Excess Winter Deaths in England Atlas:

User Guide

The aim of this document is to provide a quick reference on how to use the Excess Winter Deaths Atlas and how to interpret the data available.

There is also a helpful section answering frequently asked questions. If after reading this document you have further questions regarding how the data have been calculated or how to interpret the data, please contact the WMPHO information team at the address at the end of the document.

The Technical Guidance section defines the terms used and the calculations involved in obtaining the Excess Winter Deaths Index (EWDI) and its confidence intervals. There are also worked examples showing how the EWDI is derived for single year and 3 year aggregated period as shown in the EWD Trend atlas and 7 year aggregated period as shown in the EWD by age or underlying cause of death atlas.

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Quick Reference: How to Use the EWD Atlas

Excess Winter Deaths in England Atlas by single or three year trend
Quick Navigation Aid

Select trend years
Allows users to select either a single year or three year trend.

Select Map/Table
Click to toggle between Map or Table. Table displays data for selected age/condition for all areas. Confidence Intervals and significance are also shown in the table.

Geography
Click to change the geography from Region to local authority.

Filter
Click on filters to allow the map to zoom into a region. The filter can also be removed using the filter menu.

Adjust map colours
Click on the panel icon to adjust colours and number of deciles.

User Guide
Select this to download user guide including technical specification.

Print/Save for print options

Data download
Select this to download spreadsheet with data.

Understanding the data
This gives a brief description of the data in the atlas. More detailed information is available in the user guide.

View Bar Chart or trend chart
Click to toggle between Bar Chart and the time series trend chart.

View EWD by age or underlying cause of death
This opens a new atlas for EWD by age or underlying cause of death.

Use map to see chart for area
Hover or click on map area of interest to see bar chart for the area selected.

Comparison Values
Select an area from the table to view comparison data on the chart views or view the figures in the table. Hold Ctrl to select more than one.

View trend for selected area
Select an area from the map or bar chart or comparison table to see a trend chart for selected area.

Using the bar chart to select an area
Bar chart not shown in screen shot—can be viewed by clicking on the toggle button above the trend chart. Hover over graph to see area name and click to select the area. Each bar is plotted with 95% confidence intervals shown with 1.
Interpreting Excess Winter Deaths

The Excess Winter Deaths Index (EWD Index) indicates whether there are higher than expected deaths in the winter compared to the rest of the year. The EWDI is the excess of deaths in winter (December to March) compared with non-winter months from the preceding August to November and the following April to July expressed as a percentage.

<table>
<thead>
<tr>
<th>Year x e.g. 2010</th>
<th>Year y e.g. 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug</td>
<td>Sep</td>
</tr>
<tr>
<td>Non winter months</td>
<td>Winter months</td>
</tr>
</tbody>
</table>

As an example, consider that local authority A had an EWD Index of 26.8% for 2006-2009 with an average of 247.5 excess winter deaths. This means that:

- Local authority A had an average of 248 additional deaths each winter than would be expected from the rate of death in the non-winter months.

**Note:** The average number of excess winter deaths during the winter months does not translate directly to their being x more deaths in winter than in non-winter as the non-winter period is based on 8 months of data. The figure given has already been adjusted by being halved to take account of the non winter period covering only 4 months (Nov-Mar).

- The EWD Index for local authority A is 26.8%. This means that an additional 1 in 4 deaths occurred in winter compared to non-winter months.
- The EWD Index for local authority A is significantly higher than the England average of 18.1%.

**Explanation:** The 95% confidence interval range for the EWD Index for local authority A was 21.6 to 32.3%. As the England EWD Index is below this range, local authority A’s EWD Index is considered to be significantly higher. However, whilst it is safe to assume that non-overlapping confidence intervals indicate a statistically significant difference, it is not always the case that overlapping confidence intervals do not and further testing may be required.

Frequently Asked Questions

Why the interest in excess winter deaths?
There is some evidence to suggest that excess winter deaths (EWD) are preventable. Mortality in winter increases more in England compared to other European countries with colder climates, suggesting that it is more than just lower temperatures that are responsible for the excess mortality in winter\(^1\)\(^2\). Reducing excess winter mortality is one of the outlined outcomes for the “Healthy Life Expectancy and Preventable Mortality” domain in the Public Health Outcomes Framework ‘Healthy lives, healthy people: Improving outcomes and supporting transparency’ published in January 2012\(^3\).

Why does the excess winter deaths (EWD) year run from August to July?
The EWD Index is calculated based on the “Office for National Statistics (ONS) Method” which defines the winter period as December to March, and the non-winter period as August to November of that same year and April to July of the following year to incorporate an expected figure based on deaths either side of the winter of interest. The winter period was selected as these are the months which over the last 50 years have displayed above average monthly deaths\(^4\). However, if deaths starts to increase prior to this, for example in November, the number of deaths in the non-winter period will increase, which in turn will decrease the estimate of excess winter deaths.

Why express excess winter deaths as index (EWDI)?
Excess winter deaths are expressed as the EWD Index (EWDI), in order that comparisons can be made easily between different geographies. The EWDI indicates whether there are higher than expected deaths in the winter compared to the rest of the year. It also gives an idea where interventions need to be improved or instigated to cope with the change of seasonal temperature.

Why calculate excess winter deaths by age group?
Excess winter deaths affect all ages; however the EWDI is known to increase with age with the elderly the most susceptible group to higher death rates in winter\(^5\). In addition, as EWD and the EWDI are not age standardised, given the age profile of excess winter deaths, it is reasonable to assume that areas with a greater older population will have higher excess winter deaths. Looking at the EWDI by age group provides a solution to this problem.

Why calculate excess winter deaths by selected underlying cause of death?
Excess winter deaths can be attributed to nearly all the main causes of death. However certain conditions are known to be exacerbated during winter months. Previous studies have shown that circulatory and respiratory diseases contribute to most (70%) of the excess winter deaths in England\(^6\).

Why have 3 year rolling averages instead of single years?
The nature of excess winter deaths leads to high variation year on year\(^6\). Using 3 year rolling averages, some of the variation is smoothed out making it easier to see a trend and to make comparisons between areas.
Why have data for seven years been used for age and underlying cause of death?
The nature of excess winter deaths leads to high variation year on year. Looking at EWD by age or
selected condition for a single year makes numbers even smaller and increases the variation seen. Using data for seven years increases the sample size and provides stability in deriving the confidence intervals.

Are there any other data quality issues?
The Annual Mortality File provided by Office for National Statistics (ONS) to the Public Health Observatories (PHOs) is based on registered deaths and the EWD and EWDI calculations are based on the date of death occurrences. It is possible that a small number of deaths might not have been registered when the data were released.

The PHO extract is a different extract to that used by ONS to calculate the National Statistics. ONS use a specially generated extract of mortality data in September for deaths that were registered by this month, but which occurred up to the end of July. These figures are then adjusted using the provisional number of deaths from the previous year’s extract, compared with the final number of deaths. The figures produced by ONS are then rounded to the nearest 10 for final data and to the nearest 100 for provisional data. Current ONS data is available here: http://www.ons.gov.uk/ons/rel/subnational-health2/excess-winter-mortality-in-england-and-wales/2011-12--provisional--and-2010-11--final-/index.html
Technical Guidance

Definition: Winter Deaths
The number of deaths in the winter months is the number of deaths that occurred between 1st December and 31st March. The number of deaths was extracted from the ONS Annual Mortality Files.

For aggregated years the deaths in each winter period were summed. Using the 1990 – 1993 mortality data for all ages and all causes of deaths as an example, the winter deaths were the total number of deaths which occurred between 1st December 1990 to 31st March 1991, 1st December 1991 to 31st March 1992 and 1st December 1992 to 31st March 1993. This was repeated for the next three years rolling up until 2008 to 2011 to get the trend data. Values published in the downloadable Excel files are the average (yearly) excess winter deaths, so for the three year period, it is the total excess winter deaths divided by 3.

Definition: Non-Winter Deaths
This is the number of deaths in the following 1st April to 31st July and the preceding 1st August to 31st November of the winter of interest. The year runs from 1st August to 31st July to incorporate an expected figure based on deaths either side of the winter of interest. The number of non-winter deaths was also extracted from the ONS Annual Mortality Files.

The 3 year figures used in the EWD atlas is calculated based on aggregates of the non-winter months from the August prior to the winter of the first year to the July following the winter of the 3rd year. Using the 1990 – 1993 mortality data for all ages and all causes of deaths as an example, the total non-winter deaths is the sum of the deaths for the periods; 1st August to 31st November 1990, 1st April to 31st July 1991, 1st August to 31st November 1991, 1st April to 31st July 1992, 1st August to 31st November 1992 and 1st April to 31st July 1993. This was repeated for the next three years rolling up until 2008 to 2011 to get the trend data.

Definition: Expected Winter Deaths (Denominator)
The expected number of deaths is based on the non-winter deaths x 0.5 i.e. it is the number of deaths that occurred during the preceding four months (August to November) and subsequent four months (April to July) of the winter months. As there are 8 non-winter months compared to 4 winter months this is multiplied by 0.5 to get an average for a 4 month period.

The expected number of non-winter deaths in a 4 month period was derived as:

$$ Expected\ Winter\ Deaths = \frac{1}{2} (Non - Winter\ deaths(Aug - Nov,\ Apr - Jul)) $$

Values published are average non-winter deaths so for the three year period, the non-winter deaths are divided by 6.
Definition: Excess Winter Deaths (EWD) (Numerator)
The calculation of excess winter deaths (EWD) in this profile uses the ONS definition\(^8\) which compares deaths in the winter months (December to March) with the expected number of deaths (average non-winter months)\(^8\). The calculation can be obtained from formula 1 below:

\[
EWD = (\text{winter deaths}(Dec - Mar)) - \frac{1}{2} (\text{Non - Winter deaths}(Aug - Nov, Apr - Jul))
\]

Formula 1:

\[
EWD = a - \frac{b}{2}
\]

Where \(a\) = number of winter deaths and \(b\) = number non-winter deaths

(It is possible to have negative excess winter deaths when there are fewer deaths in winter than expected, i.e. greater rate of death in non-winter months than winter. However in this country this is rare and usually due to small numbers)

Definition: Excess Winter Deaths Index (EWDI)
The Excess Winter Deaths Index (EWDI) is the excess winter deaths expressed as a percentage of the average number of deaths in the non-winter months. The calculation can be obtained from formula 2 below:

\[
EWDI = \left( \frac{EWD}{\text{(Average of Non–Winter Deaths)}} \right) \times 100
\]

This can be rearranged to give Formula 2:

Formula 2:

\[
EWDI = \frac{a - \frac{b}{2}}{\frac{b}{2}} = 2 \left( \frac{a}{b} - 1 \right) \times 100
\]

Where \(a\) = number of winter deaths and \(b\) = number non-winter deaths

Definition: EWDI Confidence Intervals
A confidence interval is a range associated with a parameter estimate, where the estimate is obtained from a random sample. Due to the random nature of the sample the parameter estimate also has random variability associated with it. A 95% confidence interval can essentially be thought of as a range which will contain the true underlying parameter variable (which we are trying to estimate) in 95% of repeated sampling experiments.

The EWDI is treated as odds \(\left( \frac{a}{b} \right)\)

i.e. \((2 \times \frac{a}{b} - 1))\) is treated as odds

\(^8\) Although data on EWDI published by the ONS are based on single years while WMPHO published data are based on pooled years as well as single years, both organisations used the same definition of EWD and EWDI.
Where \( a \) = number of winter deaths and \( b \) = number of non-winter deaths.

2 is a constant and therefore does not need to be included in the confidence interval calculation as a constant has no variance, and -1 is also a constant and can be subtracted at the end.

The formula for a calculation of 95% confidence intervals was taken from Kirkwood and Stern\(^9\) and is based on Wald limits for \((\ln \frac{a}{b})\). This method is satisfactory when the numbers of winter and non-winter deaths are greater than 20 but produces unstable estimates when the numbers are small. Work undertaken at EMPHO by Edmondson-Jones\(^10\) has demonstrated that a Wald confidence interval with an ‘enhanced’ estimated error improves coverage properties compared to the simple Wald estimate, especially when numbers for excess winter deaths or non-winter deaths are small i.e. less than 20, but only when the numbers of winter and non-winter deaths exceed 5.

Hence when the numbers of winter and non-winter deaths are greater than 5 the 95% confidence interval is given by formula 3:

**Formula 3:**

\[
\text{Lower Confidence Limit (LCL)} = \left[ \frac{2 \times \frac{a}{b}}{e^{1.96 \times \sigma}} - 1 \right] = 2e^{(LN(\frac{a}{b}))-1.96\sigma} - 1
\]

\[
\text{Upper Confidence Limit (UCL)} = \left[ (2 \times \frac{a}{b}) \times e^{1.96 \times \sigma} - 1 \right] = 2e^{(LN(\frac{a}{b}))+1.96\sigma} - 1
\]

\( \sigma \) is the enhanced standard error for (log odds), EWDI in this case and is derived from formula 4

**Formula 4**

\[
\sigma = \sqrt{\left( \frac{1}{a} + \frac{1}{b} \right) - \frac{1}{2} \left( \frac{1}{a^2} + \frac{1}{b^2} \right) + \frac{1}{4} \left( \frac{1}{a^3} + \frac{1}{b^3} \right)}
\]

This is different from the method used by the ONS in deriving confidence intervals where the EWDI is considered as a ratio. Using the ONS method at local authority level where the number of deaths can be quite small will produce relatively unstable and wide confidence intervals.
Worked Examples

Worked Example 1: EWD, EWDI and Confidence Intervals Calculations for Single Year Data

In 2002/2003 there were 392 winter deaths and 696 non-winter deaths in a local authority in England.

<table>
<thead>
<tr>
<th>Winter Deaths</th>
<th>Non-Winter Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Sum of all deaths in the period)</td>
<td>(Sum of all deaths in the period)</td>
</tr>
<tr>
<td>December 2002, January to March 2003</td>
<td>August to November 2002, April to July 2003</td>
</tr>
</tbody>
</table>

1) From formula 1 above, the excess winter deaths (EWD) for 2002/2003 are:

\[ EWD = (392 - \frac{696}{2}) = 44 \]

There were 44 excess winter deaths in this year.

2) From formula 2 above, the excess winter deaths index (EWDI) for 2002/2003 is:

\[ EWDI = \left(2 \times \left(\frac{392}{696}\right) - 1\right) \times 100 = 12.6\% \]

3) Since both winter deaths and non-winter deaths are greater than 5, \( \sigma \) the ‘enhanced’ standard error for (log odds) EWDI uses formula 4 above:

\[ \sigma = \sqrt{\left(\frac{1}{392} + \frac{1}{696}\right) - \frac{1}{2} \left(\frac{1}{392^2} + \frac{1}{696^2}\right) + \frac{1}{4} \left(\frac{1}{392^3} + \frac{1}{696^3}\right)} = 0.06311514 \]

4) From formula 3 above, the lower (LCL) and upper (UCL) confidence limits for EWDI are:

\[ LCL = \left(2e^{\left(\frac{\ln(392)}{696}\right) - 1.96 \times 0.06311514}\right) - 1\right) \times 100 = 0.5\% \]

\[ UCL = \left(2e^{\left(\frac{\ln(392)}{696}\right) + 1.96 \times 0.06311514}\right) - 1\right) \times 100 = 27.5\% \]
Worked Example 2: EWD, EWDI and Confidence Intervals Calculations for 3 Years Pooled Data

Between 1990 and 1993 (pooled), there were 588,550 winter deaths and 990,729 non-winter deaths in England.

<table>
<thead>
<tr>
<th>Winter Deaths (Sum of all deaths in the period)</th>
<th>Non-Winter Deaths (Sum of all deaths in the period)</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 1992, January to March 1993</td>
<td>August to November 1992, April to July 1993</td>
</tr>
</tbody>
</table>

1) From formula 1 above, the excess winter deaths (EWD) for 1990-1993 are:

\[ EWD_{3\text{years}} = \frac{588550 - \frac{990729}{2}}{2} = 93185.5 \]

There were 93,174 excess winter deaths in 3 years.

The average excess winter deaths per year are:

\[ EWD_{\text{per year}} = \frac{93185.5}{3} = 31061.83 \]

2) From formula 2 above, the excess winter deaths index (EWDI) for 1990-1993 is:

\[ EWDI = \left(2 \times \left(\frac{588550}{990729}\right) - 1\right) \times 100 = 18.81\% \]

3) Since both winter deaths and non-winter deaths are greater than 5, \( \sigma \) the standard error for (log odds) EWDI uses formula 4:

\[ \sigma = \sqrt{\frac{1}{588550} + \frac{1}{990729}} - \frac{1}{2} \left(\frac{1}{588550^2} + \frac{1}{990729^2}\right) + \frac{1}{4} \left(\frac{1}{588550^3} + \frac{1}{990729^3}\right) \]

\[ = 0.001645736 \]

4) From formula 3 above, the lower (LCL) and upper (UCL) confidence limits for the EWDI are:

\[ LCL = \left(2e^{(\text{LN}\left(\frac{588550}{990729}\right) - 1.96 \times 0.001645736)} - 1\right) \times 100 = 18.4\% \]

\[ UCL = \left(2e^{(\text{LN}\left(\frac{588550}{990729}\right) + 1.96 \times 0.001645736)} - 1\right) \times 100 = 19.2\% \]
Worked Example 3: EWD, EWDI and Confidence Intervals Calculations for the EWD Index by Age and Underlying Cause of Death

Between 2004 and 2011 (pooled), there were 197110 winter deaths and 364189 non-winter deaths in the 0-64 age group in England.

<table>
<thead>
<tr>
<th>Winter Deaths (Sum of all deaths in the period)</th>
<th>Non-Winter Deaths (Sum of all deaths in the period)</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 2004, January to March 2005</td>
<td>August to November 2004, April to July 2005</td>
</tr>
<tr>
<td>December 2006, January to March 2007</td>
<td>August to November 2006, April to July 2007</td>
</tr>
<tr>
<td>December 2008, January to March 2009</td>
<td>August to November 2008, April to July 2009</td>
</tr>
<tr>
<td>December 2009, January to March 2010</td>
<td>August to November 2009, April to July 2010</td>
</tr>
<tr>
<td>December 2010, January to March 2011</td>
<td>August to November 2010, April to July 2011</td>
</tr>
</tbody>
</table>

1) From formula 1 above, excess winter deaths (EWD) for 2004-2011 is:

\[
EWD_{7\,\text{years}} = (197\,110 - \frac{364\,189}{2}) = 150\,15.5
\]

and average excess winter deaths per year is:

\[
EWD_{\text{per year}} = \frac{150\,15.5}{7} = 2145.071
\]

2) From formula 2 above, excess winter deaths index (EWDI) for 2004-2011 is:

\[
EWDI = \left( 2 \times \left( \frac{364\,189}{197\,110} - 1 \right) \right) \times 100 = 8.25\%
\]

3) Since both winter and non-winter deaths are greater than 5, \( \sigma \) the standard error for (log odds) EWDI uses formula 4:

\[
\sigma = \sqrt{\left( \frac{1}{197\,110} + \frac{1}{364\,189} \right) - \frac{1}{2} \left( \frac{1}{197\,110^2} + \frac{1}{364\,189^2} \right) + \frac{1}{4} \left( \frac{1}{197\,110^3} + \frac{1}{364\,189^3} \right)}
\]

\[
= 0.002796269
\]

4) From formula 3 above, the lower (LCL) and upper(UCL) confidence limit for EWDI are:

\[
LCL = \left( 2 \times \left( e^{\ln \left( \frac{364\,189}{197\,110} \right) + 1.96 \times 0.002796269} - 1 \right) \right) \times 100 = 7.7\%
\]

\[
UCL = \left( 2 \times \left( e^{\ln \left( \frac{364\,189}{197\,110} \right) + 1.96 \times 0.002796269} - 1 \right) \right) \times 100 = 8.8\%
\]
Contact

For further information please contact:

West Midlands Public Health Observatory, Information team

Email: bwh-tr.InfoTeam@nhs.net

Tel: 0121 415 8551

West Midlands Public Health Observatory
Birmingham Research Park
Vincent Drive
Birmingham
B15 2SQ
References

1. The Euro winter group, 1997, Cold exposure and winter mortality from ischaemic heart disease, cerebrovascular disease, respiratory disease, and all causes in warm and cold regions in Europe. *The Lancet* 349, 1341-1346


10. Edmondson-Jones M, Personal communication. 2011