Journal of Public Health Medicine

Vol. 22, No. 2, pp. 176–181
Printed in Great Britain

Investigation of the association between excess winter mortality and socio-economic deprivation

Deborah A. Lawlor, Daniel Harvey and Howard G. Dews

Abstract

Background Excess winter mortality is higher in England and Wales than in other European countries with similar or lower average winter temperatures. It might be expected that excess winter mortality would be higher in areas with greater socio-economic deprivation, and if this were so preventive interventions could be directed at populations in these areas. The association between deprivation and excess winter mortality has not been adequately investigated in the past. The aim of this study was to look at the association between excess winter mortality and socio-economic deprivation, so that policy decisions to reduce this excess mortality could be appropriately directed.

Methods Super Profile groups derived from the 1991 Census were used as a measure of socio-economic status. The age-standardized excess winter death index (EWDI) was calculated for each Super Profile group, for the population of Bradford. The EWDI was also calculated for the manufacturing districts (Office for National Statistics area classification), a relatively deprived group, and compared with that for England and Wales.

Results No significant trend was found in age-standardized excess winter mortality across the Super Profile groups. The manufacturing districts had a similar EWDI to the national value.

Conclusion Excess winter mortality is not associated with deprivation. Further research to identify the important aetiological factors and appropriate interventions to reduce excess winter mortality is needed.

Keywords: excess winter mortality, deprivation, Super Profile groups

Introduction

Excess winter mortality refers to the phenomenon of seasonal variations in mortality rates, with a significant increase in mortality occurring in the winter months compared with the rest of the year. This phenomenon has been described throughout most countries of Europe and many other countries.[1,2] An increase in the number of deaths during the winter months compared with the rest of the year, in England and Wales, has been observed and recorded since the mid-nineteenth century, and although it has decreased in size since the 1940s it remains much higher than in other European countries with similar or lower mean winter temperatures.[2]

Understanding the underlying causes of excess winter mortality is important in identifying health policy aimed at prevention. In Britain there is a marked erratic year-to-year variation in the number of winter deaths compared with the steady trends in other seasons.[3] A large proportion of this variability is related to two factors, the mean winter temperature and the number of winter deaths registered as due to influenza. Curwen and Devis, using data from the period 1949–1985, estimated that each influenza death was associated with 3.6 excess winter deaths and each degree celsius by which the winter is colder than the average was associated with 8000 excess winter deaths.[4] The relationship between mean winter temperature and excess death does not, however, hold true for all countries. For example, there is no increase in mortality in the population of Western Siberia as the temperature decreases to zero degrees celsius.[5] Ecological studies suggest a strong association between indoor and outdoor cold exposure and excess winter mortality.[5–8] There is evidence that although winter temperatures are much lower in Russia and Scandinavian countries than in Britain, the former countries suffer less excess winter mortality because the population is less exposed, as it keeps warmer both indoors and outdoors. It has been suggested that high excess winter mortality in England and Wales could be reduced if government policies were introduced to increase indoor energy efficiency, and individuals could be persuaded to wear adequate clothing and keep active whilst outdoors in the cold.[6,7]

Although excess winter mortality occurs in all age groups, it occurs predominantly in those aged 75 and older.[2] However, it

Division of Public Health, Nuffield Institute for Health, University of Leeds, 71–75 Clarendon Road, Leeds LS2 9PL.

Deborah A. Lawlor, Senior Registrar, Public Health Medicine

Sheffield Hallam University, City Campus, Howard Street, Sheffield S1 1WB.

Daniel Harvey, BA student in statistics

Nottingham Health Authority, 1 Standard Court, Park Row, Nottingham NG1 6GN.

Howard G. Dews, Health Informatics Manager

Address correspondence to Dr D. A. Lawlor.

is not simply a 'bringing forward' of deaths, by a few months, of vulnerable individuals, as there is no trough in mortality figures following on from the winter excess. An analysis of excess winter mortality over the period 1950–1990 has demonstrated that there is no marked 'peak–trough' phenomenon in winter mortality even during winters of increased influenza deaths.[9] In fact, mortality in each of the 4 months following the winter period (April–July) was slightly positively correlated with winter mortality.[9]

In Britain about 85 per cent of the excess winter deaths are due to circulatory or respiratory disease, with each being responsible for similar overall numbers.[2,3] Excess winter mortality as a result of circulatory disease is thought to occur because of an increase in arterial thrombosis associated with cold exposure. Cold exposure causes an increase in platelet, red cell and white cell counts, an increase in cholesterol and a reflex arterial spasm.[10] It has been suggested that increases in respiratory deaths can be attributed to cross-infection from indoor crowding, adverse effects of the cold on the immune system and to the fact that low temperatures assist survival of micro-organisms in droplets.[11]

It might be expected that excess winter mortality would be higher in populations with greater socio-economic deprivation, and therefore preventive policy would be most appropriately directed at these groups. Deprived groups are more likely to suffer fuel poverty[12] than the rest of the population, and are also known to be at greater risk from mortality from circulatory and respiratory disease. A longitudinal study by Fox and Goldblatt used two markers of deprivation, housing tenure and car access, and followed a cohort for 14 years from 1971 to 1985. They found a statistically significant but small increase in excess winter mortality in those living in rented accommodation without car access.[13] The small size of the difference led to the conclusion that deprivation was not an important factor in excess winter mortality.[13] However, car access and housing tenure may not be useful measures of deprivation when looking at a condition that mainly affects those aged 75 and above. In this age group, car access is likely to be low and many individuals may live in residential or sheltered accommodation.

Bradford is a relatively deprived district and part of the 'manufacturing group' from the Office for National Statistics (ONS) area classification,[14] a group characterized by low socio-economic status. A recent review of coronary heart disease epidemiology in Bradford illustrates a significant excess of deaths from coronary heart disease during the winter months.[15] Bradford's Health Action Zone strategy aims to improve the health of the population through multi-agency collaboration. In particular, it aims to improve the health of those in the most deprived areas of the district. Directing multi-agency interventions (improving housing energy efficiency, promotion of adequate clothing and keeping active whilst outdoors in the cold) to reduce excess winter mortality in the most deprived groups of the city is one potential way of moving towards this aim.

The aim of this study was to look at the association between excess winter mortality and socio-economic deprivation, in Bradford, so that policy decisions to reduce this excess mortality could be focused appropriately.

Method

Super Profile groups

The Super Profile classification[16] was used as an indicator of socio-economic status. This approach was used in preference to standard deprivation indices because it allows deprivation to be assessed as a multi-dimensional concept as opposed to the uni-dimensional concept of the composite deprivation indices commonly used in health services research.[17] Super Profile groups are derived using 120 Census variables covering demographic structure, household composition, housing, socio-economic structure and employment, to obtain clusters of enumeration districts that have similar socio-economic and demographic status. As a result, Super Profile groups allow for classification of several types of deprivation, for example, predominantly white populations on council estates, over-crowded minority ethnic populations or young early career professionals.

At the broadest level of clustering, 10 Super Profile groups are identified, which describe clear and readily identifiable sectors of the population that are both large enough for analysis but few enough for simple presentation. Names are attached to each group – these are an attempt to capture the wider characteristics of the groups in a name that can be easily referred to. Although the majority of the population living in an area described by a particular group will conform to the characteristics of the Super Profile, clearly not everyone will. The groups are sequenced according to their value on the Townsend Index of deprivation to give an indication of relative deprivation between groups. This is, however, secondary to the use of the Super Profile groups themselves to describe health experiences in each socio-demographic group. Group I, 'Affluent achievers', represent the most affluent population areas and Group X, 'Have-nots', the least affluent. Appendix 1 gives further details of the typical characteristics of each group. Super Profile groups have been used previously as a measure of socio-economic status in health service research,[18,19] and compare favourably with other deprivation indices in describing health outcomes.[17]

Association between Super Profile groups and excess winter mortality

Super Profile groups were identified for all the 1991 Census enumeration districts in Bradford. For each Super Profile group excess winter mortality was calculated using the excess winter death index (EWDI). The EWDI is the percentage excess of deaths in the four winter months of highest mortality compared

with the average of the numbers in the preceding and following four-monthly periods.[2] For most Western European countries, including England and Wales, the winter months of highest mortality are December–March. The age-standardized EWDI was calculated by the direct method of standardization, using the Bradford standard population (Appendix 2). Ninety-five per cent confidence intervals (CIs) were calculated by the exact method using the F distribution. Test for trend was calculated using the χ^2 test for trend and all other tests of significance used the χ^2 method. The EWDI was calculated using accumulated data covering the time period from August 1994 until July 1998. During this period there was no influenza epidemic. Mortality data were obtained from the 'Public Health Mortality file', which is received routinely from the ONS.

EWDI was also compared between England and Wales, health authorities in the ONS manufacturing group and Bradford. Mortality data for these national comparisons were obtained from a special tabulation supplied by the ONS.

Results

Table 1 contains values for excess winter mortality for England and Wales, the ONS manufacturing group and Bradford. The differences between the EWDI for manufacturing districts and that for England and Wales, and between Bradford and England and Wales are not statistically significantly different ($p > 0.05$).

Table 2 and Fig. 1 illustrate age-standardized EWDI for each Super Profile group in Bradford and for Bradford as a whole. Test for trend suggests no significant trend across the Super Profile groups ($\chi^2_{\text{trend}} = 0.24$, $p > 0.05$). Two Super Profile groups, 'Thriving greys' and 'Hard-pressed families', appear to have significantly higher EWDI than Bradford as a whole ($p = 0.05$ and $p < 0.05$, respectively).

Discussion

This study has used Super Profile groups to investigate the association between deprivation and excess winter mortality. The results indicate that excess winter mortality is not associated with deprivation at enumeration district level. This conclusion is further supported by the fact that excess winter mortality from the ONS manufacturing group, a relatively deprived group, is the same as that for England and Wales as a whole. Although Fox and Goldblatt's longitudinal study suggested some positive association between excess winter mortality and deprivation, the association was small.[9]

Two socio-demographic groups, 'Thriving greys' and 'Hard-pressed families', appear to have higher excess winter mortality than the rest of the Bradford population. However, these findings need to be interpreted with caution, as this was not a prior hypothesis and may be a chance finding resulting from multiple comparisons. If further research were to confirm a true increased risk in these two groups it may indicate some of the socio-demographic factors that are important in increased winter mortality.

It is possible that the 'Thriving grey' group are vulnerable because in retirement their income is no longer sufficient to maintain previous standards of living, and in particular to adequately heat their large homes. It is interesting that the 'Senior citizens' group, a relatively deprived elderly group, have a lower excess winter mortality than both the 'Thriving grey' group and the total population of Bradford. 'Hard-pressed families' may suffer because of the poor energy efficiency of council housing stock. The latest council housing stock survey in Bradford has just been completed. This indicates that, with the exception of one council housing estate, which had an extensive regeneration programme completed during the mid-1990s, the council housing stock is below average in terms of energy efficient features. However, the Super Profile group 'Have-nots', the most deprived group, also live predominantly in council housing stock and do not have a high excess winter mortality. 'Have-nots' are more likely to live in council flats

Table 1 Excess winter mortality, accumulated figures for 1995–1997, England and Wales, manufacturing districts and Bradford

	EWM	EWDI (95% CI)
England and Wales	106534	21.8 (20.7–22.2)
Manufacturing districts	07792	20.6 (17.5–22.6)
Bradford	1198	24.5 (17.5–27.9)

EWM, excess winter mortality defined as the excess of deaths in the months December–March compared with the average of the numbers in the preceding and following four-monthly periods. EWDI, excess winter deaths index defined as the percentage excess of deaths in the months December–March compared with the average of the numbers in the preceding and following four-monthly periods.

Table 2 Excess winter mortality, accumulated figures for 1994–1998, by Super Profile group, Bradford

Super Profile group	Actual EWM	Age-standardized EWDI (95% CI)
I Affluent achievers	145	29 (24–33)
II Country life	5	26 (10–46)
III Thriving greys	153	35 (30–40)
IV Settled suburbans	177	31 (27–34)
V Nest builders	222	27 (25–30)
VI Producers	207	27 (23–31)
VII Senior citizens	109	21 (16–27)
VIII Urban venturers	271	29 (27–31)
IX Hard-pressed families	154	37 (32–41)
X Have-nots	130	23 (21–27)
Bradford total	1572	28 (27–30)

EWM, excess winter mortality defined as the excess of deaths in the months December–March compared with the average of the numbers in the preceding and following four-monthly periods. EWDI, excess winter deaths index defined as the percentage excess of deaths in the months December–March compared with the average of the numbers in the preceding and following four-monthly periods.

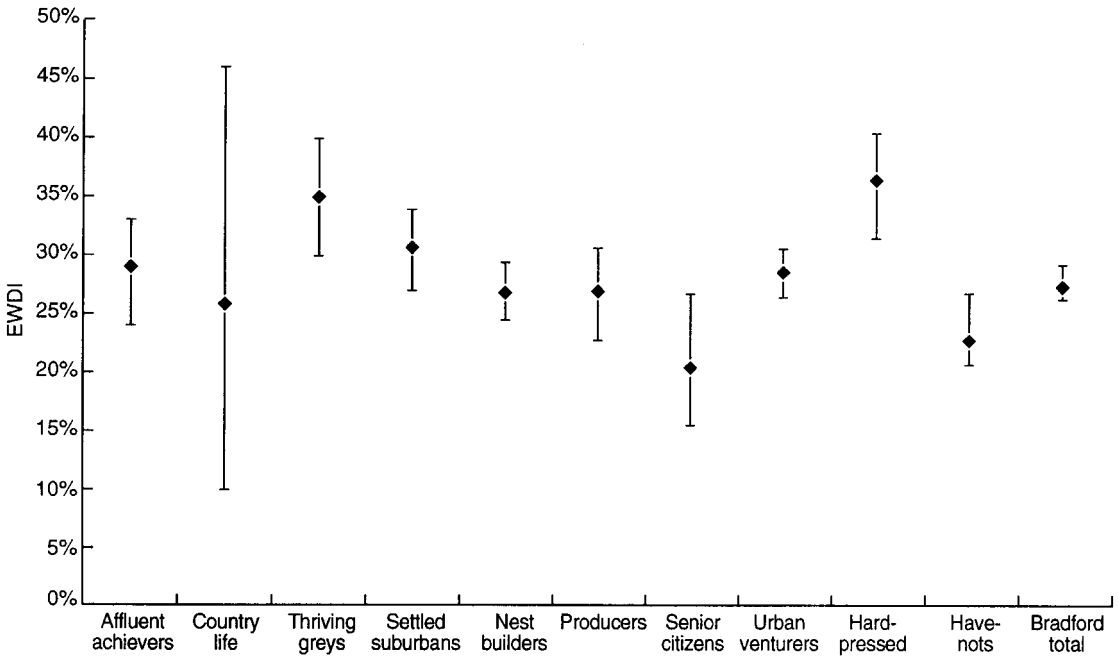

Figure 1 Standardized EWDI with 95 per cent confidence intervals for each Super Profile group.

whereas 'Hard-pressed families' are more likely to live in council terraced houses. Although the housing stock survey showed no difference in energy efficient features between council houses and flats it is likely that houses are more expensive to heat than flats and 'hard-pressed families' may not be able to afford adequate heating.

Confounding factors may be important in this study. The greater presence of nursing homes in some of the more affluent Super Profile groups may explain a higher than expected excess winter mortality in these groups. Nursing homes may be associated with excess winter mortality because of an age effect and because of an increased likelihood of spread of respiratory infections between residents. In this study age will not be a confounding factor because the results were age standardized. There were no influenza epidemics during the period covered by the study but the effect of nursing homes on the prevalence of other respiratory infections has not been accounted for. Environmental factors such as air pollution may potentially act as confounding factors, although other work has suggested that controlling for these factors has little effect on temperature-dependent variations in mortality.[20]

Finally, it is possible that there are differences in indoor and outdoor cold exposure between groups. For example, some groups may have greater exposure to cold indoors through poorly heated houses but may wear more adequate clothing and keep more active outdoors in the cold than other groups. Further research would be needed to determine whether this was the case.

These results suggest that excess winter mortality is not strongly associated with deprivation. We would recommend that policies to reduce excess winter mortality, such as improving house heating efficiency and persuading individuals to dress appropriately and keep active whilst outside in the cold, should be aimed at the whole population; in addition, that further research is undertaken to identify the important aetiological factors in excess winter mortality and the most appropriate preventive interventions.

Acknowledgements

We would like to thank Peter Fryers of the Bradford Health Authority for his statistical advice, and two anonymous referees for their helpful comments on the first submission of this paper.

References

1 Christopherson O. Mortality during the 1996/7 winter. *Population Trends* 1997; **90:** 11–17.

2 Curwen M. Excess winter mortality in England and Wales with special reference to the effects of temperature and influenza. In: *The health of adult Britain: 1841–1994.* London: The Stationery Office, 1997: 205–216.

3 Curwen M. Excess winter mortality: a British phenomenon? *Health Trends* 1990–1991; **22:** 169–175.

4 Curwen M, Devis D. Winter mortality, temperature and influenza: has the relationship changed in recent years? *Population Trends* 1988; **54:** 17–20.

5 Donaldson GC, Tchernjavskii VE, Ermakov SP, *et al*. Winter mortality and cold stress in Yekaterinburg, Russia: interview survey. *Br Med J* 1998; **316:** 514–518.

6 The Eurowinter group. Cold exposure and winter mortality from ischaemic heart disease, cerebrovascular disease, respiratory disease

and all causes in warm and cold regions of Europe. *Lancet* 1997; **349:** 1341–1346.

7 McKee M. Deaths in winter: can Britain learn from Europe? *Eur J Epidemiol* 1989; **5:** 178–182.

8 McKee M, Sanderson C, Laurent C, Vassin S, Shkolinikov V. Seasonal variation in mortality in Moscow. *J Publ Hlth Med* 1988; **20:** 268–274.

9 Curwen M. Peaks and troughs of influenza epidemics: the question of deaths 'brought forward'. Excess winter mortality in England and Wales with special reference to the effects of temperature and influenza. In: *The health of adult Britain: 1841–1994.* London: The Stationery Office, 1997: 214–215.

10 Keatinge WR, Coleshaw SRK, Cotter F, *et al*. Increases in platelet and red cell counts, blood viscosity, and arterial pressure during mild surface cooling: factors in mortality from coronary and cerebral thrombosis in winter. *Br Med J* 1984; **289:** 1405–1408.

11 Donaldson GC, Keatinge WR. Early increases in ischaemic heart disease mortality dissociated from and later changes associated with respiratory mortality after cold weather in south east England. *J Epidemiol Commun Hlth* 1997; **51:** 643–648.

12 Lowry S. Housing and health: temperature and humidity. *Br Med J* 1989; **299:** 1326–1328.

13 Fox AJ, Goldblatt PO. *Longitudinal study; socio-demographic mortality differential.* OPCS Series LS No. 1. London: HMSO, 1982.

14 Wallace M, Denham C. *The ONS classification of local and health authorities of Great Britain*. London: HMSO, 1996.

15 Webb S, Helliwell M, Dews H. *An epidemiological profile of coronary heart disease in Bradford Health District.* Bradford: Bradford Health Authority, 1998.

16 Brown B, Batey P. *Design and construction of a geodemographic targeting system: Super Profiles 1994*. Liverpool: Credit and Data Marketing Services, 1994.

17 Bensley DC, Shahtahmasebi S, Fryers PT, Merrick DW, Fryers P. Validation of use of Super Profile groups with deprivation indices and mortality. In: *A census based view of the population and its health – statistical review.* Harrogate: Yorkshire Regional Health Authority, 1994: Chapter 3.

18 Manson-Siddle C, Robinson MB. Super Profile analysis of socio-economic variations in coronary investigation and revascularisation rates. *J Epidemiol Commun Hlth* 1998; **52:** 507–512.

19 Varghese C, Barrett JH, Johnston C, *et al*. High risk of lymphomas in children of Asian origin: ethnicity or confounding by socioeconomic status? *Br J Cancer* 1996; **74:** 1503–1505.

20 Mackenbach JP, Looman CWN, Kunst AE. Air pollution, lagged effects of temperature and mortality: The Netherlands 1979–87. *J Epidemiol Commun Hlth* 1993; **4:** 121–126.

Accepted on 1 October 1999

Appendix 1: Characteristics of Super Profile groups

Group I – 'Affluent achievers'

Principally middle-aged couples with older children, many of whom are at university or college. They generally live in large, well-appointed, detached homes, which they mostly own themselves, are well qualified and have managerial or professional occupations.

Group II – 'Country life'

Mostly young and middle-aged adults, these people generally live in detached residences, many working where they live. This points to a high percentage of farmers. There is also high second home ownership in this group. The predominantly male workforce is mostly made up of manual workers, many being self employed.

Group III – 'Thriving greys'

Predominantly older middle-aged residents, whose children have left home. Many retired couples. They mostly own their own houses, which tend to be semi-detached or detached. Being well qualified, they generally have professional or managerial jobs.

Group IV – 'Settled suburbans'

A high proportion of middle-aged married couples with children. Most own their own semi-detached houses, many having white collar occupations. People within the group maintain a fairly high standard of living. There are many housewives who also work part time.

Group V – 'Nest builders'

Largely consists of young families, many of whom have mortgages on their semi-detached or terraced houses. They are mostly employed in white collar or skilled manual occupations.

Group VI – 'Producers'

Mainly older residents living in council-owned semi-detached or terraced houses. They chiefly have relatively few qualifications and are largely employed in blue collar professions.

Group VII – 'Senior citizens'

Primarily older, retired couples and single old women living alone. The majority live in flats and terraced houses. Relatively few own cars, mostly getting around on foot.

Group VIII – 'Urban venturers'

This group contains a very high relative proportion of ethnic minorities, mostly young singles, though also some young families. They principally rent their fairly small accommodation. Mainly white collar workers in the service distribution trade make up this group, although there is also a significantly high proportion of members of the armed forces. Many of these people do not own cars, and tend to use the train to travel to work.

Group IX – 'Hard-pressed families'

This group has high numbers of young people, and also contains a fairly high proportion of single-parent families. A large number of them live in medium-sized council terraces. This

group has a high rate of unemployment, those with jobs working in blue collar skilled and semi-skilled professions. With a relatively low level of car ownership, they often use buses as their main means of transport.

Group X – 'Have-nots'

This, the most deprived group, includes many single-parent families and a significantly low number of married couples. They largely live in crowded accommodation, which, with a very low level of owner occupancy, is in the main made up of council or housing association flats. In this group, where most workers are unskilled, there is a very high level of unemployment. Again, a relatively low level of car ownership means that many people in this group rely on public transport.

Appendix 2: Calculation of age-standardized excess winter death index (EWDI)

Age-standardized EWDI $= (W^{S} - N^{S}/W^{S}) \times 100$ where W^{S} is the standardized winter deaths calculated as follows:

$$W^{S} = \sum W_i^{S}$$

$$W_i^{S} = W_i^{G}(P_i^{B}/P_i^{G})$$

where $W_i{}^{S}$ is the component of standardized winter deaths in age group i, $W_i{}^{G}$ is winter deaths (deaths occurring in the months December–March) in age-group i for Super Profile group G, $P_i{}^{G}$ is the population in age-group i for Super Profile group G, $P_i{}^{B}$ is the Bradford standard population age-group i; and N^{S} is standardized non-winter deaths calculated as follows:

$$N^{S} = \sum N_i^{S}$$

$$N_i^{S} = N_i^{G}(P_i^{B}/P_i{}^{G})$$

where $N_i{}^{S}$ is the component of standardized non-winter deaths in age group i, $N_i{}^{G}$ is non-winter deaths (deaths occurring in the months April–July plus death occurring in August–November, divided by two) in age-group i for Super Profile group G, $P_i{}^{G}$ is the population in age-group i for Super Profile group G and $P_i{}^{B}$ is the European standard population age-group i.