

Article

# Excess mortality during heat-periods: 1 June to 31 August 2022

Joint analytical article between the Office for National Statistics (ONS) and UK Health Security Agency (UKHSA) on deaths during heat-periods in 2022.



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# 1 . Collaboration

This report has been produced jointly between UK Health Security Agency (UKHSA) and the Office for National Statistics (ONS).

## 2 . Main points

- A heat-period is defined as day(s) on which a Level 3 Heat Health Alert is issued and/or day(s) when the mean Central England Temperature is greater than 20°C; between June and August 2022, there were five heat-periods that met this criterion.

### Excess mortality during heat-periods

- During the five heat-periods between June and August 2022, 56,303 deaths occurred in England and Wales and were registered by 7 September; this is 3,271 deaths (6.2%) above the five-year average.
- The 2022 heat-period with the largest number of excess deaths was the second heat-period (10 to 25 July), with 2,227 excess deaths (10.4% above average).
- The average number of deaths per day was higher for heat-period days than non-heat-period days.
- Each heat-period peak, most notably that on 19 July 2022, was followed by a fall in deaths to below the average over the following days; this suggests a short-term mortality displacement, where deaths among vulnerable individuals are 'brought forward' to within the heat-periods.
- There were more excess deaths in females (2,159) compared with males (1,115) across heat-periods in 2022, a reversal of the trend observed between 2016 and 2021; further, there were 5,017 deaths above average in those aged 70 years and over, compared with 1,749 deaths below average in those aged under 70 years.
- This analysis was compiled by the Office for National Statistics (ONS), using deaths occurrence from death registrations.

### Estimated excess mortality (excluding COVID-19) during heat-periods for those aged 65 years and over

- Across all five heat-periods of 2022, adjusting for registration delays, the estimated total excess mortality (excluding coronavirus (COVID-19)) in England was 2,803 for the most vulnerable age group (those aged 65 years and over), the highest number since the introduction of the [Heatwave plan for England](#) in 2004.
- During the peak of the second heat-period, 17 to 20 July, the estimated total excess mortality (excluding COVID-19) was 1,012 excess deaths over a period of 4 days (253 excess deaths per day) for those aged 65 years and over.
- The heat-period with the highest excess mortality (excluding COVID-19) in those 65 years and over was the fourth heat-period, 8 to 17 August, with 1,458 excess deaths over a period of 10 days (146 excess deaths per day).
- This analysis was compiled by the UK Health Security Agency (UKHSA) using a statistical model to adjust for registration delays to estimate excess mortality (excluding COVID-19) during heat-periods.

### 3 . Overview of mortality statistics and heat

Maximum temperature records were broken in the UK [summer of 2022](#). In some locations, the temperature exceeded 40°C for the first time. On 18 and 19 July, a Met Office Red Extreme Heat Weather Warning and a UK Health Security Agency (UKHSA) Level 4 Heat Health Alert were in force, both for the first time since their introduction in 2020 and 2004, respectively.

The Office for National Statistics [ONS' Opinion survey](#), between 13 and 24 April, showed that over 6 in 10 adults in Great Britain think rising UK temperatures will affect them by 2030. This is why it is important to keep investigating the impact that [climate change](#) and rising temperatures has, including its impact on mortality.

Prior to 2022, the most recent [year](#) with the highest observed mortality, as reported by UKHSA, was 2020, when the total estimated excess mortality (excluding coronavirus (COVID-19)) during heat-periods in England was estimated to be 2,556 deaths. According to the [CCRA3 Technical report](#), the number of heat-related deaths in the UK could increase to 7,040 deaths per year by 2050.

ONS reports on mortality in regular [weekly](#) and [monthly](#) releases. UKHSA reports on mortality caused by specific public health incidents, such as periods of prolonged heat, in [annual](#) reports.

As both organisations publish on mortality during heat-periods, we have combined the releases to include both organisation's statistics to give a more comprehensive picture and help users understand the difference. We welcome [feedback](#) on the approach.

Both organisations use the UKHSA definition of heat-period:

- day(s) on which a Level 3 Heat Health Alert (HHA) is issued (read more on the [alerting criteria](#)) and/or
- day(s) when the [mean Central England Temperature \(CET\)](#) is greater than 20°C

Heat-periods in 2022 were defined as:

- H1: 16 to 19 June
- H2: 10 to 25 July
- H3: 30 July to 5 August
- H4: 8 to 17 August
- H5: 23 to 25 August

These definitions include one day before and after the period identified. This is added to fully capture the impact of the heat-period associated with the initial increase in temperatures and the lag from temperature to [impact on mortality](#) respectively.

UKHSA have also analysed data for the peak of the second heat-period defined as the day(s) on which a Level 4 HHA was issued, including one day before and after the period identified.

This heat-period is defined as H2 (HHA level 4 +/- 1 day): 17 to 20 July.

This heat-period definition differs from that used by the [Met Office](#). For more information, see [Section 16: Glossary](#) of this release.

There are differences in the methods used to produce the results presented in this report. More information can be found in [Section 4: Impact of methodological differences](#) and [Section 17: Data sources and quality](#) of this release.

## 4 . Impact of methodological differences

The Office for National Statistics (ONS) measure refers to the number of deaths occurring during periods of heat (including all causes), whereas the UK Health Security Agency (UKHSA) estimated excess deaths (excluding coronavirus (COVID-19)) during heat-period figures are based on a statistical model. This makes an adjustment to account for registration delays. Interpretation of the analysis presented in this report should consider these differences in methodology. The main criteria are:

Excess mortality during heat-periods

- the deaths registered in England and Wales
- all ages and broad age-group
- all causes (combined and break down)
- deaths that occurred and were registered by 7 September 2022
- uses the five-year average as a baseline, or the preceding and subsequent days relative to the number of heat-period days.

Estimated excess mortality (excluding COVID-19) during heat-periods

- the deaths registered in England
- aged 65 years and over
- removes deaths that tested positive for coronavirus (COVID-19)
- adjusts the number of deaths registered by 13 September 2022 to account for registration delays
- uses a +/- two-week baseline (average daily deaths excluding COVID-19 across the 14 non-heat-period days before and after each heat-period)

Excess mortality during heat-periods gives an overall picture of how mortality changed during heat-periods across England and Wales. It provides information on causes, ages, and geographies most impacted.

The estimated excess mortality (excluding COVID-19) during heat-periods measures estimates how many deaths in the most vulnerable group (aged 65 years and over) occurred in England. This measure includes an adjustment for the number of deaths that are not yet known due to registration delays.

## 5 . Excess mortality during heat-periods, England and Wales (ONS analysis)

Sections 6 to 10 cover analysis produced by the Office for National Statistics (ONS).

## 6 . Mortality and registration delays

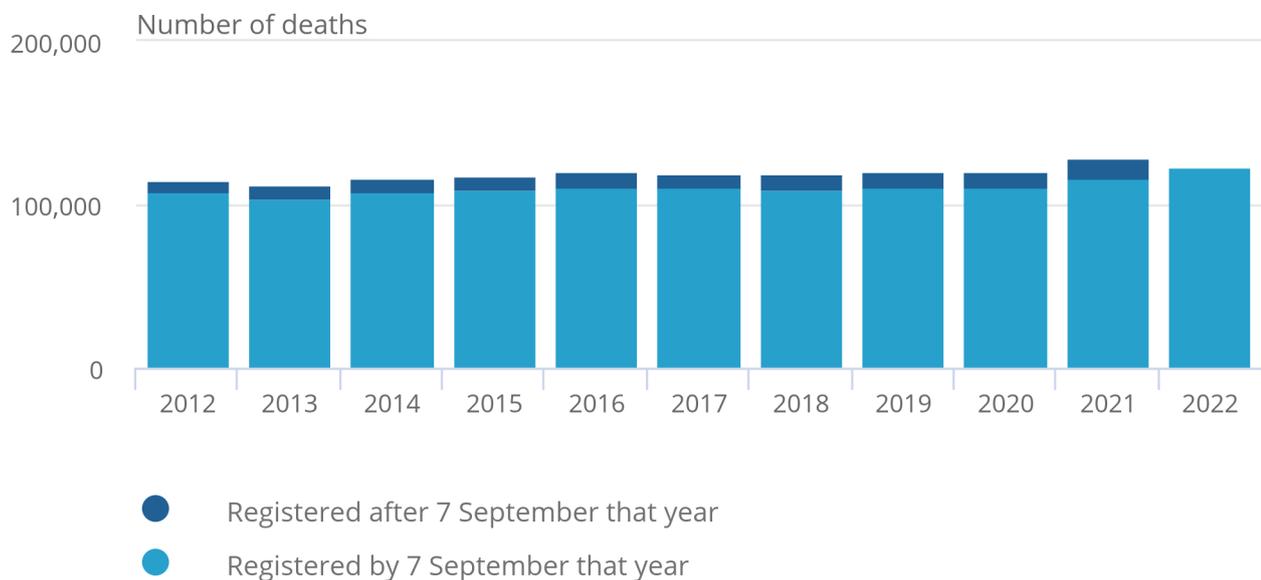
Registration delay is the difference between when the death occurred and was registered. The majority of deaths are registered within seven days ([75.2% in 2020](#)). More information can be found in the Office for National Statistics' (ONS) [Impact of registration delays on mortality statistics in England and Wales](#) release. Figures 1a and 1b show that the ONS expects to have most death occurrences between June and August 2022 already registered by the ONS cut-off point of 7 September 2022.

### Figure 1a: Most deaths that occurred between June and August are registered by 7 September that year

Number of deaths that occurred in June to August by registration date, England and Wales, 2012 to 2022

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Number of deaths that occurred in June to August by registration date, England and Wales, 2012 to 2022



Source: Office for National Statistics

#### Notes:

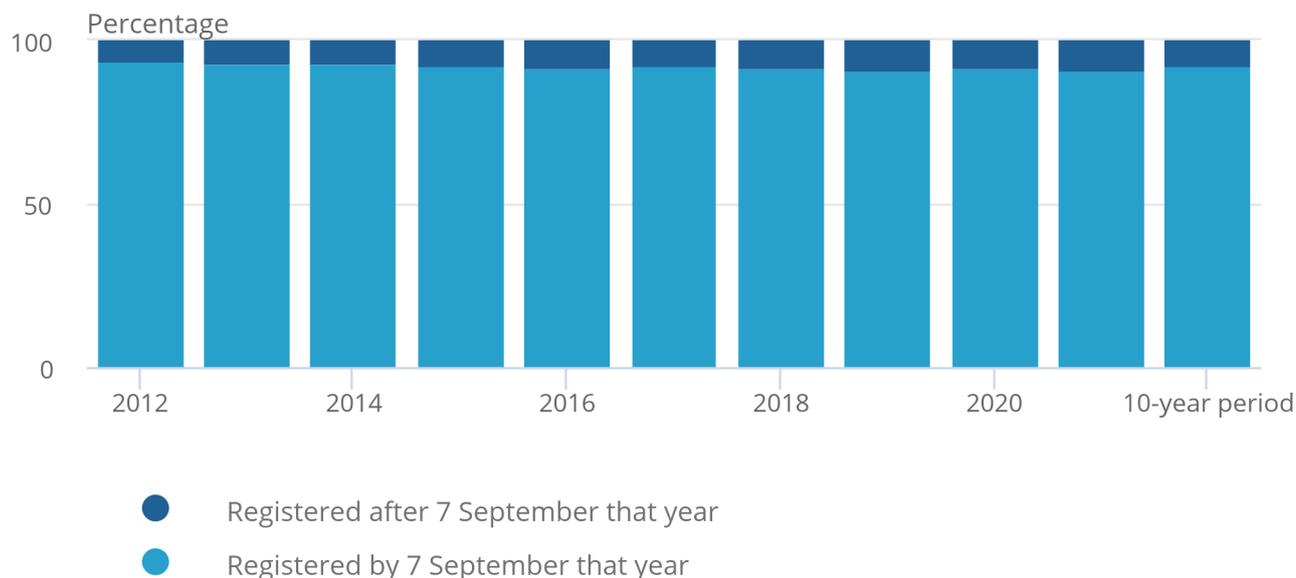
1. Figures are for death occurrences, registered up to 7 September 2022. Death occurrences will increase as more deaths are registered, particularly for later dates.
2. Figures include non-residents.

## Figure 1b: Over 90% of deaths that occur in June to August are registered by 7 September that year

Percentage of deaths that occurred in June to August that were registered by 7 September in each year, England and Wales, 2012 to 2021

### Figure 1b: Over 90% of deaths that occur in June to August are registered by 7 September that year

Percentage of deaths that occurred in June to August that were registered by 7 September in each year, England and Wales, 2012 to 2021



Source: Office for National Statistics

#### Notes:

1. Figures are for death occurrences, registered up to 7 September 2022. Death occurrences will increase as more deaths are registered, particularly for later dates.
2. Figures include non-residents.

Looking at the ten-year average, the ONS expect 7.7% of deaths have not yet been registered. Areas where registration delays will cause a substantial effect have been highlighted.

## 7 . Excess mortality during heat-periods, 2016 to 2022

Figure 2: Daily death occurrences are higher on heat-period days than non-heat-period days

Average number of daily deaths occurring on heat-period and non-heat-period days, June to September 2016 to 2021 and June to August 2022, England and Wales

#### Notes:

1. Figures are for death occurrences, registered up to 7 September 2022. Death occurrences will increase as more deaths are registered, particularly for later dates.
2. Figures include non-residents.
3. Dates of heat-period days are included in the [Glossary section](#).

#### Download the data

[.xlsx](#)

From June to September each year, the average number of deaths per day was higher on heat-period than non-heat-period days. This was largest in 2021 (191 more deaths on heat-period than non-heat-period days on average) which saw a record high temperature of 32.2°C on 22 July 2021. Data for 2022 are to August and subject to registration delays. While ONS expect around 92.3% of deaths occurring during this time have been registered (based on 2012 to 2021), comparisons of 2022 with previous years should be treated with caution.

#### **Figure 3: Daily death occurrences increase during heat-periods, followed by a sharp decrease**

#### **Number of daily death occurrences, five-year average and heat-period days, 1 June to 31 August 2022, England and Wales**

##### **Notes:**

1. Figures are for death occurrences, registered up to 7 September 2022. Death occurrences will increase as more deaths are registered, particularly for later dates.
2. Figures include non-residents.
3. Dates of heat-period days are included in the [Glossary section](#).
4. The 2016 to 2019 and 2021 five-year average has been provided for 2022, because of the impact of the coronavirus pandemic on deaths occurring in 2020. For more information see [Understanding excess deaths during a pandemic](#).

## Download the data

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In June to August 2022, 56,303 deaths occurred during heat-periods in England and Wales and have been registered so far. Of these, 52,648 deaths occurred in England and 3,535 occurred in Wales. Of all deaths in England and Wales which occurred during heat-periods in 2022, 27,799 were males and 28,504 were females, 10,655 were among people aged under 70 years, whereas 45,648 were people aged 70 years and over.

To date, 3,271 excess deaths have been recorded during heat-periods in 2022 in England and Wales. This is an average of 82 excess deaths per day, and 6.2% higher than the five-year average. The heat-period with the largest number of excess deaths was H2 (10 to 25 July) with 2,227 excess deaths (10.4% above average), an average of 139 excess deaths per day.

Excluding H5 heat-period (23 to 25 August) (which registration delays will have an impact on), H3 (30 July to 5 August) had the lowest number of excess deaths, with 10 deaths (0.1% above average).

From 2016 to 2021, deaths were above the five-year average in every heat-period, with a total of 12,598 excess deaths (9.3% above average, 119 average excess deaths per day). Across the 2016 to 2021 heat-periods, excess deaths ranged from 3.0% (2 to 9 August 2018) to 27.7% (6 to 9 September 2021) above the five-year average.

In England, from 2016 to 2021, observed deaths were above the five-year average in every heat-period, with excess deaths ranging from 149 (28 to 30 June 2019) to 1,858 (16 to 23 July 2021). This was not the case for Wales, where excess ranged from 29 deaths below average (2 to 9 August 2018) to 185 deaths above average (16 to 23 July 2021), however this could be because the heat-period definition is based on temperatures in England, which may differ to Wales.

All heat-periods (2016 to 2022) show a peak in excess deaths, most notably on 19 July 2022, which were followed by a decrease in deaths to below average in the following days. This suggests 'mortality displacement', where a period of high mortality can be followed by below-average mortality, due to deaths among vulnerable individuals being 'brought forward'. For more information, see [Excess mortality and mortality displacement in England and Wales](#).

Despite peaks in mortality during heat-periods, the majority of days in the winter period (December to March) show a higher number of deaths than during heat-periods, as demonstrated in Figure 3a of ONS' [excess winter mortality](#) report.

## 8 . Characteristics of excess deaths during heat-periods

### Sex

**Figure 4: Excess death occurrences are generally higher in males than females during heat-periods**

**Percentage of excess deaths above average by sex, 2016 to 2022 heat-periods, England and Wales**

**Notes:**

1. Figures are for death occurrences, registered up to 7 September 2022. Death occurrences will increase as more deaths are registered, particularly for later dates.
2. Figures include non-residents.
3. Dates of heat-period days are included in the [Glossary section](#).
4. Excess deaths are the number of observed deaths above average (the five-years prior to the observed year). The 2016 to 2019 and 2021 five-year average has been provided for 2022, because of the impact of the coronavirus pandemic on deaths occurring in 2020. For more information see [Understanding excess deaths during a pandemic](#).

#### Download the data

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In 2022, in England and Wales, females had a higher number of excess deaths than males in four of the five heat-periods. This is possibly due to a displacement effect, as [2021 saw more male death registrations](#) compared with females for only the second time in our series. The biggest difference was seen in H2 (10 and 25 July), which recorded 1,375 excess deaths among females and 853 in males (12.9% and 7.9% above expected, respectively). Like previous years, H3 (30 July to 5 August) recorded 22 deaths (0.5%) fewer than average for females, compared with 31 above average for males (0.7%).

Across the 2016 to 2021 heat-periods, more excess deaths occurred in males than females (7,022 and 5,570 respectively). The heat-period with the largest excess deaths for both males and females was 16 to 23 July 2021, with 1,109 and 921 excess deaths respectively. The largest difference in excess deaths between sexes was between 30 June and 10 July 2018, where there were 333 more excess deaths among males than females.

## Age

Because of the difference in the expected number of deaths in each age group, it is important to look at proportional excess (number of deaths above or below average as a percentage of the average) as well as number of deaths.

### Figure 5: Daily excess death occurrences are higher during heat-periods in people aged 70 years and over, compared with people aged under 70 years

#### Proportion of daily excess death occurrences by broad age group, 1 June to 31 August 2022, England and Wales

##### Notes:

1. Figures are for death occurrences, registered up to 7 September 2022. Death occurrences will increase as more deaths are registered, particularly for later dates.
2. Figures include non-residents.
3. Dates of heat-period days are included in the [Glossary section](#).
4. Excess deaths are the number of observed deaths above the five-year average. The 2016 to 2019 and 2021 five-year average has been provided for 2022, because of the impact of the coronavirus pandemic on deaths occurring in 2020. For more information see [Understanding excess deaths during a pandemic](#).

## Download the data

[.xlsx](#)

In England and Wales, deaths in people aged under 70 years were 1,749 below the average for that age group across the 2022 heat-periods. Deaths in people aged 70 years and over were 5,017 above average across the 2022 heat-periods. The first four heat-periods saw excess mortality, whereas H5 (23 to 25 August), so far, has seen 245 deaths (8.0%) below average in this age group. This is likely because of registration delays and should be treated with caution. These trends are generally seen in England and Wales separately.

Across the 2016 to 2021 heat-periods, there were a total of 1,954 excess deaths in people aged under 70 years. The highest excess in this age group was from 6 to 9 September 2021, at 25.9% above average. The lowest excess was from 28 to 30 June 2019, at 1.0% below average.

For people aged 70 years and over, a total of 10,649 excess deaths occurred in heat-periods from 2016 to 2021. The highest excess in this age group was also between 6 and 9 September 2021, at 28.3% above average. The lowest was between 12 to 17 September 2016, at 2.9% above average.

Across all heat-periods, two had greater proportional excess deaths in people aged under 70 years than people aged 70 years and over; this was 22 to 26 August 2016 (10.4% and 10.2% above average, respectively), and 12 to 17 September 2016 (5.6% and 2.9% above average, respectively).

## 9 . Excess deaths in heat-periods by underlying causes of death

Figure 6 shows the top leading causes of excess mortality in England and Wales across summer 2022. This analysis compared the number of deaths by cause in the combined 2022 heat-periods with the number of deaths observed in the corresponding number of preceding and succeeding days, as opposed to the five-year average (which can be found in the [accompanying dataset](#)).

**Figure 6: In 2022 heat periods, deaths due to the top ten leading causes of excess death generally increased, before declining in the following days**

**Number of deaths that occurred before, during and after heat-periods for the leading causes of excess death, June to August 2022 heat-periods, England and Wales**

### Notes:

1. Figures are for death occurrences, registered up to 7 September 2022. Death occurrences will increase as more deaths are registered, particularly for later dates.
2. Figures include non-residents.
3. Deaths during heat-periods include all 2022 heat-periods, and deaths before and after heat-periods refer to the corresponding number of preceding and succeeding days. Dates are included in the [Glossary section](#).
4. This breakdown includes some duplicated deaths due to the overlapping nature of the relevant time periods in June to August 2022.

## Download the data

[.xlsx](#)

Deaths due to dementia and Alzheimer's disease was the leading cause of excess deaths in England and Wales during 2022 heat-periods. This cause also had the highest number of deaths increase between the days preceding the heat-periods (6,304 deaths) and the days of the heat-periods (6,800 deaths), at 496 more deaths. It was also the cause with the greatest decrease in deaths in the days after the heat-periods (6,198 deaths), at 602 fewer deaths than during the heat-period. This is likely because this cause mostly affects those in older age groups and are among those [most at risk during heat-periods](#).

The leading cause of excess deaths with the largest proportional change of deaths during the heat-periods, compared with the preceding days, was in deaths due to cardiac arrhythmias (816 deaths before, compared with 958 deaths during heat-periods, a 17.4% increase). This cause also had the greatest decrease in deaths after heat-periods, at 20.6% (761 deaths after heat-periods). This is possibly because hot weather can cause [overheating, which may make symptoms worse for people who already have problems with their heart or breathing](#).

The trends for England and Wales combined also hold for England separately. Differences in Wales were that in-situ and benign neoplasms, and neoplasms of uncertain or unknown behaviour was the cause with the largest percentage increase compared with the days prior to the heat-period. Malignant neoplasm of kidney had the largest percentage decrease after the heat-period.

Numbers by leading cause of death (as opposed to leading causes of excess deaths mentioned above) can be found in the [accompanying dataset](#).

## 10 . Excess deaths during heat-periods by place of occurrence

From June to August 2022, deaths occurring in hospitals were 5.8% above average on heat-period days compared with 4.5% below average on non-heat-period days. Deaths occurring in care homes were also above average on heat-period days (9.2% above average) and below average on non-heat-period days (0.2% below average).

Deaths in private homes were the only place of occurrence where deaths were above average on both heat-period days and non-heat-period days, although proportions were still greater on the former (11.6% and 3.7% above average, respectively). For all other place of occurrences, deaths were below average during both heat-periods and non-heat-periods.

Throughout the coronavirus (COVID-19) pandemic, deaths in private homes have been consistently above average. For more information, see [Deaths registered in private homes, England and Wales article](#).

Between 2016 to 2021, deaths occurring in hospitals, private homes and hospices had similar patterns to 2022. Deaths in care homes were above average on heat-period days and non-heat-days (11.9% and 1.6% above average respectively). Deaths occurring in other communal establishments had a 13.2% excess on heat-period days, compared with 3.4% below average on non-heat-period days, and deaths elsewhere were substantially above average on both heat-period and non-heat-period days (23.6% and 14.5%, respectively).

Trends mentioned above hold for England but differ for Wales. Information for Wales can be found in the [accompanying dataset](#).

This analysis does not look at both place of death and cause, the number of deaths involving COVID-19 by place of occurrence can be found in ONS' [weekly tables](#).

## **11 . Estimated excess mortality (excluding COVID-19) during heat-periods, England (UKHSA analysis)**

Sections 12 to 13 cover analysis produced by the UK Health Security Agency (UKHSA).

## 12 . Estimated excess mortality (excluding COVID-19) during heat-periods

These statistics were compiled by the UK Health Security Agency (UKHSA) and relate to England and aged 65 years and over, the most vulnerable age group.

UKHSA has previously published figures for excess mortality during heat-periods for 2020 to 2021 in the [Heat mortality monitoring reports](#). Previous years were published by [Public Health England \(PHE\)](#).

The highest levels of estimated excess mortality during heat-periods in those aged 65 years and over since [the Heatwave plan for England](#) was first introduced in 2004, were in 2006 (2,323) and 2020 (2,244). Total excess mortality during heat-periods in other years were estimated as 1,634 in 2021, 892 in 2019, 863 in 2018, and 778 in 2017.

All UKHSA analysis uses a statistical model to adjust for registration delays in the death occurrences data to estimate excess mortality (excluding coronavirus (COVID-19)) during heat-periods for those aged 65 years and over.

Across the five heat-periods of 2022, the total estimated excess mortality (excluding COVID-19) during heat-periods in those aged 65 years and over was estimated to be 2,803, the highest number in any given year. During the peak of the second heat-period, H2 (17 to 20 July) (HHA level 4 +/- 1 day), the estimated excess mortality (excluding COVID-19) in those aged 65 years and over was 1,012 excess deaths over a period of 4 days (253 excess deaths per day). The heat-period with the highest estimated excess mortality (excluding COVID-19) in those aged 65 years and over was H4 (8 to 17 August) with 1,458 excess deaths over a period of 10 days (146 excess deaths per day).

Table 1: The estimated excess mortality (excluding COVID-19) during heat-periods of those aged 65 years and over varied across heat-periods in 2022

Estimated excess mortality (excluding COVID-19 and adjusted for registration delays) during heat-periods for ages 65 years and over in 2022, England

Heat-periods	Dates	Estimated excess mortality (excluding COVID-19) during heat-periods, people aged 65 years and over (adjusted for registration delays). Excess estimate (95% CI)
H1	16 to 19 June	219 (-2; 440)
H2	10 to 25 July	1,207 (664; 1,750)
H2 (HHA level 4 +/- 1 day)	17 to 20 July	1,012 (774; 1,251)
H3	30 July to 5 August	-104 (-428; 220)
H4	8 to 17 August	1,458 (1,016;1,900)
H5	23 to 25 August	23 (-180;227)

Source: UK Health Security Agency

#### Notes

1. Excess mortality is defined as the difference between the estimated mortality (excluding COVID-19) during heat-periods (adjusting for registration delays) and the +/- two-week baseline for each heat-period.
2. The +/- two-week baseline is defined as average daily deaths excluding COVID-19 using up to a maximum of 14 non-heat-period days before and after each heat-period as long as within +/- 21 days of the heat-period. Because the most recent data are less complete for heat periods H4 only 5 days were used and for H5 no days were used. In practice, this meant that the number of baseline non-heat-period days used for each heat-period before and after were as follows: H1: 14&14, H2: 14 & 6, H3: 4 & 7, H4:6 & 5, H5:7 & 0.
3. 95% Confidence Interval (CI) based on normal approximation of an over-dispersed Poisson with over-dispersion parameter calculated at 1.8 from the variability in non-heat-periods.
4. COVID-19 deaths (defined as COVID-19 deaths within 28 days of a positive test) have been removed from this analysis.
5. This analysis uses a statistical model to adjust for registration delays.
6. The excess estimate for H2 (HHA level 4 +/- 1 day) is included in the excess estimate for H2 and so must be removed when calculating the total annual excess estimate across all five heat-periods.
7. Heat-periods above include one day before and after the time period identified; for more information see the Overview of mortality statistics and heat section.

Throughout July and August 2022, deaths (adjusted for registration delays) were higher than the five-year baseline (defined as average daily deaths across the same day and the 14 days before and after in 2015-2019). This data can be found in the [accompanying dataset](#).

This was more pronounced during heat-periods as shown in Figure 7, when estimates excess mortality (excluding COVID-19) was higher than the +/- two-week baseline (defined as average daily deaths excluding COVID-19 across the 14 non-heat-period days before and after each heat-period).

#### **Figure 7: The estimated excess mortality (excluding COVID-19) during heat-periods of those aged 65 years and over was higher than the +/- two-week baseline**

**Estimated excess mortality (excluding COVID-19 and adjusted for registration delays) for aged 65 years and over in 2022 compared to +/- two-week baseline deaths for each heat-period, England**

## Notes:

1. This analysis uses a statistical model to adjust for registration delays.
2. The +/- two-week baseline is defined as average daily deaths excluding COVID-19 using up to a maximum of 14 non-heat-period days before and after each heat-period as long as within +/- 21 days of the heat-period. Because the most recent data are less complete for heat periods H4 only 5 days were used and for H5 no days were used. In practice, this meant that the number of baseline non-heat-period days used for each heat-period before and after were as follows: H1: 14&14, H2: 14 & 6, H3: 4 & 7, H4:6 & 5, H5:7 & 0.
3. The mean central England temperature (CET) is shown as a solid aqua line and uses the secondary vertical axis on the right of the chart.

## Download the data

[.xlsx](#)

The Office for National Statistics (ONS) analysis in [Section 8: Characteristics of excess deaths during heat-periods](#) refers to the number of deaths by age and sex occurring during periods of heat (including all causes). UKHSA plans to analyse excess mortality for 2022 by age, sex and region using a statistical modelling approach. UKHSA also intends to further explore the link between COVID-19 and exposure to heat. For more information see [Section 13: Limitations in interpreting estimated excess mortality during heat-period figures in light of COVID-19](#). Results of this analysis will be included in the annual report, which will be published in early 2023.

## 13 . Limitations in interpreting estimated excess mortality during heat-period figures in light of COVID-19

When interpreting estimates of all-cause heat-related excess mortality during heat-periods, it is helpful to consider:

- mortality rates (coronavirus (COVID-19) and non-COVID-19) were increasing before the heat-periods occurred and daily mortality rates remained elevated during less warm temperatures after the heat-periods; the excess mortality during Autumn and Summer 2021 and Spring and Summer 2022 was above the five-year average, even when temperatures were typical for England.
- more investigation is needed on what is causing these mortality patterns over this period, for example: a possible link between COVID-19 and exposure to heat, even at relatively mild elevated levels of heat exposure.
- other possible mortality causes, such as non-COVID-19 infectious diseases, have not yet been studied in this analysis.

The link between COVID-19 and exposure to heat is still being studied. For example, on 19 July (the peak of the second heat-period and a day when a Level 4 Heat Health Alert was issued), UKHSA observed 113 more deaths across all age groups within 28 days of a positive COVID-19 test compared with the 7-day average. More information can be found in the government's [Deaths in England - Coronavirus in the UK page](#).

2022 is the third year in which the concurrent risks of heat and COVID-19 have overlapped, possibly amplifying the observed impacts of extreme heat. To approve the current approach further, UKHSA is developing a new methodology to estimate both the acute impacts as a result of extreme heat and the impacts observed during less extreme hot weather periods in England, to provide an estimate of the effects of high ambient temperatures on excess mortality.

A more detailed UKHSA heat mortality monitoring report will be published in 2023. It will address some of the challenges mentioned above and provide a more detailed and disaggregated analysis of estimated excess mortality during heat-periods. Results of similar analysis for 2020 to 2021 are available in the [Heat mortality monitoring reports](#). Earlier years were published by [Public Health England](#).

## 14 . General information

The remaining sections relate to both Office for National Statistics (ONS) and UK Health Security Agency (UKHSA) analysis.

## 15 . Excess mortality during heat-periods data

[Excess mortality during heat-periods, England and Wales \(ONS\)](#)

Dataset | Released 7 October 2022

Provisional data on death occurrences in England and Wales, broken down by sex, age, geography and time. Includes comparisons of numbers of deaths and excess deaths.

[Estimated excess mortality \(excluding COVID-19\) during heat-periods, England \(UKHSA\)](#)

Dataset | Released 7 October 2022

Provisional data on excess mortality (excluding COVID-19) during heat-periods in the 65 years and over age group estimates in England, including the estimated number of deaths where the death occurred within 28 days of a positive COVID-19 result and the mean central England temperature.

## 16 . Glossary

### 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 coronavirus (COVID-19) disease is available from the WHO.

### Registration delay

Mortality statistics are compiled from information supplied when deaths are certified and registered as part of civil registration, a legal requirement. According to the Births and Deaths Registration Act 1953, a death should be registered within five days unless it is referred to a coroner for investigation. Mortality statistics for a given period can be based on occurrence (death date) or registration (registration date); registration delay is the difference between date of occurrence and date of registration.

### Heatwave (Met Office)

A UK heatwave threshold is met when a location records a period of at least three consecutive days with daily maximum temperatures meeting or exceeding the heatwave temperature threshold. The threshold varies by UK county.

### Heat-period

Both the Office for National Statistics and UK Health Security Agency (UKHSA) use the UKHSA definition of a heat-period, which is:

- day(s) on which a Level 3 Heat Health Alert (HHA) is issued (read more on the [alerting criteria here](#)) and/or
- day(s) when [the mean Central England Temperature \(CET\)](#) is greater than 20°C

In addition, the preceding and subsequent days to those identified using the definitions above were included as part of the heat-period in the analyses.

The following heat-periods for 2022 have been used for both UKHSA and ONS analysis:

- H1: lasted 4 days (16 to 19 June) during which the East of England, Southeast England and London were at HHA Level 3.
- H2: lasted 16 days (10 to 25 July) during which time all regions of England were at HHA Level 3 (between 10 and 22 July), and the CET exceeded 20°C on 24 July. This includes an extreme heat episode which lasted 4 days (17 to 20 July), during which time all regions of England were at HHA Level 4.
- H3: lasted 7 days (30 July to 5 August), when the CET exceeded 20°C on 31 July, 2 August and 3 August.
- H4: lasted 10 days (8 to 17 August), during which time all regions of England were at HHA Level 3.
- H5: lasted 3 days (23 to 25 August), when the CET exceeded 20°C on 24 August.

In addition, the following heat-periods have been used in this article by ONS, and can be found in UKHSA's (previously Public Health England (PHE)) [heatwave mortality monitoring](#):

- 18 to 22 July 2016
- 22 to 26 August 2016
- 12 to 17 September 2016
- 17 to 23 June 2017
- 5 to 7 July 2017
- 25 to 27 June 2018
- 30 June to 10 July 2018
- 21 to 29 July 2018
- 2 to 9 August 2018
- 28 to 30 June 2019
- 21 to 28 July 2019
- 23 to 29 August 2019
- 23 to 27 June 2020
- 30 July to 1 August 2020
- 5 to 15 August 2020
- 16 to 23 July 2021
- 6 to 9 September 2021

## Deaths before heat-periods

Refers to the number of deaths occurring in the days before the heat-period, respective to the number of days of the heat-period. Because of the overlapping nature of these periods, some days before heat-periods may include days of another heat-period. Before heat-period days in 2022 are defined as:

- 12 to 15 June (H1; 4 days)
- 24 June to 9 July (H2; 16 days)
- 23 to 29 July (H3; 7 days)
- 29 July to 7 August (H4; 10 days)
- 20 to 22 August (H5; 3 days)

## Deaths after heat-periods

Refers to the number of deaths occurring in the days after the heat-period, respective to the number of days of the heat-period. Because of the overlapping nature of these periods, some days after heat-periods may include days of another heat-period. After heat-period days in 2022 are defined as:

- 20 to 23 June (H1; 4 days)
- 26 July to 10 August (H2; 16 days)
- 6 to 12 August (H3; 7 days)
- 18 to 27 August (H4; 10 days)
- 26 to 28 August (H5; 3 days)

## 17 . Data sources and quality

This article provides surveillance of mortality in England and Wales, based on the best available provisional data.

Death occurrences show the number of deaths that occurred within a period and give a better indication of exactly when deaths were at their highest. This allows mortality to be related to other factors, such as weather patterns.

When a death is registered, a copy of the death certificate is sent from the General Registrars Office (GRO) to the Office for National Statistics (ONS) and UK Health Security Agency (UKHSA) where the information is processed, quality assured and analysed.

At ONS, a provisional extract of death registrations and death occurrences data is taken on the first working day after the eighth of the month, to allow time for deaths to be registered. For more detail on the data sources used, see [ONS' Coronavirus and mortality in England and Wales methodology article](#).

UKHSA receives deaths that are registered in GROs in England, therefore all deaths for England will be those registered in England. ONS use postcode of residence to distinguish between England and Wales. England and Wales separately do not sum to the England and Wales total as these includes death that were registered in England and Wales, but the residence is elsewhere.

Both organisations use the information recorded when deaths are certified and registered, but have differences in how these are used.

# Comparison of methodology

## Data Criteria

Both organisations used date of occurrence of death (not date of death registration as is normally used by ONS) for this analysis.

ONS used deaths that occurred between 1 June to 30 September 2016 to 2021, and 1 June to 31 August 2022 that were registered by 8 September 2022. June was used as the start as it had the first heat-period in 2022 and 2016 is the start of the most recent five-year average.

UKHSA used deaths that occurred between 1 May and 31 August 2022, with the same dates for 2015 to 2019 to provide a non-pandemic baseline. For the period 1 May and 31 August 2022, deaths registered until the 13 September were included. An [adjustment](#) was applied to the number of deaths to account for unknown deaths because of [registration delays](#). The analysis also excludes deaths within 28 days of a positive coronavirus (COVID-19) test. The information in this release is based on those aged 65 years and over, as previous analysis shows those at older ages are most at risk.

## Excess measure

ONS has two comparisons for looking at the number of excess deaths during heat-periods. We compare the number of deaths on specific days to the corresponding five-year average, which is our standard measure when calculating excess. We also compare the number of deaths during the heat-period with the period pre- and post-event. For example, if a heat-period lasts three days we would compare deaths on those three days, with three days before and three days after. As ONS does not adjust the number of deaths, it is important to remember that not all deaths that occurred during the most recent heat-periods will be registered. ONS does not remove deaths involving COVID-19 from the statistics, however the number of deaths due to COVID-19 (as recorded on the death certificate) can be found in the [accompanying dataset](#).

UKHSA compare the number of deaths during a heat-period to the average of the 14 non-heat-period days before and 14 non-heat-period after the heat-period (provided these days are within 21 days of the heat period), and to the historic baseline of 2015 to 2019. This is done for deaths including and excluding those that died within 28 days of a positive COVID-19 test. UKHSA model uncertainty based on two baseline methods and inclusion and exclusion of COVID-19 deaths. 95% confidence intervals are based on the normal approximation to over-dispersed Poisson with over dispersion based on mean and variance of deaths (after subtraction of COVID-19 deaths within 28 days of a positive test) on non-heat-period days since 1 May 2022. For example, if over dispersion is two and mean count in a period of interest of length five days is 1000 then the standard deviation for this mean is  $\sqrt{(1000 \cdot 2) / 5}$ . For excess estimates, two means are compared (mean during heat-period with mean in baseline) so the standard deviation for the difference between these means is used. More information can be found in [Methods for modelling excess mortality across England during the COVID-19 pandemic](#).

## Organisational remit

ONS is a Non-Ministerial Department reporting to Parliament, which means that it is part of the Civil Service but independent of political decisions. The responsibility to produce mortality statistics falls to ONS, which is required to produce an annual abstract of mortality statistics so that the Minister for the Cabinet Office can lay it before Parliament. Mortality statistics published by the ONS cover deaths that occurred in England and Wales (the legal remit of the ONS). More information can be found in [Mortality statistics in England and Wales QMI](#) and the [User Guide to Mortality Statistics](#).

UK Health Security Agency (UKHSA) is an Executive Agency of the Department of Health and Social Care, and responsible for preparing for, preventing, and responding to threats to health. Its responsibilities are for England, across the UK on reserved health matters, and in partnership with lead agencies in Scotland, Wales and Northern Ireland on devolved issues where relevant. UKHSA provides intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation's health secure. The UKHSA collects and publishes statistics related to planning, preventing, and responding to external health threats. More information can be found in [Statistics at UKHSA](#).

## 18 . Strengths and limitations

Mortality data give complete population coverage. They ensure the estimates are of high precision and representative of the underlying population at risk. However, because of registration delays, monthly death occurrence data are always somewhat incomplete. This is especially true for deaths that occurred towards the end of the month.

More quality and methodology information on strengths, limitations, appropriate uses, and how the data were created is available in the Office for National Statistics' (ONS) [Mortality statistics in England and Wales QMI](#) and the [User Guide to Mortality Statistics](#).

## 19 . Related links

### [Deaths registered weekly in England and Wales](#)

Bulletin | Released weekly

Provisional counts of the number of deaths registered in England and Wales, including deaths involving coronavirus (COVID-19), in the latest weeks for which data are available.

### [Monthly mortality analysis](#)

Bulletin | Released monthly

Provisional death registration data for England and Wales, broken down by sex, age and country. Includes deaths due to coronavirus (COVID-19) and leading causes of death.

### [Excess mortality and mortality displacement in England and Wales: 2020 to mid-2021](#)

Article | Released 15 October 2021

Deaths registered in England and Wales by week, from 28 December 2019 to 2 July 2021. Breakdowns include country, sex, age group, region, place of death, and leading cause. Includes analysis of excess deaths and relative cumulative age-standardised mortality rates.

### [Deaths registered in private homes, England and Wales: 2020 final and January to June 2021, provisional](#)

Article | Released 10 November 2021

Deaths registered in private homes by age, sex, place of occurrence and selected underlying causes of death and the leading causes of death.

### [Heat mortality monitoring report: 2021](#)

Web page | Released 17 May 2022

### [Heat mortality monitoring report: 2020](#)

Web page | Released 17 May 2022

### [Public Health England Heat mortality monitoring reports: 2016-2019](#)

Web page | Released 7 January 2020

Reports on the surveillance of excess mortality during periods of heatwave.

### [UKHSA National flu and COVID-19 surveillance reports: 2022 to 2023 season](#)

Web page | Released 29 September 2022

National influenza and COVID-19 report, monitoring COVID-19 activity, seasonal flu and other seasonal respiratory illnesses.

### [Climate change insights, families and households, UK: August 2022](#)

Article | Released 12 August 2022

Quarterly publication bringing together the latest climate change-related statistics and analysis from a range of sources.

### [Heatwave Plan for England](#)

Web page | Released 28 July 2022

The Heatwave Plan for England aims to prepare, alert and prevent people from the preventable health impacts from severe heat in England.

## 20 . Cite this release

Office for National Statistics (ONS), released 7 Month 2022, ONS website, statistical article, [Excess mortality during heat-periods: 1 June to 31 August 2022](#)

