Article

Comparisons of all-cause mortality between European countries and regions: January to June 2020

Analysis of all-cause mortality patterns of selected European countries and regions, week ending 3 January (Week 1) to week ending 12 June (Week 24) 2020.

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Notice

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Due to an error, Hungary was mentioned as one of the non-EU states compared in Table 4. Hungary is in fact a member of the EU and the Schengen area, though not of the Eurozone. We apologise for any confusion caused.

Table of contents

1 . Things you need to know about this release

There has been considerable interest in international comparisons of mortality during the coronavirus (COVID-19) pandemic. The best way of comparing the mortality impact internationally is by looking at all-cause mortality rates by local area, region and country compared with the five-year average. All-cause mortality avoids the problem of different countries recording COVID-19 deaths in different ways, and also takes into account the indirect impact of the pandemic, such as deaths from other causes that might be related to delayed access to healthcare.

2 . Main points

- Within countries there has been considerable variation in mortality; in the UK, every local authority area (NUTS3) experienced excess mortality during the peak weeks of excess mortality (week ending 3 April to week ending 8 May 2020), while other Western European countries experienced more geographically localised excess mortality.

- Analysis of Weeks 8 to 24 (week ending 21 February to week ending 12 June) at local authority level (NUTS3) across Europe shows that the highest rates of excess mortality were in areas in Central Spain and Northern Italy; Bergamo (Northern Italy) had the highest peak excess mortality of 847.7% (week ending 20 March) compared with the highest in the UK, Brent at 357.5% (week ending 17 April).

- Looking at major cities, the highest peak excess mortality was in Madrid at 432.7% (week ending 27 March) while in the UK, Birmingham had the highest peak excess mortality of any major British city at 249.7% (week ending 17 April).

- Of the four nations of the UK, England had the highest peak excess mortality (107.6% in week ending 17 April).

- England saw the second highest national peak of excess mortality during Weeks 8 to 24 (week ending 21 February to week ending 12 June), compared with 21 European countries, with only Spain seeing a higher peak; at the equivalent of local authority level, areas of Central Spain and Northern Italy saw the highest peaks of excess mortality and exceeded any parts of the UK.

- While England did not have the highest peak mortality, it did have the longest continuous period of excess mortality of any country compared, resulting in England having the highest levels of excess mortality in Europe for the period as a whole.

- This article looks at all-cause mortality as a comparable international indicator of the impact of the coronavirus (COVID-19) pandemic and does not specifically analyse deaths involving COVID-19; deaths are shown for the UK countries by date of registration.

3 . Statistician’s comment

"Due to the coronavirus pandemic, the first half of 2020 saw extraordinary increases in mortality rates across countries in Western Europe above the 2015 to 2019 average.

“The highest peak excess mortality at national level was in Spain, with some local areas in Northern Italy and Central Spain having excess mortality levels as high as 847.7% of the average.

“While none of the four UK nations had a peak mortality level as high as Spain or the worst-hit local areas of Spain and Italy, excess mortality was geographically widespread throughout the UK during the pandemic, whereas it was more geographically localised in most countries of Western Europe.

“Combined with the relatively slow downward ‘tail’ of the pandemic in the UK, this meant that by the end of May, England had seen the highest overall relative excess mortality out of all the European countries compared.”

Edward Morgan, Health Analysis and Life Events, Office for National Statistics

4 . Introduction

This article presents provisional analysis of European all-cause mortality patterns during the first half of 2020. Weekly deaths data are examined for 29 European countries where official data were available by 10 July 2020, and compares measures from week ending 3 January (Week 1) to week ending 12 June (Week 24) of 2020. Comparisons have been made for local areas (approximately local authority district or equivalent) as well as nationally for most of the countries included.

We have not previously published any international comparisons of mortality data during the coronavirus (COVID-19) pandemic period because robust and comparable data sources have not been available to do so. In this report we use weekly all-cause death registration data published by Eurostat from contributing nations of the EU and European Free Trade Association. 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.

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. Data for the UK nations are reported by date of registration, which is typically up to a week after date of death.

Analysis of all-cause mortality allows us to examine the impact of the coronavirus pandemic not only from deaths involving COVID-19, but also excess deaths that have occurred as a result of the wider impacts of the coronavirus on healthcare systems and society. Given the widely differing practices between countries 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.

The number of countries with data available by cause of death at this time is also smaller than the number able to count all-cause deaths. We describe the strengths and limitations of various data sources available in the Measuring the data section.

This article examines 2020 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". This article is not a direct comparison of COVID-19 deaths or epidemic curves.

Three measures are used as our primary indicators in this article: age-standardised mortality rates (ASMRs), relative age-standardised mortality rates (rASMRs) and relative cumulative age-standardised mortality rates (rcASMRs). Each measure has strengths and limitations when comparing populations between geographical areas. Broadly, these measures aim to reduce bias so that like-for-like comparisons can be made between countries and local authority level areas (NUTS3).

Comparisons are shown at national level, for selected major cities, and for all local areas at the level of counties or districts (using the European NUTS3 classification). Figures for the UK as a whole are available in the reference tables. We do not focus on UK-level figures in this report, as each of the four nations of the UK has its own health services and policies, and has made different decisions around responses to the pandemic such as the date and extent of implementation of lockdown measures. It is therefore meaningful to report on each of the nations of the UK separately.

We intend to update this analysis in the coming months to include more weeks of 2020 and any new data submitted to Eurostat from countries where there currently are none available. Further analysis will also include more precise analysis of the time trends by date of death, taking into account the different apparent "start dates" of the pandemic in each country.

5 . Age-standardised mortality rates

Age-standardised mortality rates (ASMRs) are the number of deaths observed per 100,000 people, standardised to control for differences in population size and age-structure between places and time points.

Figure 1: Weekly age-standardised mortality rates in 2020 highest amongst Western European countries

Age-standardised mortality rates for all persons, by week for selected European countries and the nations of the UK, Week 1 (week ending 2 January) 2015 to Week 24 (week ending 12 June) 2020

Download the data

Notes:

1. Data are provisional.
2. Age-standardised mortality rates are standardised to the 2013 European standard population.
3. For UK countries, non-residents are excluded for figures from England, Scotland and Wales but are included for Northern Ireland. However, the numbers of non-residents included are very small.
4. Information about whether non-residents are included for countries outside the UK is not provided by Eurostat.
5. Data for the UK are based on date of registration rather than date of death, most other European countries are based on date of death.

Figure 1 shows the weekly ASMRs for selected European countries from week ending 2 January (Week 1) 2015 to week ending 12 June (Week 24) 2020. For many European countries, mortality levels are seasonal, with countries often seeing peaks of mortality in winter months and relatively low mortality during the summer months. The countries of Northern Europe are less prone to seasonal variation. For many European countries, Weeks 8 to 24 2020 saw abnormally high mortality rates, associated with the global coronavirus (COVID-19) pandemic. Figure 1 shows that "spikes" in mortality during 2020 are concentrated in the countries of Western Europe, with little evidence of abnormal mortality rates in Eastern Europe.

All-cause mortality levels vary between countries. In this respect, ASMRs cannot be used to directly compare excess mortality between countries in Weeks 8 to 24 2020. For example, the highest mortality rate observed during a "normal" winter in Bulgaria has historically been greater than the highest mortality rate observed during the "abnormal" coronavirus pandemic in England. This is why relative measures of excess mortality are needed.

While we compare with the five-year average, it should be recognised that the previous five years may not reflect the long-term directional trends in mortality in any given country. For example, some countries may be experiencing long-term increasing or decreasing levels of mortality. In the UK and much of Europe, the years 2015 to 2019 included a mixture of both higher and lower mortality patterns, particularly associated with variations in seasonal influenza.

The following sections show measures of excess mortality and cumulative excess mortality, which provide insight about how mortality has deviated from normal levels in 2020.

6 . Relative age-standardised mortality rates

Relative age-standardised mortality rates (rASMRs) are weekly measures of excess mortality. Excess deaths are defined as the number of deaths registered in excess of the five-year average (2015 to 2019). These rates are calculated by subtracting the weekly 2015 to 2019 mean ASMR from the weekly 2020 ASMR and then dividing by mean annual cumulative ASMR for 2015 to 2019, which in turn is divided by 52, the number of weeks in a year. The resulting figure is a percentage change in the 2020 mortality rate, from what would have been expected in a given week based upon the five-year average mortality rate in 2015 to 2019. For example, a value of 100% indicates mortality rates were 100% higher than or double that of the five-year average in a given week.

A negative value indicates a weekly 2020 ASMR below what is expected given the five-year average. In contrast, a positive value indicates a weekly ASMR above the five-year average.

Figure 2a shows rASMRs for European countries where data are available. There is the option to select different countries of interest as well as explore differences between people of all ages, those aged 0 to 64 years, and those aged 65 years and over.

Looking at people aged 0 to 64 years, England had the highest peak rASMR out of all European countries where data were available (69.2%, week ending 24 April, Week 17). For those aged 65 years and over, Spain had the highest peak rASMR at 153.3% in week ending 3 April (Week 14).

Figure 2a: Spain had the highest peak relative age-standardised mortality rate of all European countries

Relative age-standardised mortality rates, Week 1 (week ending 3 January) to Week 24 (week ending 12 June), selected European countries

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Figure 2b: Spain had the highest peak excess mortality of countries where data were available

Relative age-standardised mortality rates for all persons by broad age group and week of 2020 for selected European countries and the nations of the UK week 1 (ending January 3rd) to week 24 (ending 12th June)

Download the data

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6. Data for the UK are based on date of registration rather than date of death, most other European countries are based on date of death.

Figure 2c shows rASMRs for selected major European cities for which data are available. Of the selected major European cities, the highest relative excess mortality was observed in Madrid where the rASMR reached 432.7%, week ending 27 March.

In the UK, Birmingham was the city with the highest peak excess mortality (249.7%, week ending 17 April), followed by London (226.7, week ending 17 April) and Manchester (198.4%, week ending 17 April).

In Italy, Milan saw a peak rASMR of 149.0% (week ending 27 March) while Rome saw a “peak” rASMR of negative 2.4%, below the five-year average (week ending 10 April).

Figure 2c: Of the selected major European cities, the highest relative excess mortality was observed in Madrid

Relative age-standardised mortality rates for selected major European countries for which data are available

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Figure 2d: Madrid had the highest peak excess mortality of major European cities

Relative age-standardised mortality rates for all persons by broad age group and week of 2020 for selected European cities Weeks 1 (week ending January 3) to 24 (week ending June 12)

Download the data

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For Week 1 (week ending 3 January) to Week 8 (week ending 21 February) 2020, observed rASMRs fell within normal historical ranges for each European country. From Week 9 2020 (week ending 28 February), mortality rates began to increase significantly in the province of Lodi, in the Lombardy NUTS3 area of Northern Italy as a result of the coronavirus (COVID-19) pandemic. In turn, the rASMR in Lodi province rose from zero (the average) to a maximum value of 449.4% in Week 11 (week ending 13 March). The highest observed national rASMR observed during 2020 was 138.5% in Spain during Week 14 (week ending 3 April). Figure 3 shows a map of rASMR at a NUTS3 level.

Figure 3: Peaks of excess mortality were geographically localised in the countries of Western Europe

Interactive map showing relative age-standardised mortality rates by week and NUTS3 region of Europe

Download the data

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At the local authority level (NUTS3), rASMRs throughout the first half of 2020 varied both between and within countries. At the local authority (NUTS3) level, rASMRs have much larger variation than those at the national level because of the smaller numbers of deaths involved, as well as specific areas within each country being more affected than others.

The highest recorded rASMR was 847.7% in the Northern Italian city of Bergamo in week ending 20 March (Week 12). The 10 highest local authority-level (NUTS3) rASMRs were all in Central Spain and Northern Italy.

At the peak of their respective epidemics, the following had the second, third and fourth highest rASMRs respectively: Cremona (Italy, 617.7%, Week 12, week ending 20 March), Segovia (Spain, 600.6%, Week 13, week ending 27 March), Ciudad Real (Spain, 532.3%, Week 13, week ending 27 March).

Table 1: Regions in Northern Italy and Central Spain had the highest recorded values of rASMRs at the peak of their respective epidemics

The twenty NUTS3 areas with the highest recorded values of rASMRs at the peak of their respective epidemic weeks in 2020

NUTS3 areas	Country	Week ending (week)	Max ASMR (per 100,000)	Max rASMR (%)
Bergamo	Italy	20 March (12)	156.5	847.7
Cremona	Italy	20 March (12)	121.6	617.7
Segovia	Spain	27 March (13)	102	600.6
Ciudad Real	Spain	27 March (13)	109.3	532.3
Brescia	Italy	27 March (13)	90.3	474.2
Piacenza	Italy	20 March (12)	93.8	459.4
Lodi	Italy	13 March (11)	95.6	449.4
Guadalajara	Spain	3 April (14)	79.1	447.6
Albacete	Spain	3 April (14)	89.5	445.2
Madrid	Spain	27 March (13)	73.9	432.7
Soria	Spain	27 March (13)	70.6	409.5
Brent (Greater London)	UK	17 April (16)	73.3	357.5
Salamanca	Spain	3 April (14)	61.8	353.7
Enfield (Greater London)	UK	24 April (17)	67.7	327.5
Parma	Italy	20 March (12)	68.3	321.8
Ealing (Greater London)	UK	17 April (16)	68.5	318
Lecco	Italy	27 March (13)	62.2	306.6
Cuenca	Spain	3 April (14)	66.4	300.2
Thurrock (Essex)	UK	17 April (16)	79	286.1
Barcelona	Spain	3 April (14)	59.3	285.9

Source: Eurostat, Office for National Statistics

Notes

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2. Age-standardised mortality rates are standardised to the 2013 European standard population. Back to table
3. Relative age-standardised mortality rates (rASMRs) are expressed as the percentage change per week in 2020 from the average expected age-standardised mortality rate in 2015 to 2019. Back to table

The top 10 NUTS3 areas with the highest peaks of rASMRs all occurred in Italy and Spain. Amongst the top 20 areas are four areas of the UK, of which three are in London and one in Essex, South East England.

The earliest abnormal increase in all-cause mortality associated with COVID-19 was in the city of Lodi in the Lombardy area of Northern Italy in Week 9 (week ending 28 February). In Week 10 (week ending 6 March), two adjacent NUTS3 areas to Lodi -- Bergamo and Cremona -- observed rASMRs in excess of 150%, and several others in excess of 50%.

In Week 11 (week ending 13 March), almost all NUTS3 areas of Northern Italy had positive rASMRs with several experiencing "extreme" values over 200%. Week 11 (week ending 13 March) also saw high values observed in Madrid (56.9%) and the Haut-Rhin area (60.9%) of Eastern France.

Week 12 (week ending 20 March) saw rASMRs increase in all Italian areas north of Rome. Areas in Lombardy in particular saw some of the highest values observed in Europe. Week 12 (week ending 20 March) also saw rASMRs increase substantially in the NUTS3 areas of Central Spain adjacent to Madrid. Increases in rASMRs in the NUTS3 areas of Eastern France adjacent to Haut-Rhin were also observed.

During Week 13 (week ending 27 March), substantial increases in rASMRs were observed in areas adjacent to Lombardy in Italy, Central Spain and Eastern France. Large increases in rASMRs were observed in Eastern NUTS3 areas of France bordering Germany, Luxembourg and Belgium, as well as large rises in Paris and its metropolitan areas.

In England, many London boroughs had rASMRs above 30%: Wandsworth, Ealing, Brent, Westminster, Hackney and Newham, Lewisham and Southwark, Lambeth, Bexley and Greenwich, Barking and Dagenham and Havering, and Tower Hamlets. West Kent in South East England also had an abnormal value of 53.5%.

In Scandinavia, Stockholm in Sweden also observed its first rASMR in excess of 50%.

Week 14 (week ending 3 April) saw positive rASMRs in almost every part of Belgium, with over one-quarter of areas having a rASMR in excess of 100%. Stockholm's rASMR increased to 101.6%. Unlike Spain, Italy and France where excess mortality has been relatively localised to certain geographical areas during the weeks of the pandemic, rASMRs increased to positive values in almost all areas of the UK, except for North and South West Wales, Warrington, Lincolnshire, East Norfolk and Medway. Spain also saw further increases in rASMRs in Northern and Eastern areas, including Barcelona. At the national level, Switzerland and Portugal saw their highest rASMRs in this week.

Week 15 (week ending 10 April) saw extreme high-value rASMRs persist in areas of Europe with highly concentrated outbreaks of COVID-19. These include: Central and North-Eastern Spain, Northern Italy, Eastern France and Paris, Belgium, most areas of the UK, Stockholm and Central Sweden.

During Week 16 (week ending 17 April), rASMRs began to decline in Spain, France, Italy, Belgium and Sweden, though still remained high in the core urban areas with prevalent COVID-19 outbreaks. The UK saw general increases in rASMRs across most areas of the country.

Week 17 (week ending 24 April) saw further falls in rASMRs across all areas of Europe with major COVID-19 outbreaks. The UK was the only exception, where rASMRs generally increased further to their peak. The UK saw 45% of NUTS3 areas with a rASMR in excess of 100% and 78% in excess of 50%. The highest rASMRs in the UK in Week 17 (week ending 24 April) were all recorded in London, with Enfield recording the highest rASMR of 327.5%.

In Week 18 (week ending 1 May), rASMRs began to fall throughout the nations of the UK, though remained abnormally high in most areas. Relatively high rASMRs persisted throughout Central Sweden while rASMRs declined to average levels in all but the core centres of disease outbreak in Belgium, France, Spain and Italy.

Between Week 19 (week ending 8 May) and Week 24 (week ending 12 June), rASMRs declined further in all areas of Europe where data was available falling more in line with average levels. These falls occurred at a faster rate in France and Spain than they did in the nations of the UK and Sweden.

Throughout 2020, no significant deviations from the five-year average mortality rate were observed in Iceland, Norway, Finland, Denmark, Lithuania, Czechia, Slovakia, Bulgaria, Austria, Estonia, and Hungary.

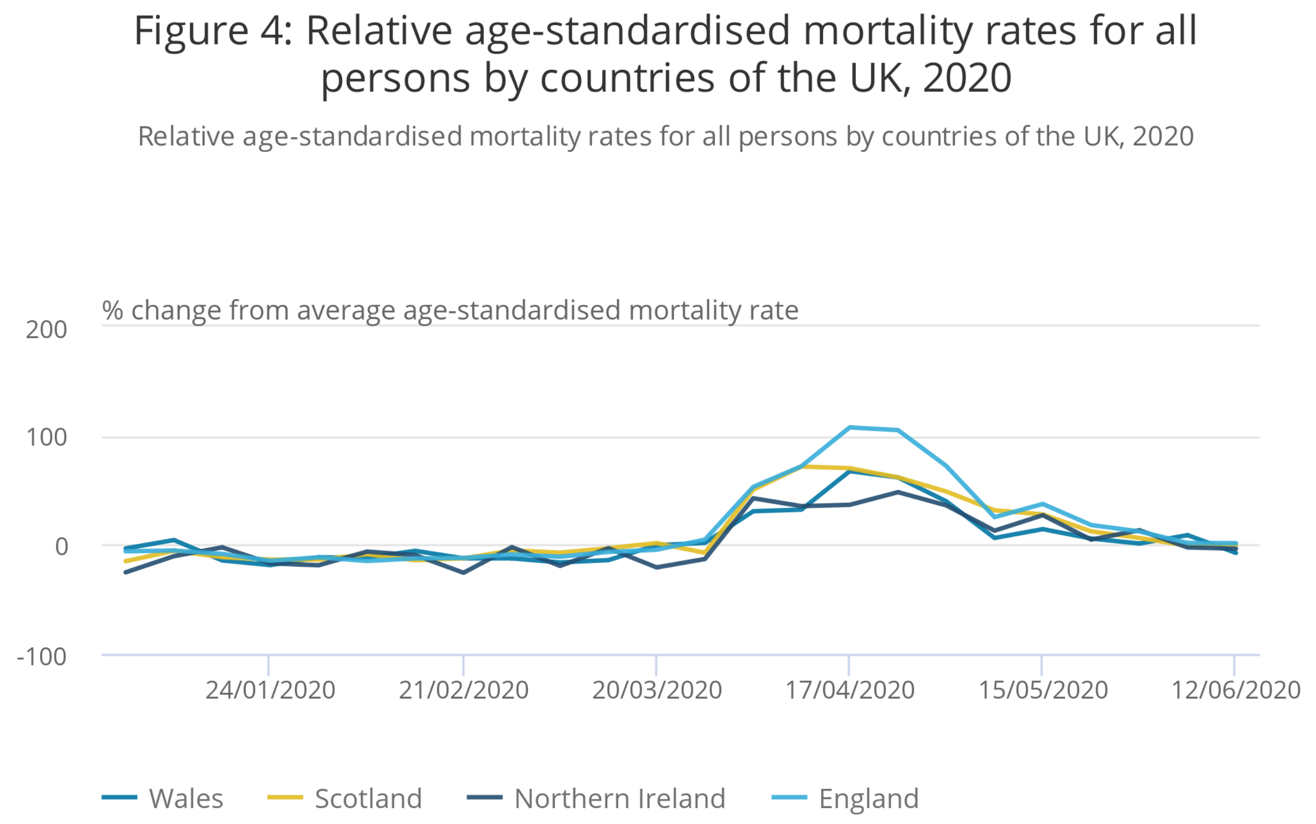
Comparisons within the UK

Looking at each of the four nations of the UK separately shows us that England had the highest peak rASMR of the four nations of 107.6% during Week 16 (week ending 17 April). This was followed by Scotland with a peak rASMR of 71.7% during Week 15 (week ending 10 April), and Wales with a peak rASMR of 68.7% during Week 16 (week ending 17 April).

Northern Ireland experienced the lowest peak rASMR of the four nations of 48.2% during Week 17 (week ending 24 April).

Figure 4: Relative age-standardised mortality rates for all persons by countries of the UK, 2020

Relative age-standardised mortality rates for all persons by countries of the UK, 2020



Source: Office for National Statistics, National Records Scotland, Northern Ireland Statistics and Research Agency

Notes:

1. Calculated using age-standardised mortality rates standardised to the 2013 European standard population.
2. Relative cumulative age-standardised mortality rates (rASMRs) are expressed as the percentage change per week in 2020 from the average annual age-standardised mortality rate in 2015 to 2019.
3. For UK countries, non-residents are excluded for figures from England, Scotland and Wales but are included for Northern Ireland. However, the numbers of non-residents included are very small.
4. Data for the UK are based on date of registration rather than date of death, most other European countries are based on date of death.
5. Data are provisional.

7 . Relative cumulative age-standardised mortality rates

This section uses relative cumulative age-standardised mortality rates (rcASMRs) to measure cumulative excess mortality relative to the 2015 to 2019 average annual mortality rates. This measure was originally developed by the Continuous Mortality Investigation (CMI), part of the actuarial profession, for its mortality monitors.

Comparing the cumulative ASMR for a point in 2020 with the average cumulative ASMR to the same point in 2015 to 2019 shows whether age-standardised mortality for 2020 has been above or below average up to that point. The rcASMR expresses this difference as a percentage of the average age-standardised mortality rate for full years 2015 to 2019.

A nil value for rcASMR indicates that age-standardised mortality for the year to date has been equal to the average. A positive value indicates worse than average mortality, and a negative value indicates better than average mortality.

If a country or area has an rcASMR of 10%, then their year-to-date mortality rate in 2020 compared with the five-year average is 10% higher than a year's worth of mortality over the previous five years.

The rcASMR can increase or decrease over time. An increase in rcASMR corresponds to a period when age-standardised mortality has been above the 2015 to 2019 average, and a decrease in rcASMR corresponds to a period when mortality has been below the average.

By using an age-standardised rate-based measure of cumulative excess mortality, we are accounting for variations in age structures and seasonal variation of countries analysed.

Measures of cumulative mortality evaluate the total extent of mortality from one time point to another. In this article, Week 1, 2020 (week ending 3 January) is used as a start point and Week 22, 2020 (week ending 29 May) is used as the end point.

Data are available for some countries up until Week 24 (week ending 12 June), but to draw a balance between how recently we report and the number of countries included in the analysis, we have reported up to Week 22 (week ending 29 May). We also report in Table 1 rcASMRs to Week 19 to include data from Italy and Czechia.

Table 2 shows that by Week 22, 2020 (week ending 29 May), England had the highest rcASMR of the 23 countries where data were available. In order of magnitude, this was followed by Spain, Scotland and Belgium. This shows that despite Spain having the highest peak of excess mortality during Weeks 8 to 24, England had higher levels of cumulative excess mortality following longer periods of time with mortality rates above the average.

In contrast, Liechtenstein saw the lowest rcASMR of negative 5.21%. This suggests that, despite the coronavirus (COVID-19) pandemic, countries with negative values such as Liechtenstein saw overall mortality improvement throughout the first half of 2020 compared with the previous five years.

Table 2: Relative cumulative age-standardised mortality rates (rcASMRs) for European countries where data are available, Week 19 (week ending 8 May) and Week 22 (ending 29 May)

Week 19 order	Country	rcASMR (%), week 19	Week 22 order	Country	rcASMR (%), week 22
1	Spain	6.96	1	England	7.55
2	England	6.24	2	Spain	6.65
3	Scotland	4.21	3	Scotland	5.11
4	Belgium	3.97	4	Belgium	3.89
5	Italy	3.84	5	Wales	2.78
6	Netherlands	2.47	6	Sweden	2.26
7	Wales	2.38	7	Netherlands	2.21
8	Sweden	1.49	8	Northern Ireland	2.03
9	Northern Ireland	1.16	9	France	0.16
10	France	0.41	10	Iceland	-0.38
11	Iceland	-0.5	11	Austria	-0.73
12	Austria	-0.63	12	Portugal	-0.91
13	Portugal	-1.18	13	Switzerland	-1.95
14	Switzerland	-1.36	14	Finland	-2.3
15	Norway	-2.21	15	Luxembourg	-2.4
16	Finland	-2.23	16	Norway	-2.68
17	Luxembourg	-2.41	17	Denmark	-2.95
18	Denmark	-2.69	18	Estonia	-3.39
19	Czechia	-2.87	19	Bulgaria	-3.91
20	Estonia	-2.97	20	Hungary	-4.25
21	Bulgaria	-3.59	21	Lithuania	-4.96
22	Liechtenstein	-3.75	22	Slovakia	-4.98
23	Hungary	-3.77	23	Liechtenstein	-5.21
24	Slovakia	-4.27			
25	Lithuania	-4.57			

Source: Office for National Statistics, National Records Scotland, Northern Ireland Statistics and Research Agency, Eurostat

Notes

1. Data are provisional. Back to table

2. Calculated using age-standardised mortality rates standardised to the 2013 European standard population. Back to table

3. Relative cumulative age-standardised mortality rates (rcASMRs) are expressed as the percentage change per week in 2020 of the cumulative age-standardised mortality rate from the average annual age-standardised mortality rate in 2015 to 2019. Back to table

4. For UK countries, non-residents are excluded for figures from England, Scotland and Wales but are included for Northern Ireland. However, the numbers of non-residents included are very small. Back to table

5. Information about whether non-residents are included for countries outside the UK is not provided by Eurostat. Back to table

6. Data for the UK are based on date of registration rather than date of death, most other European countries as based on date of death. See Information tab for further details. Back to table

7. Availability of data varies by country. Data for Italy and Czechia are unavailable for Week 22 at time of writing so are not included in the right-hand columns of this table. Week 22 (week ending 29 May) is selected as a cut-off point rather than Week 24 (week ending 12 June) as data are available for more countries. Back to table

Figures 5a to 5d show rcASMRs for countries and for major cities for weeks where data are available. Lines going up mean week-on-week mortality rates above the five-year average. Lines going down mean week-on-week mortality rates below the five-year average. Once a line has gone up it can only come down again if mortality rates fall below the five-year average.

Figure 5a: By Week 22 (week ending 29 May), England had the highest relative cumulative age-standardised mortality rate in Europe

Relative cumulative age-standardised mortality rates for selected European countries

Download the data

Notes:

1. Data are provisional.

2. UK data for England, Wales and Scotland exclude non-residents whereas data for Northern Ireland include a small number of deaths from non-residents.

3. Data for the UK are based on date of registration. Most other European countries are based on date of death.

Figure 5b: By Week 22 (week ending 29 May), England had the highest relative cumulative age-standardised mortality rate in Europe

Relative cumulative age-standardised mortality rates for selected European countries

Download the data

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Figure 5c: By Week 22 (week ending 29 May), Madrid had the highest relative cumulative age-standardised mortality rate of any major city in Europe

Relative cumulative age-standardised mortality rates for selected major European cities

Download the data

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Figure 5d: By Week 22 (week ending 29 May), Madrid had the highest relative cumulative age-standardised mortality rate in any major European city

Relative cumulative age-standardised mortality rates for selected major European cities

Download the data

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2. UK data for England, Wales and Scotland exclude non-residents whereas data for Northern Ireland include a small number of deaths from non-residents.
3. Data for the UK are based on date of registration. Most other European countries are based on date of death.

From Weeks 1 (week ending 3 January) to 8 (week ending 21 February) 2020, all countries except Iceland saw improving mortality rates. For countries with the most prevalent outbreaks of COVID-19, cumulative mortality improvement accrued during the first three months of 2020 was offset by rapidly worsening mortality.

By Week 22 (week ending 29 May), the four countries with the highest cumulative excess mortality saw the respective rcASMRs: England (7.55%), Spain (6.65%), Scotland (5.11%), Belgium (3.89%). This means that, for example, by Week 22 (week ending 29 May), England had a 7.55% cumulative increase in mortality rates compared with the same point in the year for the 2015 to 2019 average. Despite Spain having the highest peak of excess mortality during Weeks 8 to 24 2020, England had higher levels of cumulative excess mortality because of longer periods of time with mortality rates above the average.

Spain also had weeks of mortality rates below the five-year average from Week 20 (week ending 15 May 2020) onwards, which decreased the rcASMR from its peak earlier in 2020.

In contrast to many Western European countries, most Eastern European countries saw an overall decline in mortality rates by Week 19 (week ending 8 May).

Table 3 shows rcASMRs by Week 22 (week ending 29 May), split into two age groups: 0 to 64 years, and 65 years and over. For ages 0 to 64 years, Table 3 shows that England had the highest percentage change by Week 22 (week ending 29 May) at 5.65%. For this age group, only the nations of the UK and Spain had values above zero by Week 22 (week ending 29 May). England’s rcASMR was 2.39 percentage points higher than Spain in this week.

For those aged 65 years and over, England also had the highest rcASMR by Week 22 (week ending 29 May). A similarly high figure was observed for Spain. For this age group, nine countries – which also include Belgium, Sweden, Netherlands and France – had values in excess of zero. Italy and Czechia have been excluded from this table as data for those countries only go up to Week 19 (week ending 8 May) and 20 (week ending 15 May) respectively.

Table 3: Relative cumulative age-standardised mortality rates (rcASMRs) for European countries, Week 22 (week ending 29 May) by age-groups 0 to 64 years and 65 years and over

Relative Cumulative Age-standardised Mortality Rates (rcASMRs) for European countries by week 22 by age-groups 0 to 64 years and 65 years and over

Week 22 order	Country	rcASMR (%), W22, ages 0 to 64 years	Week 22 order	Country	rcASMR (%), W22, ages 65 years and over
1	England	5.65	1	England	7.88
2	Scotland	3.42	2	Spain	7.34
3	Spain	2.63	3	Scotland	5.45
4	Wales	1.82	4	Belgium	5.19
5	Northern Ireland	0.63	5	Wales	2.97
6	Estonia	-0.55	6	Sweden	2.92
7	France	-1.39	7	Netherlands	2.75
8	Netherlands	-1.56	8	Northern Ireland	2.29
9	Portugal	-1.58	9	France	0.49
10	Iceland	-1.74	10	Iceland	-0.18
11	Austria	-2	11	Austria	-0.52
12	Sweden	-2.61	12	Portugal	-0.79
13	Bulgaria	-2.78	13	Switzerland	-1.67
14	Finland	-3.07	14	Finland	-2.16
15	Belgium	-3.12	15	Luxembourg	-2.21
16	Luxembourg	-3.57	16	Denmark	-2.37
17	Norway	-3.57	17	Norway	-2.56
18	Switzerland	-3.91	18	Liechtenstein	-3.67
19	Hungary	-4.36	19	Estonia	-4.09
20	Lithuania	-4.81	20	Bulgaria	-4.18
21	Slovakia	-5.12	21	Hungary	-4.23
22	Denmark	-6.37	22	Slovakia	-4.95
23	Liechtenstein	-16.52	23	Lithuania	-5

Source: Office for National Statistics, National Records Scotland, Northern Ireland Statistics and Research Agency, Eurostat

Notes

1. Data are provisional. Back to table

2. Calculated using age-standardised mortality rates standardised to the 2013 European standard population. Back to table

3. Relative age-standardised mortality rates (rASMRs) are expressed as the percentage change per week in 2020 from the average expected age-standardised mortality rate in 2015 to 2019. Back to table

4. For UK countries, non-residents are excluded for figures from England, Scotland and Wales but are included for Northern Ireland. However, the numbers of non-residents included are very small. Back to table

5. Data for the UK are based on date of registration rather than date of death, most other European countries as based on date of death. See Information tab for further details. Back to table

8 . Country comparability

Comparability of data

Because of the established system of reporting weekly mortality events in the UK, the Office for National Statistics (ONS) submits to Eurostat weekly death counts based on date of death registration rather than actual date of death (date of occurrence). Death registration counts in any given week represent between 50% and 60% of deaths that occurred in that seven-day period.

Extensive analysis by ONS has shown that by Week 3 after date of occurrence approximately 95% of occurrences will be registered. The remaining 5% may be delayed by up to one year or more because of the length of time before a coroner's hearing and subsequent report is finalised and the cause of death is registered.

Therefore, for the ONS to submit 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 blog Counting deaths involving the coronavirus (COVID-19) and article Impact of registration delays on mortality statistics in England and Wales: 2018 about registration delays.

Eurostat reports that the following countries report by date of occurrence: Belgium, Bulgaria, Czechia, Denmark, Spain, France, Italy, Lithuania (2000 to 2019 data), Luxembourg, Hungary, Austria, Portugal, Slovenia, Slovakia, Finland (2020 data), Sweden, Switzerland, Serbia, Georgia; with data referring to recent weeks may be under-reporting the actual number of deaths and they are likely to be revised.

And the following countries report by date of registration: Latvia, Lithuania (2020 data), Finland (2000 to 2019 data), UK and Armenia.

This means that any comparison of weekly deaths between the UK and its hierarchy of Nomenclature of Territorial Units for Statistics (NUTS) with other European countries should, therefore, be subject to caveats in relation to the temporal comparability for any given week. Patterns of total deaths by date of registration broadly follow those of deaths by date of occurrence but are affected by public holidays when register offices are closed.

We intend to publish a revision to this report when more data are available in the Eurostat database.

Demographic comparability

Table 4 contains a selection of European states including two non-EU states: the UK and Switzerland.

Six socio-economic and demographic variables have been selected to compare the UK's values with those of the other 9 states. The intention is to highlight countries with indicator values close to the UK's, as that may play a significant causal effect upon the scale (numbers) and spread of the coronavirus (COVID-19) during the 2020 pandemic and its impact upon cumulative excess deaths.

Belgium has values close to the UK for five out of six indicators. Spain is close to the UK for two indicators, namely: "percentage population over 65 years", and "percentage population living in "urban" areas".

France is close to the UK for two indicators, namely: "gross value added/gross domestic product (GVA/GDP) per head (2019)", and "percentage of population in "urban" areas" (Eurostat definition).

Hungary is also close to the UK for two indicators, namely: "percentage population aged over 65 years" and "percentage of elderly living in care homes".

Sweden was selected because of its governmental policy difference during the coronavirus pandemic where no mandatory lockdown was imposed upon the population, in stark contrast with most of Europe. The only Sweden indicator value close to the UK's is "percentage of elderly in care homes".

Table 4: Demographic characteristics for selected nation states

Nation State	Mortality Per 100,000 persons (2016)	Percentage Pop over 65 years	Percentage Urban Pop	Percentage Elderly in Care Homes	GDP/GVA Per head (2019)	Doctors per 1,000 pop (2018)
Ireland	n/a	14.2	63	6.6	90,141	3.07
Switzerland	630.0	18.8	74	5.7	70,485	4.3
Spain	647.2	19.6	80	1.8	41,758	3.88
Italy	649.1	23	70	1.4	43,889	3.99
France	659.4	20.4	80	4.5	47,823	3.16
Sweden	709.5	20.2	87	2.7	54,834	n/a
Belgium	740.7	19	98	4.1	53,612	3.08
Netherlands	752.5	16	91	5	59,420	3.58
UK	762.6	18.5	83	3.2	48,092	2.81
Hungary	1113.6	19.7	71	2.8	33,792	3.32

Source: Office for National Statistics, National Records Scotland, Northern Ireland Statistics and Research Agency, Eurostat

9 . 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 between populations in differing geographical areas to be made. Each measure has revealed something different about the patterns of all-cause mortality during 2020 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.

We can see from rASMRs the weeks in which the coronavirus (COVID-19) pandemic has been prolific in European countries, and how steeply numbers of deaths rose above average and then the varying speeds in which they subsequently fell following the peak weeks. It has revealed the coronavirus pandemic to have affected different countries at different points in time, some countries to have a very high peak excess mortality but a relatively short period to decrease towards average levels like Spain, Belgium and Italy, whereas others had lower peaks but have taken a longer time to return to near average levels of mortality, like the UK. It has also revealed that countries in Eastern Europe have seen little to no impact of the pandemic on all-cause mortality rates.

We are provided by rcASMRs with a year-to-date measure of excess mortality, which describe how the overall level of mortality during the year so far compares with the five-year average. This measure shows that despite Spain having the highest peak of excess mortality during Weeks 8 to 24 2020, England and the UK as a whole had higher levels of cumulative excess mortality following longer periods of time with mortality rates above the average.

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.

There are other potential statistical measures that could be used to measure excess mortality, these include P-Scores and Z-Scores. We have provided the opportunity to download tables containing analysis with a description of how the P and Z scores are calculated in the Measuring the data section. 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.

10 . Measuring the data

Data sources

All data analysed in this article are publicly available on the Eurostat website (European Union Statistics Office). The Office for National Statistics (ONS) contributes weekly counts of death registrations from all causes of death on behalf of the UK. This is combining death registration data for England and Wales held by the ONS as well as death registration data for Scotland from National Records Scotland and Northern Ireland from Northern Ireland Statistics and Research Agency.

The metadata for the weekly mortality data can be found on the Eurostat website . Each national statistical institute in the EU has been requested to provide mortality counts by week, sex, five-year age group and a geographical breakdown to NUTS3 level. Where these are not possible broader age groups or geographical areas are accepted.

At the time of this project's commencement in May 2020 there were three international online resources publishing weekly deaths for either COVID-19 deaths only, or total mortality (all causes combined). The organisations involved are as follows: Johns Hopkins University and Medicine' Coronavirus Resource Centre (JHU-CRC), European Centre for Disease Prevention and Control (ECDC), and Eurostat, the EU's central statistical agency.

Dealing firstly with the JHU-CRC, the statistics collected and published online relate to those weekly deaths identified as being caused by coronavirus (COVID-19) symptoms on the death certificate, or via a coronavirus test, if one was ever conducted for the deceased, either before death, or immediately afterwards.

Readily available international comparisons of 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. The JHU-CRC does not provide country-specific metadata on the way that COVID-19 weekly deaths are recorded or what coverage they include. In the early weeks of the pandemic, many countries were reporting hospital-based mortality only.

As has been noted elsewhere in this bulletin and by health statisticians across the globe "excess mortality" is the most robust international comparator for the coronavirus pandemic. Therefore, a reliance on the JHU-CRC's published COVID-19 deaths only, would be methodologically and statistically flawed to meet this project's terms of reference and would fail to provide policymakers with the evidence base required.

The leading source of comparisons on excess mortality in Europe has been the ECDC (EUROMOMO) system. This reports for 24 countries on a weekly basis, with the usual reporting lags. This means for many countries the latest data are estimated. The dataset only has broad age bands and lacks regional granularity -- both of which are vital to understanding the coronavirus pandemic. Additionally, the geographical coverage of the ECDC within Europe is less than that potentially available from the Eurostat Weekly Mortality Portal that includes the 27 EU States and nine non-EU states.

The Eurostat Weekly Mortality Online Database has emerged since March 2020 containing the greatest granularity of total weekly mortality, both in demographic terms, quinary deaths by gender, and geographically with published deaths by nation state and sub-nationally at NUTS 1, 2 and 3 levels. Furthermore participating European countries have supplied 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 "incremental excess mortality" during the pandemic in Weeks 1 (week ending 3 January) to 24 (week ending 12 June) of 2020.

We have therefore concluded that the Eurostat Weekly Mortality Online Database is the most robust source of published mortality statistics to conduct our Europe-wide comparisons as presented in this article.

Methodology

In this article, three measures for evaluating levels of mortality have been calculated. We have also calculated two further measures of evaluating deviations from expected levels of mortality that users may wish to use – these are P-scores and Z-scores. The following section describes how each measure is calculated.

Age-standardised mortality rates

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:

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

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,s) is the standard population for age x and sex s
- 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 January 1 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:

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

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, that is:

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

Relative age-standardised mortality rates

Relative age-standardised mortality rates (rASMRs) are weekly measures of excess mortality using age-standardised mortality rates that are standardised to the 2013 European standard population. This measure was developed by the Continuous Mortality Investigation (CMI) and was originally described in working paper 111 (PDF, 1.07MB). 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. This excess mortality is then expressed as a proportion of the five-year average ASMR for full years. The following formula is used:

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

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 to 2019

Relative cumulative age-standardised mortality rates

Relative cumulative age-standardised mortality rates (rcASMRs) were also developed by the CMI and was originally described in working paper 111 (PDF, 1.07MB). Rather than absolute values of death counts, rcASMRs sum all age-standardised mortality rates between two time points. In this article, rcASMRs are calculated cumulatively from Week 1, 2020 until Week 22, 2020 (unless otherwise specified) and are relative to the 2015 to 2019 average cumulative age-standardised mortality rate for that time period. This difference is then expressed as a percentage of the average cASMR the final week of the year in the previous five years, equivalent to the average annual rate. The following formula is used:

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

Where:

- cASMR(G,w,y) is cumulative standardised mortality rate in week w and year y, as defined previously
- $\overline{cASMR}(G, w, 2015-19)$
  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

P-scores

P-scores are weekly measures of excess mortality. Janine Aron and John Muellbauer, alongside Charlie Giattino and Hannah Ritchie (all based at University of Oxford) published a guest article on 29 June 2020 on the Our World in Data website 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 (2015 to 2019). To determine a p-score, the following formula is used:

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

Where:

- is the P-score at time point t
- (G i,2020) is the number of deaths for group G in time interval i in 2020
- DG,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 rASMR except that the p-score:

- uses deaths rather than age-standardised mortality rates, so does not control for changes in the population
- the denominator for P-scores is for the period rather than the full year

Z-scores

Z-scores are weekly measures of excess mortality. The difference in numbers of death between the weekly observed value and that expected by the five-year average is calculated. This is then divided by the standard deviation of the five-year average. The resulting Z-score in the number of standard deviations the current observed number of deaths is from the average. Z-scores can be either positive or negative. The following formula is used:

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

Where:

- z is the Z-score at time point t
- (G i,2020) is the number of deaths for group G in time interval i in 2020
- $\overline{D(G, i, 2015 - 19)}$ is the mean number of deaths for group G in time interval i in years 2015 to 2019 inclusive
- $\sigma(D(G, i, 2015 - 19))$ is the standard deviation of the number of deaths for Group G in time interval i