

Deaths in winter in Northern Ireland: the role of low temperature

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SUMMARY

Many European countries experience a seasonal excess in deaths each winter compared to summer. The magnitude of the excess is greater in the United Kingdom than in many other European countries. Examination of the data for Northern Ireland indicates that myocardial infarction, respiratory disease and stroke exhibit the greatest increases during winter. Excess deaths from these conditions are closely associated with low environmental temperature.

INTRODUCTION

Many European countries experience a seasonal increase in deaths each winter. A recent study has demonstrated that the British Isles experience some of the largest increases of any European countries.¹ In particular, the Scandinavian countries have much smaller seasonal changes and Iceland experiences virtually none. Although data for Northern Ireland was not analysed separately, when the measure of seasonal mortality (the difference between observed deaths and those which would be expected if the monthly mortality in June to September pertained throughout the year) which was used is applied to Northern Ireland data, the calculated excess winter mortality of 12·9% is similar to that for the UK as a whole (13·1%). The present study seeks to identify which causes of death contribute to the seasonal variation in mortality in Northern Ireland, to examine the association of mortality with temperature, and to review evidence in this and other investigations to determine if the association might be causal.

METHODS

Monthly data relating to the years 1980–1984 were extracted from the annual reports of the Registrar General for Northern Ireland. The data extracted comprised the number of deaths in each of the categories in the A series of the International Classification of Diseases (Ninth Revision), and the average monthly temperatures for the province as a whole. Deaths from cancer and infectious disease were compiled as two separate groups as the numbers of deaths in individual categories were small. The effect of differing lengths of months was allowed for by standardising the number of deaths to a month of 30 days. Seasonality was determined using Edwards' method,² which indicates if the pattern of deaths had a seasonal distribution. This method uses the data to generate a sinusoidal curve which represents the seasonal variation, and indicates the date corresponding to the peak of the curve. The use of this technique

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partially overcomes the effect of random month to month variation and the use of months which are arbitrary periods of time. The date of the peak thus calculated may not coincide exactly with the highest monthly total of deaths. The percentage variation in monthly deaths which could be explained by temperature was examined by linear regression of the standardised monthly deaths from each cause against mean monthly temperatures. The percentage was given by $100 \times r^2$ where r is the correlation coefficient.

RESULTS

Seasonal trends

The mean total numbers of deaths each month during the study period for each cause of death are summarised in Table I. There were approximately 300 more deaths from all causes in January than in August, an increase in monthly mortality of about 33%.

When analysed by cause of death there is no evidence of a seasonal trend in deaths from infectious diseases or neoplasms. There is a significant peak in male deaths from mental disorders in early winter but not in female deaths at the same time.

The peak in deaths from myocardial infarction was greatest in mid February. The winter peak was almost 50% higher than the summer level, representing a difference of approximately 100 deaths per month. The calculated peak in deaths from heart failure occurred two weeks later (under the Registrar General's rule 3 governing the attribution of cause of death, if heart failure and myocardial infarction are both mentioned as conditions directly leading to death, the death will be ascribed to myocardial infarction (C Cope, personal communication)).

Although the numbers are small there is a significant seasonal trend in deaths from asthma, bronchitis and emphysema with about 20 deaths per month more in winter than in summer. Deaths from pneumonia are twice as high in winter than in summer, with about 60 additional deaths per month. The calculated peaks in deaths from both respiratory conditions were in late February.

Stroke deaths also showed a 50% increase in winter, representing about 60 additional deaths per month. The calculated peak was in late February, shortly after the peak in deaths from the respiratory conditions. As with deaths from asthma, bronchitis and emphysema this may reflect a considerable variation in seasonal morbidity. There was a seasonal trend in deaths attributed to fractures among both sexes, but the peak among women was in late February and among men was in late March.

Relationship with seasonal change

There is a significant correlation between deaths from all causes and the month of the year. Nearly two thirds (60%) of the variation in total deaths can be explained by these changes, which may be related to temperature. When individual causes of death are considered the association is strongest for myocardial infarction and stroke (Table II).

Deaths from infectious diseases, cancer and fractures were not shown to be related to seasonal changes. In the case of fractures, the peaks were later than for most other conditions, which would be consistent with a situation in which an elderly patient falls and dies from a complication such as pneumonia some time later. The fracture will be recorded as the underlying cause of death. This is

TABLE I
Monthly deaths by cause: Northern Ireland 1980-84

| Diagnosis | Myocardial infarction | Ischaemic heart disease | Heart failure | Stroke | Pneumonia | Asthma, bronchitis and emphysema | Fractures | Mental disorders | Cancer | Infectious diseases | All causes |
|---------------------------------|-----------------------|-------------------------|---------------|--------|-----------|----------------------------------|-----------|------------------|------------------|---------------------|------------|
| ICD-9 A Code | 270 | 27 | 289 | 29 | 321 | 323 | 47 | 21 | 93, 94, 101, 141 | 01, 03, 07 | |
| January | 291 | 84 | 31 | 164 | 125 | 30 | 24 | 4 | 100 | 3 | 1230 |
| February | 280 | 78 | 34 | 163 | 135 | 33 | 21 | 3 | 107 | 3 | 1230 |
| March | 287 | 90 | 37 | 151 | 120 | 27 | 18 | 1 | 107 | 5 | 1246 |
| April | 258 | 64 | 29 | 149 | 95 | 26 | 20 | 2 | 92 | 3 | 1078 |
| May | 243 | 67 | 33 | 130 | 81 | 21 | 21 | 1 | 95 | 2 | 1036 |
| June | 224 | 74 | 26 | 128 | 67 | 18 | 20 | 1 | 102 | 3 | 1016 |
| July | 216 | 60 | 22 | 124 | 68 | 15 | 14 | 2 | 91 | 4 | 922 |
| August | 195 | 56 | 24 | 107 | 59 | 16 | 13 | 2 | 101 | 2 | 870 |
| September | 213 | 61 | 24 | 114 | 65 | 13 | 16 | 4 | 97 | 3 | 916 |
| October | 238 | 63 | 24 | 124 | 75 | 20 | 14 | 2 | 102 | 2 | 981 |
| November | 246 | 73 | 26 | 122 | 71 | 18 | 17 | 3 | 96 | 3 | 1024 |
| December | 250 | 78 | 30 | 138 | 92 | 21 | 17 | 3 | 102 | 2 | 1068 |
| Significance of seasonal trend* | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | NS | 0.05 | NS | NS | 0.001 |
| Male | 0.001 | 0.01 | 0.001 | 0.001 | 0.001 | 0.001 | NS | NS | NS | NS | 0.001 |
| Female | 0.001 | 0.01 | 0.001 | 0.001 | 0.001 | 0.001 | NS | NS | NS | NS | 0.001 |

*see text. (p values, NS = not significant). Figures presented are total male and female deaths.

M O N T H

suggested from a re-analysis of the data; for men there is a significant association between deaths from fractures and the mean monthly temperature both two and three months previously ($r = 0.324$, $p < 0.001$ and $r = 0.366$, $p < 0.001$ respectively), but this relationship is not present for women.

TABLE II

Variation in monthly deaths from various causes which may be explained by temperature

| Code ICD 9A | Cause | Percentage variation explained by temperature | |
|----------------|-------------------------------|---|----------|
| | | Male | Female |
| 270 | Myocardial infarction | 58.5 *** | 50.1 *** |
| 27 | Ischaemic heart disease | 14.8 ** | 10.9 ** |
| 289 | Heart failure | 13.2 ** | 21.3 ** |
| 29 | Cerebro-vascular disease | 25.4 *** | 45 *** |
| 321 | Pneumonia | 30.7 *** | 34.2 *** |
| 323 | Asthma, bronchitis, emphysema | 25.7 *** | 27.5 *** |
| 47 | Fractures | 21.7 NS | 20.0 NS |
| | All causes | 57.9 *** | 53.7 *** |

** $p < 0.01$

*** $p < 0.001$

NS not significant

Derived from Annual Reports of the Registrar General for Northern Ireland 1980–84.

DISCUSSION

This paper demonstrates that there is an excess of deaths due to certain causes in winter in Northern Ireland, and that this excess is associated with environmental temperature. Certain criteria are important in distinguishing whether an association is likely to be causal or simply due to chance.³ Bradford Hill has proposed that they include the following: the association should be strong, consistent, specific, biologically plausible, the proposed cause should precede the effect, and there should be a biological gradient. It is not necessary that all of the criteria should be met, although if most are met the hypothesis that causality exists is strengthened.

The association between low temperature and mortality due to certain causes fulfils these criteria. The association is strong. Deaths from myocardial infarction are 49% higher in January than in August. There is a 53% excess of deaths from stroke.

It is consistent, as studies in different parts of the United Kingdom at different times have demonstrated a relationship between temperature and death rates from cardiovascular disease⁴⁻⁶ and from respiratory disease.⁷ Although low temperature is associated with an excess of deaths from many causes, it is strongly associated with only a few. The seasonal effect on mortality from some of these causes, such as stroke and myocardial infarction, may be indirect and the additional deaths may be due to co-existing chest infections. Anderson and Le Riche⁸ have suggested that this is the case with myocardial infarctions in

Canada although Bull and Morton⁹ in the United Kingdom and Rogot¹⁰ in the United States dispute this interpretation. If excess deaths were a secondary effect of chest infections one would expect at least a small non-specific seasonal change in all causes of death, but the study by Bull and Morton and the current study have found no seasonal trend among any of the types of cancer examined. In Northern Ireland the monthly variation in deaths from all cancers (representing about a quarter of all deaths) fluctuated by less than 5%, with no seasonal trend. There is also evidence that the severity of influenza epidemics may be related to preceding periods of cold¹¹ and it has been suggested¹² that the increase in cardiovascular mortality might be due to influenza, but the relationship is inconsistent.¹³

The association between cold and death is biologically plausible. Cardiovascular changes include an increase in systolic blood pressure among normal individuals in winter¹⁴ and among elderly patients exposed to cold.¹⁵ Red cell and platelet counts, and blood viscosity increase after cooling.¹⁶ Respiratory changes include diminished action of respiratory cilia in the presence of cold air,¹⁷ reduced relative humidity causing prolonged survival of airborne micro-organisms,¹⁸ and sleep apnoea due to exposure to cold air while asleep.¹⁹

Changes in temperature can be shown to precede changes in mortality. It is recognised that the use of figures averaged over a month will obscure many short term and local fluctuations in both temperature and deaths. This will tend to reduce the apparent association and McFarlane has demonstrated the importance of using daily data to indicate the short term relationship between temperature and mortality.¹³ Bull and Morton demonstrated that periods of cold precede peaks in deaths from myocardial infarction by 1–2 days and strokes by 2–3 days.⁹ Bull also demonstrated that short term changes in temperature and humidity precede increases in deaths from pneumonia.²⁰ Finally, a biological gradient, as indicated by the correlation between temperature and deaths from certain causes, is observed.

This study suggests that cold has a major effect on mortality in Northern Ireland. Although the routinely published data for Northern Ireland is not sub-divided by age, corresponding data for England and Wales indicate that the elderly are at greatest risk.²¹ The increased mortality in winter is widely recognised by health care professionals and by the public, but there are few concerted efforts to combat the problem. Wicks²² has suggested that the adoption of the definition of hypothermia as a core temperature of less than 35°C²³ has tended to obscure the extent of low temperature related deaths. Most parliamentary questions on this subject tend to ask only about cases in which hypothermia is mentioned on the death certificate despite evidence that cold is implicated in many more deaths. The association of cold with myocardial infarction is now well established but many medical textbooks make no mention of it.

While programmes which lead to a reduction in the seasonal peak may simply lead to the deaths being postponed until later in the same year, it is possible that some of the individuals affected might be enabled to live for several additional years. Cold may be an important cause of premature mortality in Northern Ireland. It may not be coincidental that Northern Ireland has a high rate of both cold related deaths and deaths from myocardial infarction. In a region where large sums of money are spent on the treatment of ischaemic heart disease, some might be spent more appropriately on helping the elderly to conserve heat and providing improved heating and insulation.

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