Office for National Statistics

Article

International comparisons of possible factors affecting excess mortality

Comparisons of pre-existing causal factors that may result in all-cause and cause-specific excess mortality before and during the coronavirus (COVID-19) pandemic.

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1 . Collaboration

This report has been produced jointly between Department of Health and Social Care (DHSC) and the Office for National Statistics (ONS).

2 . Main points

- International comparisons of mortality during the coronavirus (COVID-19) pandemic are complex and need to be interpreted carefully.
- There is consistent international evidence that contributory or pre-existing conditions preceding or contributing to a death, known as comorbidities, are a driver of COVID-19 mortality, and that multiple comorbidities increase the risk of mortality further.
- In particular, cardiovascular diseases, diabetes, chronic obstructive pulmonary disease, dementia and Alzheimer's disease, as well as risk factors of obesity and smoking.
- Internationally, a significant proportion of the total deaths due to COVID-19 have been among elderly populations receiving long-term care (in care homes and other locations); comparison of data between countries is difficult because of differences in recording practices, underlying populations' structures and availability of data.
- Multiple pre-existing factors, such as socio-economic differences, climate and ethnicity as well as differing coronavirus pandemic responses contributed to differences in excess mortality across countries; however, comparing these is complex.
- This exploratory analysis shows the complexity of international comparisons and the need for further work to fully understand the causal factors impacting excess mortality across the world.

3 . Overview of causal factors impacting excess mortality

Throughout the coronavirus (COVID-19) pandemic, the Office for National Statistics (ONS) has produced international comparisons of all-cause mortality to investigate relative excess mortality.

The best way of comparing the impact of the coronavirus pandemic on mortality internationally is by looking at all-cause mortality compared with the five-year average. All-cause mortality avoids the problem of different countries recording COVID-19 deaths in different ways and takes into account the indirect impact of the coronavirus pandemic, such as deaths due to other causes that might be related to delayed access to healthcare, or changes to behaviours during the coronavirus pandemic.

The ONS has sourced European mortality and population data from databases published by Eurostat. There are strict criteria that data must meet to be included, so analysing data from this source provides an opportunity to be as comparable as possible.

The purpose of this review is to explore select pre-existing factors that have driven excess mortality during the coronavirus pandemic. This article considers sources beyond all-cause mortality and additional countries beyond those featured in ONS statistics to show the complexity of international comparisons. We welcome feedback and suggestions for future analysis through health.data@ons.gov.uk or statistics@dhsc.gov.uk.

4 . Factors that contributed to excess mortality during the coronavirus pandemic

International evidence indicates that excess all-cause mortality during the coronavirus (COVID-19) pandemic was driven by a wide range of factors, including the nature of the pandemic response and pre-existing characteristics such as population and socioeconomic factors.

Evidence suggests that advanced age is consistently the greatest predictor of higher COVID-19 mortality (SAGE, 2020) (OECD, 2021). However, other variables have been cited as contributory factors, such as:

- existing health infrastructure (Bayraktar, 2021) (Chang, 2022)
- increased susceptibility to infection from COVID-19
- differences in the health vulnerability of populations, including presence of comorbidities (Treskova-Schwarzbach, 2021)
- settings (in particular, for those in long-term care)
- levels of deprivation and inequality
- population density
- sex
- ethnicity
- climate
- occupation

The nature of the pandemic response across countries also contributed to differences in COVID-19 mortality:

- types and timings of health protection measures
- resourcing and mobilisation of healthcare workforce
- use of technology and data
- vaccination for example, speed, coverage, type
- treatment type
- disruption to health systems and other unmet care needs
- societal behavioural responses, for example, conformance with guidance

Comparison across these factors is complex and difficult to disentangle, as many aspects of national-level coronavirus pandemic responses were closely influenced by prevalence of COVID-19 and by pre-existing circumstances such as existing health infrastructure and resources.

This article focuses on pre-existing factors where primary data are available on COVID-19 or excess mortality rates, in particular:

- prevalence of comorbidities or pre-existing conditions in COVID-19 deaths
- differences for older people in long-term care
- a discussion of factors contributing to excess mortality identified in research literature but with limited data or comparability

5 . Comparison of characteristics internationally

Comorbidities

Frequently referred to as "contributory", or "pre-existing"" conditions, a comorbidity is any condition that either preceded the disease of interest (for example, coronavirus (COVID-19)) in the sequence of events leading to death, or was a contributory factor in the death but was not part of the causal sequence.

While age remains the largest risk factor for COVID-19 mortality (OECD, 2021) (Dessie, 2021) (ONS, 2022), international evidence suggests that people of all ages with a range of underlying health conditions face an elevated risk of hospitalisation or death; in particular, cardiovascular and some respiratory conditions as well as dementia and risk factors such as obesity and smoking (Sanchez-Ramirez, 2020) (Katz, 2020) (Dessie, 2021). Evidence in this section is based on COVID-19 mortality data where COVID-19 was identified as the underlying cause of death and where comorbidities were identified.

An international systematic review of 32 studies found that hospital patients with any comorbidity were two times more likely to die due to COVID-19. Multiple comorbidities also increase the risk of COVID-19 mortality (Kompaniyets, 2021) (Bucholc, 2022).

It is important to note that the average number of comorbidities increases substantially with age. As age is also the largest risk factor for COVID-19 mortality, it is difficult to disentangle the impacts of each factor.

Evidence syntheses have identified conditions associated with an increased risk of COVID-19 mortality. An umbrella review of 160 primary studies involving countries, from Europe, North America and the Western Pacific, and covering 42 pre-existing conditions, found that hazard ratios for COVID-19 mortality were highest for diabetes, obesity, heart failure, chronic obstructive pulmonary disease (COPD) and dementia across multiple nations. Data from Europe and North America also showed that liver cirrhosis and active cancer were associated with increased risk of death due to COVID-19.

Studies have also found mixed or negative relationships between COVID-19 mortality and particular conditions. For example, a systematic review of variation in COVID-19 case fatality rates (CFR) found a negative relationship between lower respiratory infections and COVID-19 mortality, as did a systematic review of the relationship between asthma and COVID-19 mortality. These studies suggest that characteristics of the condition, treatments and COVID-protection measures (such as shielding) may have acted as protective factors.

Available national statistical data and cohort studies across multiple countries show that a substantial percentage of COVID-19 deaths were in individuals with comorbidities. In some cases, up to 97% of national COVID-19 deaths recorded multiple conditions at death (PDF, 558KB). Also, 85.8% of deaths due to COVID-19 in England and Wales in 2021 recorded at least one pre-existing condition. By comparison, data from England and Wales in 2019 showed that 72.8% of deaths due to Alzheimer's disease reported at least one pre-existing condition on the death certificate and 64.3% of deaths due to ischaemic heart disease in England and 55.9% in Wales, recorded at least one pre-existing condition. More research is needed to determine the relative impact of comorbidities on COVID-19 mortality compared with other conditions.

While evidence strongly indicates that certain pre-existing conditions increase risk of COVID-19 mortality, comparability of data is limited. Data for other countries on the prevalence of comorbidities in COVID-19 deaths are sparse or infrequent and cannot comparatively control for different national peaks in COVID-19 mortality. In some cases, cohorts were very small and included suspected cases of COVID-19. The level of categorisation and coding of comorbidities also differs internationally. In other cases, country-level statistics may only reference the number of conditions listed on death certificates, or may not define whether conditions detected were pre-existing.

Conditions may also be reported differently, for example, dementia and Alzheimer's disease may be reported together (England and Wales) or separately (Spain). Evidence from Africa, South and Latin America, Southeast Asia, and the Eastern Mediterranean region is also scarce and skews findings towards European and North American countries.

For the main comorbidities associated with COVID-19 deaths, comorbidity data alone do not reflect their overall prevalence and impact in the general population. However, it is possible to compare the relative disease burden between countries for these conditions before the coronavirus pandemic using the most recent Global Burden of Disease (GBD) data.

Overall disease burden is measured in Disability Adjusted Life Years (DALYs), the number of years lost because of ill-health, disability, or early death. One DALY is the equivalent of losing one year in good health because of premature death or morbidity. A higher number of DALYs for a country indicates a higher disease burden. Globally, cardiovascular diseases present the highest burden of disease.

Across the same subset of European countries as explored in Office for National Statistics comparisons of all-cause mortality, the highest age standardized disease burden was in Eastern Europe, with England and the UK similar to Greece and Czechia for all causes in 2019 (Figure 1).

For the selected conditions, the UK had a higher rate of DALYS for chronic obstructive pulmonary disease (COPD) per 100,000 population than other conditions observed and higher than the Organisation for Economic Cooperation and Development (OECD) average. The UK had a lower rate for cardiovascular diseases, and Alzheimer's disease and other dementias (Figure 1).

A 2020 study of GBD data exploring population vulnerability to COVID-19 in Europe similarly found countries in Eastern Europe to be at highest risk when comparing the burden of Years Lived in Disability (YLDs) due to all causes. Further research is required to understand the relative impact of pre-existing conditions on COVID-19 mortality.

For different diseases there will be variation in the quality of data and diagnostic criteria between countries, which impacts the comparability of data. For example, COPD tends to be diagnosed by the GOLD (Global Initiative for Chronic Obstructive Lung Disease) criteria, but not all countries featured in these comparisons are represented within GOLD.

The burden of disease from these specific conditions may indicate pressures on mortality before the coronavirus pandemic but does not explain excess mortality or variance in COVID-19 mortality alone. For example, these do not account for factors such as socio-economic differences between countries, which some research suggests may have a greater effect on mortality during the pandemic than certain specific comorbidities.

Figure 1: 2019 burden of disease ranges across European countries

Disability-adjusted life years (DALYs) per 100,000 population by selected causes and risk factors, European countries, 2019

Notes:

1. Disability-adjusted life years (DALYs) are a measure of overall disease burden, expressed as the number of years because of ill health, disability or early death per 100,000 population, standardised by age.

2. Selected causes and risk factors informed by studies include: chronic obstructive pulmonary disease, Alzheimer’s disease and other dementias, cardiovascular diseases, diabetes mellitus, neoplasms (cancers), cirrhosis and other chronic liver diseases, high body mass index and tobacco use.

Download the data

.xlsx

Mortality of older people receiving long-term care (including care home settings)

Most deaths involving COVID-19 have occurred in older populations, with 93% of deaths across Organisation for Economic Co-operation and Development (OECD) countries up to May 2021 occurring among those aged 60 years and over, and close to three-fifths (58%) of all deaths occurring among people aged 80 years and over across deaths figures for 21 OECD countries.

Comparative data up to May 2021 shows COVID-19 mortality among older people was particularly high in Slovenia, Belgium, the UK and United States, with a mortality rate of more than 2.5% in those aged 80 or 85 years and over.

Research suggests the proportion of older people in a population (aged 65 years and over) correlates with higher COVID-19 mortality in that population.

Elderly populations in care homes were identified as vulnerable during the early stages of the coronavirus pandemic because of the age and health status of most residents (Salcher-Konrad, 2020). People aged 80 years and over represent approximately 50% of those receiving care across OECD countries. Deaths due to COVID-19 have been heavily concentrated in this demographic, particularly during the first wave of the coronavirus pandemic. OECD analysis also estimates that COVID-19 deaths among long-term care (LTC) residents mostly occurred in LTC facilities as opposed to hospitals.

Share of deaths of long-term care residents in total COVID-19 deaths

OECD evidence of cumulative COVID-19 deaths in LTC residents (in all locations) up to February 2021 showed the OECD average of deaths in LTC residents of all ages as a share of COVID-19 deaths was 41%, with highest shares of deaths in Australia (75%) and New Zealand (64%). The lowest shares were in Greece (8%), Lithuania (12%) and Latvia (16%). In January 2021, UK rates were below the OECD average at 33% for England and 34% across all UK nations (PDF, 952KB).

There is potential for bias with this measure, that countries with low overall mortality rates were also likely to show a higher share of mortality in LTC residents, as evident in the high proportions seen in Australia, New Zealand and Norway, which are amongst the lowest in overall COVID-19 mortality.

Comparing the proportion of care home residents who have died by country provides a different perspective. COVID-19 mortality as a percentage of the total care home resident population (PDF, 952KB) ranges from 0.04% in New Zealand and Hong Kong to the highest rates in Belgium (9.4%), Slovenia (8.2%), Spain (7.9%), United States (7.2%) and the UK (7.2%) up to January 2021.

When focusing analysis on older LTC recipients, similar rates of long-term care COVID-19 deaths were seen. Population age structures will account for some but not all differences observed.

Data comparisons between countries are very limited because of variances in recording and calculation. Examples of variance include: differences in recording between confirmed or confirmed and suspected COVID-19 deaths (PDF, 952KB), recording of deaths in all LTC residents or only those that died in LTC settings (only UK, France, Sweden, Belgium and Hong Kong separately record both deaths in care home residents and deaths within care homes), statistics based on death certification or based on estimations of excess mortality over a given period, and varied definitions of LTC settings. For example, Germany includes homeless shelters and prisons in their definition.

Furthermore, because of differences in the reporting frequency and availability of data, measures are frequently drawn from different periods in the coronavirus pandemic for different countries and do not consider differences in peak infection rates. Limited data on the individual characteristics of residents were also identified as a barrier to comparison and to response planning for the coronavirus pandemic.

It is also important to note that the mortality rate in LTC facilities has fallen significantly in many countries since the first wave of the coronavirus pandemic. In England, for example, during the first wave of the coronavirus pandemic, 23.2% of deaths among care home residents in all locations were due to COVID-19, but only 3.6% of deaths during the third wave between June 2021 and January 2022. Excess care-home deaths also fell below the five-year average for the second and third waves of the coronavirus pandemic.

Potential drivers

Aside from population age distributions and the heightened health vulnerabilities of those living in LTC facilities, other potential drivers of increased COVID-19 mortality internationally include the level of healthcare investment, staffing levels and accessibility of healthcare services, supply of personal protective equipment (PPE) and testing equipment, delays between case identification and the implementation of interventions in LTC settings, safety failures and decisions made in response to the coronavirus pandemic.

6 . Other characteristics

Deprivation and socio-economic factors

Evidence suggests that socially disadvantaged people have been at higher risk of infection, severe illness and death throughout the coronavirus (COVID-19) pandemic. A study of 91 countries found that income inequality significantly positively correlated with confirmed COVID-19 cases and deaths across the world, and that higher education-levels significantly correlated with lower infection and mortality rates. All-cause and non-COVID mortality is also associated with deprivation.

Evidence suggests that deprivation increases the risk of infection and higher mortality, as those on low incomes are more likely to be physically present at their workplaces, use public transport, and to prioritise daily necessities for living over their health. Those who are more deprived are also more likely to live in overcrowded housing, and therefore less able to isolate, putting them at greater risk of infection (Anderson, 2020).

Studies from other countries found similar trends, with higher numbers of cases and deaths in socioeconomically marginalised communities in countries including the United States, Australia, Portugal, France (PDF, 975KB), Brazil and Mexico, where lack of access to health services was also a suggested factor in deaths involving COVID-19. Because of variations in study design, methodologies, timeframes and measures of deprivation, as well as variance in socio-economic conditions between countries, international comparisons of socio-economic difference are complicated, however, they illustrate the widespread link between dimensions of deprivation and higher COVID-19 mortality around the world.

Although low-income populations within countries are at higher risk of infection and death, less wealthy countries have generally reported a lower case and mortality rates overall. Studies have found a positive relationship between countries' gross domestic product (GDP) per head and the severity of COVID-19 (Chang, 2022) (Feng, 2020). Influencing factors include; higher levels of international trade in developed countries leading to more interactions across borders, and developing countries having younger populations. However, inequalities in data and testing between countries can also lead to underreporting of COVID-19 (Biswas, 2020) (Thenon, 2022).

Ethnicity

Evidence largely from the United States and the UK indicates higher COVID-19 mortality rates for minority ethnic groups (Mackey, 2021) (Drivers of the higher COVID-19 incidence, morbidity and mortality among minority ethnic groups, GOV.UK, 2022). UK data suggest that over the course of the coronavirus pandemic, minority ethnic groups experienced a higher prevalence of COVID-19 infections and higher COVID-19 mortality than White ethnic groups.

Analysis by the Office for National Statistics (ONS) found that in the first wave of the coronavirus pandemic, mortality rates were greatest amongst Black African groups followed by Bangladeshi groups, although this changed over the course of the pandemic. Some evidence also suggests that even after controlling for known risk factors, higher mortality rates were still seen for Pakistani and Bangladeshi ethnic groups.

Drivers may also include the interaction with modifiable social factors such as deprivation, occupation and household composition (GOV.UK, 2022) (GOV.UK, 2022) (CHIME, 2022). A lack of international data coverage limits comparison, with the majority of studies exploring ethnic disparities in COVID-19 outcomes centred around the United States and the UK. There is also substantial variation in ethnic demographics and ethnicity recording practices between countries that prevents direct comparison.

Other factors

Evidence has highlighted other factors associated with COVID-19 mortality around the world.

A study of 93 countries found that higher CO2 emissions correlated with increased COVID-19 deaths, as well as higher levels of tourism driving increased movement of people across borders.

Multiple evidence sources have found that temperature negatively correlated with the severity of a COVID-19 outbreak, with warmer climates being linked to fewer cases and deaths (Asem, 2021) (Wu, 2020) (Chang, 2022) (Bannister-Tyrell, 2020). However, this has not prevented warmer countries, such as India and Brazil, from seeing particularly severe outbreaks.

Population density has also been found to have a significant positive relationship with confirmed infections and deaths, suggesting that COVID-19 spreads faster in more densely populated regions and urban areas (Chang, 2022) (Rocklov, 2020). Until July 2022 in England, the most densely populated areas have seen more than double the number of cumulative COVID-19 deaths than the least densely populated areas.

Multiple studies have shown that biological sex plays a role in COVID-19 severity and mortality, with higher rates of mortality in males (Chang, 2022) (Dessie, 2021) (Li, 2021).

Finally, multiple studies have found that higher levels of trust in the government boosts conformance with restrictions and regulations (Chang, 2022) (Siegrist, 2014) (Bloomberg, 2022). One study found that confidence in health agencies positively affects people's willingness to adopt recommended behaviour.

7 . Glossary

Case fatality rate (CFR)

The case fatality rate is an epidemiological term that describes the proportion of people who die from a specified disease among all individuals diagnosed with the disease over a certain period of time.

Coronaviruses

The World Health Organization (WHO) defines coronaviruses as "a large family of viruses that are known to cause illness ranging from the common cold to more severe diseases such as Middle East respiratory syndrome (MERS) and severe acute respiratory syndrome (SARS)". Between 2001 and 2018, there were 12 deaths in England and Wales due to a coronavirus infection, with a further 13 deaths mentioning the virus as a contributory factor on the death certificate.

Coronavirus (COVID-19)

COVID-19 refers to the "coronavirus disease 2019" and is a disease that can affect the lungs and airways. It is caused by a type of coronavirus. Further information about COVID-19 disease is available from the World Health Organization (WHO).

Comorbidities

Frequently referred as "contributory", or "pre-existing" conditions, a comorbidity is any condition that either preceded the disease of interest (for example, COVID-19) in the sequence of events leading to death, or was a contributory factor in the death but was not part of the causal sequence. Data on comorbidities in COVID-19 mortality are available at differing scales and across different time periods and do not reflect one particular time period during the coronavirus pandemic.

Hazard ratio

Hazard ratios are measures of association; they describe the relative risk of the complication based on comparison of event rates. A hazard ratio of 1 means lack of association, a hazard ratio greater than 1 suggests an increased risk and a hazard ratio below 1 suggests a smaller risk.

Long-term care

There is no accepted international definition of long-term care (LTC) – however broadly, in the context of this work, LTC includes facilities such as nursing homes, skilled nursing facilities, retirement homes, assisted-living facilities, residential care homes or care services in other settings, such as domiciliary (home) care, that take care of people requiring support who experience difficulties living independently in the community because of the interaction between barriers in the environment and physical, mental, intellectual or sensory impairments possibly related to old age or chronic medical conditions (OECD, 2021), (Eurosurveillance,2020).

Years lived with disability (YLD)

YLD is a measure reflecting the impact an illness has on quality of life before it resolves or leads to death. YLDs account for the severity of a disability and are typically weighted so that young adult ages are valued higher than infants or the very elderly.

8 . Data sources and quality

While statistics on coronavirus (COVID-19) related mortality are available for many European and Organisation for Economic Co-operation and Development (OECD) countries, differences in coding and reporting practices as well as periods of available data reduce comparability internationally. For example, some countries include suspected COVID-19 deaths within COVID-19 death statistics, and coding differences over the registration of COVID-19 deaths and comorbidities differ within countries, which can create inconsistencies or biases when considering international comparisons. In some countries, subnational areas with devolved health administration have not agreed on a common methodology to count deaths.

Data from the OECD are based on collections from the Office for National Statistics, National Records of Scotland and Northern Ireland Statistics and Research Agency and collated statistics from Comas-Herrera. A and others (2021) (PDF, 952KB) and the 2021 OECD Questionnaire on COVID-19 in long-term care (LTC). Methodologies for each country vary and include national statistics, sample studies and variances in setting (some statistics are for all locations, some in LTC facilities only. (see Comas-Herrera, 2021 for a detailed explanation (PDF, 952KB)). The analysis:

- includes confirmed and suspected COVID-19 deaths for the UK, United States, France, Belgium, Canada and New Zealand
- data for Finland, New Zealand and Norway only include deaths occurring within LTC facilities
- data come from regional governments using different methodologies, some including suspected deaths
- data for Slovenia include deaths in nursing homes and social LTC facilities

9 . Related links

Comparisons of all-cause mortality between European countries and regions: 28 December 2019 to week ending 1 July 2022
Article | Released 20 December 2022
Comparisons of all-cause excess mortality on a weekly basis since the start of the coronavirus pandemic. Measures include relative age-standardised mortality rates and relative cumulative age-standardised mortality rates.

Comparing different international methods of measuring excess mortality
Article | Released 20 December 2022
Outlines the different statistical measures used to calculate all-cause excess mortality and outlines their strengths and limitations depending upon the context and geographical coverage for their application.

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11 . Cite this article

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