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Original research

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Abstract

Background/Aims As well as age and presence of comorbidities, research has suggested that socioeconomic factors, such as income and ethnicity, may affect an individual's risk of severe COVID-19. This study looked at the geographic variations in rates of hospitalisation and death from COVID-19, exploring whether socioeconomic factors were linked to these variations.

Methods A cross-sectional retrospective quantitative study was conducted using data regarding the number of cases of COVID-19 cases during the first wave of the pandemic in England (March–July 2020). A total of 242,624 confirmed cases of COVID-19 from across England were anlysed. The extent to which predisposing factors, such as population density, age and comorbities, affected morbidity and mortality rates in the different regions was calculated. The impact of socioeconomic factors, such as employment status and ethnicity, were also analysed.

Results There was a significant association between long unemployment and likelihood of death from COVID-19. Areas with higher proportions of individuals from Black, Asian and ethnic minority backgrounds were also more likely to have higher rates of hospitalisations and deaths from COVID-19. Overall, London was the region with the highest standardised rates of hospitalisation (67.73%) and mortality (20%).

Conclusions Socioeconomic factors have contributed to the geographic variations in COVID-19 mortality across different areas of England. This implies that these factors should be taken into account when planning healthcare and public health strategies.

Key words

COVID-19, Geographic variations, Hospitalisation, Mortality, Unwarranted variations

Introduction

Geographic disparities in the delivery of healthcare services during the COVID-19 pandemic have been a critical issue throughout this period. Research has suggested that these geographic variations are not only a result of variations in clinical characteristics (such as existing comorbidities) or geographical features (such as population density), but also of other factors, such as socioeconomic characteristics. For example, Khunti et al (2020) found that poor housing, low income and overcrowding increased morbidity and mortality from COVID-19. The resulting pressures on services in areas with these characteristics negatively affects healthcare delivery, leading to increased costs and even higher mortality rates (Wennberg, 2014; Hillary et al, 2016).

This study explored the geographic variations in rates of COVID-19 hospitalisation and mortality in England, both in terms of expected predisposing factors, such as age, and socioeconomic factors, such as income and ethnicity.

Methods

An explorative retrospective study was conducted, using data from the first 4 months following the declaration of the pandemic in the UK (17 March–18 July 2020). This period was chosen because the pandemic had a significant impact on socioeconomic factors such as unemployment, so data were collected from the early stages of the pandemic to minimise this impact.

Data on a total of 242,624 patients with confirmed COVID-19 were collected. Data were taken from stratified datasets from each NHS region, found on the UK Government (2020) website, and used to calculate rates of hospitalisation and mortality from COVID-19. The following categories of data were collected:

- The number of laboratory-confirmed cases of COVID-19 in different NHS regions
- The number of hospitalisations for COVID-19 in different NHS regions, including those who tested positive before arriving at hospital and those who contracted the virus while in hospital
- The number of patients who required mechanical ventilation as a result of COVID-19 (categorised as critically ill patients) in different NHS regions
- The number of patients admitted to hospital for COVID-19 per day in different NHS regions
- The number of deaths from COVID-19 in different NHS regions, defined as death in patients with a laboratory-confirmed diagnosis of COVID-19.

Variations in morbidity and mortality

In the present study, population density, population age and existing comorbidities were examined as non-socioeconomic factors that were expected to impact the rates of hospitalisation and death from COVID-19 in each geographical area. The population density of each NHS region and upper-tier local authority were collected using the Local Health (2020) database to measure the impact of this factor on variations in hospitalisation and mortality from the virus. It is also known that elderly people are at higher risk of developing severe COVID-19, requiring hospitalisation and dying from the virus (Jordan, 2020). Therefore, the number of people aged 65 years and over and the number of people aged 85 years and older in each area were calculated.

Research has shown that patients with existing comorbidities are at a higher risk of developing severe complications from COVID-19 that require hospital treatment and increase the risk of death (Jordan, 2020; Yang et al, 2020). To represent the rate of existing comorbidities in each area, a standardized admission ratio was calculated for patients with chronic obstructive pulmonary disease, myocardial infarction, stroke, coronary heart disease, cancer and long-term illness of disability. These

data were all collected from the Local Health (2020) database. However, it should be noted that socioeconomic factors can play a role in the incidence of comorbidities (Mair and Jani, 2020).

Meanwhile, three socioeconomic factors and their relation to COVID-19 hospitalisation and mortality rates were also analysed for each area: unemployment, long unemployment and ethnicity. Unemployment was defined as the percentage of the working-age population (16–64 years old) who were claiming out-of-work benefits (e.g. governmental support allowance and Universal Credit) while long unemployment was defined as the average number of monthly claimants of jobseeker's allowance who have been claiming for more than 12 months (expressed as a rate per 1000 of the working-age population).

Research has shown that patients with COVID-19 are more likely to have poor outcomes if they are of a Black, Asian or minority ethnic (BAME) background (Pareek et al, 2020). This is particularly the case in areas with poor housing, low incomes and overcrowding (Khunti et al, 2020). Therefore, data from the Office for National Statistics (2011) were used to analyse the ethnic backgrounds of the populations of the different areas to determine if areas with a higher proportion of BAME individuals has higher rates of hospitalisation and death from COVID-19.

Statistical analysis

Data were aggregated and analysed using Microsoft Excel and the Statistical Package for the Social Sciences (version 23). Descriptive statistics were used to describe the demographics and other characteristics of patients. Categorical variables were expressed as frequencies (percentages) and continuous variables as averages with standard deviations. After adjusting crude hospitalisation and mortality rates for sex and age across all NHS regions, standardised mortality rates and hospitalisation rates were calculated, with the cases of COVID-19 in England used as the standard population. Correlations and multiple regressions were applied to identify relationships between predisposing factors and standardised mortality rates and/or standardised hospitalisation rates. F-test was used for multiple regression analysis with a *P* value of less than 0.001 taken to be statistically significant.

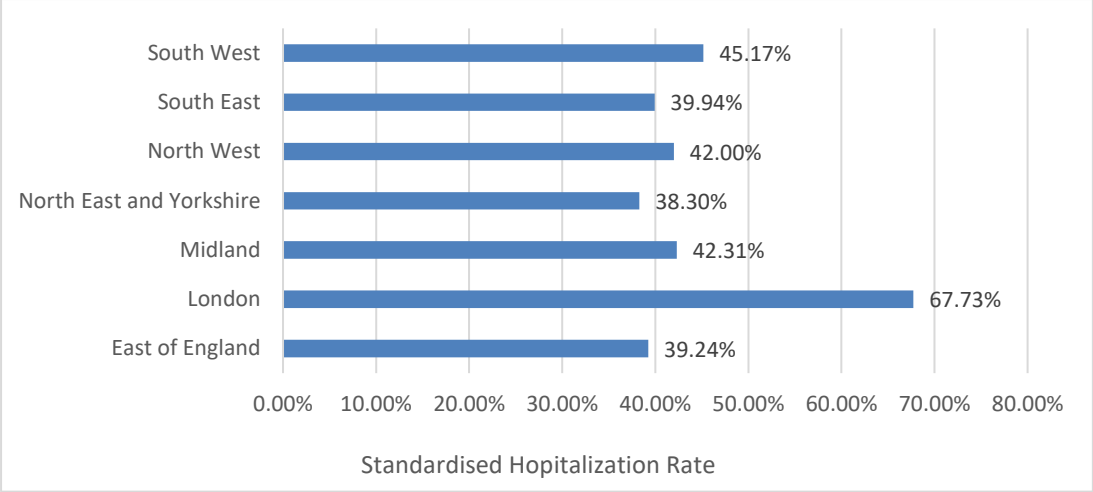
Results

Overall morbidity and mortality

Of the 242,624 patients identified as having COVID-19 from 17 March to 18 July 2020, just over half (*n*=137,612, 56.72%) were female and 88,481 (36.47%) were elderly (65 years or older).

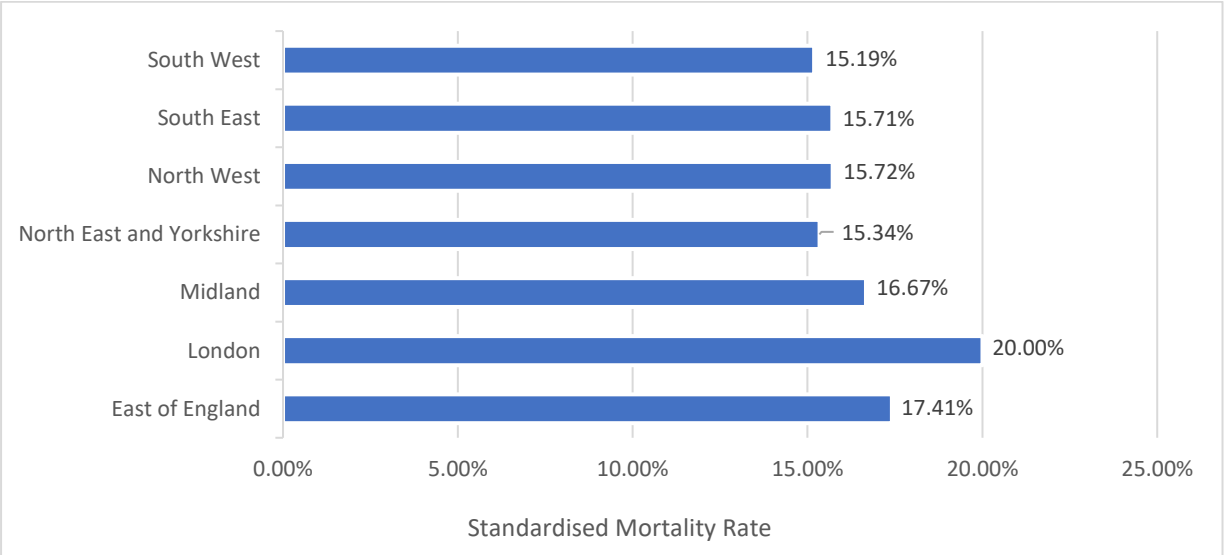
A total of 107,765 patients in the sample (44.42%) were admitted to hospital with COVID-19, of which two-thirds (*n*=71,205, 66.07%) were aged 65 years or older and over a fifth (*n*=24,647, 22.87%) were aged over 85 years. London was found to have the highest standardised hospitalisation rate of 67.73%, with all other regions having rates of less than 46% (Figure 1). London also had the highest number of patients requiring mechanical ventilation. However, this was not necessarily a direct result of higher disease severity in London, as it could be at least partly caused by people from other regions passing through London, as well as international arrivals of infected persons in London at the beginning of the pandemic.

Figure 1. Standardised hospitalisation rates in different NHS regions (% per total number of patients with COVID-19) from 17 March to 18 July 2020.



A total of 40,233 patients in the sample died during the study period, giving a crude mortality rate of 16.58%. Over half (*n*=22,797, 56.66%) of those who died were men and 89.56% (*n*=63,032) were aged over 65 years. The age group with the next highest mortality rate was 45–64 years, who made up 9.27% (*n*=3731) of the deaths in the sample, while only 1.17% of those who died were aged 44 years or younger. After adjusting the crude rate for age and sex, and computing the standardised mortality rates, London was found to have the highest standardised mortality rate of 20% (Figure 2).

Figure 2. Standardised mortality rates in different NHS regions (% per total number of patients with COVID-19) from 17 March to 18 July 2020.



Clinical and geographical factors

Population density and age

Higher population density was associated with increased spread of COVID-19 (*P*<0.001, R square=0.76) and increased number of deaths (*P*<0.001, R square=0.82). A significant correlation was also found between the number of people aged 65 years and the number of deaths from COVID-19 (*P*<0.001, R square=0.69). However, the correlation between the proportion of people aged 85 years or over and the number of deaths from COVID-19 was not statistically significant.

Existing comorbidities

The population health status varied widely across the NHS regions, with the north east, north west and Yorkshire regions having the highest rate of emergency admissions for cardiovascular disease. For example, in the north west, 60% of upper-tier local authorities had a standardized admissions ratio of over 120 for myocardial infarction, compared to only 10% of upper-tier local authorities in London, the east of England, the south east and the south west. Similarly, rates of coronary heart disease, stroke, chronic obstructive pulmonary disease and cancer were found to be considerably higher in the north west, north east and Yorkshire regions than the southern regions. However, despite these regional variations, the distribution of deaths from COVID-19 did not follow any of these patterns, with no correlation found between COVID-19 mortality rates and comorbidity rates.

Socioeconomic factors

The unemployment rate ranged from 0.6% to 6.3% of total working-age population in each region, with the north east and Yorkshire experiencing the highest rates of unemployment, followed by the midlands and north west regions. The long-term unemployment rate ranged from 0.7% to 13.5% of the total working-age population, once again with the highest rates in the north east and Yorkshire regions, followed by the Midlands. The number of deaths from COVID-19 was found to be positively correlated with both unemployment and long-term unemployment in the north east and Yorkshire, although this association was only significant for long-term unemployment ($P< 0.05$, R square=0.97).

The distribution of people from a BAME ethnic background ranged from 2.4% to 83.3% of the different upper-tier local authority areas, with the highest proportion living in London, followed by the midlands and the south east. In all other regions, over 50% of the population were white. In the London upper-tier local authorities, deaths from COVID-19 were positively correlated with the proportion of BAME individuals in the area ($P<0.001$, R square=0.92).

Discussion

The calculated standardised hospitalisation rates varied across the different NHS regions. London had the highest standardised hospitalisation rate at 67.73%, with all other regions having rates of less than 46%. However, higher hospitalisation rates do not necessarily reflect higher clinical severity of COVID-19 among the area's population. The number of hospital admissions for COVID-19 sometimes exceeded the number of cases in an area, as patients could be transferred to hospitals outside of their locality when needed (NHS Critical Care Network, 2020). London hospitals admitted the highest number of patients in this period, often taking those from other regions, reaching a total of approximately 5000 admissions for COVID-19, which was considerably more than that of hospitals across all other regions. Further investigation with data regarding the home addresses of hospital inpatients would be needed for conclusive results regarding the geographic variations in COVID-19 hospitalisation. Notably, the east of England admitted far fewer patients (1500) for COVID-19 than London, but had a slightly higher rate of patients requiring mechanical ventilator use (23% vs 20%). This rather unexpected observation requires further intra-region investigation.

Non-socioeconomic factors

As COVID-19 is spread through close contact, it is unsurprising that high population density was linked with higher case numbers. In the present study, areas with a population size of over 1 million people, such as Essex, Hampshire and Kent, had a higher number of cases and deaths from COVID-19 than areas with lower population densities.

Among the 242,624 patients with confirmed COVID-19 identified in the study period, there was a crude hospitalisation rate of 44.42%, of which two-thirds were aged over 65 years and over one-

fifth were aged over 85 years. It should be noted that, at this time, laboratory testing for COVID-19 was less widely available, so many people with milder symptoms would not have been included in the study population, which may explain why the hospitalisation rate was so high. Of those who died from COVID-19 in this period, nearly 90% were aged over 65 years. This aligns with other research across various countries showing that hospitalisation and death from COVID-19 is significantly more likely in older people (Chen et al, 2020; Onder et al, 2020; Palaiodimos et al, 2020; Wu and McGoogan, 2020).

However, the present study did not find any significant associations between identified comorbidities and rates of hospitalisation and death from COVID-19. This was somewhat surprising; not all studies have found a significant correlation between some comorbidities and COVID-19 morbidity or mortality (Charpiot et al, 2021), the majority of research has shown that comorbidities such as cardiovascular diseases, pulmonary diseases and cancer have all been identified as independent risk factors for severe COVID-19 (Baradaran et al, 2020; Wang et al, 2020). It should be noted that the present study used standardized emergency admission rates for the identified comorbidities, as it was expected that this would identify people with comorbidities that were poorly controlled and had a considerable impact on their health. It is possible that using general prevalence measures that included both well-controlled and poorly-controlled cases of each comorbid condition would lead to different outcomes.

Socioeconomic factors

It has been argued that socioeconomic factors, particularly wealth and ethnicity, have resulted in some groups being more affected by COVID-19 than others. For example, in a study conducted in the United States of America, it was shown that people of non-Hispanic Black ethnicity, those with low incomes and those with a high school level of education or less were more vulnerable to infection, severe illness and death from COVID-19 (Wiemers et al, 2020). In England, the mortality rate from COVID-19 was found to be 2–4 times higher among people from BAME backgrounds than among white people (Morales and Ali, 2021). The present study supported these findings, showing a significant correlation between deaths from COVID-19 and proportion of people from BAME backgrounds in high-tier local authority areas of London. This suggests that factors relating to race and ethnicity can impact an individual's likelihood of severe complications and death from COVID-19.

A significant association was also found between long-term unemployment and death from COVID-19, suggesting that socioeconomic status can impact vulnerability to the virus. This finding is in keeping with previous studies that have indicated that patients with lower socioeconomic status have a poorer prognosis if they contract COVID-19, even when clinical and genetic factors are accounted for. Poor housing, low income, social deprivation, differences in occupational risk and overcrowding in communities have all been shown to contribute to poorer COVID-19 outcomes (Khunti et al, 2020; Pareek et al, 2020; Public Health England, 2020).

The combination of factors related to wealth and ethnicity was shown to compound the negative impact of COVID-19. Franz et al (2022) found that residential segregation and systemic racism are associated with negative outcomes in the United States of America, with Black Americans being 2.14 times more likely to die from COVID-19 than white Americans. Overall, people from BAME backgrounds are between two and three times more likely to live in persistent poverty than their white counterparts (Social Metrics Commission, 2020) and are more exposed to overcrowded households, intergenerational living and higher-risk jobs in the UK (Cheshmehzangi, 2022). This also contributes to lower vaccine uptake among people from BAME backgrounds and those with lower income, increasing their risk (Nguyen et al, 2022).

The present study adds further evidence to these trends, implying that non-clinical factors can play a significant role in determining variations in COVID-19 mortality across different geographical

locations. This suggests that such socioeconomic factors should be taken into account by policymakers when planning interventions for communicable diseases such as COVID-19.

Limitations

This research has some limitations. First, the data analysed were only related to England, so these results may not be generalisable to other countries in the UK or elsewhere. Second, the study also assumed that testing capacity was homogenous across each region in England, which may not have been the case. Lower levels of testing in some areas may have skewed the results with artificially lower numbers of COVID-19 cases. Third, the study explored socioeconomic factors quantitatively, looking at figures such as income level and time spent unemployed, without exploring more qualitative cultural factors.

It should also be remembered that this study took place during the first wave of the pandemic in England, when testing capacity was relatively low. Furthermore, since this time there have been several other variants of COVID-19 with their own features, so it is possible that, if data from later in the pandemic were analysed, the results may be different.

Conclusions

This study demonstrated the impact of certain socioeconomic factors on vulnerability to COVID-19. Different regions of England were shown to have considerable variations in their population health status, yet these were not significantly associated with rates of hospitalisation or death from COVID-19. Instead, socioeconomic factors, such as unemployment and ethnicity, were shown to be significant pre-disposing factors for severe COVID-19. This suggests that socioeconomic factors may be just as, if not more, important as clinical comorbidities when predicting risk of severe illness and death.

With this in mind, the authors recommend that policies aiming to increase employment opportunities and social empowerment should be prioritised in England. This would not only stimulate economic growth, but could also improve population health, leading to individual benefits and relieving pressure on the healthcare system. The ethnic disparities in COVID-19 outcomes suggest that decision makers should take the ethnic and racial composition of the local area into account when planning healthcare policies and interventions.

While non-clinical factors such as socioeconomic status and ethnicity have not traditionally been at the centre of attention for healthcare managers and policymakers, the results of this research, along with those of other studies, express that these factors played a significant role in the COVID-19 pandemic. More research regarding these variations and possible strategies to mitigate them are needed. Meanwhile, further investigation is required into the role of comorbidities in determining wider aspects of health and vulnerability to communicable diseases.

Key points

- This analysis of the rate of hospitalisations and deaths from COVID-19 in the first wave of the pandemic showed that socioeconomic factors played a significant role.
- Regions with higher levels of long unemployment and higher proportions of individuals from Black, Asian and ethnic minority backgrounds had higher rates of morbidity and mortality.
- There was no significant association between the rate of comorbidities and mortality from COVID-19.
- These results suggest that policy makers should take regional socioeconomic factors such as employment and ethnicity into account when planning healthcare and public health interventions.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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