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Temperature, housing, deprivation and their relationship to excess winter mortality in Great Britain, 1986–1996

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Objectives To examine the associations between temperature, housing, deprivation and excess winter mortality using census variables as proxies for housing conditions.

Design Small area ecological study at electoral ward level.

Setting Great Britain between 1986 and 1996.

Participants Men and women aged 65 and over.

Main outcome measures Deaths from all causes (International Classification of Diseases, Ninth Revision [ICD-9] codes 0–999), coronary heart disease (ICD-9 410–414), stroke (ICD-9 430–438) and respiratory diseases (ICD-9 460–519). Odds of death occurring in winter period of the four months December to March compared to the rest of the year.

Results During the study period (excluding the influenza epidemic year of 1989/90), a total of 1 682 687 deaths occurred in winter and 2 825 223 deaths occurred during the rest of the year among people aged ⩾65 (around 30 000 excess winter deaths per year). A trend of higher excess winter mortality with age was apparent across all disease categories ($P < 0.01$). There was a significant association between winter mortality and temperature with a 1.5% higher odds of dying in winter for every 1°C reduction in 24-h mean winter temperature. The amount of rain, wind and hours of sunshine were inversely associated with excess winter mortality. Selected housing variables derived from the English House Condition Survey showed little agreement with census-derived variables at electoral ward level. For all-cause mortality there was little association between deprivation and excess winter mortality, although lack of central heating was associated with a higher risk of dying in winter (odds ratio [OR] = 1.016, 95% CI : 1.009–1.022).

Conclusions Excess winter mortality continues to be an important public health problem in Great Britain. There was a strong inverse association with temperature. Lack of central heating was associated with higher excess winter mortality. Further work is needed to disentangle the complex relationships between different indicators of housing quality and other measures of socioeconomic deprivation and their relationship to the high number of excess winter deaths in Great Britain.

Keywords Mortality, seasonal, epidemiology, small-area analysis

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It has long been known that mortality in England and Wales is higher in the winter than in the rest of the year. In the Registrar General's Third Annual Report,[1] William Farr devoted several pages to a discussion on mortality in London during the years 1838–1841. The same phenomenon still accounts for up to 40 000 extra deaths in winter[2,3] in England and Wales; it also occurs to a lesser extent in other countries, particularly in Scandinavia and neighbouring parts of Western Europe.[4,5]

Regression analysis indicates that about 88% of the variation in the numbers of excess winter deaths per annum in England and Wales can be accounted for by three variables: mean national winter temperature, number of winter deaths registered

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to influenza, and time (a reduction of excess winter deaths by about 500 a year).[3]

Excess mortality in winter is an important public health issue in the UK, potentially amenable to prevention. This study examines the associations of temperature, deprivation and housing (based on census variables) with excess winter mortality across electoral wards in Great Britain during 1986–1996. The focus is on people aged ⩾65, for whom the excess risk of winter death is greatest.[4]

Methods

We used the Office for National Statistics[6] definition for winter given as the four months from December to March. Deaths from all causes (International Classification of Diseases, Ninth Revision [ICD-9] codes 0–999), coronary heart disease (ICD-9 410–414), stroke (ICD-9 430–438), respiratory diseases (ICD-9 460–519) and influenza (ICD-9 487) were obtained for males and females aged ⩾65 from the national death registration database held at the Small Area Health Statistics Unit. Numbers of deaths were obtained for each electoral ward in Great Britain for each year between 1 August 1986 and 31 July 1996.

In order to examine the relationship between housing conditions and excess winter mortality in Great Britain at ward level, we required nationwide predictors of poor- or good-quality housing, with particular reference to thermal conditions. Such data are not available nationally, although the English House Condition Survey (EHCS) contains data relating to the energy and thermal properties of houses,[7] based on a random survey of individual households in England, conducted every 5 years. The aim was to relate the EHCS at individual level to census variables for the corresponding electoral wards and then to use these area-level data for the main analysis.

Data for a total of 9089 households was obtained from the 1991 EHCS. The numbers of observations per variable varied from 4484 to 9089. In order to work with a small subset of the available variables, we first examined relationships within the survey. We derived 14 variables from the EHCS (Figure 1) for further consideration based on completeness and relevance to heating and thermal efficiency. Eleven categorical variables were taken in their original form, one was a continuous measure, which we categorized into quintiles and two were categorical, which were dichotomized. We used Goodman and Kruskal's Gamma statistic[8] to measure association and incorporated this into a hierarchical agglomerative clustering algorithm[9,10] in order to obtain variables measuring different aspects of housing quality. Subsequently one variable was chosen from each cluster for further analysis.

Twenty-six 1991 census variables and the Carstairs[11] deprivation index were obtained at electoral ward level (Figure 1). The Carstairs index is a score derived from four census variables (unemployment, overcrowding, social class of head of household and car ownership), standardized to have zero mean across wards in Great Britain. All values were expressed in proportions of the appropriate population or households at ward level. Each house condition survey record was assigned census values using the ward code. To examine the relationship between the chosen housing variables and the available census variables we derived a categorical variable (in quintiles) from each census variable and then calculated the gamma statistic for the chosen subgroup of housing variables against the census variables. The relationship between the variables within the two data sources was then examined. Where variables were common to both data sets,

1991 Census	English House Condition Survey
Proportion households with one person	Energy SAP rating
Proportion households lacking/sharing use of bath/shower	Tenure
Proportion households with no central heating	Wall insulation
Proportion households owner occupied, owner outright	Loft insulation
Proportion households owner occupied, buying	Cylinder insulation
Proportion households rented privately, furnished	Double glazing
Proportion households rented privately, unfurnished	Mould growth index
Proportion households rented with a job or business	Adequate provision for heating
Proportion households rented from a housing association	External WC
Proportion households rented from a local authority/New town	Rising damp
Proportion households of non-permanent accommodation	Penetrating damp
Proportion male residents	Bath/shower present and working
Proportion persons aged 65 and over	Central heating
Proportion males aged 65 and over	Overall temperature interviewer rating
Proportion females aged 65 and over	
Proportion persons economically active	
Proportion persons unemployed	
Proportion residents with long-term limiting illness	
Proportion residents over 65 with long-term limiting illness	
Proportion households with over 1.5 persons per room	
Proportion households with over 1 and up to 1.5 persons per room	
Proportion households with over 0.5 and up to 1 persons per room	
Proportion households with up to 0.5 persons per room	
Proportion households with no car	
Proportion households with head in social class IV	
Proportion households with head in social class V	
Carstair's deprivation index	

Figure 1 List of variables derived from 1991 English House Condition Survey and 1991 Census for which relationships were explored

we compared them directly (e.g. central heating), otherwise we compared all possible combinations.

Interpolated seasonal meteorological data were assigned to each ward by spatial smoothing using geographical information system techniques based on daily data from the national network of 116 meteorological stations and were obtained from the meteorological office. The variables were 24-h mean temperature, daytime minimum temperature, night-time minimum temperature, number of days below 0°C based on 24-h mean, days below 0°C based on daytime minimum, days below 0°C based on night-time minimum, mean daily rainfall (mm), daily bright sunshine (h) and daily mean wind speed (knots). Smoothed contours of 24-h mean temperatures for the winter season, 1986, are shown in Figure 2, together with the locations of the meteorological stations. The winter season values were calculated for each year by averaging daily measurements from December until March of the next year. Wards on the periphery of Great Britain which could not be assigned a value and those where complete census data were not available were excluded. This left 9143 out of the 10 933 wards originally identified for the analysis.

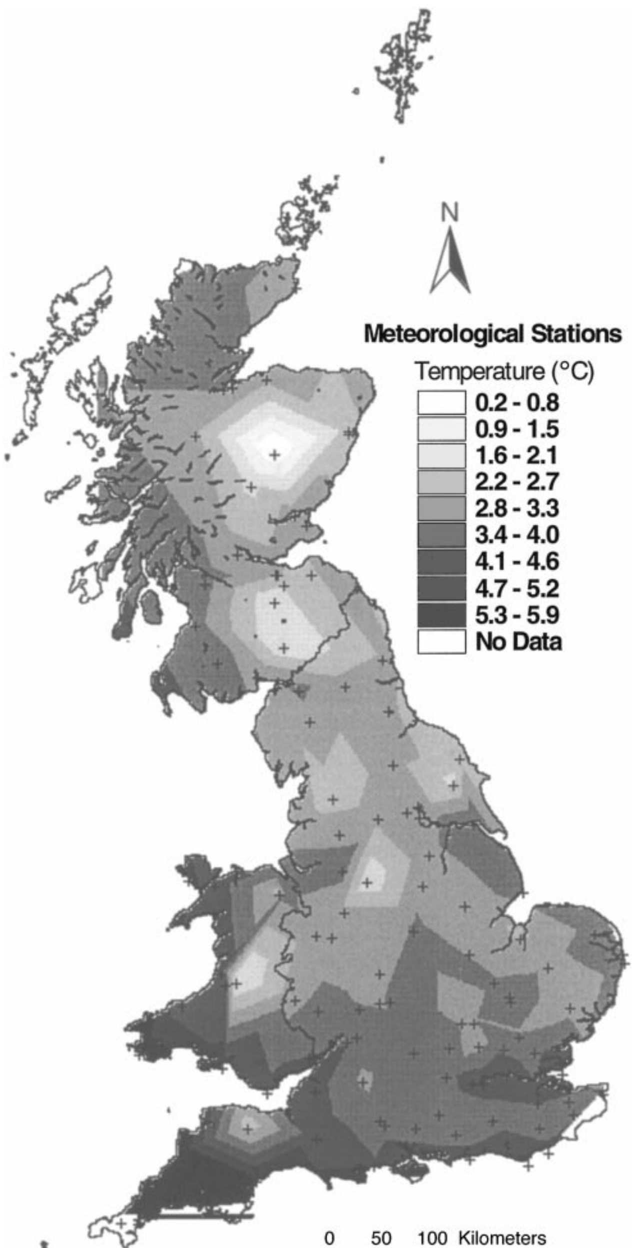

Figure 2 Map of Great Britain showing 24-h mean temperature for the 1986 winter season

The Excess Winter Deaths Ratio was used as a simple descriptive measure, based on the Office for National Statistics[6] definition given as the numbers of deaths occurring in the four months from December to March compared to the average numbers of deaths occurring in the preceding and following four months.

The relationship between the selected census variables, deprivation and age with excess winter mortality was then explored for each individual meteorological variable by assuming that the counts of winter and non-winter deaths each came from a Poisson distribution. With this assumption, conditioning on the total number of deaths, the number of winter deaths is binomially distributed, with the number of trials equal to the total number of deaths (winter and non-winter). The probability in this model represents the conditional probability of a winter death given that a death has occurred. This probability was modelled as a function of the explanatory variables using a logistic regression function. Odds ratios (OR) for an increase of one unit were calculated. Census variables (including Carstairs deprivation score) were re-scaled so that the OR compare 5th and 95th percentiles. The temperature data were standardized to have zero mean over the country over 10 years.

Results

Among the 14 housing variables considered in the EHCS (Figure 1), the clustering algorithm identified five groups. One representative variable from each group was selected for comparison with census variables. These were the presence of mould, the presence of rising damp, wall insulation, tenure and lack of central heating. They showed little agreement (not shown) with the 26 census-derived variables at electoral ward level. The two significant associations were between proportion of those economically active and presence of mould ($\gamma = -0.08$, $P = 0.002$) and between proportion of residents with long term limiting illness and mould ($\gamma = 0.07$, $P = 0.003$).[12] The significance levels were not adjusted for multiple testing. These two census variables were chosen, together with tenure (the proportion of owner occupied and privately rented households) and the lack of central heating in households with one or more residents of pensionable age, common to both the census and the EHCS, although not significantly associated ($p \geqslant 0.12$ and $P = 0.32$ respectively). We also included the Carstairs index of deprivation, which showed significant relationships with four of the five variables (γ in modulus $\leqslant 0.35$, $P < 0.001$), rising damp being the exception ($\gamma = 0.02$, $P = 0.58$). The mean, median and 5th and 95th percentiles of the five selected census variables and Carstairs deprivation index are given in Table 1.

The coldest average winter night-time minimum temperature occurred in 1995/96 (2.7°C) and the highest occurred in 1988/89 (5.9°C) (Figure 3). There was high correlation between all temperature variables ranging from 0.82 to 0.96 (Table 2). There was only modest correlation between the temperature variables and rain and wind ranging in modulus between

Table 1 Mean and median values of the five selected census variables and Carstairs deprivation index for 1991 census wards, and their 5th and 95th percentiles

Census variables	Mean	Median	5th percentile	95th percentile
Proportion households with no central heating with one or more residents of pensionable age	0.218	0.196	0.055	0.451
Proportion of people economically active	0.608	0.610	0.499	0.708
Proportion of residents in households with limiting long-term illness (all ages)	0.117	0.112	0.070	0.185
Proportion households owner occupied with one or more residents of pensionable age	0.622	0.650	0.260	0.893
Proportion households rented privately with one or more residents of pensionable age	0.062	0.047	0.005	0.167
Carstairs deprivation index	0.108	–0.866	–3.816	6.919

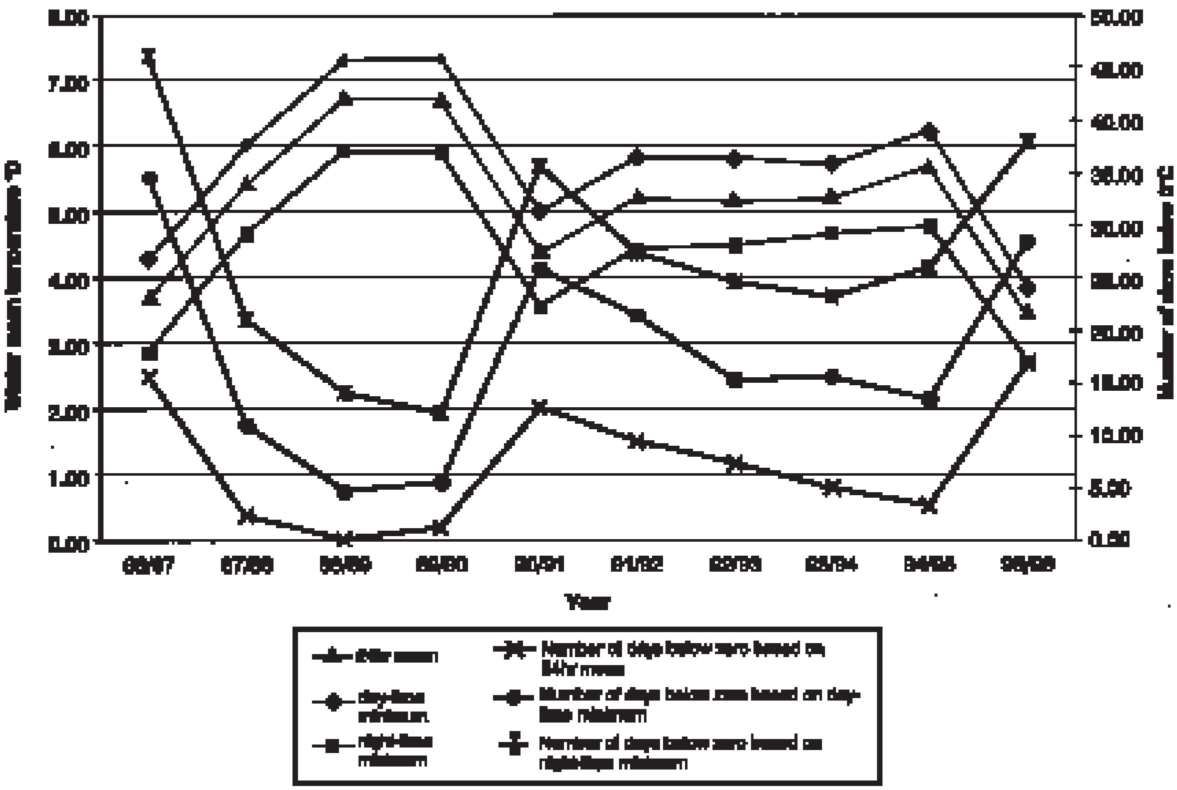

Figure 3 Mean winter temperatures and number of days below 0°C for electoral wards, 1986–1996 in Great Britain

Table 2 Correlation matrix of annual meteorological variables in winter[a] between 1986 and 1996, Great Britain

Meteorological variables	24-h mean temperature (°C)							
Daytime min. temp. (°C)	0.95	Daytime min. temp. (°C)						
Night-time min. temp. (°C)	0.93	0.96	Night-time min. temp. (°C)					
No. days below 0°C based on 24-h mean	–0.84	–0.82	–0.84	No. days below 0°C based on 24-h mean				
No. days below 0°C based on daytime min.	–0.86	–0.88	–0.90	0.87	No. days below 0°C based on daytime min.			
No. days below 0°C based on night-time min.	–0.84	–0.84	–0.90	0.83	0.95	No. days below 0°C based on night-time min.		
Mean daily rainfall (mm)	0.09	0.10	0.23	–0.26	–0.22	–0.26	Mean daily rainfall (mm)	
Mean daily bright sunshine (h)	0.53	0.52	0.44	–0.53	–0.42	–0.30	–0.04	Mean daily bright sunshine (h)
Daily mean wind speed (knots)	0.24	0.20	0.26	–0.29	–0.23	–0.26	0.26	0.28

All values significant ($P < 0.001$).

[a] Winter defined as 1 December to 31 March.

0.09 (rainfall and 24-h mean temperature) and 0.29 (wind speed and number of days below 0°C based on 24-h mean). Hours of sunshine were most strongly correlated with 24-h mean temperature and number of days below 0°C based on 24-h mean (0.53 and –0.53 respectively). There was a spatial pattern in temperature variables with a tendency for lower temperatures on the East coast of Britain (Figure 2).

There was an influenza epidemic during the winter of 1989/90 when the excess winter mortality ratio for influenza deaths rose above 70. The ratio was also high for respiratory deaths, and, to a lesser extent, all-cause mortality (Figure 4). Subsequent analyses were therefore carried out excluding 1989/90 data.

The median number of excess deaths per ward varied between 1.5 (5th and 95th percentiles of –5 and 11.5) in 1988/89 and 3.0 (–4 and 15) in 1995/96. Table 3 shows the numbers of deaths by cause in Great Britain. Within the study period (excluding 1989/90), a total of 1 682 687 deaths occurred among people aged ⩾65, in the four months December to March, and 2 825 223 deaths occurred during the rest of the year. This gave an excess mortality in the winter period over 9 years of 1 682 687 – 0.5 × 2 825 223, i.e. an average of around 30 000 excess winter deaths per year. Unadjusted all-cause excess winter death ratios were identical (1.19) in both excluded and included wards. Table 3 also shows

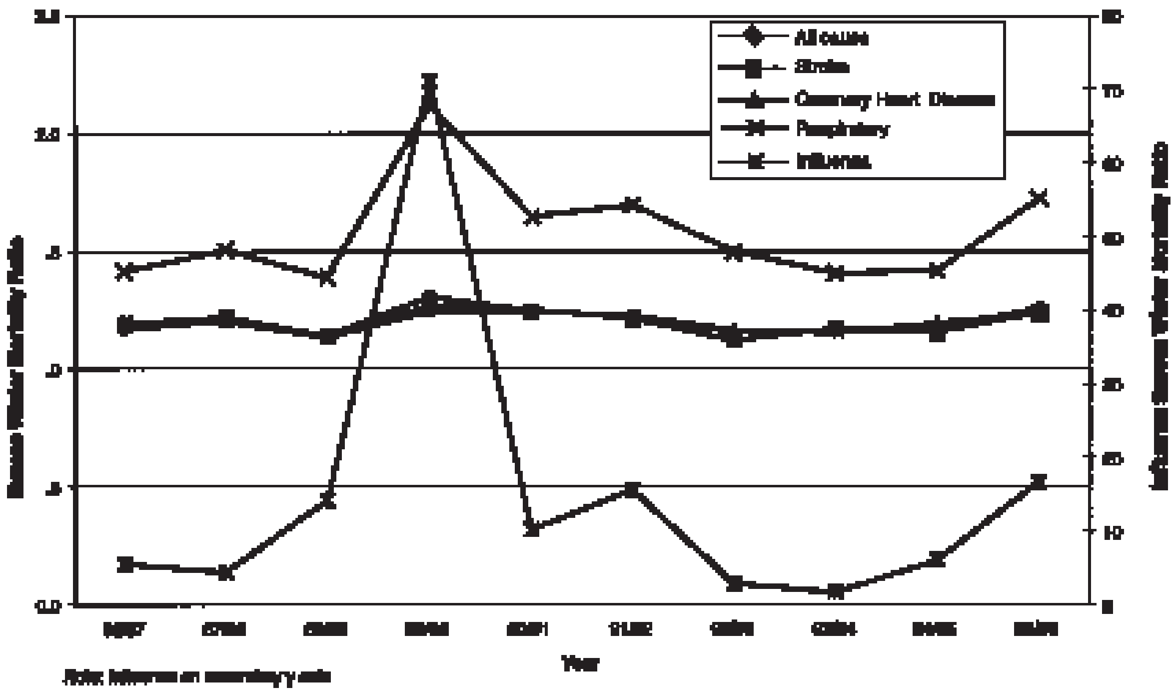

Figure 4 Annual excess winter mortality ratios[a], 1986–1996 in Great Britain

[a] Winter defined as 1 December to 31 March.

Excess winter mortality expressed as the ratio of the number of deaths in winter to half of those in the previous and subsequent 4 months.

Table 3 Deaths in people age ⩾65 by cause occurring between 1 August 1986 and the 31 July 1996 (excluding 1989/90) in Great Britain, and odds of death in winter[a], by age (years)

			65–74		75–84		85+	
Cause	**Winter[a]**	**Remainder of year**	OR[b,c]	95% CI	OR[b,c]	95% CI	OR[b,c]	95% CI
All causes (ICD-9[d] 0–999)	1 682 687	2 825 223	1.127	1.114–1.139	1.180	1.167–1.193	1.252	1.238–1.267
CHD[e] (ICD-9 410–414)	449 054	753 083	1.145	1.120–1.170	1.179	1.154–1.204	1.217	1.191–1.245
Stroke (ICD-9 430–438)	220 462	370 726	1.119	1.084–1.156	1.153	1.118–1.189	1.178	1.142–1.216
Respiratory diseases (ICD-9 460–519)	272 366	358 493	1.485	1.441–1.530	1.506	1.463–1.550	1.577	1.532–1.623

[a] Winter defined as 1 December to 31 March.

[b] Odds ratio.

[c] Logistic regression analysis of odds of death in winter compared with remainder of year, adjusted for 24-h mean temperature, deprivation and the five census variables.

[d] International Classification of Diseases, Ninth Revision.

[e] Coronary heart disease.

results from the conditional logistic model for each of three age groups, adjusting for 24-h mean temperature, deprivation and the five census variables. An increasing trend with age in the odds of dying in winter was apparent across all disease categories ($P < 0.01$). Subsequent analyses were adjusted for age using these three groups.

Table 4 gives the OR and 95% CI for a unit of each meteorological variable adjusted for census variables, age and deprivation. The three mean temperature variables had similar associations with the odds of dying in winter ranging from 1.015 (95% CI : 1.013–1.017) to 1.017 (95% CI : 1.015–1.019) for all-cause mortality. Thus there was a 1.5% higher odds of dying in winter for every 1°C *decrease* in the 24-h mean winter temperature below the 10-year national average. Similar associations across all three mean temperature measures were found for coronary heart disease and stroke. For respiratory deaths, the associations with the temperature variables were larger, ranging from 1.032 (95% CI : 1.027–1.037) to 1.041 (95% CI : 1.035–1.045).

The three variables describing number of days with temperatures below zero were similarly related to all cause excess mortality with OR ranging from 1.001 (95% CI : 1.001–1.002) to 1.003 (95% CI : 1.002–1.003) per one day *increase*. There was a 0.3% higher odds of dying in winter for a one-day increase in the number of days where the mean 24 hour temperature fell below 0°C.

The amount of rain was inversely related to excess winter mortality with 0.8% lower odds of dying for all causes for every mm increase above the 10-year national average. Wind speed had a small inverse relationship with all-cause winter mortality. Hours of sunlight was also inversely related to excess winter mortality with 2.9% lower odds for every additional hour of daily sunshine. Again these relationships were more marked for respiratory deaths (Table 4).

Table 5 gives OR for the census variables and Carstairs deprivation index, adjusted for 24-h mean temperature and age. Of the census variables considered, only lack of central heating showed significant associations with the odds of dying in winter, for all causes and coronary heart disease, with OR ranging from 1.016 (95% CI : 1.009–1.022) for all causes, to 1.029 (95% CI : 1.011–1.048) for stroke. There was no association between the Carstairs deprivation index, all-cause and coronary heart disease excess winter mortality, although there was borderline significant lower excess mortality with increasing deprivation for respiratory disease.

Table 4 Odds ratios (OR) of the odds of death in winter[a] for a change of one unit of independently modelled meteorological variables[b] adjusted for age, deprivation and the five census variables, Great Britain 1986–1996 (excluding 1989/90)

	All causes		Coronary heart disease		Stroke		Respiratory	
Meteorological variables	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Decrease in 24-h mean temp. (°C)	1.015	1.013–1.017	1.015	1.011–1.018	1.018	1.013–1.024	1.032	1.027–1.037
Decrease in daytime min. temp. (°C)	1.016	1.014–1.018	1.016	1.012–1.019	1.018	1.013–1.024	1.035	1.030–1.040
Decrease in night-time min. temp. (°C)	1.017	1.015–1.019	1.017	1.014–1.021	1.018	1.013–1.024	1.041	1.035–1.045
No. of days below 0°C based on 24-h mean	1.003	1.002–1.003	1.003	1.002–1.003	1.003	1.002–1.003	1.007	1.006–1.008
No. of days below 0°C based on daytime min.	1.002	1.001–1.002	1.002	1.001–1.002	1.002	1.001–1.003	1.004	1.004–1.005
No. of days below 0°C based on night-time min.	1.001	1.001–1.002	1.001	1.001–1.002	1.002	1.001–1.002	1.003	1.003–1.004
Mean daily rainfall (mm)	0.992	0.990–0.995	0.996	0.992–1.000	0.996	0.991–1.002	0.955	0.950–0.960
Mean daily bright sunshine (h)	0.971	0.967–0.976	0.973	0.964–0.983	0.976	0.963–0.990	0.917	0.906–0.928
Daily mean wind speed (knots)	0.996	0.995–0.997	0.997	0.995–0.999	0.996	0.993–0.999	0.985	0.982–0.987

[a] Winter defined as 1 December to 31 March.

Table 5 Odds ratios (OR) of the odds of death in winter[a] for an increase from the 5th to 95th percentile values of census-derived variables at ward level, adjusted for 24-h mean temperature and age, Great Britain, 1986–1996 (excluding 1989/90)

	All causes		Coronary heart disease		Stroke		Respiratory	
Census-based variables	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Proportion households with no central heating with one or more residents of pensionable age	1.016	1.009–1.022	1.017	1.005–1.029	1.029	1.011–1.048	1.014	0.998–1.031
Proportion of people economically active	0.995	0.986–1.005	1.004	0.986–1.022	0.998	0.972–1.024	0.980	0.957–1.005
Proportion of residents in households with limiting long-term illness (all ages)	0.996	0.987–1.005	1.003	0.986–1.021	0.994	0.970–1.019	0.982	0.960–1.005
Proportion households owner occupied with one or more residents of pensionable age	0.995	0.987–1.003	0.994	0.979–1.010	1.019	0.996–1.043	1.004	0.983–1.026
Proportion households rented privately with one or more residents of pensionable age	1.003	0.995–1.010	0.996	0.982–1.011	1.003	0.982–1.024	1.017	0.997–1.036
Carstairs deprivation index	0.999	0.990–1.009	1.000	0.982–1.018	1.014	0.988–1.041	0.976	0.953–1.000

[a] Winter defined as 1 December to 31 March.

Discussion

Excess winter mortality is still an important public health problem in Great Britain, particularly in the very old. There was no apparent continuation of the reported decrease of excess winter mortality over time,[13] which has been linked to an increased use of central heating.[14,15] We found an average excess winter mortality of 30 000 deaths per year in Great Britain over a 9-year period (excluding 1989/90), and for 1995/96 it was in excess of 40 000.

Our findings support previous reports of an association between seasonal temperature and excess winter mortality.[2] The inverse relationship with rainfall and wind could be explained by a reduction of outdoor excursions when it is raining or windy preventing outdoor cold stress.[16] We found a significant relationship between excess winter mortality and lack of central heating. While Kunst *et al*.[17] speculated that the introduction of central heating had had minimal impact, our findings are more consistent with the Eurowinter Group.[18] They reported high indices of cold-related mortality associated with low living room temperatures and limited bedroom heating, as well as among people who wore fewer clothes and were less active outdoors.

In colder climates, it has been suggested that the maintenance of warmth in houses has a protective effect on winter mortality.[19,20] One possible reason for the much lower excess winter mortality in Norway compared with England and Wales[4] may be that heating is usually included in the rent. Consequently, poor households should have a warm indoor environment. The presence of central heating in the UK may be a proxy for the maintenance of warmth in houses. However, due to financial constraints, some poorer households may not make use of their heating. If this were the case, the relationship between excess winter mortality and central heating found in our study might have been diluted since unheated households would have been allocated to the central heating group.

By use of the EHCS,[7] we endeavoured to select a small number of census variables that appeared to be relevant to aspects of housing quality. There was, however, poor agreement between individual-level EHCS data and the area-level census data. This may have reflected to some extent the fact that wards contain around 2500 households, where as only one or two households per ward were included in the EHCS. Furthermore, wards, particularly in urban areas can be quite heterogeneous in social and housing conditions. In addition, it is possible that there may have been some bias in the selection of properties for the survey, which could affect the relationship with census data.

Within the survey, owner occupation was associated with more double-glazing, the overall temperature interviewer rating and generally better heating and thermal insulation. Better heating and insulation were also found to be associated with relative affluence and higher social class,[7] although in our analysis using census-based variables, the correlation between Carstairs deprivation index and 'no central heating' was low (–0.01), as was the correlation between Carstairs index and 'owner occupied' (–0.03).

The lack of association between deprivation and excess winter mortality was perhaps surprising but is consistent with two recent studies carried out in Scotland and Croydon.[21,22] Nor was there any association between privately rented housing, a potential indicator of poor housing, and excess winter mortality. Two issues need to be considered in the interpretation of these findings. First, the census variables may only partly reflect housing quality, which may attenuate any associations with mortality. Secondly, caution is required in making inferences from small-area ecological studies to individual or household level.[23] The Carstairs deprivation index is a deprivation measure calculated from data for the whole population, whereas this study is limited to deaths in those aged ⩾65. However, both the Carstairs and the Townsend deprivation index show a strong relationship with mortality in the elderly.[24,25] We therefore think it unlikely that an alternative measure of deprivation, would have behaved very differently than Carstairs in association with excess winter deaths. It is also possible that people living in deprived areas with poor housing were compensating by wearing warm clothes and adopting other protective behaviours.[19]

It is possible that the deaths we are observing in winter represent shifts in the timing of events that lead to death ('mortality displacement'), and that the effects of temperature simply serve to bring forward a death by a short period of time. However, as our study examines seasonal shifts in mortality, this delay would have to be in the order of months rather than days to account for the annual winter excess mortality. The design of our study is such that we are unable to explore further this potential displacement effect.

The aetiology of excess winter mortality has yet to be determined. Environmental temperature has an inverse relation with blood pressure.[26] A raised blood pressure in a cold environment has several adverse effects. It alters the ratio of myocardial oxygen supply to demand. It increases the ventricular wall stress, cardiac work, and oxygen requirements, and reduces mechanical efficiency which could precipitate myocardial infarction.[26] Vallance *et al*.[27] suggest that infection may partly explain the seasonal variation in death from cardiovascular disease. The mechanism they put forward is that systemic inflammatory response increases risk by raising the concentration of circulating clotting factors such as fibrinogen. Alternatively, endothelial function might be altered. Khaw *et al*.[28] reported that in an observational study of 96 men and women living in their own homes, the observed winter rise in fibrinogen was related to a winter increase in infection. Pell *et al*.[29] suggest that people who suffer cardio-pulmonary arrest in winter have a significantly lower likelihood of surviving, in part because of a higher frequency of associated risk factors.

Excess winter mortality continues to be an important public health problem in Great Britain. International comparisons showing much higher levels of winter mortality in the UK than other countries and that the maintenance of warmth in houses has a protective effect on winter mortality suggest that it may be amenable to intervention. There was a strong inverse association with temperature. Lack of central heating was associated with higher excess winter mortality. If this relationship were causal, and the excess deaths were not simply due to a 'mortality displacement' effect, then there could be policy implications in providing central heating to people who were not able to afford it. However, mechanisms would also have to be in place to ensure that people were able to run and afford their central heating once installed. Further work is needed to disentangle the complex relationships between different indicators of housing quality and other measures of socioeconomic deprivation and their relationship to the high number of excess winter deaths in Great Britain.

Contributors

PA, PE and LJ were involved in the conception and management of the project. PA, SM and AG were involved in the development of the project with JW overseeing the statistics. PA prepared the first draft of this paper and SM, JW, PE, AG and LJ contributed to the final submitted version. PA is the guarantor.

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KEY MESSAGES

- Excess winter mortality continues to be an important public health problem in Great Britain and accounted for in excess of 40 000 extra deaths in the winter of 1995/96.
- It occurs to a lesser extent in other countries, particularly in Scandinavia and neighbouring parts of Western Europe.
- There is a strong inverse association with mean seasonal temperature.
- There is little association between deprivation and excess winter mortality.
- Lack of central heating was associated with higher excess winter mortality.
- Further work is needed to disentangle the complex relationships between different indicators of housing quality and other measures of socioeconomic deprivation and their relationship to the high number of excess winter deaths in Great Britain.

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