Office for National Statistics

Comparisons of all-cause mortality between European countries and regions: data up to week ending 3 September 2021, Methodology guide

Quality, methodology and comparability information for data used to calculate excess all-cause mortality for the UK, and European countries and regions, as reported in the Comparisons of all-cause mortality between European countries and regions article. Includes methodology for calculating measures of excess mortality, quality the data sources, comparability of the measures, and how to interpret the data.

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Release date:
18 November 2021

Next release:
To be announced

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1 . Data sources and quality

Weekly all-cause death registration data published by Eurostat from contributing nations of the European Union and European Free Trade Association are used in the article Comparisons of all-cause mortality between European countries and regions: data up to week ending 3 September 2021. There are clear criteria set out by Eurostat for data to be submitted to their database, based on official recording of deaths occurring in all settings, to maximise comparability.

All data analysed in this article are publicly available on the European Union Statistics Office (Eurostat) website. We contributed weekly counts of death registrations from all causes of death on behalf of the UK up until the end of 2020, following the departure of the UK from the European Union. For the UK we use Office for National Statistics (ONS) data for England and Wales, National Records Scotland (NRS) data for Scotland and Northern Ireland Statistics and Research Agency (NISRA) data for Northern Ireland.

The metadata for the weekly mortality data can be found on the Eurostat website. Each national statistical institute in the European Union has been requested to provide mortality counts by week, sex, five-year age group and a geographical breakdown to NUTS3 level (nomenclature of territorial units for statistics level 3). NUTS3 level is broadly equivalent to local authority level; you can find out more about the NUTS classification on the Eurostat website. Where these breakdowns were not possible, broader age groups or geographical areas were accepted.

Readily available international comparisons of coronavirus (COVID-19) mortality are of limited quality because of different reporting systems and definitions. National differences in testing and diagnosis make comparisons especially difficult, along with hospital versus non-hospital coverage. The distinction between numbers based on death certification and those depending on test results is reflected in the international differences in data availability and quality. Excess all-cause mortality is therefore the most robust international comparator for the COVID-19 pandemic.

The weekly mortality data made available by Eurostat includes a back series of five years of weekly deaths (2015 to 2019 inclusive) at the national and sub-national levels, enabling the calculating of average deaths per week, an essential part of the calculation of excess mortality and cumulative excess mortality during the pandemic.

Timeliness

The timeliness of the analysis is limited by the availability of data on the Eurostat website. For the UK, data up until the latest weekly reporting are readily available. However, some countries update their submission of weekly deaths data to Eurostat on an infrequent basis, and are not able to report data as quickly as the UK because of variations in civil registration systems and reporting practices.

In our article, we report up until the latest week available on the Eurostat website at the time of data download for all countries that have submitted data in the format required. This is to calculate age-standardised mortality rates (disaggregated into quinary age bands and back series data available for 2015 to 2019).

Data coverage

The data coverage of the article Comparisons of all-cause mortality between European countries and regions: data up to week ending 3 September 2021 is dependent on data submitted to and published on the Eurostat website.

The article uses age-standardised mortality rate-based measures for comparisons of excess mortality between countries and regions. Because of this, only countries and regions where deaths and populations are available by quinary age groups can be included in our analyses. We are also reliant on these data being available for the comparison period from 2015 to 2019.

Therefore, we cannot include statistics for Albania, Germany, the Republic of Ireland, Montenegro, and the Republic of Serbia. When we downloaded the data, they were not available for these countries in the format required for the time period. In addition, Liechtenstein was excluded due to large fluctuations in weekly mortality data.

NUTS geography

Eurostat introduced an update to their NUTS (nomenclature of territorial units for statistics) boundaries in 2021. Deaths on their weekly mortality database are reported by these boundaries from week 52 of 2020 onwards, whereas corresponding population estimates and projections published on their website are still reported by the preceding 2016 boundaries. As we require both deaths and populations to calculate age-standardised mortality rates and our measures of excess mortality, from week 52 of 2020 onwards, we have only been able to include those areas where boundaries have not changed from 2016 to 2021.

2 . Methodology

In the article Comparisons of all-cause mortality between European countries and regions: data up to week ending 3 September 2021, three measures for evaluating levels of mortality have been calculated. We have also calculated p-scores, a further measure of evaluating deviations from expected levels of mortality that users may wish to use.

Analysis of all-cause mortality allows us to examine the impact of the coronavirus (COVID-19) pandemic. This includes deaths due to COVID-19, but also excess deaths that have occurred as a result of the wider impacts of the virus on healthcare systems and society. Given the differing practices in recording and reporting deaths relating to COVID-19, it is not possible at this time to conduct accurate international comparisons of deaths involving COVID-19 specifically.

Comparisons of all-cause mortality between European countries and regions: data up to week ending 3 September 2021 article examines 2020 and 2021 mortality patterns set against patterns observed during the preceding five years (2015 to 2019). The difference between the current period and a past average is often referred to as "excess mortality". Therefore, the article is not a direct comparison of COVID-19 deaths or epidemic curves.

We focus on two main measures of excess mortality. These are:

- relative age-standardised mortality rates (rASMRs)
- relative cumulative age-standardised mortality rates (rcASMRs)

Each measure has strengths and limitations when comparing populations between geographical areas. Broadly, these measures aim to control for non-modifiable population characteristics. These can include the age structure and size of differing populations so that like-for-like comparisons can be made between countries and regions.

For assessing weekly levels of excess mortality, rASMRs are a good measure to show periods where mortality rates were higher than average, the same as the five-year average, or below average. They also allow for identification of peaks in excess mortality.

rcASMRs are a good measure for assessing the accumulation of weekly excess mortality over a longer period. They are calculated weekly, and the value at the end of the period of interest shows whether the mortality rate is above or below the five-year average, and to what extent, for the whole period up to that week.

Population denominator estimation

To create the age-standardised mortality rates (ASMRs), relative age-standardised mortality rates (rASMRs), and relative cumulative age-standardised mortality rates (rcASMRs), two data sources are required. These are:

- deaths by quinary age and sex for each week of the study period
- corresponding population denominators for each week of the study period

Population estimates for each quinary age-group and sex were sourced at NUTS (nomenclature of territorial units for statistics) 2016 hierarchies from the Eurostat website for week one of each year in the study period: 2015, 2016, 2017, 2018, 2019. Projected population estimates for week one of 2020, 2021 and 2022 have also been sourced from Eurostat for NUTS 2016 levels 0 and 3.

The calculated change in population between week one of 2015 and week one of 2016 was divided by 53, the number of statistical weeks in 2015, to create interpolated population denominators for each week of the year. This process was then repeated for years 2016, 2017, 2018 and 2019, dividing the annual change by 52 (number of statistical weeks in each of those years). For all areas outside the UK, the 2020 weekly interpolated populations were calculated by dividing by 53, the number of statistical weeks in that year. For 2021, the interpolated population denominators for each week follow the 52-week division of projected annual change from week one of 2021 to week one of 2022.

For the UK, week one of 2020 estimates produced by the Office for National Statistics (ONS) have been extrapolated through to week one of 2021 using the calculated change from week one of 2019. On account of the current lack of an estimate of UK NUTS populations at week one of 2021, we have continued the weekly linear extrapolation up to week 36 of 2021[1].

Age-standardised mortality rates (ASMRs)

Age-standardised mortality rates (ASMRs) are used to allow comparisons between populations that may contain different overall population sizes and proportions of people of different ages. The 2013 European Standard Population is used to standardise age-specific rates to a consistent population. The formula used is:

$$ASMR\left(100,000\right)\left(G,i\right)=\frac{100,000}{\sum\left(x,s\right)\in GESP(x)}\sum\left(x,s\right)\in G\left(\frac{D\left(x,s,i\right)}{E\left(x,s,i\right)}\right)\ ESP\left(x\right)$$

Where:

- G is the group (defined by some combination of age and sex) for which we calculate the ASMR
- i is the time interval for which we calculate the ASMR
- x is age
- s is sex
- ESP(x) is the standard population for age x
- D(x,s,i) is the number of deaths for age x and sex s in time interval i
- E(x,s,i) is a measure of the exposure for age x and sex s in time interval i

Weekly estimates of person-years exposed has been calculated using known population estimates on 1 January 2015, 2016, 2017, 2018 and 2019; between these dates, weekly population estimates have been calculated by means of linear interpolation.

For example:

Writing P(x,s,w,y) for the population in week w of year y, we set P(x,s,1,y) equal to the population estimates at January 1 and calculate exposure by:

$$E\left(x,s,w,y\right)=P\left(x,s,1,y\right)+\frac{\left(w-1\right)}{52}\left(P\left(x,s,1,y+1\right)-P\left(x,s,1,y\right)\right)$$

We define cASMR, the cumulative ASMR, which is used in calculating relative ASMRs and relative cASMRs, as the sum of weekly ASMRs up to that point in the year.

For example:

$$cASMR\left(G,w,y\right)=\sum_{i=1}^{i=w}ASMR\left(G,w,y\right)$$

Relative age-standardised mortality rates (rASMRs)

Relative age-standardised mortality rates (rASMRs) are weekly measures of excess mortality using age-standardised mortality rates (ASMRs) that are standardised to the 2013 European standard population.

Excess mortality for a particular week is defined as the difference between the ASMR for that week and average ASMR for that week in the five years from 2015 to 2019 inclusive. For the years that do not have 53 weeks (2016 to 2019 and 2021) we have used the mid-point between week 52 and week one of the following year for the calculation of the ASMR. This excess mortality is then expressed as a proportion of the five-year average ASMR for full years.

The following formula is used:

$$rASMR(G,w,y)\ =\ \frac{ASMR(G,w,y)\ -\ \overline{ASMR}(G,w,2015-19)}{\frac{\overline{cASMR}(G,52,2015-19)}{52}}$$

This formula is used where:

- rASMR(G,w,y) is relative age-standardised mortality rate in week w and year y
- ASMR(G,w,y) is age-standardised mortality rate in week w and year y, as defined in the Age-standardised mortality rates section

$\overline{ASMR}(G,w,2015-19)$

- is mean age-standardised mortality in week w, averaged over years 2015-19

$\overline{cASMR}(G,52,2015-19)$

- is mean age-standardised mortality for the end of the year, averaged over the full years 2015-19

Relative cumulative age-standardised mortality rates (rcASMRs)

Rather than absolute values of death counts, relative cumulative age-standardised mortality rates (rcASMRs) sum all age-standardised mortality rates between two time points. In this article, rcASMRs are calculated cumulatively from week one 2020 until the latest week available. The 2015 to 2019 average cumulative age-standardised mortality rate for that time period is used. Where the time period extends beyond one year, this is treated as an extension of the number of weeks in the year, for example week one of 2021 is effectively week 54 in the period of interest. For the five-year average, week one onwards of the 2015 to 2019 average is used in the calculation of the cumulative age-standardised mortality rates (cASMR). The following formula is used:

$$rcASMR(G,w,y) = \frac{cASMR(G,w,y) \; - \; \overline{cASMR}(G,w,2015-19)}{\overline{cASMR}(G,52,2015-19)}$$

This formula is used where:

- cASMR(G,w,y) is cumulative standardised mortality rate in week w and year y, as defined in the Age-standardised mortality rates section
- $\overline{cASMR}(G,w,2015-19)$ is mean cumulative age-standardised mortality rate to week w, averaged over 2015-19
- $\overline{cASMR}(G,52,2015-19)$ is mean age-standardised mortality, averaged over the full years 2015-19

To include week 53 of 2020 in our calculations and extend the rcASMR beyond the end of the calendar year for 2020, we calculate a pseudo ASMR for week 53 for the years 2016, 2017, 2018 and 2019 to include in the 2015 to 2019 average. This is calculated as the mid-point between the ASMR for week 52 and week one of the following year.

Proportional-scores (P-scores)

Proportional-scores (P-scores) are weekly measures of excess mortality. An article was published in June 2020 recommending the use of p-scores in evaluating excess mortality in the coronavirus (COVID-19) pandemic.

Excess deaths are defined as the number of deaths registered in excess of the five-year average (from 2015 to 2019). To determine a p-score, the following formula is used:

$$\rho_t \; = \; \frac{D(G,i,2020) \; - \; \overline{D}(G,i,2015-19)}{\overline{D}(G,i,2015-19)}$$

This formula is used where:

- ρ_t is the p-score at time point t
- D(G i,y) is the number of deaths for group G in time interval i in the period of interest (y)
- $\overline{D(G,i,2015-19)}$ is the mean number of deaths for group G in time interval i in years 2015 to 2019 inclusive.

The formula for a p-score is similar to that for relative age-standardised mortality rate (rASMR). However, the p-score uses deaths rather than ASMRs, so does not control for changes in the population, and the denominator for p-scores is for the weekly period rather than the full year.

Notes for: Methodology

1. NUTS regions NO061 and NO062 were missing population estimate and projection data after week one of 2018, linear extrapolation was also used in this instance.

3 . Interpreting the data

As statistical measures, age-standardised mortality rates (ASMRs), relative ASMRs (rASMRs), and relative cumulative ASMRs (rcASMRs) all aim to reduce bias, allowing for comparisons to be made between populations in differing geographical areas of differing sizes and demographic structures. Each measure has revealed something different about the patterns of all-cause mortality during 2020 and 2021 so far. Presentation of age-standardised mortality rates shows us how these vary by seasons within countries and how they vary in size between countries.

It is important to keep in mind that countries and regions with smaller populations are subject to greater fluctuations and variations in relative measures of excess mortality. Small changes in the total number of deaths may be represented by large changes in relative excess mortality.

The measures we have reported on do not, however, offer conclusive explanations for the reasons behind the patterns observed. Nonetheless, our measures do offer insight into relative change in mortality levels.

We have chosen to report on age-standardised mortality rate-based measures in this report to account for differing age structures of the populations of the countries included in our analyses. In addition, we also provide reference tables for p-scores. We include data for Germany in the table for p-scores, but not in those for ASMRs, rASMRs and rcASMRs. Deaths data for Germany by quinary age group and by sex were not available on the Eurostat database at the time of our analyses, so it is not possible to calculate age-standardised mortality rates. We additionally include data for Albania, Montenegro and the Republic of Serbia in the table for p-scores, because of more recent data becoming available for these countries in the run up to publication.

4 . Country comparability of the data

Because of the established system of reporting weekly mortality in the UK, we submit weekly death counts to Eurostat based on date of death registration rather than actual date of death (date of occurrence). Death registration counts in any given week represent approximately 46% of deaths that occurred in that seven-day period. Analysis by the Office for National Statistics (ONS), Predicting total weekly death occurrences in England and Wales methodology, has shown that by three weeks after the week of occurrence, approximately 92% of occurrences will be registered. The remaining 8% may be delayed, with around 2% being delayed by one year or more. This is to allow for a Coroner's hearing and subsequent report to be finalised, and the cause of death to be registered.

Therefore, for us to submit relatively comprehensive counts of weekly deaths by date of occurrence on behalf of the UK, there would need to be at least a three-week delay in the reporting of total deaths. This is because of the delay between death occurrence and death registration. Please see our recent Counting deaths involving the coronavirus (COVID-19) blogand Impact of registration delays on mortality statistics in England and Wales: 2018 article about registration delays.

The following countries report deaths by date of occurrence: Austria, Belgium, Bulgaria, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovenia, Slovakia, Spain, Sweden, and Switzerland. Data referring to recent weeks may be under-reporting the actual number of deaths and they are likely to be revised. The UK reports deaths by date of registration.

We refer to weeks starting on a Saturday and ending on a Friday, as is standard for the weekly reporting of deaths for England, Wales, and Northern Ireland. Scotland, and the rest of Europe report weeks starting on Monday and ending on Sunday; therefore, these dates are a guide rather than exact for all countries. This means that any comparison of weekly deaths between the UK and its hierarchy of NUTS (nomenclature of territorial units for statistics) units, with other European countries, is subject to caveats in relation to the temporal comparability for any given week. Patterns of deaths by date of registration broadly follow those of deaths by date of occurrence, but are affected by public holidays when registry offices are closed.

Eurostat also assigns deaths with an unknown age to "UKN"; we exclude these deaths as we cannot know which quinary age group to assign them to when calculating an age-standardised mortality rate. This affects a range of countries, in particular, deaths reported from France from reporting year 2019 onwards. In 2020, 5133 deaths were reported as age unknown for France. The country next most affected was Spain with 202 deaths of unknown age in 2020.

In addition, where the NUTS3 (local authority equivalent) geography of a death is unknown, but the NUTS0 (country level) is known, we include the death in the country total but not in any further geographical breakdowns.