Estimating excess winter mortality in England and Wales

**INTRODUCTION**

England and Wales, in common with other European countries, experiences higher levels of mortality in the winter than in the summer. A measure of this increase is provided, on an annual basis, in the form of the excess winter mortality figure. This figure is a simple way to assess mortality levels over the winter as a whole and can be used as a basis for comparison with previous years. The EWM index (excess winter deaths divided by the average non-winter deaths expressed as a percentage) can be used as a comparison with other countries. There is evidence that EWM is to some extent preventable. Recent research that aimed to identify measures that could reduce excess winter mortality levels in England and Wales has focused on indoor temperature (adequate home heating)\(^1\) and measures to reduce outdoor cold stress (keeping warm while outdoors).\(^2\)

Lower temperatures in winter are responsible for some deaths. The Eurowinter Group\(^2\) in their study of winter mortality in Europe found that mortality increased, in a broadly linear way, with each fall in mean daily temperature below 18°C. Mortality during winter increases more in England and Wales than other European countries with colder climates.\(^2,3\) This finding suggests that factors, other than temperature alone, contributed to higher levels of excess winter mortality in England and Wales.

The Eurowinter Group\(^2\) looked at possible explanations for greater increases in mortality, for a given fall in temperature, in regions with warm winters (for example, England and Wales) compared with other European countries with colder winters. Findings were that regions with warm winters had cooler homes and took fewer protective measures against the cold, such as wearing warm clothing when outdoors. Indoor

During the winter months, mortality in England and Wales reaches higher levels than during the summer months. The aim of calculating an excess winter mortality figure is to measure this annual increase. For each winter, excess winter mortality (EWM) is calculated in the same way, using an arbitrarily defined winter period. Over the last 50 years, in December to March mortality levels have remained above average and in May to October mortality has been consistently below average. There has been a steady log-linear decline in EWM. Although year-on-year variability, which is most pronounced in the winter months, remains. In general, the current ONS method of estimating EWM gives similar results to other methods of calculating EWM over the last 50 years. However, due to the year-on-year variability seen in seasonal mortality, mortality can also be above average in the autumn or spring. Where these periods are included in the comparison period for excess winter mortality calculations, as with the current ONS method, this has the effect of decreasing the EWM estimate.
temperatures are also important; improving the thermal efficiency of homes and the affordability of home heating could have substantial health benefits. Measures to reduce cold stress, i.e. keeping warm while indoors and outdoors, are therefore important if current levels of winter mortality are to be further reduced.

This article examines trends in EWM in England and Wales looking at cause-specific patterns over the period 1993–2001. It also looks at EWM in the context of long-term trends in seasonal mortality and examines the effectiveness of the current ONS method of estimating EWM compared with alternative methods, using data for 1993–2001. The choice of December to March as a winter period is arbitrary, as is the choice of comparison non-winter period, and the rationale for these choices will be examined with reference to average monthly mortality over the last 50 years.

**METHODS**

EWM is calculated by comparing the number of deaths in winter with a non-winter period:

\[
EWM = \text{winter deaths} - \text{average non-winter deaths}
\]

Currently a standard method for the calculation of EWM is used each year for England and Wales. This is referred to in the article as the ‘ONS method’. This defines the winter period as December to March and compares it with the average of deaths occurring in the preceding August to November and the following April to July.

Two other methods will be considered. The first method compares deaths occurring in the four months December to March with the deaths occurring in a four-month non-winter period (August and September preceding; June and July following the winter period). The second method takes a six-month period of October to March as winter and compares it with a six-month non-winter period (August and September preceding plus April to July following).

**RESULTS**

**Winter Mortality 1993–2001**

More deaths occurred in the winter months of 1993 to 2001 than in the summer (Figure 1). While the number of deaths in the summer period were at consistent levels the winter peaks had much greater variation in size. Winters with particularly high numbers of deaths were 1996/97.

This seasonal variation in mortality does not reflect a change in mortality from all causes of death. Curwen\textsuperscript{3} observed a specific rather than general effect on cause of death that could be seen during the winter months. The Eurowinter Group\textsuperscript{5} note the increase of deaths in winter months is due to either a breakdown of the cardiovascular or respiratory systems. This could be seen for 1993 to 2001 in England and Wales (Figure 2). When examining average daily deaths by month, shown as a percentage of average daily deaths for the whole year,\textsuperscript{2} circulatory and respiratory illnesses exhibited marked seasonal fluctuations. Deaths from respiratory illnesses had the largest percentage seasonal increase. Deaths from neoplasms have also been presented and as expected there was no clear seasonal pattern.

Seasonality of mortality also varied with age. Increased mortality in the winter months affected those over the age of sixty-five (Figure 3). Of this group, the largest difference between mortality in winter and summer was seen in those over the age of 85.

### Winter mortality 1950–1999

On average, over the last 50 years, December through to March (which corresponds to the winter months used in the ONS method of calculating EWM) has stood out as the period with the highest mortality levels (Figure 4). There has been little change in the seasonal pattern of mortality over the second half of the Twentieth Century, although there has been a decrease in the difference between the typically highest winter months (December to March) and the lowest summer months of June to September. November and April had average mortality in both 25-year periods.

In the period 1975–99, there was still clear absolute variability in seasonal mortality although this was much less pronounced than in the preceding 25 years (Figure 4) – leading to reduced excess winter mortality. This reduction in variability could be due to the fact that influenza had much greater impact on winter mortality levels prior to the 1970s. For example, the high EWM figure in the winter of 1950/51 reflected a severe influenza epidemic which occurred at that time. Although influenza was not always the cause of high mortality; the winter of 1962/63 was particularly cold.

Smoothed EWM estimates allowed long-term trends to be clearly seen (Figure 5). There has been a log-linear decrease over time, showing a general downward trend over a period of years rather than a sharp decline in any particular time-period. This trendline shows EWM tending towards a value of 13,500 over the very long term. Relative year-on-year variability in EWM has not declined over the last 50 years.

### Comparison of different methods of estimating EWM

A problem with defining the winter period as December to March (the winter period in the ONS method) is that if mortality starts to increase prior to this, in November for example, the number of deaths in the comparison non-winter period will be increased. This serves to decrease the estimate of excess winter mortality. Daily deaths in England and Wales in 1993 started to rise above average in October, and both 1993 and 1995 had daily deaths above average in November (Figure 6). A similar increase was reported in Scottish mortality figures in November 1993.\textsuperscript{7} The nature of the method of the calculation of excess winter mortality can therefore lead to the perverse situation of a longer more sustained winter period (beyond December to March) resulting in a lowered estimate of excess winter mortality than if the increased deaths were confined to December to March only.
Information which could therefore usefully supplement the annual EWM figure is the daily pattern of deaths for the winter the EWM figure relates to. For example, average daily deaths in November 1993 were higher than average daily deaths in January (Figure 7a). Daily deaths in April 1998 were above average (Figure 7b). Figure 7c shows a more typical pattern for the winter of 1998/99, with December through to March higher than the daily average for the whole period.

One alternative method of estimating EWM is to compare December to March with June to September, which is the period where deaths are lowest and vary least (Table 1). The difference between the spring/autumn period and the summer period of June to September was also calculated; the number of deaths in this spring/autumn period was consistently higher than June to September and this increase in spring/autumn varied from year to year. By removing the spring and autumn from the calculation this variability was removed. This necessarily resulted in an increased EWM estimate compared with the ONS method, as the comparison figure was lowered. It can be seen by looking at the figures for spring/autumn against summer (June to September) that there was a particularly high excess in spring/autumn in 1993/94. Therefore, inclusion of spring/autumn decreased the ONS estimate of EWM in
Comparisons of ONS method with alternative methods of estimating excess winter mortality and spring/autumn excess, 1993/94–2000/01

<table>
<thead>
<tr>
<th>Year</th>
<th>Current ONS method: (December to March) – (The average of August to November and April to July)</th>
<th>Winter against summer: (December to March) – (June to September)</th>
<th>Spring/autumn against summer: (April + May + Oct + Nov) – (June to September)</th>
<th>Winter against summer – Current ONS method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993/94</td>
<td>25,900</td>
<td>36,680</td>
<td>21,610</td>
<td>10,780</td>
</tr>
<tr>
<td>1994/95</td>
<td>27,290</td>
<td>33,240</td>
<td>11,890</td>
<td>5,950</td>
</tr>
<tr>
<td>1995/96</td>
<td>40,190</td>
<td>47,900</td>
<td>15,410</td>
<td>7,710</td>
</tr>
<tr>
<td>1996/97</td>
<td>47,680</td>
<td>52,840</td>
<td>10,310</td>
<td>5,160</td>
</tr>
<tr>
<td>1997/98</td>
<td>22,900</td>
<td>30,380</td>
<td>14,960</td>
<td>7,480</td>
</tr>
<tr>
<td>1998/99</td>
<td>46,840</td>
<td>52,170</td>
<td>10,660</td>
<td>5,330</td>
</tr>
<tr>
<td>1999/00</td>
<td>48,440</td>
<td>53,270</td>
<td>9,670</td>
<td>4,830</td>
</tr>
<tr>
<td>2000/01</td>
<td>24,840</td>
<td>31,670</td>
<td>13,710</td>
<td>6,850</td>
</tr>
</tbody>
</table>

When deaths increase prior to December it could be argued that these deaths should be included as part of excess winter mortality. Figure 8 therefore compares the ‘winter against summer’ method described above with the current ONS method and another method using a six-month winter period (as discussed by Bowie and Jackson) using Scottish mortality data. For the winter of 1993/94 in particular, the six-month method produced a much higher estimate of EWM than the other methods. However, this was due to the fact that a high November period was included in the winter period. Comparing December to March with a summer baseline of June to September did increase EWM estimates beyond those with the existing ONS method; but not to the same extent as the six-month method shown where the ‘spring/autumn excess’ was included as part of ‘winter’ mortality. Table 2 assesses the advantages and disadvantages of these three different methods of estimating EWM.

Advantages and disadvantages of three methods of estimating excess winter mortality

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current ONS method: (December to March) – (The average of August to November and April to July)</td>
<td>- The winter period reflects the months which over the last 50 years have displayed above average monthly mortality</td>
<td>- Some years will show an annual increase in mortality that is not included in the winter period</td>
</tr>
<tr>
<td>Winter against summer: (December to March) – (June to September)</td>
<td>- The winter period reflects the months which over the last 50 years have displayed above average monthly mortality</td>
<td>- Excess in the autumn or spring will artificially decrease the winter period</td>
</tr>
<tr>
<td>Winter against summer: (December to March) – (June to September)</td>
<td>- The summer period reflects the months which have low mortality and least year-on-year variability</td>
<td>- Excess in the autumn will increase the winter period</td>
</tr>
<tr>
<td>Winter against summer: (December to March) – (June to September)</td>
<td>- The autumn and spring which are on average neither high or low, are not included in either winter or the summer</td>
<td>- Some years will show an annual increase in mortality that is not included in the winter period</td>
</tr>
</tbody>
</table>

Discussion

A standard method of calculating EWM can have drawbacks when a pre-determined winter period does not reflect the size and timing of a winter peak in a particular year. However, over the last 50 years there has been little change in the months in which mortality is above average (December to March) and those where it is below average (May to October). For this reason, the ONS figure calculated using the ONS method usually provides a clear guide to winter mortality levels. For the purposes of assessing change in EWM in England and Wales this estimate can be useful when viewed in the context of long-term trends.

Of the methods of measuring EWM discussed here, comparing December to March against a summer period of June to September offers a potential alternative to the current ONS method of estimating EWM. There are three main reasons why this method has advantages over the current ONS method. Firstly, removing the autumn and spring periods from the ‘non-winter’ average avoids the situation where EWM is decreased due to the fact that winter deaths are being subtracted from an inflated non-winter period. Secondly, by restricting the ‘winter’ to December to March as opposed to extending it to all months where an annual increase could be seen, the measure is providing a guide to excess winter mortality rather than including an autumn or spring excess. Lastly, mortality returns to consistent levels during the summer (June to September) and this is therefore a reasonable baseline against which to compare numbers of deaths in December to March.
The four-month-baseline method also has advantages for use in England and Wales compared with the six-month period method used by Bowie and Jackson for Scottish data, as it does not include October in the winter period. Our analysis has shown that, in England and Wales over the last 50 years, October has had consistently below average mortality. In fact, if a six-month winter period were to be used, April would be the better month to choose as it has had higher mortality than October over the last 50 years.

As discussed, December to March does not always have the highest mortality, although these are the months that had consistently higher than the annual average over a 50-year period (Figure 4), and therefore make the most sensible choice of winter period. A useful addition to the annual winter mortality figure published by ONS could be to provide details of average daily deaths per month (as shown in Figure 7) giving an indication of the size and timing of winter peaks.

It has been shown in this article that winter mortality is cause and age specific. The elderly are more vulnerable than others during the winter. Policies aimed at tackling excess winter mortality, such as winter fuel payments, and influenza vaccinations focus particularly on the elderly, who are more likely to develop life-threatening complications of influenza such as pneumonia.

**CONCLUSION**

On average, over the last 50 years, the December to March period has stood out as having above average levels of mortality. The period from May to October has stood out as having below average levels.

Over time EWM has been declining log-linearly in England and Wales, although year-on-year variability remains. When interpreting the impact of seasonal mortality in England and Wales changes over time can be disguised by short-term variations. It is therefore important to interpret the impact of measures such as winter fuel payments and influenza vaccinations in the context of long-term trends. However, the lack of any sharp downturn in any particular period in the last 25 years makes it difficult to draw conclusions over the effectiveness of any recent initiatives.

A consistent measure of excess winter mortality is necessary if comparisons are to be made over time. Generally the current ONS method of calculating EWM produces broadly similar patterns to other methods. The selection of winter months does not always reflect the months which saw the highest number of deaths, however over the last 50 years December to March are the months in which mortality is consistently above average. Levels of mortality in spring and autumn are more variable. Where these periods are included in the ‘summer’ period against which the winter excess is compared, and mortality is above average in these months, estimates of excess winter mortality are artificially decreased. On average spring and autumn are neither particularly high nor low. There is therefore no rationale for including them in either the winter or the summer of excess winter mortality calculations. By removing spring and autumn from excess winter mortality calculations, and instead using a comparison period of June to September, the effect of an autumn or spring excess on excess winter mortality is removed.

**Key findings**

- On average, over the last 50 years, the months from December to March have stood out as having above average mortality levels, and the months from May to October have had consistently below average mortality.
- Over the last 50 years levels of EWM have decreased, although there is still clear year-on-year variability.
- The current ONS method of calculating EWM includes the autumn and spring as part of the ‘summer’ which is compared with the December to March ‘winter’. In most years this produces broadly similar results to other methods of calculating EWM. However, if mortality is high in the spring or autumn this has the effect of decreasing the ONS estimate of EWM.
- An alternative method of calculating EWM compares December to March with a restricted summer period of June to September. This is the period where deaths are typically low and vary least. Any spring or autumn excess will therefore not influence the estimated level of excess winter mortality.

**REFERENCES**