Public Health England

Protecting and improving the nation's health

# Analysis of the relationship between pre-existing health conditions, ethnicity and COVID-19

# Contents

# Introduction

During the first wave of the COVID-19 pandemic in England, people from some ethnic minority groups, particularly Black and Asian, were more likely to be infected, diagnosed and die than people in White ethnic groups (1-5). Recent reports by the Scientific Advisory Group for Emergencies (SAGE) and the Race Disparity Unit summarise the available evidence to date on reasons for these inequalities (6, 7).

Higher prevalence, in some ethnic groups, of health conditions that are known to increase the risk of poor outcomes from COVID-19, such as diabetes, has been suggested as a possible contributing factor to poor outcomes (6). However, a report from the Office for National Statistics (ONS) found that high death rates, in both males and females, among Black African, Black Caribbean, Indian, Pakistani and Other ethnic groups remained after taking account of socioeconomic characteristics and pre-existing health conditions (1). Other studies have shown similar findings, that higher mortality in some ethnic minority groups remained after taking account of these factors (8-10).

Death rates from COVID-19 in the population are determined by the combined effects of the risk of getting COVID-19 (or being diagnosed through a positive test result) and survival (or risk of death) once diagnosed. The ONS report focused on death rates in the population and did not separate out risk of diagnosis and survival among those diagnosed. Other studies have focused on death rates in hospital or in a defined population such as those registered with a group of general practitioners.

This Public Health England (PHE) report looks at COVID-19 diagnoses (cases), deaths involving COVID-19 and survival following diagnosis in England during the first wave of the pandemic. It analyses these components separately, in order to gain a better understanding of the potential explanations for high death rates among some ethnic groups. This helps to identify whether high mortality in some ethnic groups is due to increased likelihood of being diagnosed with COVID-19, reduced survival following diagnosis, or both.

The overarching aim of this analysis is to provide further evidence of the role of pre-existing health conditions in ethnic inequalities in diagnoses, deaths and survival from COVID-19. It does not attempt to explain fully the reasons for ethnic inequalities in COVID-19 as the evidence on this has been summarised elsewhere (6, 7). In addition, it does not quantify the risk associated with specific co-morbidities, as that has been reported elsewhere (10).

In particular, the objectives of this analysis are to:

- describe COVID-19 diagnoses (cases) and deaths by ethnicity and pre-existing health conditions

- compare the numbers of cases and deaths involving COVID-19 by ethnic group among people with pre-existing conditions to determine whether ethnic differences exist among people with similar pre-existing conditions

- compare survival following COVID-19 diagnosis by ethnic group, adjusting for age, sex, socioeconomic characteristics and pre-existing conditions, to determine the extent to which pre-existing conditions explain differences in survival between ethnic groups

The analysis presented covers the first wave of the COVID-19 pandemic in England. Data were analysed looking at broad ethnic groups (Black, White, Asian, Mixed and Other) and detailed Black and Asian groups (Bangladeshi, Pakistani, Indian, Chinese, Asian Other, Black African, Black Caribbean, Black Other).

In this analysis, pre-existing conditions were defined by a hospital admission in the previous five years, mentioning one of the clinical conditions of interest in the clinical record. It is recognised this will not identify all pre-existing conditions that may affect outcome from COVID-19 such as those that are only seen in primary care. In addition, some known risk factors, such as obesity, are not always recorded on admission to hospital if not related to the reason for admission.

The pre-existing conditions examined are:

1. A ‘long list’ of relevant conditions referred to as the ‘long list’ throughout this document. Details of these conditions are provided in the technical document. These conditions were selected based on a review of the evidence on health conditions associated with poor outcomes for COVID-19 and other respiratory infections (such as pneumococcal disease) and expert clinical assessment.

2. Specific conditions of interest:

- Cardiovascular disease (ICD-10 I00 to I99)
- Hypertensive diseases (ICD-10 I10 to I15)
- Cerebrovascular disease (ICD-10 I60 to I69) or transient ischaemic attack (ICD-10 G45 to G46)
- Diabetes (ICD-10 E10 to E14)
- Chronic kidney disease (ICD-10 N18)
- Chronic lower respiratory disease (ICD-10 J40 to J47)
- Dementia/Alzheimer’s disease (ICD-10 F00 to F03, G30, G31.0, G31.8)

Evidence on the relationship between pre-existing conditions and risk from COVID-19 is continually emerging. This list may not reflect more recent publications.

# Main findings

This report shows that, in the first wave of the COVID-19 pandemic in England, among people with a similar history of previous hospital admission mentioning pre-existing health conditions, there were ethnic differences in the numbers of cases and deaths involving COVID-19. In addition, ethnic inequalities in survival following diagnosis of COVID-19 were not explained by differences in such patterns of admission with pre-existing health conditions between ethnic groups. This conclusion is consistent with other studies reviewed in this document.

Information on previous admissions will not identify all differences in pre-existing conditions that may affect outcomes from COVID-19, particularly for those that are mainly seen in primary care such as obesity, diabetes and hypertension. It is possible that, if this information were included that the ethnic differences would reduce further. However, other studies that have used primary care data have shown similar findings, in that higher mortality in some ethnic minority groups remained after taking account of co-morbidities (8-10).

## Deaths

Among people with one or more pre-existing health condition, there were more deaths involving COVID-19 in every ethnic minority group examined than would be expected if they had the same COVID-19 death rate as all people with the conditions.

Among people with cardiovascular disease (CVD), hypertension and chronic kidney disease (CKD), all Black ethnic groups had twice as many COVID-19 deaths as expected and the Asian group as a whole had 1.5 times as many deaths as expected.

These differences in the numbers of COVID-19 deaths will be determined by differences in the risk of being diagnosed or infected with COVID-19 and the risk of dying from COVID-19 once diagnosed. These need to be examined separately to interpret the variation in mortality by ethnic group.

## Diagnoses

Among people with one or more pre-existing health condition, there were more COVID-19 cases in every ethnic minority group (apart from Chinese) than would be expected if they had the same rate of COVID-19 diagnoses as all people with the conditions.

These differences in the number of cases between ethnic groups will be determined by differences in exposure to the virus and therefore risk of infection. This is influenced by factors such as number of social contacts and broader social circumstances such as housing and occupation. However, COVID-19 diagnosis is confirmed by a positive test

result. Therefore, increased testing in an ethnic group may also result in a higher number of cases.

# Survival

Poor survival from COVID-19 indicates a higher risk (or odds) of dying once diagnosed. At the broad ethnic group level, the Asian and Black groups had poorer survival following diagnosis with COVID-19 than the White group when age, sex, deprivation, region, testing pillar and time since start of the epidemic were accounted for. When controlling for pre-existing health conditions as well, poorer survival in these groups remained.

When detailed ethnic groups were examined, after adjusting for the factors above, the Bangladeshi ethnic group had the poorest survival and had 1.88 times the odds of dying once diagnosed when compared with the White ethnic group. The Pakistani, Chinese, and Black Other ethnic groups had 1.35 to 1.45 times the odds of dying once diagnosed and the Indian group 1.16.

Poorer survival may be partially due to higher prevalence of pre-existing conditions that have not been fully accounted for, such as those seen primarily in primary care. It may also be due to socioeconomic factors that were not fully accounted for. However, survival may also be influenced by differences in testing between ethnic groups: reduced availability of testing or seeking testing later among an ethnic group may mean that people are tested later in the course of illness with COVID-19, which may result in later treatment, more severe disease, a higher risk of dying and hence poorer survival.

People belonging to the Bangladeshi, Pakistani, Indian and Black Other ethnic groups had both a high number of cases and poor survival following diagnosis. Therefore, the high death rates seen in these groups will be determined by those factors that affect risk of getting COVID-19 and those that affect risk of dying once diagnosed.

People belonging to the Black African, Black Caribbean, Asian Other, Mixed and Other ethnic groups had a high number of cases but did not have poor survival following diagnosis. Therefore, the high death rates seen in these groups were largely determined by a high risk of getting COVID-19 rather than a high risk of dying once diagnosed.

# Descriptive analysis of COVID-19 cases and deaths by ethnic group

## Number of cases and deaths

Data on laboratory confirmed cases of COVID-19 in England were taken from PHE's Second Generation Surveillance System (SGSS) and data on deaths in England were obtained from ONS death registrations. As population registers for people with similar pre-existing health conditions or access to primary care data for the whole population was not available, data on cases and deaths were linked to more than 20 years of Hospital Episode Statistics (HES) data in order to determine presence of pre-existing conditions and ethnicity.

As recorded clinical information in outpatients and A&E data is incomplete, a pre-existing condition was defined by a hospital admission in the previous five years mentioning one of the pre-existing conditions of interest in one of the recorded clinical fields. It is recognised this will not identify all pre-existing conditions that may affect outcome from COVID-19 such as those that are only seen in primary care.

Ethnicity is presented using the 5 broad ethnic groups (White, Black, Asian, Mixed, Other). In addition to this, the detailed Black and Asian ethnic groups are presented separately where possible.

More details on the linkage process and the data used are presented in the accompanying technical document.

At the time of analysis there were 275,834 laboratory confirmed cases of COVID-19 (people diagnosed with COVID-19) in England reported to PHE with a specimen date before 16 August 2020. The following were excluded:

- 10,135 cases with missing age, sex or place of residence
- 1,973 cases in children aged under 5 years
- a further 17,422 cases that could not be linked to HES to obtain information on pre-existing health conditions

This descriptive analysis includes 246,304 cases that had a valid age, sex and place of residence, and could be linked to HES. Those that could not be linked either had no hospital activity in the previous 20 years or could not be linked for other reasons, such as data quality. Ethnicity was available for 93.9% of linked cases (231,353).

Between 21 March 2020 and 17 July 2020 there were 48,505 deaths among England residents, aged 5 and over, with COVID-19 mentioned on the death certificate and 151,317 deaths from other causes. This descriptive analysis includes 99.7% (48,374) of

deaths with COVID-19 mentioned that could be linked to HES. Ethnicity was available for 98% of linked deaths mentioning COVID-19.

Data tables containing the results for this section of this report are provided in the accompanying data pack.

# Age profile of cases and deaths by ethnic group

Figures 1 and 2 show the age distribution of cases and COVID-19 deaths that could be linked to HES, in each broad and detailed ethnic group examined. Overall, 72% of cases and 86% of COVID-19 deaths that could be linked to HES were in the White ethnic group, and these proportions were greater at older ages.

In summary, Figures 1 and 2 show that:

Overall, 50% of linked cases were in people aged under 55. With the exception of the Black Caribbean group, the age profile of cases in ethnic minority groups was younger than average.

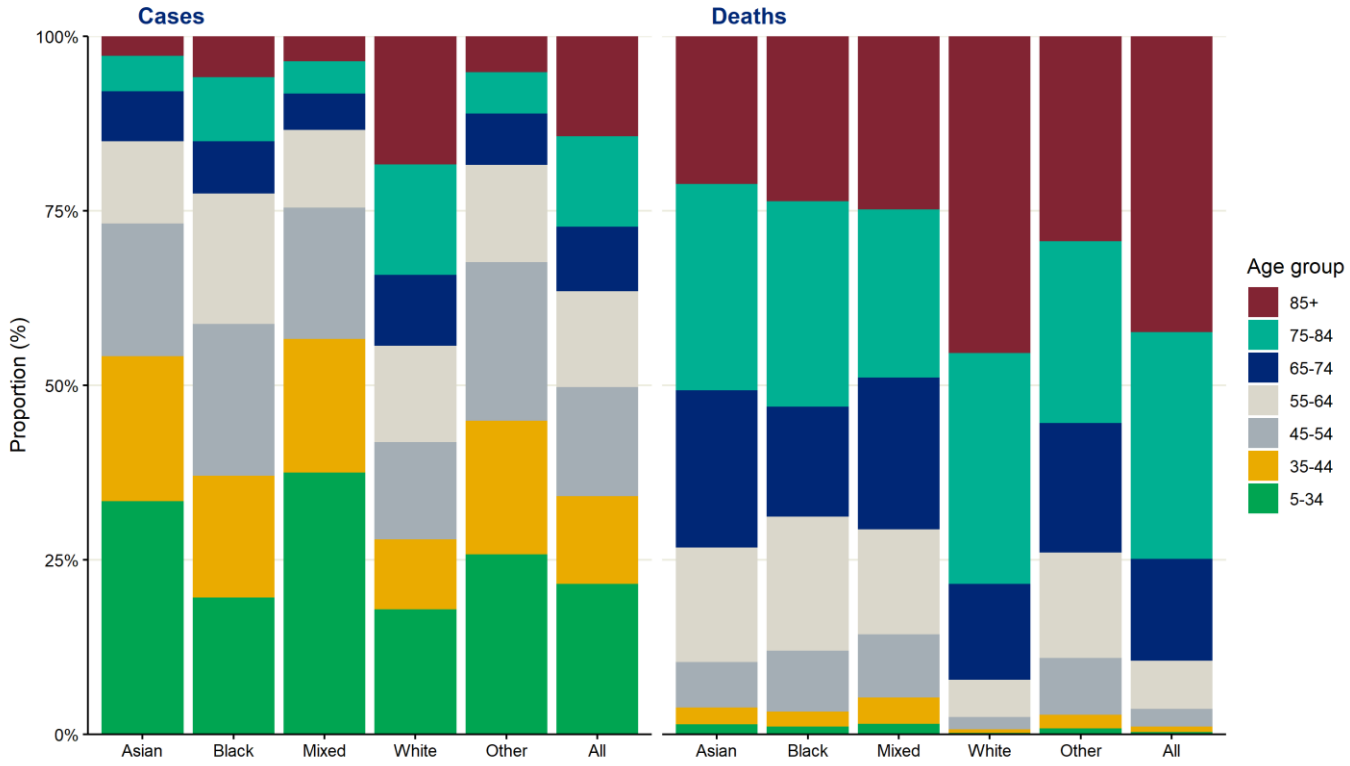
Among the Asian group the proportion of cases under 55 was 73%, but was as high as 79% in the Pakistani group. Among the Black group the proportion aged under 55 was 59%, but was much smaller in the Black Caribbean group (33%) than the Black African (70%) and Black Other group (65%).

Overall, 4% of those who died with COVID-19 were aged under 55 and 42% aged 85+. The age profile of COVID-19 deaths in ethnic minority groups was younger than average:

- In the Black group, 12% were under 55 and 24% 85+. Deaths in the Black Caribbean group had an older profile than other Black groups with 6% under 55 and 34% 85+.
- In the Asian group 10% were under 55 and 21% 85+. Deaths in the Bangladeshi group had a younger profile with 17% under 55 and 15% 85+.
- In the Mixed ethnic group 14% were under 55 and 25% 85+.

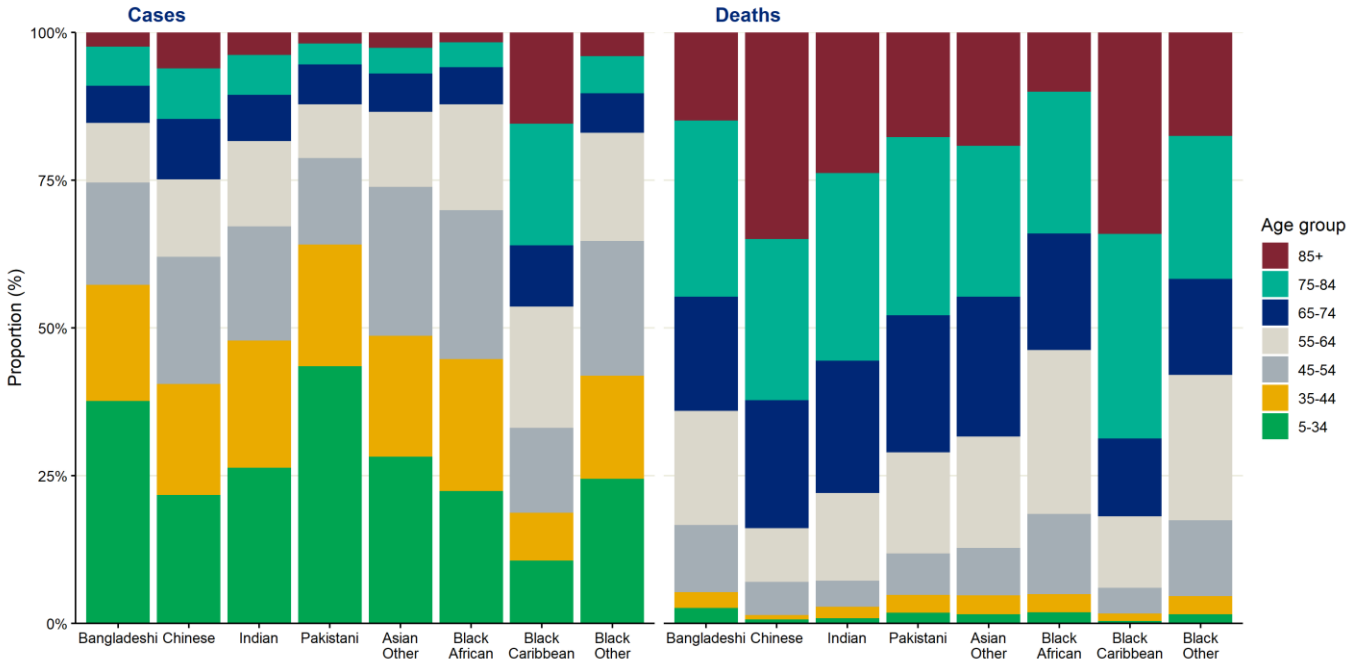
These differences in the age profile of cases and deaths by ethnic group will partly reflect the differences in the overall population age profile. The average age of the White group in the population is older than the other groups and within the Black group, the Black Caribbean group has an older age profile (11, 12).

## Figure 1. Age profile of cases and deaths mentioning COVID-19* in each broad ethnic group, England




*Includes cases up to 16 August 2020 and deaths occurring between 21 March and 17 July 2020
Source: PHE Second Generation Surveillance System, ONS death registrations and Hospital Episode Statistics

## Figure 2. Age profile of cases and deaths mentioning COVID-19* in detailed Black and Asian groups, England




*Includes cases up to 16 August 2020 and deaths occurring between 21 March and 17 July 2020
Source: PHE Second Generation Surveillance System, ONS death registrations and Hospital Episode Statistics

# Breakdown of cases and deaths by ethnic group and pre-existing health conditions

Pre-existing health conditions among cases and deaths were determined by admission to hospital with the condition in the previous 5 years. Among those that could be linked to HES, 47% of cases had one or more pre-existing condition on the long list compared with 84% of COVID-19 deaths.

This proportion of cases with a pre-existing condition on the long list increased with age from 15% in under 35s, 21% in under 55s to 88% in those aged 85+. For deaths this proportion was 58% in under 55s, rising to 88% in those aged 85+.

Figures 3 and 4 show the prevalence of pre-existing health conditions in each broad and detailed ethnic group among those who have been diagnosed or died with COVID-19. These charts exclude cases and deaths that could not be linked to HES.

In summary, Figures 3 and 4 show:

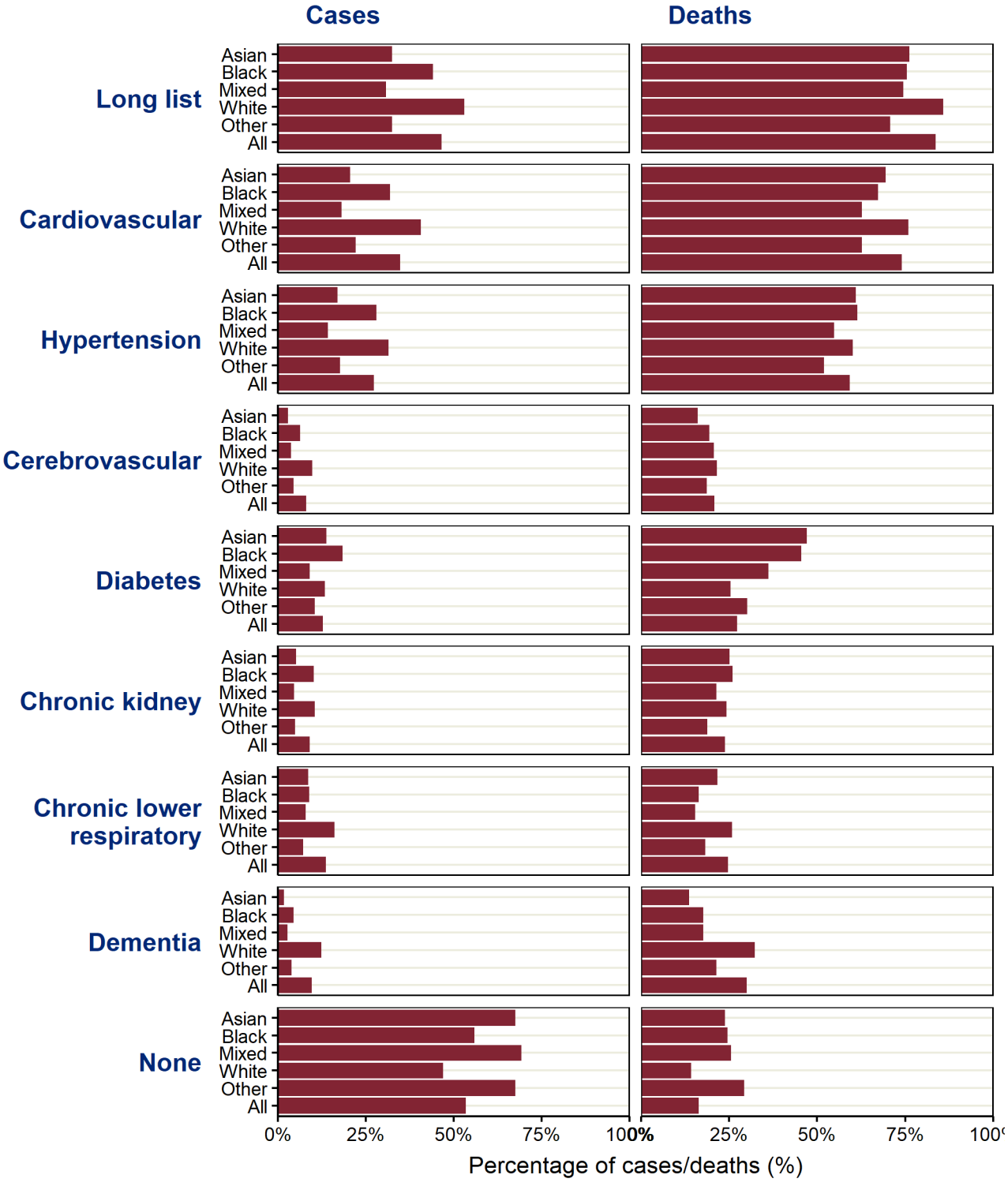
The prevalence of a pre-existing condition on the long list among cases was higher in the White group (53%) than the Black group (44%) and the Asian, Mixed and Other ethnic groups (31-33%). This general finding is likely to be related to the age profile of cases in the ethnic groups: cases in the White group were more likely to be older and therefore more likely to have pre-existing health conditions.

The Black and Asian groups had the highest proportions of cases with diabetes. This is consistent with data from the National Diabetes Audit which suggest that type II diabetes prevalence is higher in these groups (13).

When detailed ethnic groups in the Black and Asian groups were examined, cases in the Black Caribbean group were most likely to have a health condition on the long list (62%) which could also be related to the older age profile of cases in this group.

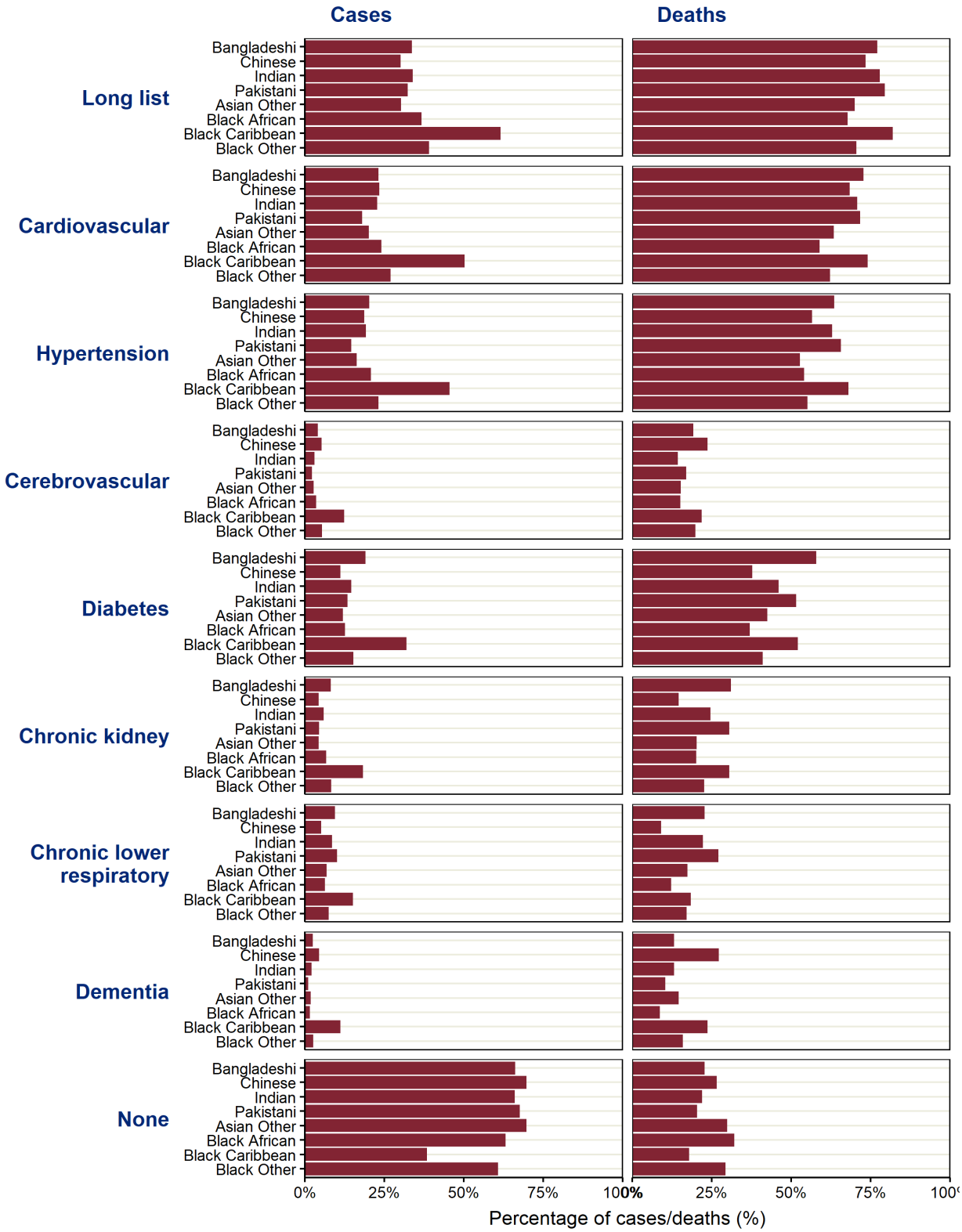
The proportion of COVID-19 deaths with one or more condition on the long list was greater in the White group than in each of the other broad ethnic groups. The same is true for the proportion with cardiovascular disease, cerebrovascular disease, chronic lower respiratory disease and dementia. As stated above this is likely to be related to the older age profile of deaths among the White ethnic group. Also like the findings for cases, the proportion with diabetes was much higher in the Black and Asian groups.

**Figure 3. Percentage of cases and deaths mentioning COVID-19* with pre-existing health conditions** in each broad ethnic group, England**




*Includes cases up to 16 August 2020 and deaths occurring between 21 March and 17 July 2020
** Long list = Relevant conditions were selected based on a review of the evidence on health conditions associated with poor outcomes for COVID-19 and other respiratory infections (such as pneumococcal disease) and expert clinical assessment.
Source: PHE Second Generation Surveillance System, ONS death registrations and Hospital Episode Statistics

**Figure 4. Percentage of cases and deaths mentioning COVID-19* with pre-existing health conditions** in detailed Black and Asian groups, England**




*Includes cases up to 16 August 2020 and deaths occurring between 21 March and 17 July 2020
** Long list = Relevant conditions were selected based on a review of the evidence on health conditions associated with poor outcomes for COVID-19 and other respiratory infections (such as pneumococcal disease) and expert clinical assessment.
Source: PHE Second Generation Surveillance System, ONS death registrations and Hospital Episode Statistics

# Age-standardised diagnosis ratios by ethnic group

The aim of this descriptive analysis is to compare the number of COVID-19 diagnosis by ethnic group among people with similar pre-existing conditions. The population with pre-existing conditions was estimated by identifying all people in the general population who had had a hospital admission in the previous five years with any of the pre-existing conditions mentioned.

Age standardised COVID-19 diagnosis ratios among people with pre-existing health conditions were calculated to take account of the age distributions of different ethnic groups when comparing outcomes. The ratios identify differences between ethnic groups in the risk of getting COVID-19 among people in the general population with specified pre-existing conditions. They were calculated separately for the population with each pre-existing condition, for example the population with diabetes. The details of the calculations are explained in the technical document.

For people with a particular condition, the age-standardised ratios compare the observed number of COVID-19 cases in an ethnic group with the number expected if that ethnic group had the same COVID-19 diagnosis rates in each age group as all people with that condition. For example, they compare the number of COVID-19 cases in the Black group with diabetes with the number expected based the COVID-19 diagnosis rates for all people with diabetes.

An age-standardised ratio higher than 1 means that the number of COVID-19 cases was higher than expected and a ratio lower than 1 means that the number of COVID-19 cases was lower than expected. An age-standardised diagnosis ratio of 2 means that the number of COVID-19 cases was twice as high as expected.

Figure 5 shows age-standardised diagnoses (cases) and mortality (death) ratios by ethnic group for people with the pre-existing conditions examined. Figure 6 shows the same information for the Black and Asian groups broken down by more detailed ethnic groups. Age-standardised mortality ratios are explained in the section below.

The summary finding is that, among people with any condition (except dementia), after accounting for age, the number of COVID-19 cases in the broad Black, Asian, Mixed and Other ethnic groups was higher than expected (Figure 5). The number of COVID-19 cases in the White group was lower than expected. Among people with dementia, the Asian group had a lower number of cases than expected.

When detailed ethnic groups were examined, among people with any health condition on the long list, all except the Chinese group had more cases than expected (Figure 6). Among people with the specific conditions (except dementia), the Black Caribbean, Black African and Black Other groups had more cases than expected, but the pattern for the Asian groups varied by condition.

These findings indicate that there were ethnic inequalities in the risk of getting COVID-19 among people with similar pre-existing health conditions. However, there may be differences between ethnic groups in how pre-existing health conditions are identified and recorded, and in the severity of these conditions which may be influencing these results.

# Age-standardised mortality ratios by ethnic group

Age-standardised mortality ratios were produced in a similar way to the age-standardised diagnosis ratios described above. The summary finding is, among people with any condition (except dementia), after accounting for age, the number of COVID-19 deaths in the broad Black, Asian, Mixed and Other ethnic groups was higher than expected, based on the COVID-19 death rate for all people with the same conditions (see Figure 5).

When detailed Black and Asian groups were examined, among people with any condition on the long list, all had more COVID-19 deaths than expected. Unlike the results for cases, the Chinese group also had a higher number of deaths than expected (see Figure 6).

The Black group had the highest age-standardised mortality ratios. Among people with cardiovascular disease (CVD), hypertension and chronic kidney disease (CKD), after accounting for age, those belonging to the Black group had double the COVID-19 deaths expected and those belonging to the Asian group had 1.5 times the number of deaths expected. The Black Caribbean, Black African and Black Other groups had a similarly high number of deaths. Among the Asian groups, age-standardised mortality ratios were highest in the Bangladeshi and Other Asian groups.

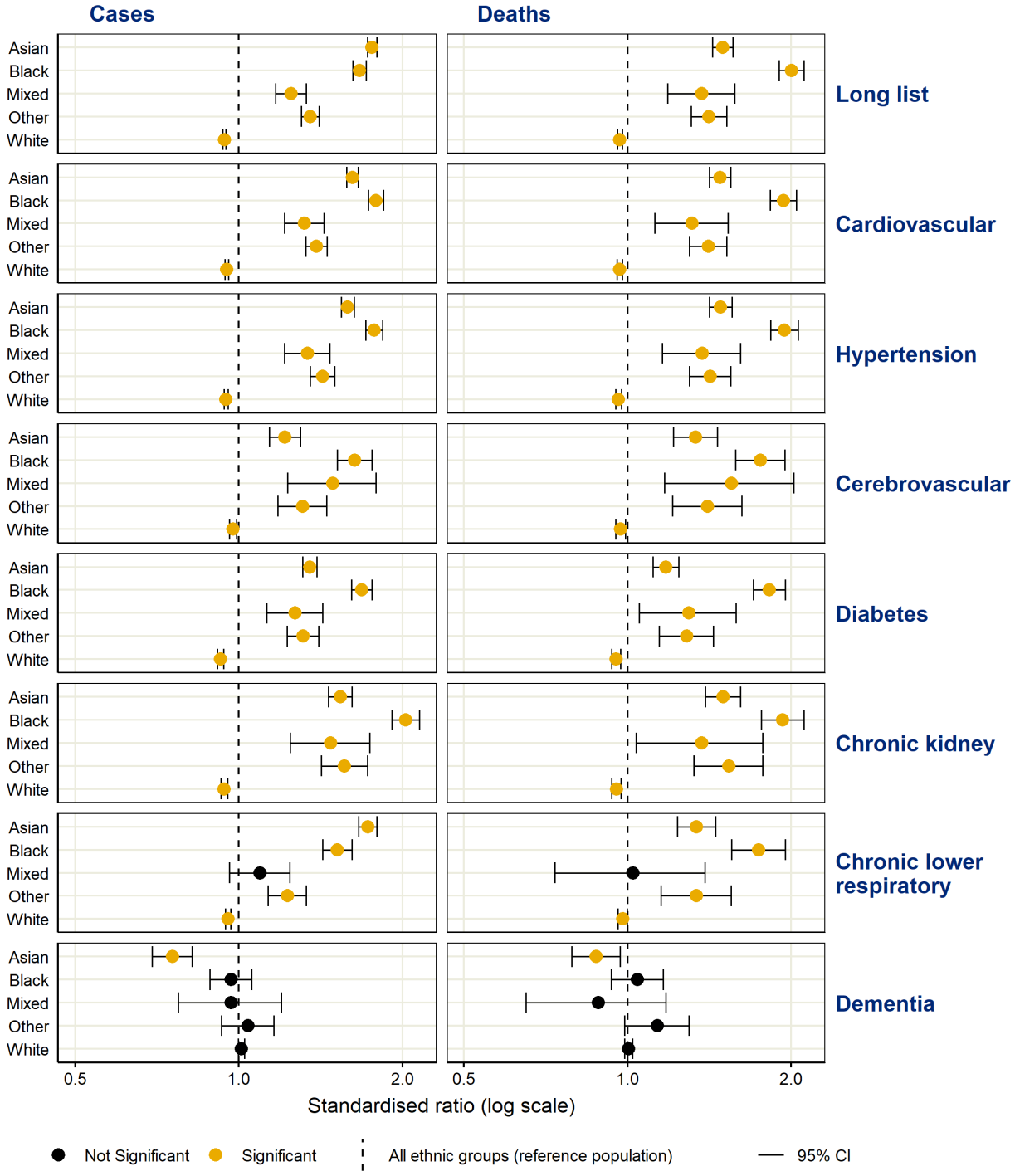
Among people with diabetes, cerebrovascular disease and respiratory disease, those belonging to the Black group had 1.7 to 1.8 times the COVID-19 deaths expected and those belonging to the Asian group had 1.2 to 1.3 times the number expected. Within the Black groups, the Other Black group had the highest mortality ratios among people with these conditions. With the exception of respiratory disease, within the Asian groups the Bangladeshi, Chinese and Other Asian groups had the highest mortality ratios.

Among people with all specific conditions (except dementia), people in the White ethnic group, had a lower number of COVID-19 deaths than expected. Among people with dementia, the Asian group, specifically the Pakistani and Indian groups, had a lower number of COVID-19 deaths than expected, and the Chinese group had a higher number than expected.

These results indicate that, as with COVID-19 cases, inequalities in COVID-19 deaths by ethnic group exist even among people with similar pre-existing conditions. However, this finding is also subject to the same caveats as those described above. There may be differences between ethnic groups in how pre-existing health conditions are identified and recorded, and in the severity of these conditions which may be influencing these results.

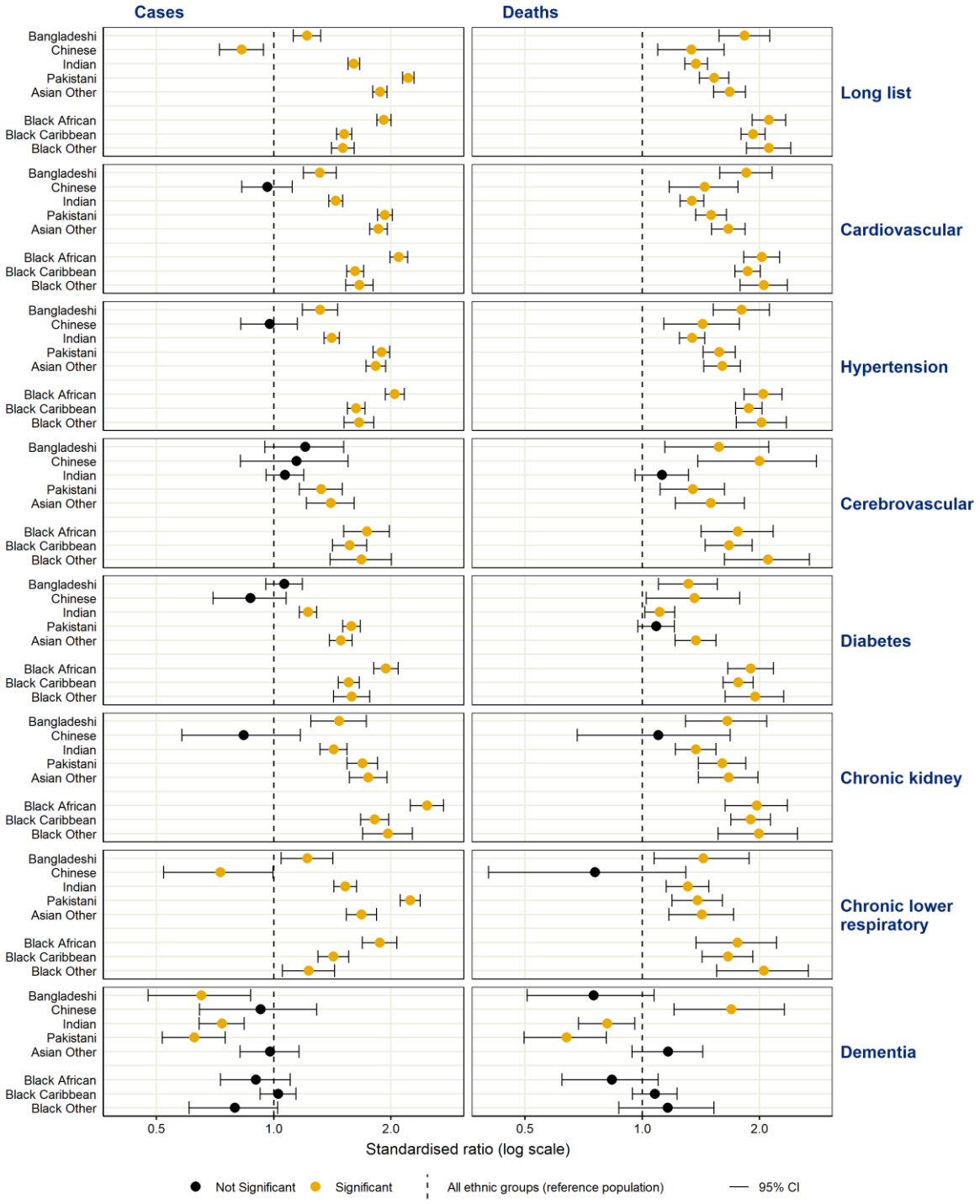
Higher COVID-19 deaths than expected in Black, Asian, Mixed and Other ethnic groups were seen in both sexes, but these inequalities were not seen in deaths from other causes or in earlier years. These results are presented in the accompanying data tables. However, comparisons with earlier years may be affected by changes in the quality of ethnicity coding over time, or migration patterns among ethnic minority groups.

**Figure 5. Standardised COVID-19 diagnosis ratios and mortality ratios for deaths* mentioning COVID-19 by ethnic group among people with pre-existing conditions, England**




*Includes cases up to 16 August 2020 and deaths occurring between 21 March and 17 July 2020
** Long list = relevant conditions selected based on a rapid review of the evidence on health conditions that are associated with poorer COVID-19 outcomes, conditions associated with poorer outcomes of other respiratory infections (such as flu) and expert clinical assessment.
Source: PHE Second Generation Surveillance System, ONS death registrations and Hospital Episode Statistics

**Figure 6. Standardised COVID-19 diagnosis ratios and mortality ratios for deaths* mentioning COVID-19 by detailed Black and Asian groups among people with pre-existing conditions, England**




*Includes cases up to 16 August 2020 and deaths occurring between 21 March and 17 July 2020
** Long list = relevant conditions selected based on a rapid review of the evidence on health conditions that are associated with poorer COVID-19 outcomes, conditions associated with poorer outcomes of other respiratory infections (such as flu) and expert clinical assessment.
Source: PHE Second Generation Surveillance System, ONS death registrations and Hospital Episode Statistics

# Survival following a positive test for COVID-19

Death rates in the population are determined by the combined effects of diagnosis rates (risk of getting COVID-19) and survival (or risk of dying once diagnosed). To examine the risk of dying from the disease, once diagnosed, logistic regression models were fitted to the data on laboratory confirmed cases.

The results of the logistic regression models are presented as odds ratios, where each ethnic group's odds of death are compared with those for the White group. An odds ratio of 1 means the odds are the same – numbers greater than 1 indicate increased risk of death (lower survival rates).

The time scale for the pandemic limited the length of follow-up time for the analysis at the time of carrying out the analysis. Cases were defined as having died if their date of death was within 28 days of the specimen date for their first positive test and COVID-19 was mentioned on the death certificate. Otherwise they were defined, for the purposes of the analysis, as having survived. The effect of the 28 day cut-off was tested by running the models on subsets of the data with different cut-offs, including 60 days, to check that the results were consistent.

Specimen dates were restricted to those taken between 20 March 2020, when a reliable data feed for mortality data became available, and 13 July 2020, to allow for a 28 day follow up. The final analysis dataset consisted of 221,276 cases and 33,493 deaths.

Full details of the methodology and alternative approaches considered are in the technical document.

A baseline model, controlling for age group, sex, deprivation quintile, testing pillar, region and time (since 20 March) showed variations in odds of death by ethnic group:

- people in the Asian ethnic group had odds of death following a positive test 1.23 times those for the White group (95% confidence interval 1.15 to 1.30)
- people in the Black ethnic group had odds of death following a positive test 1.13 times those for the White group (95% CI 1.05 to 1.22)
- there were no significant differences between the White group and the Mixed or Other ethnic groups

In order to examine the extent to which these differences in survival by ethnic group can be explained by different levels of pre-existing health conditions, the presence of different conditions (CVD, diabetes, CKD, chronic lower respiratory disease and dementia – hypertension and cerebrovascular disease were not included as they were too closely related to CVD) were added to the model. Pre-existing health conditions

were each included separately in preference to including the single long list variable. Each was added as a binary variable where a person either had a pre-existing condition or didn't. After controlling for these conditions, as well as the sociodemographic variables already included, the inequalities in odds of death between the ethnic groups remained almost unchanged:

- people in the Asian ethnic group had odds of death following a positive test of 1.21 times those for the White group (95% confidence interval 1.14 to 1.28)
- the Black group had odds of death following a positive test 1.12 times those for the White group (95% CI 1.04 to 1.21)

When the same model (with pre-existing health conditions) was fitted to a subset of the data with a 60 day cut-off for death, the same general pattern was seen, but the effect sizes, while still statistically significant, were reduced:

- people in the Asian ethnic group had odds of death following a positive test of 1.14 times those for the White group (95% confidence interval 1.08 to 1.22)
- the Black group had odds of death following a positive test 1.09 times those for the White group (95% CI 1.01 to 1.18)

When models were fitted based on 10 day cut-offs for death, the effect sizes were increased, compared with the 28 day cut-off. This indicates that people in the Asian and Black groups experienced lower overall survival rates than the White group but, in particular, had higher risks of dying sooner after the first positive sample date. This could be a reflection of more severe disease, lack of intervention, or later testing after infection.

When all other factors in the model were accounted for, the effect of ethnic group on survival was not consistent across all ages:

- in the Asian group, the odds of death following a positive test were higher than for the White group in the 5 to 34, 55 to 64 and 75 to 84 and 85+ age groups, but in people aged 45 to 54 they were lower (odds ratio of 0.76)
- in the Black group, the odds of death following a positive test were higher than for White people only in the 5 to 34 age group – in other age groups there were no significant differences

When the broad Asian and Black ethnic groups were broken down into subgroups, clear differences in survival were seen within each group:

- the highest risk of death was in the Bangladeshi group (odds ratio 1.88), followed by Chinese (1.45), Pakistani (1.35) and Black Other (1.43)
- the Indian group also had higher odds of death following a positive test than the White group (1.16)

The analysis will need to be repeated with a longer follow-up time for death, before being able to draw firm conclusions about the poor survival in ethnic minority groups amongst positive cases.

Although it was not the main aim of the study the baseline model also showed strong relationships between odds of death and other socio-demographic variables, reinforcing findings in other studies: age was the strongest determinant of survival, men had around 1.75 times the odds of death compared with women, and as deprivation (measured by IMD quintile) increased, odds of death also increased.

In people with a dementia diagnosis recorded, the odds of death following a positive test were 1.29 times those for people without dementia. For CVD and CKD, the increase in odds was 1.21 times, for diabetes 1.15, and for respiratory disease 1.14. Comparisons between conditions should be interpreted with some caution as some are more likely to result in hospital admissions and therefore be included in this analysis than others, for example diabetes is usually managed in primary care.

Tables of results, including details of the effects of age group, sex, deprivation quintile, pre-existing conditions and time (since 20 March), are provided in the accompanying data pack.

# Consistency with findings from other studies

A structured literature review was undertaken to test these findings against other published literature. The details of the review can be found in the technical document. Generally, the findings in this report are consistent with other studies that have considered ethnic disparities in COVID-19 and the role of pre-existing health conditions.

When compared with this analysis, the range of studies identified considered different time frames: most focussed on the earlier part of the pandemic and/or sample groups including primary care, hospital settings and those included in UK Biobank. This comparison focusses on the findings for Black and Asian groups only as there was less consistency in how other ethnic groups were treated in the studies compared.

- 1 study (8) reported higher testing rates for Black and Asian groups, but did report lower testing rates for some detailed ethnic groups particularly Bangladeshi, Pakistani and Chinese
- 4 studies (14-17) reported higher positivity rates in tests carried out
- 4 studies (8, 17-19) reported higher infection or diagnosis rates
- 4 studies (8, 10, 19, 20) reported higher hospitalisation or rates of admission to intensive care

- 2 studies (21, 22) reported poorer survival rates following hospital admission along with another study that looked at South Asians only (23)
- 5 studies (1, 8-10, 24) reported higher mortality (death rates) along with another study that looked at South Asians only (23)
- 15 studies (1, 8-10, 14-24) reported that pre-existing conditions did not fully explain these disparities. However, some did suggest that higher prevalence rates of diabetes may have been a factor, particularly in the Asian groups.

The analysis of survival presented in this report updates previous analysis undertaken by PHE, extending the time frame for analysis and including pre-existing health conditions in the model. The findings are consistent with those presented in the previous report (2).

The recent ONS report looked at population-based death rates, adjusting for several factors including pre-existing health conditions, and found that ethnic inequalities remained (1). Therefore, their conclusion about the role of pre-existing conditions in ethnic inequalities in COVID-19 is consistent with this analysis.

The ethnic inequalities in the population-based death rates presented by ONS were greater than the inequalities in survival presented in this report. This is likely to be because, as explained earlier, population-based death rates are determined by diagnosis rates (risk of getting COVID-19) as well as by survival (or risk of dying once diagnosed). The ONS population-based death rates measure two components whereas survival analysis just looks at one as all those included already had COVID-19.

In the ONS population-based analysis, death rates were highest among Black African males (Hazard Ratio[1] (HR) 2.51, 2.23 to 2.83) and females (HR 2.06, 1.75 to 2.42), followed by the Black Caribbean group and then the Asian groups. This general pattern is consistent with the standardised mortality ratios presented here.

This report shows the poorest survival (among those who had COVID-19) in the Bangladeshi, Chinese, Pakistani, Other Black and Indian groups. People belonging to the detailed Black African and Black Caribbean and Other Asian group did not have poor survival. This suggests that the high population-based death rates in the Black African, Black Caribbean and Other Asian groups presented by ONS was largely determined by high diagnosis rates (risk of getting COVID-19). Whereas for all the other Asian groups, both high diagnosis rates and poor survival were contributing to the high death rates seen.

[1] The hazard ratio is a comparison of the probability of death in each ethnic group, with the probability of death in the reference group.

# Interpretation and limitations

The objective of this PHE analysis was to provide further evidence of the role of pre-existing health conditions in ethnic inequalities in diagnosis, death and survival from COVID-19. It did not set out to and does not attempt to fully explain the reasons for ethnic inequalities in COVID-19. Reports by the Scientific Advisory Group for Emergencies (SAGE) (6) and the Race Disparity Unit quarterly report on progress to address COVID-19 health inequalities (7) summarise all evidence to date on reasons for the inequalities reported.

There are various points to consider when interpreting the analysis presented.

The analysis presented covers the first wave of the COVID-19 pandemic in England. The coronavirus restrictions implemented during the first wave and beyond may have reduced the differences between ethnic group and this analysis may be repeated once more data are available.

The number of cases and survival will have been influenced by testing capacity and policy, which has changed throughout the pandemic. During March and April in particular, nearly all testing was under pillar 1[2] and was generally among people with more severe disease. Capacity and uptake of testing may have varied across the country and between ethnic groups, particularly after pillar 2[3] testing was introduced. Increased availability of testing or willingness to seek testing in an ethnic group may therefore result in a higher number of cases. It is possible that this may also result in less severe disease being detected which may inflate survival rates. This will have influenced the results presented in this report.

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. Some deaths in people with COVID-19 may not have had it recorded on the death certificate, particularly if they were not tested and diagnosed. These deaths were therefore assigned to deaths from other causes.

Presence of a pre-existing health condition was defined by a hospital admission in the previous five years, mentioning one of the clinical conditions of interest, among one of the recorded diagnoses fields in the clinical admission record. People who had not been diagnosed, admitted to hospital (for example, only seen in primary care), or had not had

[2] Pillar 1 - PCR (Swab) testing in PHE labs and NHS hospitals for those with a clinical need, and health and care workers
[3] Pillar 2 - PCR (Swab) testing in commercial laboratories for the wider population

the diagnosis recorded in their admission record, were counted as not having the condition in the analysis. Therefore, any remaining inequalities between ethnic groups could be partially a result of other health conditions that have not been accounted for.

Access to healthcare for pre-existing conditions and the severity of conditions on admission may vary by ethnic group. This has not been accounted for in the analysis. They may also be systematic biases in the way that conditions are identified and recorded which may also influence these findings. In addition, those whose records could not be linked were excluded from the analysis.

Ethnicity was obtained through linkage to hospital activity data and determined by the most recent ethnicity stated. There are several limitations with this approach. Ethnicity is supposed to be self-reported by the patient in hospital records, but this may not always be the case. Patients may also report different ethnicities in different episodes of care. People from certain ethnic backgrounds may be less likely to have complete records with which to complete the linkage to hospital data. Previous analysis has shown higher population-based diagnoses and death rates in the Other ethnic group due to a mismatch between ethnicity assigned in the population data and hospital records (2). As population data were not used in this analysis this issue does not affect the results shown. However, further work is still ongoing to improve the allocation of ethnicity to COVID-19 diagnoses and deaths.

The standardised ratios presented are specific to each health condition. They are designed to compare each ethnic group with an expected figure based on all ethnic groups with the same health condition. Because each set of analyses uses a different reference group (all ethnic groups with that health condition) the ratios don't show which condition presents the greatest risk of COVID-19 diagnosis or death (every condition is scaled to 1.0).

In this analysis we have not be able to adjust for all factors that may affect the relationship between ethnicity and risk of diagnosis or death from COVID-19. For example, we have not adjusted for occupation or migration which may impact on many factors such as ability to adhere to social distancing measures and self-isolation guidelines. In addition, although deprivation is included in the survival model, the indicator used may not fully reflect deprivation experienced by all ethnic groups.

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