Statistical bulletin

Climate-related mortality, England and Wales: 1988 to 2025

Relative risk of all-cause mortality and estimated deaths associated with the hottest and coldest days for regions of England, and Wales from 1988 to 2025.

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1 . Main points

- An estimated 40,063 deaths (95% confidence interval: 27,942 to 51,656) in England and 2,070 deaths (95% confidence interval: 1,067 to 2,938) in Wales were associated with the hottest days between 1988 and 2025.
- An estimated 138,944 deaths (95% confidence interval: 121,058 to 156,019) in England and 10,098 deaths (95% confidence interval: 8,745 to 11,489) in Wales were associated with the coldest days between 1988 and 2025.
- Historically, more deaths were associated with the coldest temperatures than the hottest; the proportion of deaths associated with the hottest days has increased in recent years, and the gap between heat- and cold-related deaths is narrowing.
- Relative mortality risk and the corresponding impact of temperature-related mortality varied geographically; London had the highest proportion of deaths attributable to both the hottest and coldest days.
- People aged 65 years and over showed increased vulnerability to both the hottest and coldest temperatures; significantly higher mortality impacts were associated with the coldest temperatures in people aged 65 years and over, compared with those aged under 65 years.
- The hottest and coldest 2.5% of days across the time series, where mortality risk increased, corresponded to temperatures higher than approximately 19 degrees Celsius and lower than approximately 0 degrees Celsius, respectively; these temperatures can change depending on region or demographic group.

These are official statistics in development. Read more in Section 9: Data sources and quality.

2 . Temperature-related mortality risk

The impacts of temperatures on human health are of global concern. Although higher numbers of deaths in England and Wales are historically associated with colder temperatures, the Met Office's UK climate projections indicate that average temperatures are expected to increase with more frequent and longer-lasting hotter periods.

This bulletin presents modelled analysis of mortality attributable to the hottest and coldest 2.5% of ambient outdoor temperatures. Our analysis uses daily mean temperatures from 38 years of climate and mortality data for England and Wales during the period 1988 to 2025. We used a statistical model to estimate the relationship between temperature and mortality, while accounting for other factors that may influence mortality risk, for example, air pollution.

This analysis does not include the heatwaves seen in 2026. For sources of estimates on the impacts of these heatwaves, go to Section 9: Data sources and quality.

We have used the methodology developed as part of the Standards for Official Statistics on Climate-Health Interactions (SOSCHI) project in our analysis. This bulletin incorporates methodological, analysis code and data source improvements, which means these estimates supersede those published in our previous Climate-related mortality, England and Wales: 1988 to 2022 article.

For monitoring reports on temperature-related mortality across the UK nations, see:

- the UK Health Security Agency's (UKHSA) heat and cold mortality monitoring reports for England
- Public Health Wales's heat and cold mortality monitoring reports for Wales
- Public Health Scotland's Heat impacts on health in Scotland and Winter mortality in Scotland publications
- Northern Ireland Statistics and Research Agency's (NISRA) Winter mortality in Northern Ireland publication

Our modelled estimates use historical data to monitor long-term trends of the health impacts of changing temperature patterns. They are complementary to the active monitoring and reporting systems used by other government bodies. However, because the underlying data and methods are different, our estimates should not be expected to be equivalent to estimates from other sources.

For definitions of terms used, see Section 8: Glossary. For further details of the definitions, data sources, methods used and comparability, see Section 9: Data sources and quality and our Climate-related mortality, England and Wales, quality and methods guide.

3 . Mortality risk in regions of England, and Wales

This section presents the relative risk of mortality associated with mean outdoor ambient temperature, using data at the regional level to account for geographical differences in temperature exposure.

Mortality risk is measured relative to the optimal temperature for each group and region (Figure 1), representing the temperature associated with the lowest mortality risk. For example, a relative risk (RR) of 1.1 indicates a 10% higher mortality risk, compared with the optimal temperature. The optimal temperature can vary depending on region or demographic.

Mortality risk increases as temperatures reach the hottest and coldest temperatures. Nearly all English regions, and Wales, experienced an increase in relative mortality risk of at least 50% at temperatures exceeding 24 degrees Celsius; the South East had a 40% increased relative risk, which may be because of the region's population demographic. The highest risk temperatures occurred on relatively few days during the study period and therefore contributed to comparatively few deaths. However, the frequency of such days is expected to increase under future climate scenarios.

Variability across regions of England, and Wales was greatest at lower temperatures, reflecting differences in cold-related mortality risk. All regions of England, and Wales showed at least a 20% increased mortality risk at 0 degrees Celsius.

Figure 1: There is a higher relative mortality risk as temperatures reach the hottest and coldest temperatures

Temperature-related relative mortality risk, English regions and Wales, 1988 to 2025

Notes:

1. The temperature thresholds correspond to the 97.5th and 2.5th percentiles of the regional temperature distributions for England and Wales over the period 1988 to 2025.
2. Because of substantial variation observed between English regions, it was not appropriate to combine them into one meta-analytical model to produce national-level relative risk estimates.

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4 . Deaths associated with the hottest and coldest days

In this analysis, we estimated deaths associated with the coldest 2.5% and hottest 2.5% of days across the time series, where mortality risk was increased. To reflect geographical and demographic differences in temperature exposure and mortality, thresholds are calculated for each region, country and demographic group. Across regions, these ranged from below 0 degrees Celsius in some areas to a high of above 20 degrees Celsius in others (Figure 1). The full results for all regions and groups are available in our accompanying dataset.

Changes over time in deaths associated with hottest and coldest days

In England, an estimated 40,063 deaths (0.21% of all deaths) were associated with the hottest temperatures, and 138,944 (0.72% of all deaths) with the coldest, between 1988 and 2025.

In Wales, an estimated 2,070 deaths (0.16% of all deaths) were associated with the hottest temperatures, and 10,098 (0.79% of all deaths) with the coldest.

Historically, more deaths in England and Wales were associated with the coldest days (Figure 2). However, the number of heat-related deaths has increased in recent years and is starting to converge with cold-related mortality.

Cold-related deaths were substantially higher in 2010 than in the surrounding years (estimated 17,584 deaths in England and 1,521 in Wales). This coincided with severe cold weather during both the 2009/2010 winter and the exceptionally cold period in December 2010. The smoothed trend line shifts the cold peak to 2013, which had an exceptionally cold spring. Conversely, 2022 saw the highest daily temperatures recorded for England and Wales. This caused an increased number of heat-related deaths in 2022, compared with surrounding years (estimated 4,430 deaths in England and 222 in Wales).

For uncertainty measures (confidence intervals) of the estimates, see our accompanying dataset. The dataset also includes a table of annual estimates where we excluded deaths due to coronavirus (COVID-19) from the analysis. All other estimates presented do not control for COVID-19 deaths.

Figure 2: The percentage of deaths associated with the hottest days increased in recent years, and the gap between heat- and cold-related deaths is narrowing

Estimated proportion of deaths related to the hottest and coldest days, England and Wales, 1988 to 2025 presented as a five-year smoothed series

Notes:

1. England-level estimates are calculated from the sum of the English regions.
2. As we present a smoothed series using a simple five-year moving average, the years 1988 to 1991 are not presented here as the data for 1984 to 1987 were not included in the analysis.
3. The results for unsmoothed attributable fraction by year can be found in our accompanying dataset.

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Differences in regional temperature-related deaths

Not all regions of England, and Wales equally experienced the mortality impacts of the 2.5% of the hottest and coldest days. The South East had the highest number of deaths attributable to the coldest temperatures of all regions (Table 1). This may be because of the population demographic of the South East. London had the highest number of deaths attributable to the hottest temperatures. London also had the highest percentages of total deaths that were associated with both the hottest and coldest temperatures (0.36% and 0.88%, respectively).

This suggests a more complex pattern of heat exposure and vulnerability in London, which may be explained by factors that are not included in the model. From previous studies, we know that higher temperatures, combined with the urban heat island effect, may increase overheating risks, compared with other regions of England, and Wales. We did not include certain socioeconomic factors that influence vulnerability to heat and are more prevalent in London in our model. These factors include higher living costs and household overcrowding, which may limit the capacity to adapt to high temperatures; they may also contribute to the increased proportion of cold-related deaths.

Table 1: Estimated deaths and percentage of total deaths related to the hottest and coldest days across English regions, and Wales, 1988 to 2025

Region	Heat attributable number	Heat attributable fraction (%)	Cold attributable number	Cold attributable fraction (%)
East Midlands	3,548 (2,319 to 4,752)	0.21 (0.14 to 0.28)	10,836 (9,050 to 12,495)	0.64 (0.54 to 0.74)
East of England	5,121 (3,849 to 6,295)	0.25 (0.18 to 0.30)	15,784 (13,858 to 17,760)	0.76 (0.66 to 0.85)
London	7,675 (6,434 to 8,795)	0.36 (0.30 to 0.41)	18,984 (17,023 to 20,777)	0.88 (0.79 to 0.97)
North East	2,098 (1,113 to 3,023)	0.19 (0.10 to 0.27)	5,727 (4,195 to 6,984)	0.52 (0.38 to 0.63)
North West	4,229 (2,429 to 5,955)	0.15 (0.09 to 0.21)	19,307 (16,775 to 21,617)	0.67 (0.59 to 0.75)
South East	6,226 (4,606 to 7,759)	0.20 (0.15 to 0.25)	24,228 (21,916 to 26,624)	0.78 (0.71 to 0.86)
South West	3,340 (2,063 to 4,635)	0.16 (0.10 to 0.22)	17,127 (15,233 to 18,875)	0.81 (0.72 to 0.89)
West Midlands	4,467 (3,115 to 5,749)	0.21 (0.15 to 0.27)	15,590 (13,661 to 17,460)	0.74 (0.65 to 0.83)
Yorkshire and The Humber	3,359 (2,014 to 4,693)	0.17 (0.10 to 0.23)	11,361 (9,347 to 13,427)	0.56 (0.46 to 0.66)
Wales	2,070 (1,067 to 2,938)	0.16 (0.08 to 0.23)	10,098 (8,745 to 11,489)	0.79 (0.68 to 0.90)

Source: Office for National Statistics

Notes

1. The attributable fractions are presented as the percentage of all deaths attributable to the hottest and coldest days for each of the nine English regions and Wales across the time series.

2. 95% confidence intervals for each estimated value are provided in the parentheses.

5 . Identifying those most at risk

Understanding how mortality risk changes at different temperatures can help identify which regions and population groups are most vulnerable to the hottest and coldest temperatures. This can support the development of targeted public health interventions and adaptation strategies, including for health and social care systems.

The mortality risks reported in this bulletin are calculated relative to the respective optimal temperature for each region, country or demographic group.

While mortality risk increased towards the highest and lowest temperatures across all populations, the size of this increase varied between demographic groups. This means that not all individuals are equally vulnerable to the health impacts of the hottest and coldest temperatures. Baseline mortality risk is influenced by a range of factors, including:

- age
- sex
- socioeconomic status
- underlying health conditions
- other demographic characteristics

We explored age, sex and deprivation. We found statistically significant differences in the impact of temperatures on mortality between the age categories. We did not find statistical differences in the other demographics that we explored, which may be because of small mortality counts in each group.

Results for all findings can be found in our accompanying dataset.

Temperature-related mortality by age

People aged 65 years and over in each region of England, and Wales experienced at least a 50% increased mortality risk at temperatures exceeding 24 degrees Celsius, compared with optimal temperatures. They also experienced at least a 40% increased risk at temperatures below minus 4 degrees Celsius.

Figure 3 shows that there is a statistically significant difference in deaths associated with the coldest days for people aged 65 years and over. It shows that those aged 65 years and over are more vulnerable, compared with those under 65 years of age.

The number of deaths of people aged under 65 years was not large enough to accurately estimate the risks and deaths associated with higher temperatures. However, the risk in this age group is generally found to be lower, compared with those aged 65 years and over.

Figure 3: People aged 65 years and over experience a higher proportion of deaths associated with the coldest days than younger people

Estimated proportion of deaths related to the hottest and coldest days by age, England and Wales, 1988 to 2025

Notes:

1. England-level estimates are calculated from the sum of the English regions.

2. The under 65 years age group had a limited number of death counts, resulting in insufficient power to determine statistical significance.

3. The lower confidence interval attributable fraction for those aged under 65 years shown as a negative can suggest that, in the context of the model, the hottest temperatures may be associated with a reduction in mortality, indicating a potential protective or inverse relationship. However, this should be interpreted with caution, given the uncertainty around these estimates, as shown by the wide confidence intervals.

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6 . Data on climate-related mortality

Climate-related mortality, England and Wales
Dataset | Released 26 August 2026
Results from modelled analysis of mortality attributable to the hottest and coldest 2.5% of ambient outdoor temperatures, using daily mean temperatures for regions of England, and for Wales. Includes detailed results for controlling for coronavirus (COVID-19), demographic breakdowns, underlying cause of death, and guidance for interpreting and using the results.

7 . Collaboration

The statistics in this bulletin present an application of the methodology developed as part of the Standards for Official Statistics on Climate-Health Interactions (SOSCHI) project. They are official statistics in development.

The methodology was developed following advice from the project's Topic Expert Group, comprising of international experts in climate and health. With special thanks for Professor Antonio Gasparrini from the London School of Hygiene and Tropical Medicine and the UK Met Office. This project is an international collaboration led by the Office for National Statistics (ONS) and funded by Wellcome (Grant number 224682/Z/21/Z). It aims to develop a standardised and globally generalisable statistical framework and online Climate-Health Platform to assist in the production of official statistics on climate and health.

8 . Glossary

Attributable fraction

The estimated percentage of all deaths that can be attributable to the hottest and coldest temperatures that would not have occurred if there had been no exposure to the hottest and coldest temperatures.

Attributable number

The estimated number of deaths that are attributable to the hottest and coldest temperatures that would not have occurred if there had been no exposure to the hottest and coldest temperatures.

Coldest temperatures

Mean temperatures below or equal to the 2.5th percentile of the country or region's temperature distribution across the full time series.

Confidence interval

A confidence interval gives an indication of the degree of uncertainty of an estimate, showing the precision of an estimate. The 95% confidence intervals are calculated so that if we repeated the study many times, 95% of the time the true unknown value would lie between the lower and upper confidence limits. A wider interval indicates more uncertainty in the estimate. Overlapping confidence intervals indicate that there is little or no evidence of a true difference between two estimates, at that level of confidence.

Hottest temperatures

Mean temperatures above or equal to the 97.5th percentile of the country or region's temperature distribution across the full time series.

Optimal temperature

The temperature at which the relative mortality risk in a particular country or region is lowest, also known as the minimum mortality temperature (MMT). The optimal temperature is calculated for each respective region, country or demographic group.

Relative risk

The likelihood of an individual dying during, or shortly after, exposure to a certain daily temperature. When a temperature has a relative risk (RR) of 1, this means there is neither an increase nor a decrease in the likelihood of the individual dying during, or shortly after, exposure to that temperature, compared with the optimal temperature.

9 . Data sources and quality

Information on the data sources used, and coverage are summarised in this section.

Estimates of mortality associated with the 2026 heatwaves

This analysis does not include the heatwaves seen in 2026. For short-term monitoring and estimation, see the UK Health Security Agency's Interim heat mortality monitoring report, England: May and June 2026. For modelled estimates for England and Wales, see Imperial College London's UK climate heat health risks May and June 2026 publication.

Official statistics in development

These statistics are labelled as "official statistics in development". Until September 2023, these were called "experimental statistics". Read more about the change in the guide to official statistics in development.

These statistics are modelled estimates and not observed counts of individual deaths attributable to mean outdoor ambient temperatures. We are developing how we collect and produce the data to improve the quality of these statistics. Read more in our Climate-related mortality, England and Wales, quality and methods guide.

Once the developments are complete, we will review the statistics with the Statistics Head of Profession. We will decide whether the statistics are of sufficient quality and value to be published as official statistics, or whether further development is needed. Production may be stopped if they are not of sufficient quality or value. Users will be informed of the outcome and any changes.

We value your feedback on these statistics. Contact us at climate.health@ons.gov.uk.

Data sources

Mortality data

We used our daily deaths occurrences data for deaths registered in England and Wales from 1988 to 2025. Death occurrences (the date of death) were used, as opposed to death registrations (the date the death was registered), to better understand the association between death and weather patterns at, or around, the time of death.

For more information on mortality statistics, go to our User guide to mortality statistics.

Climate data

We used UK Met Office data derived from the European Centre for Medium-Range Weather Forecasts Reanalysis Generation 5 (ERA5) dataset. ERA5 is a comprehensive climate reanalysis that combines observations from weather stations, satellites and other sources.

We used this data source to obtain mean temperature, which is our main climatic variable of interest. To control for their impact on the temperature-mortality relationship, we also used the following variables:

- surface (air) pressure, converted to hectopascal (hPa)
- 10 metre wind speed, in metres per second (m/s)
- relative humidity, as a percentage (%)

For further information on these variables, see ERA5 hourly data on single levels from 1940 to present.

Climate data were mapped to the regional boundary shapefiles from our Open Geography Portal.

Air pollution data

The Daily Air Quality Index (DAQI) is produced by the Department of Food and Rural Affairs and is used to assess air pollution levels in the UK. We used DAQI to adjust for pollution effects on mortality risk. DAQI is a summary measure, graded from 1 to 10, of the highest level of pollution across five pollutants:

- nitrogen dioxide (NO2)
- sulphur dioxide (SO2)
- ozone (O3)
- particles less than 2.5 micrometres (PM2.5)
- particles less than 10 micrometres (PM10)

Important strengths and limitations

Death registration is mandatory, so these data have high completeness. We have used a widely applied methodological approach to assess temperature-related mortality, as advised by global experts in the field. Our model accounts for the non-linear temperature-mortality relationship and the delayed effects of temperature on mortality.

We included all occurrences of deaths that were registered up until the end of 2025. Because of registration delays, some deaths that occurred in 2025 are not included in our analysis. This will affect the later months of 2025 most; therefore, the estimated cold-related deaths for 2025 may be underestimated.

The relative risks and optimal temperature estimates are based on the whole time series and therefore assume that the temperature-mortality relationship does not change; this should be interpreted with caution, as results may not provide evidence for changes in risk over time resulting from adaptation or changing climate impacts, for example.

Implementing one single model for both the hottest and coldest temperatures is unable to account for season-specific temperature-mortality relationships and their respective differences in delayed effects. Because we used a combined model, we did not control for the incidence of seasonal diseases, such as influenza, which can affect mortality observed in winter months.

It is not possible to determine whether individuals were outdoors during the temperatures that deaths were associated with.

The estimates presented are not age-standardised and therefore do not account for regional differences in population age structure, including the higher mortality typically observed in older populations.

For some regions and demographic categories, the number of deaths were too small to draw statistically significant conclusions in our analysis. However, this does not necessarily mean that these differences and relationships do not exist.

More quality and methodology information

More quality and methodology information on strengths, limitations, appropriate uses, and how the data were created is available in our Climate-related mortality, England and Wales, quality and methods guide.

10 . Related links

Standards for official statistics on climate-health interactions
Corporate information | Last updated 29 June 2026
An overview of the Standards for Official Statistics on Climate-Health Interactions (SOSCHI) project, which aims to develop a transparent and globally usable framework and technical platform for official statistics on climate change, environment, and health. The methodology developed for the mortality attributable to high and low temperatures was applied for this analysis.

SOSCHI Methodology: Mortality attributable to high and low temperatures
Methodology | Released 14 May 2026
This article provides full details and guidance of applying the methodology used for the current analysis. This methodology was developed with advice from experts in the climate and health field. In March 2026, the methodology was endorsed by the United Nations Statistical Commission who agreed to incorporate this indicator into the Global Set of Climate Change Statistics.

Suicides in England and Wales: 1981 to 2024
Statistical bulletin | Released 3 October 2025
This statistical bulletin includes an application of another SOSCHI indicator: suicides attributable to extreme heat. The analysis presents relative risk of suicide for extreme temperatures. The estimated deaths presented are associated with the hottest 2.5% of daily mean ambient outdoor temperatures.

Climate-related mortality, England and Wales: 1988 to 2022
Article | Released 22 September 2023
Relative risk of death associated with temperature for England and Wales: 1988 to 2022. This has been superseded by the current bulletin, following methodological and data source improvements.

11 . Cite this statistical bulletin

Office for National Statistics (ONS), released 26 August 2026, ONS website, statistical bulletin, Climate-related mortality, England and Wales: 1988 to 2025