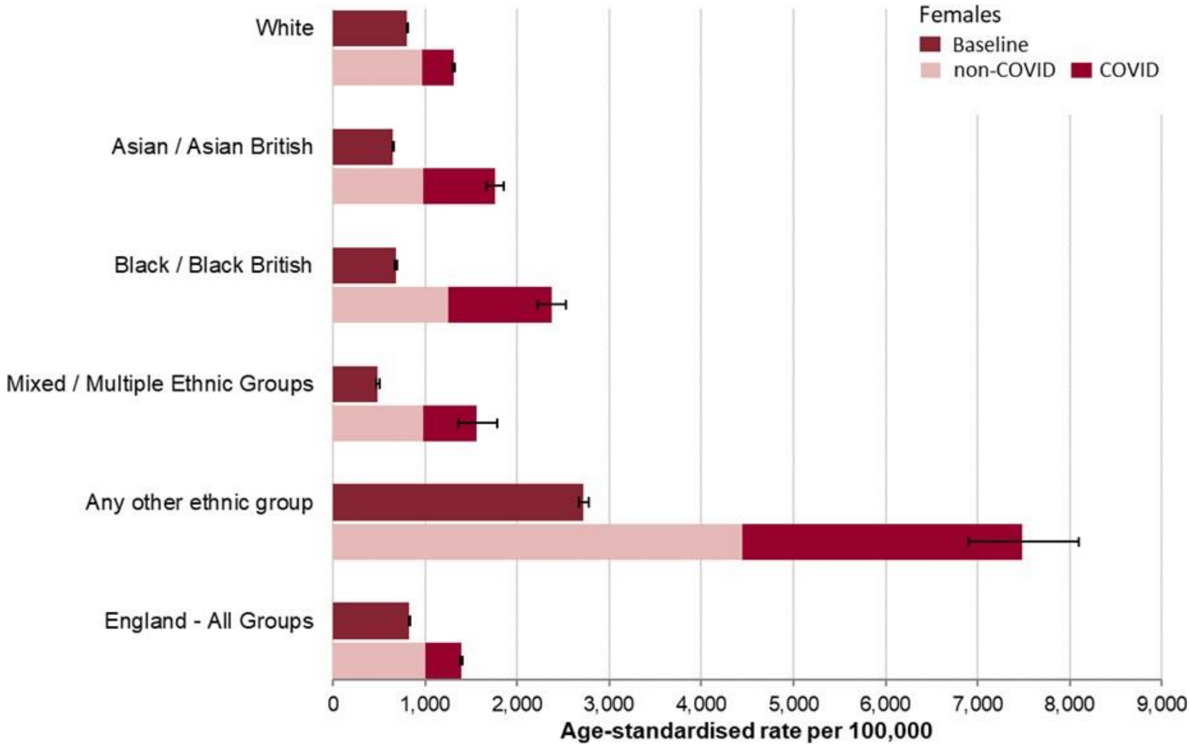


Figure 4.6A and 4.6B. Age-standardised mortality rates for all cause deaths and deaths mentioning COVID-19, 21 March to 1 May 2020, compared with baseline mortality rates (2014 to 2018), by ethnicity and sex, England. Source: Public Health England analysis of ONS death registration data.

4.7 Excess mortality

The excess mortality model shows the number of excess deaths by sex and ethnic group in the period 20 March to 7 May against the number of deaths that would be expected for corresponding dates in 2014 to 2018 (Figure 4.7). It also quantifies how many deaths had COVID-19 mentioned on the death certificate.

Overall, the model suggests there have been 43,941 excess deaths among the White group, 2,301 Black, 3,083 Asian, 385 Mixed and 1,038 in the Other ethnic group. Deaths in Black males were 3.9 times higher than expected in this period, compared with 2.9 times higher in Asian males and 1.7 times higher in White males. Among females, deaths were between 2.7-2.8 times higher in Black, Mixed and Other ethnic groups in this period, compared with 2.4 in Asian and 1.6 in White females.

The percentage of these excess deaths for which COVID-19 is mentioned is highest in males in the Other ethnic group (94.0%) and Asian males (80.9%), and lowest in Mixed females (58.2%) and females in the Other ethnic group (62.8%).

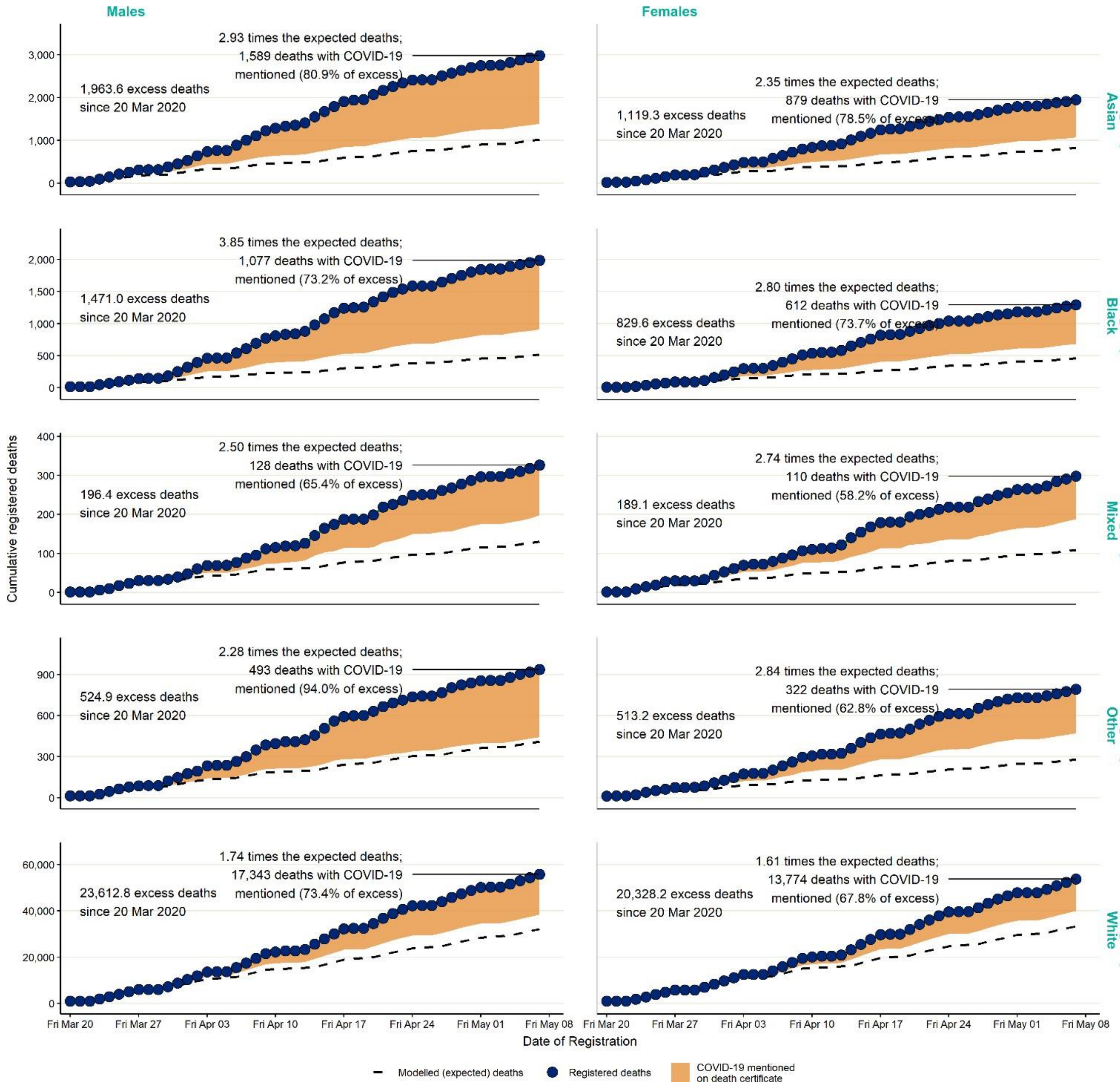


Figure 4.7. Cumulative all cause deaths by date of registration by ethnicity, 20 March to 7 May 2020, England. Source: Public Health England excess mortality model based on ONS death registration data.

5. Occupation

5.1 Main messages

A total of 10,841 COVID-19 cases were identified in nurses, midwives and nursing associates, representing 1.9% of the health professionals who are registered with the Nursing and Midwifery Council (NMC). By ethnic group, this represents 3.9% of nurses, midwives and nursing associates of Asian ethnic groups, 3.1% of Other ethnic groups, 1.7% of White ethnic groups and 1.5% of both Black and Mixed ethnic groups. This analysis did not look at the possible reasons behind these differences, which may be driven by factors like geography or nature of individuals' roles.

ONS reported that men working as security guards, taxi drivers and chauffeurs, bus and coach drivers, chefs, sales and retail assistants, lower skilled workers in construction and processing plants, and men and women working in social care had significantly high rates of death from COVID-19. Our analysis expands on this and shows that nursing auxiliaries and assistants have seen an increase in all cause deaths since 2014 to 2018. For many occupations, however, the number of deaths is too small to draw meaningful conclusions and further analysis will be required.

5.2 Background

Some occupations require close or frequent contact with other individuals, which leads to an increased risk of COVID-19 infection. Early reports suggest that occupational exposure accounts for some infections (26), with healthcare workers (HCW) being particularly at risk of infection, but also individuals working in other people-facing occupations such as retail, hospitality, transport and security. Epidemiological data from European countries suggest that HCW may account for 9% to 26% of those infected (27).

ONS created an estimate of exposure to disease and physical proximity for UK occupations, which provides an indication of which roles may be more likely to come into contact with people with COVID-19 (21). HCW are exposed to disease on a daily basis and require close contact with others. Other occupations, such as those working in the emergency services (police, fire, ambulance), social care and educators, and other occupations such as bar staff and hairdressers, also have close contact with others but are less likely to be exposed to people with the disease when compared to HCW.

For some people in these occupations, social distancing measures have substantially reduced their physical proximity to others. Among workers in occupations that are more likely to be in frequent contact with people and exposed to disease, 3 in 4 are women and one in 5 are from BAME groups (21). An analysis of 119 deaths of NHS staff showed a disproportionately high number of BAME staff among those who had died (28).

Despite the differences in likelihood of exposure, the ONS Coronavirus (COVID-19) Infection Survey for England found no evidence of a difference between the proportions testing positive for patient-facing healthcare or resident-facing social care roles and people not working in these roles (29). These are provisional results and there is a high level of uncertainty about this estimate.

ONS has recently reported that men working in low skilled occupations had the highest rate of death involving COVID-19 up to 20 April 2020 (52). Men working in some specific occupations had significantly raised rates of death involving COVID-19, including security guards, taxi drivers and chauffeurs, bus and coach drivers, chefs, sales and retail assistants, and lower skilled occupations in construction and processing plants. Men and women working in social care were also reported to have had significantly raised rates of death involving COVID-19. HCW were not found by ONS to have higher rates of COVID-19-related death when compared with those of the same age and sex in the general population.

5.3 Cases in nurses, midwives and nursing associates

This section presents laboratory confirmed cases that were matched to the professionals on the Nursing and Midwifery Council (NMC) register on 14 May 2020. The cases were identified under Pillar 1 testing. The majority of testing under this pillar has been offered to those in hospital with a medical need as well as NHS key workers, rather than the general population. Confirmed cases therefore represent the population of people with severe disease, rather than all of those who get infected.

A total of 10,841 diagnosed COVID-19 cases in nurses, midwives and nursing associates were identified, 9,385 of whom were in females. This represents 1.9% of the professionals on NMC register. The median age of cases was 45.5 and 45.1 for males and females, respectively.

Figure 5.1 shows the proportion of COVID-19 cases among registered nurses, midwives and nursing associates by ethnic group. This proportion was highest among those of Asian ethnic groups (3.9%), followed by Other ethnic groups (3.1%), White ethnic groups (1.7%) and Black and Mixed ethnic groups (both with 1.5%).

These results are not adjusted for factors that may influence the likelihood of becoming infected, such as age, sex, geographical location or nature of individuals' professional roles.

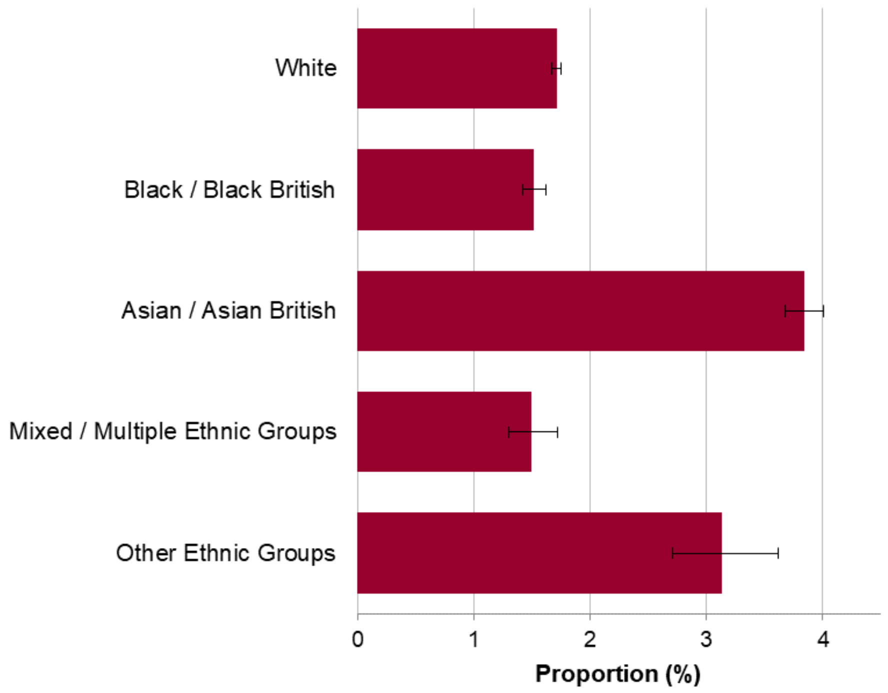


Figure 5.1. Proportion of registered nurses, midwives and nursing associates with laboratory confirmed COVID-19 by ethnic group, as of 18 May 2020, England. Source: NMC register and Public Health England Second Generation Surveillance System.

5.4 Mortality by occupation

This section examines the relative increase in all cause death registrations by occupation in the period 21 March to 8 May 2020, compared with the average for the same period in the years 2014 to 2018. Deaths in people aged 20 to 64 in 2020 were 1.5 times higher than average.

For 3 occupations the relative increase in deaths in 2020 was significantly higher than the average of 1.5: Caring Personal Services, Elementary Security Occupations, and Road Transport Drivers (Table 5.1). Of these groups, the biggest increase was for Elementary Security Occupations, where deaths were 2.3 times higher in 2020 than in the same period in 2014 to 2018. Workers in these groups were also identified in the ONS analysis as having high rates of death involving COVID-19.

Within these groups, there were 3 occupational ‘unit groups’ where the increase in deaths in 2020 was significantly higher than the increase for everyone aged 20 to 64. These were nursing auxiliaries and assistants, security guards and related occupations, and taxi and cab drivers and chauffeurs.

Table 5.1. Relative increase in all cause deaths registered between 21 March and 8 May 2014 to 2018 and 2020, for people aged 20-64, by occupational groups, England.* Source: Public Health England analysis of ONS death registration data

Occupation	Deaths 2014-18 average all causes	Deaths 2020 all causes	Relative increase between 2014-18 and 2020	Lower 95% confidence interval	Upper 95% confidence interval
Caring Personal Services	414	760	1.8	1.6	2.1
Nursing auxiliaries and assistants	52	128	2.5	1.8	3.4
Elementary Security Occupations	117	267	2.3	1.8	2.8
Security guards and related occupations	80	209	2.6	2.0	3.4
Road Transport Drivers	384	694	1.8	1.6	2.0
Taxi and cab drivers and chauffeurs	87	217	2.5	1.9	3.2
All people aged 20-64	**9,440**	**14,409**	**1.5**	**1.5**	**1.6**

*Occupations are only listed where the relative increase was significantly higher than the average for all persons. Results for all occupational groups can be found in the Table 5a and 5b in the data pack.

Although only these small number of occupations had a significant relative increase in deaths in 2020, other occupations have seen a large increase in their absolute number of deaths since the start of the pandemic. These are listed in Table 5a and 5b in the data pack. These tables also include the number of deaths in 2020 where COVID-19 was recorded on the death certificate, and the percentage of the excess deaths in 2020 which were due to COVID-19.

The largest absolute increase was for workers in Caring Personal Services. There were 760 deaths from all causes among these workers in the period 21 March to 8 May 2020 for people aged 20 to 64. This is 346 more than in the same period in 2014 to 2018 and 74% had COVID-19 recorded as a cause of death.

For workers in Construction and Building Trades, the number of deaths related to COVID-19 was slightly higher than the number of excess deaths. This indicates that deaths from other causes have gone down which may be due to a reduced risk of occupational related injuries over this time period.

As noted above, ONS did not find that healthcare workers had higher rates of death involving COVID-19 compared with the general population. The ONS definition of HCW includes people in 26 different occupational groups, who are likely to have had different levels of contact with individuals, particularly during the pandemic. Table 5b in the data pack shows that the relative increase in the number of deaths registered for medical practitioners was 2.5 times higher than in 2014 to 2018. This is a larger increase than the average for all people aged 20-64 (1.5) but is not statistically significant. The relative increase for nurses was 1.7. This was also not significantly higher than average, but nurses are one of the occupations with the highest absolute increase in deaths between 2014 to 2018 and 2020 (from 133 to 233).

6. Inclusion health groups

6.1 Main messages

For people born outside of the UK and Ireland, the relative increase in deaths in 21 March to 8 May 2020 was higher than the average. The biggest relative increase was for people born in Central and Western Africa (which includes Nigeria, Ghana and Somalia), the Caribbean, South East Asia (which includes Malaysia, the Philippines and Vietnam), the Middle East and South and Eastern Africa (which includes South Africa, Zimbabwe and Kenya).

There were 54 men and 13 women diagnosed with COVID-19 with no fixed abode, likely to be rough sleepers. We estimate that this represents 2% and 1.5% of the known population of women and men who experienced rough sleeping in 2019.

6.2 Introduction

Populations who are socially excluded, such as people who experience homelessness and vulnerable migrants, tend to have the poorest health outcomes, putting them at the extreme end of the gradient of health inequalities (30). This is a consequence of being exposed to multiple, overlapping risk factors, such as facing barriers in access to services, stigma and discrimination.

Notably, people who are socially excluded are not consistently recorded in electronic records, often making them effectively invisible for policy and service planning purposes (31). Nevertheless, there is strong evidence that inclusion health groups have very high levels of morbidity and mortality, often with multiple and complex needs including overlapping mental and physical ill-health, and substance dependency (32). This puts these populations at increased risk from the consequences of emergencies, such as pandemics.

A recent modelling exercise, for example, estimated that in a “do nothing” scenario, 34% of people living in hostels and sleeping rough would be infected with COVID-19, leading to over 4,000 hospital admissions (33). Other countries have reported outbreaks in homeless shelters (34) and among migrant workers (35).

6.3 Mortality in Migrants

This section uses deaths reported by ONS to compare deaths between 21 March and 8 May 2020 with deaths in previous years by country of birth. Being born outside of the UK does not necessarily mean a person is a vulnerable migrant, but migration is a factor that impacts on people's health. In the UK resident population, there is some association between ethnicity and being born abroad.

In the period 21 March to 8 May 2020, the number of death registrations from all causes for people in England was 1.7 times higher than in the same period for the average of the years 2014 to 2018. For people born in England, Scotland, Wales, Northern Ireland, and Ireland, the relative increase was similar to this (Figure 6.1). For all other groups of countries, the relative increase was higher than the average and in almost all cases this increase was significantly higher.

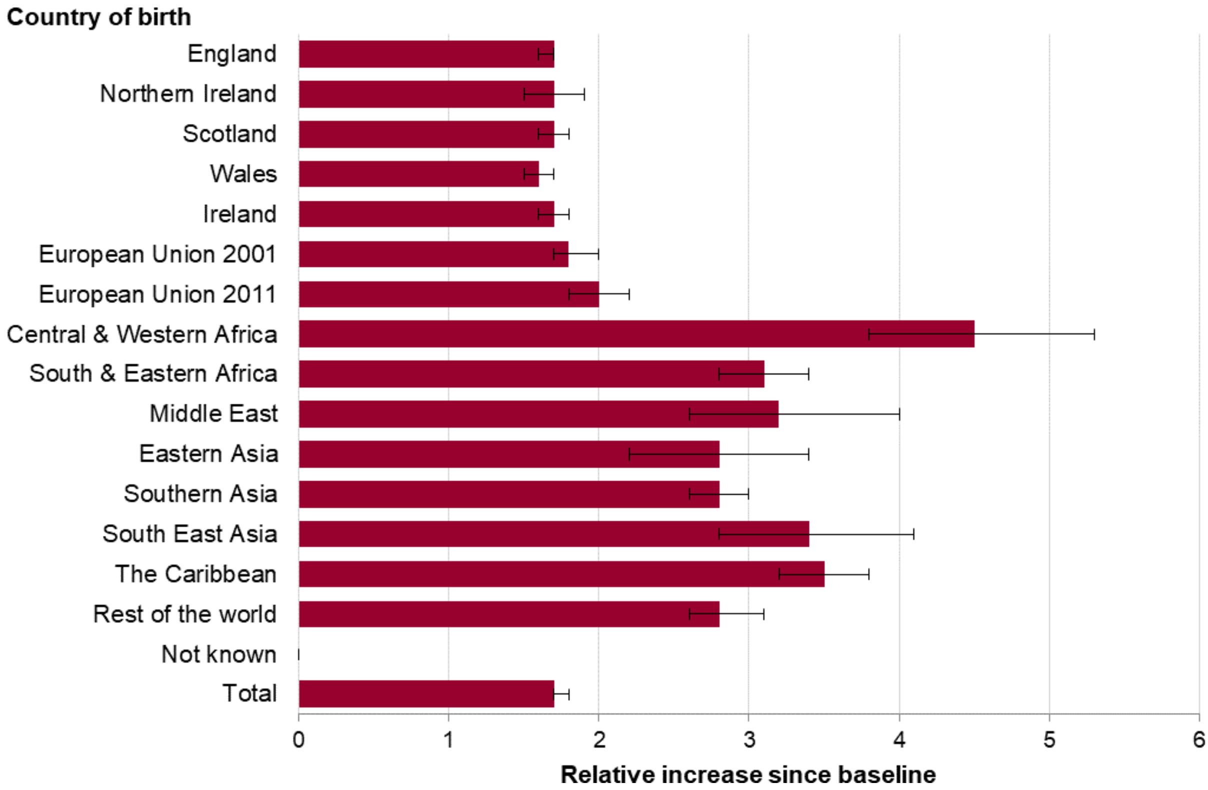


Figure 6.1. Relative increase in total deaths registered in England in 2020 compared to the average for 2014 to 2018, 21 March to 8 May, by country of birth.* Source: Public Health England analysis of ONS death registration data.
(*The numbers of deaths in each of the country groupings can be found in Table 6a in the data pack. The list of countries in each of the groups can be found in Table 6b in the data pack.)

The biggest relative increase was for people born in Central and Western Africa (4.5 times higher in 2020 than in 2014 to 2018). This group of countries includes Nigeria, Ghana and Somalia. For people born in 4 other groups of countries, deaths in 2020 were more than 3 times higher than the equivalent period in 2014 to 2018: the Caribbean (3.5), South East Asia, which includes Malaysia, the Philippines and Vietnam (3.4), the Middle East (3.2) and South and Eastern Africa, which includes South Africa, Zimbabwe and Kenya (3.1).

For people born in the European Union 2001, the relative increase was 1.8 times higher, and this was the only group of countries not significantly higher than the average for England. This group includes all countries which were EU members in 2001. Countries which joined the EU between 2001 and 2011 (such as Poland and the 9 other countries which joined in 2004) are included in the European Union 2011 group, for which the relative increase was 2.0.

6.4 People with no fixed abode

Overall, there were 67 diagnoses of COVID-19 among people assigned a ‘no fixed abode’ (NFA) code. Of these, 54 (80.6%) were men.

Taking into account the estimated number of people sleeping rough in England in Autumn 2019, this represents 1.6% of the rough sleeping population. This is lower for men (1.5%) than women (2.1%) (Figure 6.2).

These figures are subject to uncertainty and should be treated as estimates.

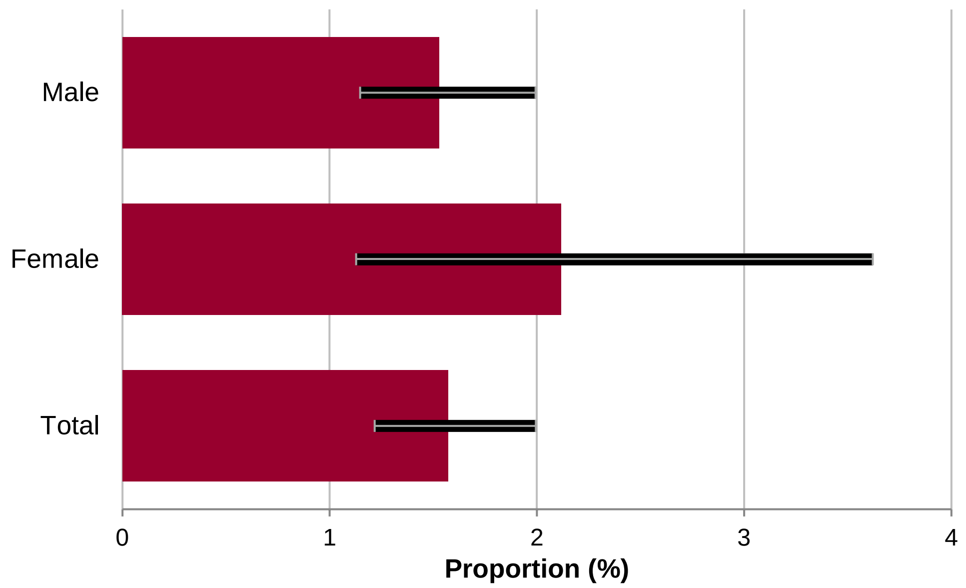


Figure 6.2. Proportion of cases assigned a no fixed abode code per 100 population of rough sleepers by sex and in total as of 13 May 2020, England. Source: Public Health England Second Generation Surveillance System and Ministry of Housing, Communities and Local Government.

7. Deaths in care homes

7.1 Main messages

By the 10 April 2020, deaths in care homes accounted for 10% of all deaths from COVID-19 in England. However, this percentage has increased over time and in the week ending 8 May care homes accounted for a much greater proportion (43%). The number of deaths from COVID-19 in hospitals peaked in the week ending 17 April, but the number in care homes peaked a week later.

The excess mortality model suggests that there have been 2.3 times the number of deaths in care homes than expected between 20 March and 7 May which equates to around 20,457 excess deaths. The number of COVID-19 deaths over this period is equivalent to 46.4% of the excess, suggesting that there were many excess deaths from other causes or an under-reporting of deaths from COVID-19.

7.2 Background

Between 9 March and 17 May 2020 there were 5,887 outbreaks of COVID-19 reported in care homes in England (36). There are 15,514 care homes in England, so this indicates that 38% had experienced an outbreak.

Many countries have seen a significant proportion of COVID-19 deaths in care homes or in care home residents and this proportion seems to be higher in countries where there have been a larger number of deaths (37).

7.3 Death registrations

Data reported by ONS show that 9,492 deaths mentioning COVID-19 on the death certificate that occurred in care homes were registered up until 8 May 2020. This is 27% of all COVID-19 deaths (7). This figure will not include all deaths of care home residents who may die elsewhere.

The number of deaths from COVID-19 in hospitals has been greater than the number in care homes each week between week ending 27 March and 8 May (Figure 7.1). The number of deaths from COVID-19 in hospitals peaked in the week ending 17 April, but the number in care homes peaked a week later.

By the 10 April 2020, deaths in care homes accounted for 10% of all deaths from COVID-19 in England. However, this percentage has increased over time and in week ending 8 May 2020 deaths in care homes accounted for a much greater proportion (43%), compared with 50% for hospitals.

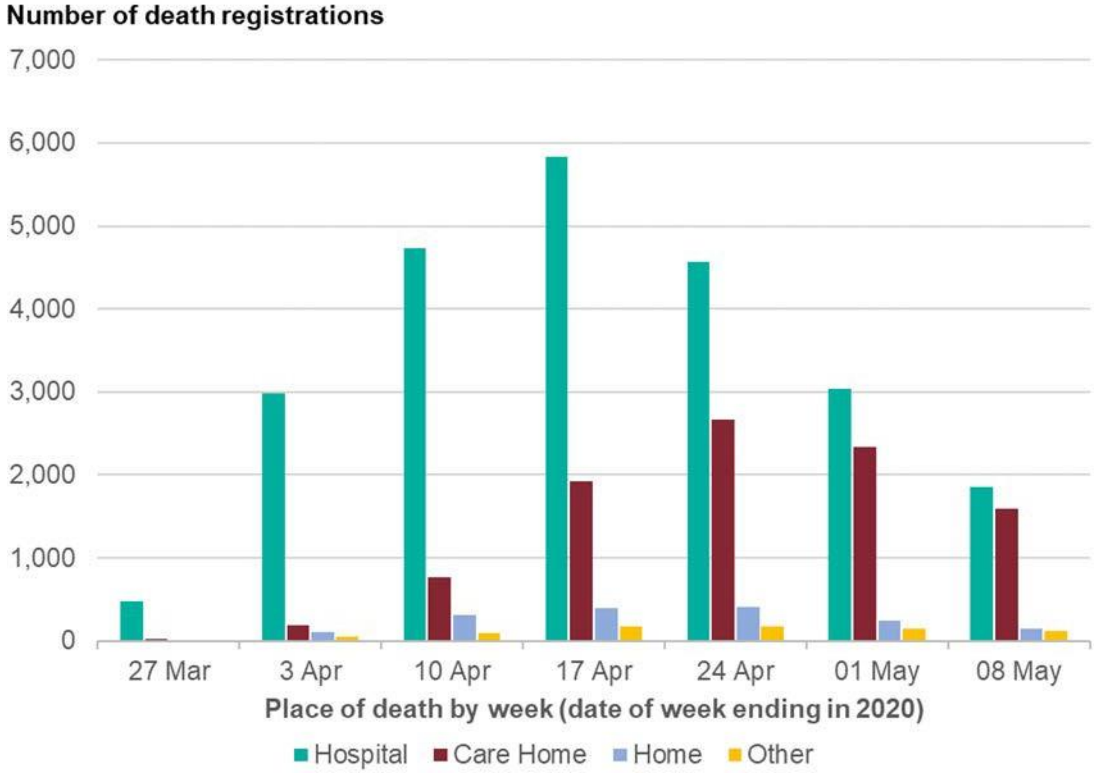


Figure 7.1. Weekly provisional death registrations for deaths where COVID-19 was mentioned on the death certificate, by place of occurrence, data up to 8 May 2020, England. Source: Public Health England analysis of ONS death registration data.

The Care Quality Commission report on deaths of care home residents, regardless of where the death took place. Between 11 April and 8 May 2020, there were 27,817 deaths of care home residents (38). This is 3,024 more than the number of deaths occurring in care homes reported by ONS during the same period (24,793). During this period, 73% of care home residents died in care homes, 13% died in hospital and for the majority of the remainder information on place of death was not available.

7.4 Excess mortality

Table 7.1 shows results from the excess mortality model and includes the number of excess deaths by place of death in the period 20 March to 7 May against the number of deaths that would be expected for corresponding dates in 2015 to 2019. It also quantifies how many deaths have COVID-19 mentioned on the death certificate.

Table 7.1. Cumulative all cause deaths by date of registration and place of death, 20 March to 7 May 2020, England. Source: Public Health England excess mortality model based on ONS death registration data.*

	Observed deaths	Expected deaths	Ratio observed/ expected	Excess deaths	COVID-19 deaths	COVID-19 deaths as % excess
Home	26400	16858	1.6	9542	1630	17.1%
Care home	35933	15476	2.3	20457	9496	46.4%
Hospital	47913	31897	1.5	16016	23569	>100%
Hospice	3617	4006	0.9	-389	453	No excess deaths
Other places	2406	1674	1.4	732	291	39.8%
Total	116269	69911	1.7	46358	35439	76.4%

*Note that the model for place of death is slightly different from other models and therefore the number of excess deaths is slightly different.

Overall the model suggests that there have been 20,457 excess deaths in care homes between 20 March and 7 May 2020 and 16,016 in hospitals. The care home finding is consistent with the finding reported in section 1, that 75% of excess deaths are in people aged 75 and over. It is not possible to say whether these excess deaths in care homes have been concentrated in a few with outbreaks or distributed among many. There have been no excess deaths in hospices.

The number of COVID-19 deaths in hospitals is greater than the estimated number of excess deaths. This suggests that deaths in hospitals from causes other than COVID-19 have reduced over this period or that COVID-19 has also contributed to deaths from other causes.

In care homes the number of COVID-19 deaths is equivalent to 46.4% of the excess. This is consistent with figures reported by ONS (39) and suggests that there has been an increase in deaths from other causes over this period in care homes or an under-reporting of COVID-19 on death certificates. Deaths in care homes were around 2.3 times the number expected in this period.

8. Comorbidities

8.1 Main messages

Among deaths with COVID-19 mentioned on the death certificate, a higher percentage mentioned diabetes, hypertensive diseases, chronic kidney disease, chronic obstructive pulmonary disease and dementia than all cause death certificates.

Diabetes was mentioned on 21% of death certificates where COVID-19 was also mentioned. This finding is consistent with other studies that have noticed a higher risk of death from COVID-19 among patients with diabetes. By age, the percentage was highest in males aged 60 to 69, was higher in all BAME groups than the White group and was 43% in the Asian group and 45% in the Black group. The same inequalities were seen for hypertensive disease.
Several studies, although measuring the different outcomes from COVID-19, report an increased risk of adverse outcomes in obese or morbidly obese people.

PHE is seeking to obtain and link additional datasets that measure body mass index (BMI), a more comprehensive range of comorbidities and other sociodemographic characteristics such as ethnicity to understand the combination of these risks further.

8.2 Introduction

People with underlying health conditions or other recognised risk factors for severe outcomes from respiratory infections appear to be at a higher risk of poor outcomes from COVID-19 than people without these conditions. One review suggested the most commonly reported conditions associated with poor outcomes were diabetes mellitus, chronic lung disease and cardiovascular disease (40). Persons with certain underlying conditions are classed as ‘extremely clinically vulnerable’ or ‘clinically vulnerable’ to COVID-19 (41).

Emerging evidence has established a need to better understand the association between obesity and COVID-19 particularly as 28% of adults in England in 2018 were obese (Body Mass Index (BMI) of 30kg/m^2 or more) and 3% were morbidly obese (BMI of 40kg/m^2 or more) as indicated by the Health Survey for England (42). In addition, patients living with obesity may not be equally exposed to COVID-19 or may have other underlying conditions, such as those mentioned above, which influence their outcome from COVID-19.

The prevalence of obesity and underlying health conditions such as diabetes also varies by ethnic group. Data from the National Diabetes Audit suggests that type II diabetes prevalence is higher in people from BAME communities (25). The latest data from the Health Survey for England indicates that obesity prevalence rises to 54% in Black females but was as low as 16% in Asian males (42).

However, there are limitations in the availability of appropriately linked data to understand the relationship between obesity, underlying health conditions, socioeconomic characteristics including ethnicity and risk of adverse outcomes from COVID-19. For example, some datasets are limited to inpatient data or patients admitted to ICU, so they will not include all cases or deaths from COVID-19. This section summarises the available data to date.

8.3 Obesity

The latest report from the Intensive Care National Audit and Research Centre (ICNARC) used data up to 21 May 2020 and showed that 7.7% of patients critically ill in intensive care units (ICU) with confirmed COVID-19 were morbidly obese compared with 2.9% of the general population (after adjusting for age and sex) (2). This disparity was also seen when looking at white and non-white patients separately.

The report also showed a relationship between BMI and death from COVID-19 in BMI over 30 kg/m^2. This analysis controlled for other demographics and health conditions but is restricted to those patients admitted to ICU from 289 participating trusts.

A study using data from over 400,000 patients aged 40 to 69 from UK Biobank linked to COVID-19 test data from PHE found that higher BMI was associated with a positive COVID-19 diagnosis (43). Compared with non-overweight people (BMI < 25 kg/m^2), the odds ratios[1] were 1.26 (confidence interval of 1.01-1.56) for those who were overweight, 1.37 (1.06-1.76) for those in obese class I and 2.04 (1.50-2.77) for those in obese classes II and III combined[2].

A study by the OpenSAFELY collaborative used a dataset of 17 million adult primary care electronic health records linked to deaths data from the COVID-19 Patient Notification System (CPNS) up to 25 April 2020 (44). This found a relationship between death from COVID-19 and BMI when controlling for demographics and other health

[1] The odds of an event occurring is the probability of an event occurring divided by the probability of an event not occurring.
The odds ratio is the odds of one event occurring divided by the odds of another event occurring.
In this case, the odds ratio divides the odds of a person having COVID-19 in a particular overweight or obese BMI group by the odds of a patient having COVID-19 in the control group which is those people who were not overweight (BMI < 25 kg/m^2).
[2] Overweight is 25-29.9 kg/m^2, obese class I is 30-34.9 kg/m^2, obese class II is 35-39.9kg/m^2 and obese class III is 40 kg/m^2 or more and is also sometimes referred to as being morbidly obese.

conditions. The hazard ratio[3] compared to those who were not obese increased as BMI increased and was 1.27 (1.18-1.36) for those in obese class I, 1.56 (1.41-1.73) for those in obese class II and 2.27 (1.99 to 2.58) for those in obese class III (morbidly obese).

Although measuring the different outcomes of dying from COVID-19 once in ICU, contracting COVID-19 and dying from COVID-19, all 3 studies have shown a relationship between COVID-19 and increasing BMI. Of the studies mentioned, the study by the OpenSAFELY collaborative covers the broadest cohort of patients.

These findings are also consistent with studies from other countries. A study based on 383 COVID-19 patients admitted to the Third People's Hospital of Shenzhen in China found that obesity, especially in men, significantly increases the risk of developing severe pneumonia in COVID-19 patients (45). In France, a study of 124 patients admitted to intensive care in a hospital in Lille found the proportion of patients who required invasive mechanical ventilation increased with increasing BMI category (46).

NHS England have also looked at the relationship between BMI and diabetes and the risk of death from COVID-19 (47). The study linked data from the National Diabetes Audit, Hospital Episode Statistics and deaths from COVID-19 for around 265,000 people with type I diabetes and 2.9m people with type II diabetes. The analysis adjusted for demographics and other health conditions and showed the hazard ratio was highest for those with low and high BMI. For those with a BMI < 20 kg/m^2, the hazard ratio was 2.11 (1.32-3.38) for type I diabetes and 2.26 (2.04-2.50) for type II, and for those who were morbidly obese it was 2.15 (1.37-3.36) for type I and 1.64 (1.50-1.79) for type II.

8.4 Other conditions mentioned on death certificates

This section examines other conditions which have been mentioned on death certificates where COVID-19 is mentioned. The conditions included relate to people who are classed as 'clinically vulnerable' (41). Dementia has also been analysed since it is the leading cause of death among older people in England.

As this section only looks at death certificates, it will be an underestimate of the number of people who die from COVID-19 who have underlying health conditions as not all will be mentioned on the certificate.

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[3] The hazard ratio is a comparison between the probability of events in a treatment group, compared to the probability of events in a control group.
In this case, it is a comparison of the probability of dying from COVID-19 for people in a particular obese BMI group compared to the probability of dying for people who were not obese (BMI < 30 kg/m^2)

All of the conditions examined were more likely to be mentioned on a death certificate when COVID-19 was also mentioned, than they were for deaths overall. However, for cardiovascular disease, the difference was very small (Table 8.1).

The largest difference was for diabetes, which includes type I and type II. Diabetes was mentioned on 15% of all death certificates between 21 March and 1 May. However, it was mentioned on 21% of death certificates where COVID-19 was also mentioned.

Data from NHS England suggests that 26% of those who died in hospital and have tested positive for COVID-19 up to 19 May 2020 had diabetes as a pre-existing condition (48). A study using data from the National Diabetes Audit reports that death rates in those with diabetes have doubled during the pandemic (47).

Table 8.1. Percentage of all deaths, and percentage of COVID-19 deaths where one of the conditions were mentioned, 21 March to 1 May 2020, England. Source: Public Health England analysis of ONS death registration data.

Condition	Percentage of all deaths where condition is mentioned	Percentage of COVID-19 deaths where condition is mentioned
Cardiovascular disease	44.1	44.5
Diabetes	14.6	21.1
Hypertensive diseases	14.5	19.6
Chronic Kidney Disease	8.5	10.8
Chronic Obstructive Pulmonary Disease	10.6	11.5
Dementia	23.8	25.7

More detailed breakdowns of the data for each of the conditions can be found in Table 8a, 8b and 8c in the data pack.

Diabetes

The proportion of COVID-19 deaths where diabetes is also mentioned was higher among males than females (24% compared with 18%), and by age was highest among males aged 60 to 69 (31%).

Diabetes was more likely to be mentioned on the death certificate in more deprived areas. In the most deprived areas, 26% of COVID-19 deaths also mentioned diabetes. This is significantly higher than in the least deprived areas (16%) (Figure 8.1). The proportion of COVID-19 deaths where diabetes is mentioned ranged from 18% in the White ethnic group, 43% in the Asian group to 45% in the Black group.

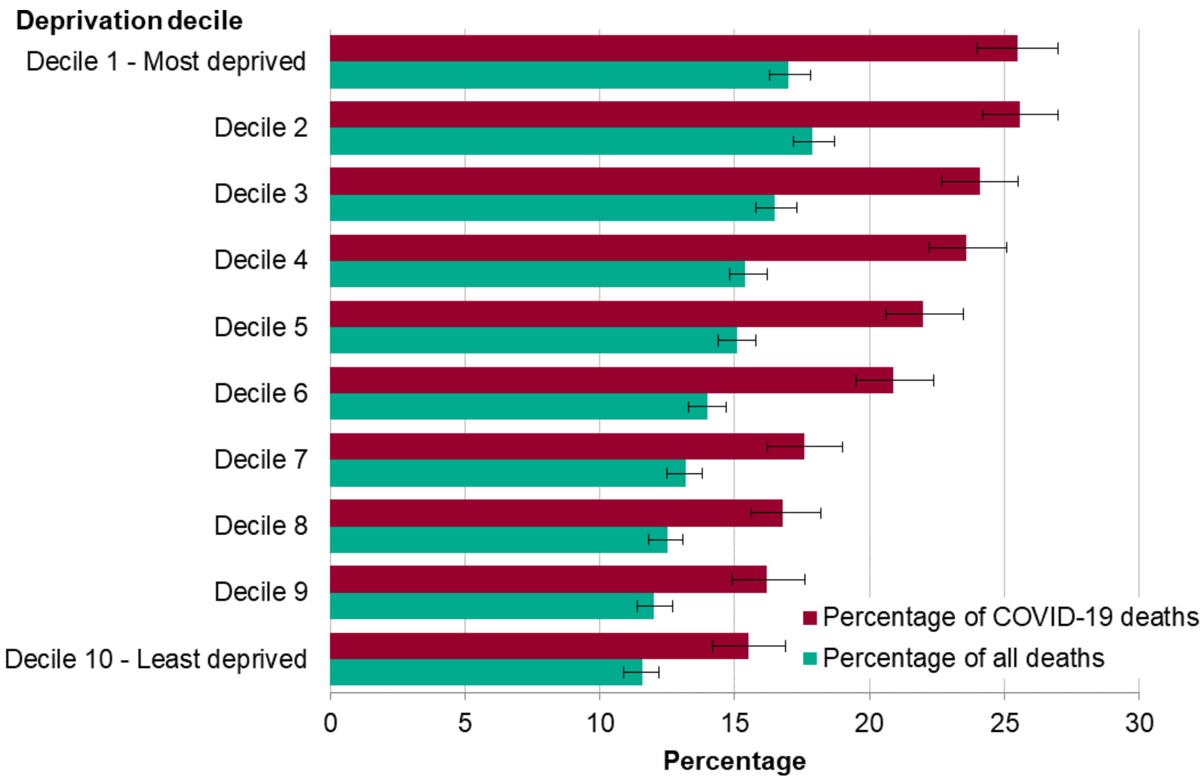

Figure 8.1. Percentage of COVID-19 deaths where diabetes was also mentioned on the death certificate, by deprivation decile, 21 March and 1 May 2020, England. Source: Public Health England analysis of ONS death registration data.

Hypertensive disease

The proportion of COVID-19 deaths where hypertensive disease is also mentioned is higher among males than females (21% compared with 18%), and by age highest among males aged 60 to 69 (26%). The proportion of COVID-19 deaths where hypertensive disease is mentioned ranged from 17% in the White ethnic group to 40% in the Black group but is also high in the Asian and Mixed groups (Figure 8.2).

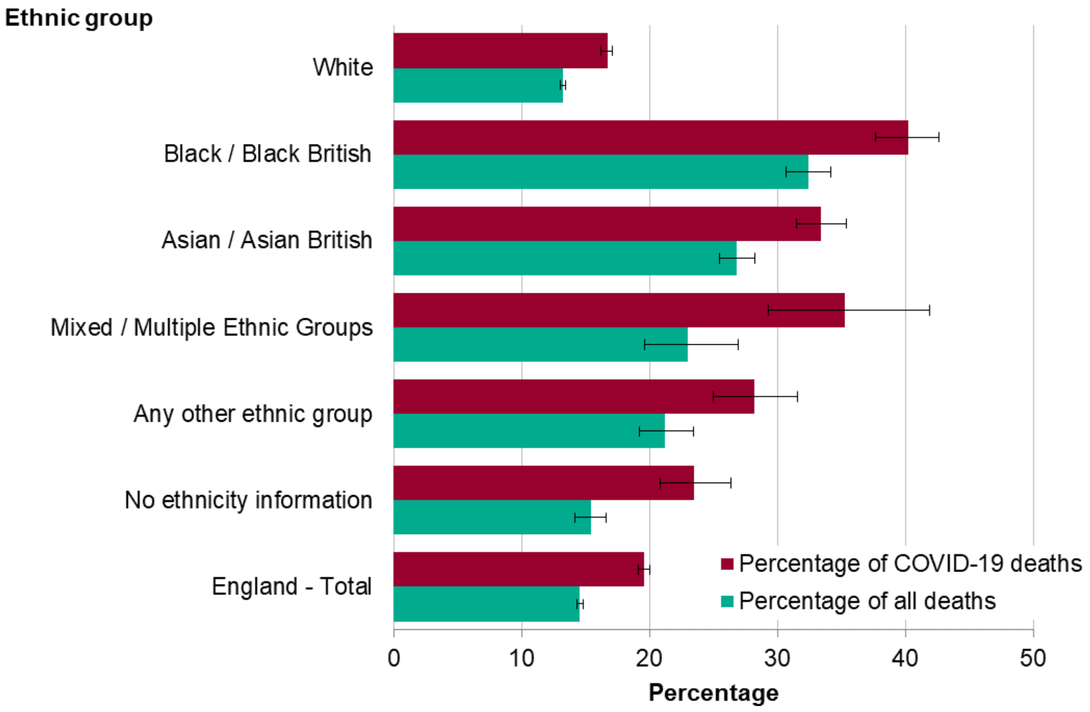

Figure 8.2. Percentage of COVID-19 deaths where hypertensive disease was also mentioned on the death certificate, by broad ethnic group, 21 March to 1 May 2020, England. Source: Public Health England analysis of ONS death registration data

9. Limitations

The analyses presented in this review use data available to PHE through multiple surveillance systems. These analyses are mostly descriptive and compare disparities in diagnosis and death from COVID-19 across a range of data sources. The descriptive nature of the analysis therefore limits the conclusions that can be drawn about the reasons for the disparities shown. In addition, there are other important limitations that must be considered when interpreting their findings.

Laboratory confirmed cases analysed in this report refer to Pillar 1 testing only. The majority of testing under this pillar has been offered to those in hospital with a medical need as well as NHS key workers, rather than the general population. Confirmed cases therefore represent the population of people with severe disease only, rather than all of those who get infected. This has important implications when considering, for example, the proportion of deaths among confirmed cases, which will be high as confirmed cases are mostly people with severe disease.

In addition, the numbers of cases and diagnosis rates are likely to be strongly influenced by case definition and testing policy, both of which have changed since the first cases were identified, may vary between geographical areas, and must be interpreted under that light. For example, when case definition included travel history, this may have made it more likely to test people of specific ethnic groups.

As of 19 May, 42 trusts had reported lower level of care patients (defined as admission to any hospital ward, excluding ICU or HDU), and 94 trusts contributed ICU/HDU (critical care) patient data to the COVID-19 Hospitalisation in England Surveillance System (CHESS).

Reporting to CHESS varies by trusts and the majority of trusts in London do not consistently report which will impact on the representativeness of the hospitalised cases. To account for variation in Trusts reporting within regions (and batch reporting), rather than providing daily number of hospitalised patients by region, daily rates are reported as 3 days moving averages using only the reporting trusts' catchment area populations (rather than regional population denominator). The demographic data presented here has not been adjusted for Trust underreporting as we cannot confidently assume and impute the missing demographic profiles of hospitalised patients for Trusts who have not reported. Because demographic composition of the population is considerably different in London from the rest of the country, the hospitalisation data must be interpreted with caution. Further analyses of the CHESS dataset have not been presented in this report because of its current limitations.

The analyses of ONS mortality data are based on records which have been provided to PHE very shortly after they have been registered. These records will have passed a series of automatic validation processes but will not have been subject to all the procedures which ONS undertake to ensure the quality and completeness of mortality data. These data are therefore provisional and small changes will be likely after data have been finalised. However, these changes are unlikely to affect the conclusions drawn from the data.

Ethnicity information for cases and deaths was derived through linkage to hospital records. Ethnicity information for the population denominators used to calculate the rates was derived from the 2011 Census. This creates a mismatch between the 2 sources and it is possible that there are proportionally more people assigned to the Other ethnic group in the hospital data than there are in the census data. This may explain the high diagnosis and mortality rates in the Other group, which requires further investigation and no firm conclusions can be drawn about this group.

However, this mismatch described above will not be apparent in the survival analysis presented as population denominators are not used for that analysis. In addition, it should not affect the comparisons of inequality with data for previous years as data for all time periods will be subject to a similar bias.

It was not possible to obtain ethnicity information for some records, although the proportion with missing ethnicity was low for most data sources (see data and methods section). CHESS data had the largest percentage with missing ethnicity data, particularly for ICU data, and therefore these findings should be given less weight. People with missing ethnicity data have been excluded from the analysis by ethnic group. This may have introduced some bias by excluding people who are less likely to have a hospital record or ethnicity recorded in their records.

The linked datasets used do not currently include all data that would be useful to understand disparities across all groups. They don’t include, for example, information about household composition or genetic factors, which may explain some of the findings.

Information on vulnerable groups is lacking. Very few surveillance systems accurately capture groups of the population who are known to have the poorest health outcomes such as vulnerable migrants, sex workers or people experiencing homelessness or rough sleeping. These analyses therefore do not allow us to accurately assess the impact of COVID-19 on the most vulnerable groups of the population.

Occupational data is not currently available for all diagnosed cases. Robust data are available for those who have died and have been included in this report. Analysis of diagnosed cases has currently only been undertaken for nurses, midwives and nursing assistants registered with the NMC. This data will continue to be analysed and further work of other healthcare workers is being planned.

The analysis of comorbidities presented in this report is currently limited to an analysis of death certificates and other published sources of data on obesity. Very few datasets available for analysis by PHE contain information on height and weight to calculate BMI and link to diagnosed cases and deaths.

A more thorough analysis is required to fully understand the relationships between comorbidities including obesity, sociodemographic characteristics such as ethnicity and occupation and the risk of diagnosis and death to understand these disparities further.

Comparisons have been made against the most appropriate baseline or group available at the time of analysis. This has created some complexities in interpretation and it may be possible to improve this when other data become available.

Some of the papers referenced in this report are early publication papers and have not been peer reviewed and should therefore be interpreted with some caution. However, many are authored by academics from multiple institutions which may give more confidence in the approach taken and conclusions drawn.

10. Data sources and methodologies

10.1 Testing and laboratory confirmed cases

Respiratory Datamart and the Second Generation Surveillance System (SGSS) were used for information about all samples tested and their results (positive and negative) from public health, NHS and private laboratories that report to PHE.

SGSS is an application that stores and manages data on laboratory isolates and notifications and is the preferred method for capturing routine laboratory surveillance data on infectious diseases and antimicrobial resistance from laboratories across England. Respiratory datamart is a laboratory-based surveillance system for influenza and other respiratory viruses in England.

The same individual can receive multiple tests. These were deduplicated so that a laboratory confirmed case of COVID-19 is any individual who has received a positive test result for the SARS-CoV-2 virus.

The majority of testing to date has been offered to those in hospital with a medical need. Laboratory confirmed cases therefore are likely to represent the typical population of people with severe disease, rather than all of those who get infected.

10.2 Hospitalised cases

New patients admitted to hospital with COVID-19 are reported daily to the COVID-19 Hospitalisations in England surveillance system (CHESS) by acute NHS trusts in England through a secure web portal. There are 2 subsets of data within CHESS: COVID-19 cases admitted to a lower level of care (defined as admission to any hospital ward, excluding ICU or HDU); COVID-19 cases admitted to ICU/HDU (critical care). Trusts report aggregate numbers by age group of all new hospital admissions with COVID-19 or acute respiratory illness. All acute trusts are asked to report individual level data on all new ICU/HDU admissions with COVID-19 and a sentinel network of Trusts report individual level data on all new hospital admissions at any level of care. All data are cleaned and analysed daily.

Reporting varies by trusts and not all trusts report daily; as of 19 of May, 42 trusts had reported lower level of care, and 94 trusts contributed critical care patient data to CHESS. The majority of trusts in London do not consistently report to CHESS which will impact on the representativeness of the demographic profile of hospitalised cases, including those in critical care.

Checking the validity of CHESS aggregate data has been done by comparing CHESS data with NHS England data for fields common to both datasets where trusts did report to both systems and there is good agreement via scatter plot and Bland–Altman plots. Nevertheless, further analyses of the CHESS dataset have not been presented in this report because of its current limitations.

10.3 Mortality

Public Health England receives reports of death from 3 sources:

1. NHS England (NHSE) line listing of deaths reported by NHS trusts in the COVID-19 Patient Notification System (CPNS).
2. Health protection teams (HPTs) reporting deaths notified to them (primarily non- hospital settings).
3. The Demographic Batch Service (DBS) traced data, which takes a complete record level list of all individuals with a positive test in SGSS and links that to the central NHS Digital patient record of all deaths.

Data from each source are merged and duplicates removed in order to retain only one record per individual. Cleaned data sets are sent to DBS for tracing of missing information and then merged to form the final dataset.

This dataset only includes deaths in which the deceased has had a positive test result. More detail about the PHE data series on deaths in people with COVID-19 is available here: https://www.gov.uk/government/publications/phe-data-series-on-deaths-in-people-with-covid-19-technical-summary.

10.4 ONS registered deaths

Death registration data supplied by the Office for National Statistics over the period 24 March to 8 May 2020 was obtained and used for this analysis.

10.5 Data linkage to assign ethnicity

Completeness of ethnicity recording in the above datasets is low; this is common among similar systems. To mitigate this, data was linked with Hospital Episode Statistics (HES) data to assign ethnicity information. HES is a database containing details of all admissions, A&E attendances and outpatient appointments at NHS hospitals in England. HES use ethnic categories as classified by the 2001 ONS census (49).

Ethnicity was assigned to all datasets by linking, using NHS number and date of birth, to the latest recording of ethnicity in the Outpatient Hospital Episode Statistics (HES) or the HES Admitted Patient Care data set.

Records that could not be linked to HES, either because there was not a record to link to within HES or because information on date of birth and/or NHS number was inconsistent or missing, were excluded from the ethnicity analyses in this report. People from certain ethnic backgrounds may be less likely to have an NHS number or full date of birth than those from other ethnic groups and consideration needs to be given to this in the interpretation of the findings within this report.

It was possible to obtain ethnicity for:

- 91.9% of COVID-19 cases
- 89.5% of cases in the lower level of care subset and 80.9% of cases in the ICU subset (for hospitalised cases)
- 99.4% of the deaths in laboratory confirmed COVID-19 patients
- 97% of all cause deaths

For the excess mortality model any unknown or not stated ethnicities were imputed using direct imputation methodology.

10.6 Population data

The denominators used to calculate rates by ethnic group are from the ONS 2018 ‘aged-on’ population for ethnic groups, based on the 2011 Census, which uses the Harmonised Classification of Ethnic Groups. For ethnicity categories to match between HES and ONS denominators, the following were merged:

- in ONS data, the “Gypsy or Irish Traveller” category was merged into “Any other White background”
- in HES data, the “Chinese” category was moved to the “Asian or Asian British” grouping
- in both datasets, the “Arab” category was included in “Any Other Ethnic Group”

Appendix B provides a comparison of the ONS and HES ethnic categories.

ONS 2019 mid-year populations for Government Office Regions were used for population denominators by region and Upper Tier Local Authority (UTLA). ONS 2018 population estimates by LSOA were grouped into deprivation quintiles and deciles and used for population denominators.

10.7 Assigning deprivation quintiles and deciles

Deprivation quintiles and deciles have been constructed using Index of Multiple Deprivation scores at lower super output area (LSOA) level. LSOAs are small geographic areas produced by ONS to enable reporting of small area statistics in England and Wales. There are 32,844 LSOAs in England, each having a population of approximately 1,500.

LSOAs within England were ranked from most to least deprived and then divided into ten categories (deciles) or 5 categories (quintiles) with approximately equal numbers of LSOAs in each. The deprivation index used was the Index of Multiple Deprivation 2019 (IMD2019) scores from the English Indices of Deprivation 2019, released by the Ministry of Housing, Communities & Local Government (13).

10.8 Age standardisation

Age-standardised rates adjust for differences in the age structure of populations and allow comparisons to be made between geographical areas and through time, allowing identification of any underlying change in mortality rates. The direct method uses the age-standardised rate for a particular condition which would have occurred if the observed age-specific rates for the condition had applied in a given standard population. The standard used throughout this report is the European Standard Population 2013. Death rates calculated using ONS registered deaths were annualised to enable comparisons with previous years and with ONS analysis.

10.9 Cox regression

COVID-19 laboratory confirmed cases were matched to reported deaths by NHS number. Records that contained the linking field were included in the final analysis dataset (n = 130,101 cases, n = 28,246 deaths). Cox proportional hazards regression models were used (presented in Appendix A) to model survival time between date of positive specimen and date of death or survival to 13 May 2020 among people with confirmed COVID-19 by age, sex, ethnicity, region and deprivation (IMD quintile). Interaction between variables was assessed; since there are interactions between age and some of the other variables, models were stratified by age in sub-models: an all ages model, one for working age patients (20-64 years of age) and one for older patients (65+ years of age). All 3 models included all variables. The proportional hazards assumption was tested using Schoenfeld residuals and only sex was significant. However, sex was not adjusted for as a time varying covariate due to the nature of the stability of this factor. Hazard ratios from the crude and fully adjusted models are shown in Appendix A with 95% confidence intervals.

10.10 Nurses, midwives and nursing assistants

The data referring to the cases and deaths among Nurses and Midwives used the Nursing and Midwifery Council (NMC) register data of currently eligible to work nurses, midwives and nursing associates. The register data does not include temporary registrants who may have re-joined the temporary register recently to work in the COVID-19 response.

The NMC register was obtained on 14 May. This was linked to laboratory confirmed cases of COVID-19 as of 19 May. Linking was done using surname, first name, sex, date of birth and postcode. The linking process excluded cases for which information did not match, which means it will not identify some professionals.

A match with a confirmed COVID-19 case and being on the NMC register does not imply that the infection was acquired occupationally.

10.11 People with no fixed abode

The data for homelessness are based on the no fixed abode (NFA) code through the residential address ascribed in SGSS. NFA codes are subject to underreporting or misclassification, as well as changes in reporting over time.

Population (denominator) figures to calculate rates are based on estimates of the number of people sleeping rough in England in autumn 2019 (50). People sleeping rough are defined as “People sleeping, about to bed down (sitting on/in or standing next to their bedding) or actually bedded down in the open air (such as on the streets, in tents, doorways, parks, bus shelters or encampments). People in buildings or other places not designed for habitation (such as stairwells, barns, sheds, car parks, cars, derelict boats, stations, or ‘bashes’ which are makeshift shelters, often comprised of cardboard boxes)”. These figures are subject to some uncertainty and should be treated as estimates of the number of people sleeping rough on a single night and an indication of trends over time.

10.12 Excess mortality model

Excess deaths

Total cumulative excess mortality is estimated by calculating the cumulative deaths between March 20 and 7 May 2020 and subtracting the expected cumulative deaths in this period. Expected deaths are modelled using the previous 5 years of data, except when modelling for ethnicity, where the period 2014 to 2018 was used.

ONS compared deaths in 2020 with the simple average for the years 2015 to 2019. However, this will not adjust for ageing of the population or the effect of Easter or bank holidays on the number of deaths registered. The PHE model does adjust for this.

Daily registered deaths

We present daily ONS registered deaths from March 20 to 7 May 2020. To maximise correspondence with the pattern of death registrations in the baseline data (expected deaths), all weekend and public holiday death registrations were reassigned to the nearest working day.

Modelled expected deaths

Models to develop baseline estimates of the expected number of deaths on a given working day of the year were constructed using a combination of deaths and population-denominator data from 2015 to 2019. Because historically deaths were registered on working days, the few deaths registered on weekends or bank holidays were assigned to the nearest working day.

Data structure and covariates

Independent variables included day of week, whether a day was a bank holiday, and time of year allowing for seasonal effects. The model also includes specific adjustments for registrations around bank holidays, a linear trend by year and covariates allowing for the effect of age, gender, deprivation, ethnicity and geographical region. In addition, we include an interaction term between age and sex to allow sex to modify the effect of age on death.

The model structures are hierarchical with population denominators and counts of death each being fully disaggregated to demographic sub-groups. England, and region models contain variables for age, sex, and upper tier local authority (UTLA). Ethnicity and deprivation models were built separately from the England model because, by including UTLA in these models, the datafile became too large to model. Ethnicity and deprivation models therefore each contain age, sex and region.

To avoid competing risk, for place of death analyses, each outcome (e.g. death at home) was modelled separately. These models are currently built with no demographic structure and no denominators.

Statistical modelling

The models are Quasi-Poisson regression models, on the logarithmic scale (a ‘log link’) which account for over dispersion. The models for all causes, by age, sex, ethnicity and deprivation contained the set of covariates outlined in the section above and an offset reflecting the log-population-size in each population subset. Data were analysed using the glm function in R. In calculating the expected total number of deaths in a given population subgroup (e.g. males aged 85+ years in the Middlesbrough UTLA) on a given date in 2020, we added up the number of deaths expected in that specific subgroup taking appropriate account of the (gradually increasing) size of that sub-population size between 2015 and 2019.

COVID-19 deaths

Among cumulative death charts we added an orange ‘ribbon’ to represent deaths with a mention of COVID-19 on the death certificate. Even though it is well recognised that many people dying of COVID-19 had other significant co-morbidities, the majority (96%) of COVID-associated deaths are recorded as having COVID as the underlying cause of death.

Occupational classification

Mortality has been analysed according to the Standard Occupational Classification 2010 (SOC 2010) ‘minor groups’ and ‘unit groups’, the lowest level of the classification (51).

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Appendices

Appendix A: Multivariate analyses

COVID-19 laboratory confirmed cases were matched to reported deaths by NHS number. Records that contained the linking field were included in the final analysis dataset (n = 130,101 cases, n = 28,246 deaths). Missing data excluded from regression: sex, n=10; age group, n=38; ethnic group, n=2,024; region, n=446; deprivation quintile, n=639.

Cox proportional hazards regression models were used to model survival time between date of positive specimen and date of death or survival to 13 May 2020 among people with confirmed COVID-19 by age, sex, ethnicity, region and deprivation (IMD quintile). Interaction between variables was assessed; since there are interactions between age and some of the other variables, models were stratified by age in sub-models: an all ages model, one for working age patients (20-64 years of age) and one for older patients (65+ years of age). All 3 models included all variables. The proportional hazards assumption was tested using Schoenfeld residuals and only sex was significant. However, sex was not adjusted for as a time varying covariate due to the nature of the stability of this factor. Hazard ratios from the crude and fully adjusted models are shown in Appendix A with 95% confidence intervals.

In all 3 models, men had a significantly higher probability of death compared to women (adjusted hazard ratio (aHR)=1.54 (95%CI 1.50-1.57)) (Table A1). The increased risk was higher for working age adults (aHR=1.99 (95%CI 1.85-2.14)) than for older adults (aHR=1.47 (95%CI=1.44-1.51)).

Compared to the youngest age group of patients (<20), the probability of death significantly increased with age up to approximately 70-fold for those aged 80 and over (aHR=70.26 (95%CI 43.66-113.07)).

Those living in the most deprived areas had a higher probability of death when compared to those living in the least deprived (aHR for the most deprived quintile was 1.16 (95%CI 1.12-1.21) when compared to the least deprived quintile (Table A1). The risk was higher for working age patients (aHR=1.93 (95%CI 1.70-2.19)) (Annex A, Table A2) than for older patients (aHR=1.09 (95%CI 1.04-1.13)) (Table A3).

Regional differences were observed, with probability of death being higher as compared to London in East of England (aHR=1.10 (95%CI 1.05 - 1.15)) and lower as compared to London in North East (aHR=0.82 (95%CI 0.77 - 0.87)), North West (aHR=0.92

(95%CI 0.88 - 0.96)), South East (aHR=0.92 (95%CI 0.88 - 0.96)), South West (aHR=0.89 (95%CI 0.84 - 0.94)), West Midlands (aHR=0.93 (95%CI 0.89 - 0.98)) and Yorkshire and Humber (aHR=0.92 (95%CI 0.88 - 0.97)). The increased probability in East of England compared to London was observed in older age groups only (Table A3), whereas the lower probability in other regions as compared to London was primarily observed in the working age group (Table A2).

Six ethnic groups had significantly higher probability of death when compared to White British ethnicity in the model with all ages: Bangladeshi (aHR=2.02 (95% CI 1.74-2.35)), Pakistani (aHR=1.44 (95% CI 1.31-1.58), other Black (aHR=1.35 (95% CI 1.18-1.55), Chinese (aHR=1.28 (95%CI 1.04-1.58), Indian (aHR=1.22 (95% CI 1.13-1.32), other Asian (aHR=1.13 (95% CI 1.02-1.25)) and Black Caribbean (aHR=1.10 (95% CI 1.02-1.19) (Table A1). People of White Irish ethnicity had lower probability of death when compared to White British ethnicity (aHR=0.88 (95% CI 0.79-0.99)).

These results were replicated in both age groups for people of Bangladeshi, Pakistani, Black Caribbean and Black other ethnic groups. For older age groups, the probability of death was also higher among people of Chinese, Indian and Other Asian ethnic groups (Tables A2 and A3).

Table A1. Multivariable hazard ratios for death among those with laboratory confirmed COVID-19. Data up to 13 May, England. Source: Public Health England Second Generation Surveillance System.

				Univariable			Multivariable	
	number died	**numbe r total**	**HR**	**95% CI**	**p-value**	**aHR**	**95% CI**	**p-value**
Sex								
Female	11,470	69,558	1.00 (ref)			1.00 (ref)		
Male	16,776	60,533	1.74	(1.69-1.78)	<0.001	1.54	(1.50 - 1.57)	<0.001
Age group								
<20	19	2,004	1.00 (ref)			1.00 (ref)		
20-39	190	22,267	0.89	(0.54-1.47)	0.65	0.97	(0.59 - 1.59)	0.90
40-49	455	15,349	3.20	(1.97-5.20)	<0.001	3.27	(2.01 - 5.31)	<0.001
50-59	1,507	19,217	8.98	(5.57-14.49)	<0.001	9.03	(5.60 - 14.56)	<0.001
60-69	3,226	15,002	26.77	(16.62-43.12)	<0.001	25.50	(15.83 - 41.08)	<0.001
70-79	6,937	19,060	51.42	(31.95-82.77)	<0.001	50.18	(31.17 - 80.79)	<0.001
80+	15,912	37,164	66.92	(41.59-107.68)	<0.001	70.26	(43.66 - 113.07)	<0.001
Ethnic group								
White - British	22,880	99,098	1.00 (ref)			1.00 (ref)		
Asian / Asian British - Bangladeshi	182	708	1.10	(0.95-1.27)	0.21	2.02	(1.74 - 2.35)	<0.001
Asian / Asian British - Chinese	92	470	0.78	(0.64-0.96)	0.02	1.28	(1.04 - 1.58)	0.02
Asian / Asian British - Indian	746	4,149	0.75	(0.69-0.81)	<0.001	1.22	(1.13 - 1.32)	<0.001
Asian / Asian British - Other	412	3,233	0.51	(0.46-0.56)	<0.001	1.13	(1.02 - 1.25)	0.02
Asian / Asian British - Pakistani	483	2,353	0.86	(0.78-094)	0.001	1.44	(1.31 - 1.58)	<0.001
Black / Black British - African	430	3,157	0.53	(0.48-0.58)	<0.001	1.06	(0.96 - 1.18)	0.24
Black / Black British - Caribbean	713	2,367	1.30	(1.21-1.40)	<0.001	1.10	(1.02 - 1.19)	0.01
Black / Black British - Other	229	1,167	0.79	(0.69-0.91)	<0.001	1.35	(1.18 - 1.55)	<0.001
Mixed - Other	97	629	0.63	(0.51-0.77)	<0.001	1.04	(0.85 - 1.28)	0.68
Mixed - White and Asian	30	285	0.43	(0.30-0.61)	<0.001	1.20	(0.84 - 1.72)	0.32
Mixed - White and Black African	22	201	0.42	(0.28-0.65)	<0.001	0.79	(0.50 - 1.24)	0.30

Mixed - White and Black Caribbean	46	248	0.77	(0.57-1.02)	0.07	1.18	(0.88 - 1.57)	0.28
Other - Any other ethnic group	574	3,725	0.62	(0.57-0.67)	<0.001	1.02	(0.94 - 1.12)	0.60
White - Irish	293	1,072	1.20	(1.07-1.35)	0.002	0.88	(0.79 - 0.99)	0.04
White - Other	951	5,215	0.76	(0.71-0.81)	<0.001	0.98	(0.92 - 1.05)	0.62
Region								
London	5,666	24,797	1.00 (ref)			1.00 (ref)		
East Midlands	2,038	7,828	1.22	(1.16-1.29)	<0.001	0.97	(0.92 - 1.03)	0.35
East of England	3,061	12,426	1.16	(1.11-1.21)	<0.001	1.10	(1.05 - 1.15)	<0.001
North East	1,562	8,987	0.79	(0.74-0.83)	<0.001	0.82	(0.77 - 0.87)	<0.001
North West	4,603	22,258	0.94	(0.91-0.98)	0.004	0.92	(0.88 - 0.96)	<0.001
South East	3,667	19,117	0.85	(0.82-0.89)	<0.001	0.92	(0.88 - 0.96)	<0.001
South West	1,490	7,023	0.96	(0.91-1.02)	0.21	0.89	(0.84 - 0.94)	<0.001
West Midlands	3,617	14,887	1.14	(1.10-1.20)	<0.001	0.93	(0.89 - 0.98)	0.003
Yorkshire and Humber	2,492	12,332	0.94	(0.90-0.99)	0.01	0.92	(0.88 - 0.97)	0.002
Deprivation quintile								
1 - most deprived	6,748	30,040	1.08	(1.04-1.13)	<0.001	1.16	(1.12 - 1.21)	<0.001
2	6,250	28,724	1.03	(1.00-1.07)	0.09	1.10	(1.05 - 1.14)	<0.001
3	5,372	25,584	1.00	(0.96-1.04)	0.98	1.04	(1.00 - 1.09)	0.04
4	5,175	23,791	1.04	(0.10-1.08)	0.07	1.04	(1.00 - 1.08)	0.06
5 - least deprived	4,531	21,323	1.00 (ref)			1.00 (ref)		

Table A2. Multivariable hazard ratios for death among those with laboratory confirmed COVID-19 and between 20 and 64 years of age. Data up to 13 May, England. Source: Public Health England Second Generation Surveillance System.

			Univariable			Multivariable		
	number died	**number total**	**HR**	**95% CI**	**p-value**	**aHR**	**95% CI**	**p-value**
Sex								
Female	1,202	37,677	1.00 (ref)			1.00 (ref)		
Male	2,346	27,284	2.68	(2.49 - 2.87)	<0.001	1.99	(1.85 - 2.14)	<0.001
Age group								
20-39	190	22,267	1.00 (ref)			1.00 (ref)		
40-49	455	15,349	3.59	(3.01 - 4.30)	<0.001	3.33	(2.79 - 3.99)	<0.001
50-59	1,507	19,217	10.08	(8.59 - 11.82)	<0.001	8.94	(7.61 - 10.50)	<0.001
60-64	1,396	8,129	23.36	(19.91 - 27.41)	<0.001	19.01	(16.18 - 22.35)	<0.001
Ethnic group								
White - British	2,255	44,588	1.00 (ref)			1.00 (ref)		
Asian / Asian British - Bangladeshi	59	474	2.48	(1.90 - 3.22)	<0.001	1.81	(1.38 - 2.37)	<0.001
Asian / Asian British - Chinese	19	310	1.24	(0.79 - 1.94)	0.36	1.12	(0.71 - 1.77)	0.61
Asian / Asian British - Indian	164	2,734	1.21	(1.03 - 1.42)	0.02	1.06	(0.90 - 1.25)	0.50
Asian / Asian British - Other	122	2,468	1.00	(0.83 - 1.20)	0.99	0.92	(0.77 - 1.12)	0.42
Asian / Asian British - Pakistani	142	1,563	1.86	(1.57 - 2.21)	<0.001	1.48	(1.24 - 1.76)	<0.001
Black / Black British - African	197	2,461	1.57	(1.36 - 1.82)	<0.001	1.04	(0.89 - 1.22)	0.59
Black / Black British - Caribbean	127	1,050	2.44	(2.03 - 2.92)	<0.001	1.31	(1.09 - 1.58)	0.005
Black / Black British - Other	96	834	2.31	(1.88 - 2.85)	<0.001	1.50	(1.21 - 1.86)	<0.001

Mixed - Other	22	409	1.11	(0.73 - 1.70)	0.61	1.18	(0.78 - 1.80)	0.43
Mixed - White and Asian	8	224	0.74	(0.37 - 1.49)	0.40	0.87	(0.43 - 1.74)	0.70
Mixed - White and Black African	6	140	0.87	(0.39 - 1.93)	0.73	0.72	(0.32 - 1.60)	0.42
Mixed - White and Black Caribbean	12	161	1.56	(0.89 - 2.76)	0.12	1.50	(0.85 - 2.66)	0.16
Other - Any other ethnic group	156	2,614	1.19	(1.01 - 1.41)	0.04	0.92	(0.77 - 1.09)	0.34
White - Irish	19	324	1.23	(0.78 - 1.93)	0.37	0.96	(0.60 - 1.53)	0.87
White - Other	132	3,059	0.88	(0.74 - 1.05)	0.17	0.80	(0.66 - 0.96)	0.01
Region								
London	1,092	13,436	1.00 (ref)			1.00 (ref)		
East Midlands	227	3,063	0.95	(0.82 - 1.10)	0.50	1.00	(0.86 - 1.16)	0.98
East of England	355	5,828	0.76	(0.67 - 0.86)	<0.001	0.96	(0.84 - 1.09)	0.52
North East	133	4,787	0.34	(0.29 - 0.41)	<0.001	0.44	(0.37 - 0.54)	<0.001
North West	499	11,311	0.55	(0.50 - 0.62)	<0.001	0.64	(0.57 - 0.72)	<0.001
South East	416	10,291	0.50	(0.44 - 0.56)	<0.001	0.70	(0.62 - 0.80)	<0.001
South West	139	3,350	0.51	(0.43 - 0.62)	<0.001	0.63	(0.52 - 0.76)	<0.001
West Midlands	412	6,276	0.85	(0.76 - 0.96)	0.007	0.87	(0.77 - 0.98)	0.03
Yorkshire and Humber	268	6,313	0.54	(0.47 - 0.62)	<0.001	0.64	(0.55 - 0.74)	<0.001
Deprivation quintile								
1 - most deprived	1,050	15,199	2.01	(1.78 - 2.27)	<0.001	1.93	(1.70 - 2.19)	<0.001
2	933	14,759	1.80	(1.59 - 2.03)	<0.001	1.65	(1.46 - 1.88)	<0.001
3	638	12,894	1.40	(1.23 - 1.60)	<0.001	1.38	(1.21 - 1.57)	<0.001
4	520	11,424	1.29	(1.13 - 1.48)	<0.001	1.32	(1.15 - 1.52)	<0.001
5 - least deprived	381	10,302	1.00 (ref)			1.00 (ref)		

Table A3. Multivariable hazard ratios for death among those with laboratory confirmed COVID-19 and over 64 years of age. Data up to 13 May, England. Source: Public Health England Second Generation Surveillance System.

	number died	number total	Univariable HR	Univariable 95% CI	Univariable p-value	Multivariable aHR	Multivariable 95% CI	Multivariable p-value
Sex								
Female	10,262	30,817	1.00 (ref)			1.00 (ref)		
Male	14,417	32,277	1.40	(1.36 - 1.43)	<0.001	1.47	(1.44 - 1.51)	<0.001
Age group								
65-69	1,830	6,873	1.00 (ref)			1.00 (ref)		
70-79	6,937	19,060	1.50	(1.43 - 1.58)	<0.001	1.55	(1.47 - 1.64)	<0.001
80+	15,912	37,164	1.95	(1.86 - 2.05)	<0.001	2.15	(2.05 - 2.26)	<0.001
Ethnic group								
White – British	20,617	53,291	1.00 (ref)			1.00 (ref)		
Asian / Asian British - Bangladeshi	122	203	1.95	(1.63 - 2.34)	<0.001	2.02	(1.68 - 2.42)	<0.001
Asian / Asian British - Chinese	73	153	1.21	(0.96 - 1.54)	0.11	1.32	(1.04 - 1.67)	0.02
Asian / Asian British - Indian	580	1,300	1.19	(1.10 - 1.29)	<0.001	1.28	(1.18 - 1.39)	<0.001
Asian / Asian British - Other	288	671	1.08	(0.96 - 1.22)	0.18	1.22	(1.08 - 1.38)	0.001
Asian / Asian British - Pakistani	339	723	1.26	(1.13 - 1.41)	<0.001	1.38	(1.24 - 1.54)	<0.001
Black / Black British - African	230	608	0.90	(0.79 - 1.03)	0.13	0.98	(0.86 - 1.13)	0.83
Black / Black British - Caribbean	586	1,305	1.14	(1.05 - 1.24)	0.002	1.09	(1.00 - 1.19)	0.05
Black / Black British - Other	132	305	1.10	(0.93 - 1.31)	0.27	1.19	(1.00 - 1.42)	0.05
Mixed – Other	75	180	1.07	(0.85 - 1.34)	0.58	1.01	(0.80 - 1.27)	0.92
Mixed - White and Asian	22	48	1.23	(0.81 - 1.87)	0.33	1.37	(0.90 - 2.09)	0.14
Mixed - White and Black African	16	45	0.86	(0.52 - 1.42)	0.55	0.82	(0.47 - 1.41)	0.47
Mixed - White and Black Caribbean	34	76	1.11	(0.80 - 1.56)	0.53	1.11	(0.79 - 1.55)	0.56
Other - Any other ethnic group	418	1,028	1.02	(0.92 - 1.12)	0.74	1.05	(0.95 - 1.16)	0.36

White – Irish	274	745	0.90	(0.80 - 1.02)	0.09	0.89	(0.79 - 1.00)	0.06
White – Other	819	2,050	1.01	(0.94 - 1.08)	0.76	1.02	(0.95 - 1.10)	0.60
Region								
London	4,564	10,981	1.00 (ref)			1.00 (ref)		
East Midlands	1,811	4,642	0.97	(0.92 - 1.02)	0.28	0.99	(0.94 - 1.05)	0.83
East of England	2,704	6,401	1.10	(1.05 - 1.16)	<0.001	1.14	(1.08 - 1.20)	<0.001
North East	1,429	4,113	0.89	(0.84 - 0.94)	<0.001	0.91	(0.85 - 0.97)	0.004
North West	4,103	10,687	0.96	(0.92 - 1.00)	0.07	0.99	(0.94 - 1.04)	0.64
South East	3,249	8,398	0.94	(0.90 - 0.98)	0.008	0.97	(0.93 - 1.02)	0.28
South West	1,351	3,554	0.92	(0.86 - 0.98)	0.006	0.94	(0.89 - 1.01)	0.08
West Midlands	3,202	8,373	0.95	(0.91 - 0.99)	0.03	0.96	(0.92 - 1.01)	0.12
Yorkshire and Humber	2,223	5,843	0.96	(0.92 - 1.01)	0.16	0.99	(0.94 - 1.04)	0.66
Deprivation quintile								
1 - most deprived	5,695	14,383	1.05	(1.00 - 1.09)	0.03	1.09	(1.04 - 1.13)	<0.001
2	5,312	13,528	1.03	(0.98 - 1.07)	0.24	1.04	(1.00 - 1.09)	0.05
3	4,727	12,294	1.00	(0.96 - 1.05)	0.87	1.02	(0.97 - 1.06)	0.48
4	4,652	11,993	1.01	(0.97 - 1.05)	0.62	1.02	(0.97 - 1.06)	0.47
5 - least deprived	4,149	10,682	1.00 (ref)			1.00 (ref)		

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Appendix B: Ethnicity classification in Hospital Episode Statistics (HES) data and in Office for National Statistics (ONS) data

HES ethnicity classification	**ONS ethnicity classification**
White A British B Irish C Any other White background	White • English / Welsh / Scottish / Northern Irish / British • Irish • Gypsy or Irish Traveller • Any other White background
Mixed D White and Black Caribbean E White and Black African F White and Asian G Any other mixed background	Mixed / Multiple ethnic groups • White and Black Caribbean • White and Black African • White and Asian • Any other Mixed / Multiple ethnic background
Asian or Asian British H Indian J Pakistani K Bangladeshi L Any other Asian background	Asian / Asian British • Indian • Pakistani • Bangladeshi • Chinese • Any other Asian background
Black or Black British M Caribbean N African P Any other Black background	Black / African / Caribbean / Black British • African • Caribbean • Any other Black / African / Caribbean background
Other Ethnic Groups R Chinese S Any other ethnic group	Other ethnic group • Arab • Any other ethnic group

Appendix C: updates and corrections

Updates and corrections to the report

Correction made on 10 June 2020

Page 54
Corrected to list Somalia in in South and Eastern Africa rather than Central and Western Africa.

Corrections made on 11 August 2020

Page 15
The first paragraph said "Overall, the mortality rates among confirmed cases per 100,000 population among males were 1.3 to 2.1 higher than among females for all age groups (Figure 1.5). Overall the age standardised mortality rate in males (74.0 per 100,000) was twice that of females (38.0 per 100,000)."

The age standardised rates quoted here were based on analysis by ethnic group which used a different population to the analysis by age and sex. Figures have been corrected to 76.1 for males and 38.8 for females.

Page 15
The second paragraph said "An analysis of survival among people with confirmed COVID-19 by sex, age group, ethnicity, deprivation and region, shows that, compared with people under 40, the probability of death was about 3-times higher among those aged 40 to 49, 9-times higher among those aged 50 to 59, 27-times higher among those aged 60 to 69, fifty times higher among those aged 70 to 79 and seventy times higher among those aged 80 and over."

Two corrections as follows:

- For the 60-69 age group this was corrected to 26 times higher, rather than 27.
- The first sentence was reworded to say: "An analysis of survival among people with confirmed COVID-19 adjusted for sex, ethnicity, deprivation and region…"

Page 16
The third paragraph said "Males accounted for 57% of deaths from COVID-19 and females 43%, while the baseline all cause figures were 51% and 49%. This indicates that males make up a larger percentage of COVID-19 deaths than all causes."

The baseline figures were corrected to 49% for males and 51% for females.

Page 16
The fourth paragraph said “8% of deaths from COVID-19 among males were in those under 60 years of age compared with 6% of females. This compares with 14% and 9% for baseline all cause deaths respectively.”

The baseline figures were corrected to 13% for males and 8% for females.

Page 17
The label on the x axis for Figure 1.6A and 1.6B was corrected from ‘Age-standardised rate per 100,000’ to “Age-specific rate per 100,000”.

Page 39 and page 45

Both pages corrected to say ‘Black Caribbean’ rather than just ‘Caribbean’.

Page 71

Section 10.6 corrected to say that the denominators used to calculate rates by ethnic group are from “the ONS 2018 ‘aged-on’ population for ethnic groups, based on the 2011 Census” rather than “the ONS 2018 mid-year populations for England”.