Deprivation and excess winter mortality

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Abstract

***Objective*—To investigate the effect of material deprivation on the winter rise in mortality and temperature dependent variations in mortality.**

***Design*—Ecological comparison of seasonal mortality at electoral ward level. Main outcome measures were ratios of winter to rest of the year mortality rates (seasonality ratios) and monthly deaths as the outcome variable in a model with monthly average temperature and Townsend score as main predictors.**

***Setting*—Croydon, London, United Kingdom.**

***Subjects*—All deaths of Croydon residents for the period 1990–1995.**

***Main results*—There was a clear relation between overall mortality and deprivation. There was no evidence of a relation between age and sex standardised seasonality ratios and Townsend scores for all deaths (Kendall's $\tau = -0.066$, p=0.63) or cardiovascular deaths or respiratory deaths. There was no evidence of an interaction between Townsend score and temperature in the model of ward mortality rates (p=0.73). These findings were not affected by exclusion of deaths of nursing and residential home residents.**

***Conclusion*—This study provides no evidence of an effect of deprivation on excess winter mortality or temperature dependent variations in mortality. The findings question simple assumptions about the relation between deprivation and excess winter mortality and highlight the need for further study to guide interventions.**

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Seasonal variations in mortality are well described in the United Kingdom and other industrialised countries.[1–3] Mortality in England and Wales rises by up to 20% in the period from December to March and this represents approximately 40 000 additional deaths a year.[1 4] Analyses in a number of countries show that outdoor temperature and influenza incidence are key determinants of excess winter mortality.[4–7]

Tackling inequalities in health is central to current UK health policy but there is a recognised deficit in our knowledge of its determinants and effective interventions to reduce inequalities.[8 9] A widely held belief is that excess winter mortality is determined by socioeconomic deprivation and, in particular, fuel poverty.[10 11] The Acheson Report on Inequalities in Health in the United Kingdom has recommended action on fuel poverty to reduce inequalities in health.[12]

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International comparisons of seasonal mortality, which demonstrate greater excess winter mortality in the United Kingdom, support this belief.[13] Similarly social class analysis of routine mortality data and data from the Office for National Statistics Longitudinal Study show a socioeconomic gradient in seasonal mortality.[1 14] However, other studies have questioned these findings and postulated alternate hypotheses that emphasise behavioural determinants or the importance of brief outdoor exposure to the cold.[15 16] Differences in the use of outdoor clothing and physical activity may explain international variations in excess winter mortality and the paradox that countries with colder winters experience lower levels of excess winter mortality.[15] There have been no detailed studies that have attempted to test the hypothesis that socioeconomic deprivation predisposes to excess winter mortality.

In this study, we attempt to test this hypothesis in a single district with marked variations in mortality. The restriction of analysis to a relatively small geographical area reduces the potential confounding effect of geographical dispersion of the study population. Also, local data allowed the exclusion of deaths of nursing and residential home residents whose thermal environment is unlikely to be determined by socioeconomic circumstances.

Methods

STUDY DESIGN

The study used ecological comparison at electoral ward level of seasonality ratios and temperature dependent variation in mortality.[1 4] Seasonality ratios are a widely used quantitative description of the seasonal mortality. They are the ratio of mortality rates in winter (December to March) to those in the rest of the year multiplied by one hundred. Townsend scores were used as a measure of socioeconomic deprivation at ward level.[17]

SUBJECTS AND DATA SOURCES

Croydon is an outer London district with a population of one third of a million. Mortality data for Croydon residents for a six year period (1990–5) were available in the Croydon Mortality Database.[18] This contained details of 17 761 deaths including age, ward of residence, date of death, cause of death and whether the individual was a permanent resident in a residential or nursing home at the time of death. Complete data were available on 17 744 deaths and these were used in subsequent analyses.

Data from the 1991 census were used to calculate Townsend scores for each electoral ward based on the Croydon ward average.[17] Wards were allocated into deprivation quintiles based on these scores. Daily temperature data for London were obtained from the London

Table 1 Standardised mortality ratios (SMRs) for ward deprivation quintiles, based on Townsend scores, before and after exclusion of nursing and residential home deaths

Ward deprivation quintiles	*All age SMR before exclusion (observed)*	*95% Confidence intervals*	*All age SMR after exclusion (observed)*	*95% Confidence intervals*
I (most affluent)	89.5 (3745)	86.7 to 92.4	89.1 (3064)	85.9 to 92.2
II	97.8 (3550)	94.6 to 101.0	94.2 (2770)	90.7 to 97.7
III	102.2 (3772)	99.0 to 105.5	100.1 (2974)	96.5 to 103.7
IV	100.8 (2976)	97.2 to 104.4	104.9 (2499)	100.8 to 109.0
V (most deprived)	112.6 (3701)	108.9 to 116.2	114.8 (3322)	110.9 to 118.7

(Before exclusion, χ^2 for trend = 90.3, p<0.001. After exclusion,χ^2 for trend=118, p<0.001).

Weather Centre and national estimates of quarterly influenza incidence, based on Royal College of General Practitioners spotter practice data, were extracted from Office for National Statistics series MB2. Statistical analysis was undertaken with SPSS 6.1 for Windows.

CALCULATION OF MORTALITY RATES AND SEASONALITY RATIOS

Standardised mortality ratios and a test for trends in these ratios were calculated using standard methods.[19] Seasonality ratios were calculated for each ward and deprivation quintile from the ratio of crude winter and rest of the year mortality rates. Age and sex standardised seasonality ratios were calculated from the ratio of directly standardised death rates.[20] The ratio of directly standardised death rates is a consistent summary of age specific seasonality ratios for a population and take account of variations of seasonality ratios with age. Standardisation made little difference to ward seasonality ratios. The relation between standardised seasonality ratios and Townsend score at ward level was assessed using Kendall's rank correlation.[21] Analysis was performed before and after exclusion of nursing and residential home deaths.

TEMPERATURE DEPENDENT VARIATION IN MORTALITY

Multiple linear regression was used to develop a model of monthly ward mortality, expressed as number of deaths per 30 day month. A square root transformation of the outcome variable was performed to normalise the residuals. Predictors in the model included average monthly temperature, Townsend score, population size, influenza incidence, and ward age structure. All models met the assumptions of least squared regression. The relation between temperature dependent variations in mortality and deprivation was tested by addition of a linear interaction term between temperature and Townsend score.

Table 2 Age and sex standardised seasonality ratios for all deaths by ward deprivation quintiles before and after exclusion of nursing and residential home deaths

Ward deprivation quintile	*Standardised seasonality ratio (95% confidence intervals)*	*Standardised seasonality ratio (95% confidence intervals)*
		Institutional deaths excluded
I	121.7 (109.1 to 135.8)	119.7 (106.0 to 135.1)
II	120.3 (107.5 to 134.6)	120.2 (105.8 to 136.6)
III	117.2 (105.0 to 130.8)	113.0 (100.0 to 127.9)
IV	125.4 (110.9 to 141.8)	121.5 (106.2 to 139.0)
V	115.9 (103.7 to 129.5)	115.3 (102.6 to 129.6)
Croydon	119.7 (116.1 to 123.4)	117.4 (111.1 to 124.1)

Table 3 Details of the model of all monthly ward deaths after square root transformation and the effect of an interaction term*

Variable	*Coefficient*	*95% Confidence intervals*	*p value*
Mean temperature (°C)	−0.0264	−0.033 to −0.019	<0.001
Influenza incidence†	1.23×10^{-4}	0.381 to 2.09 ×10−4	0.0046
Total population	1.39×10^{-4}	1.26 to 1.53 × 10−4	<0.001
% pop below 16	−0.033	−0.044 to −0.022	<0.001
% pop above 65	0.082	0.068 to 0.096	<0.001
Townsend score	0.027	0.019 to 0.035	<0.001
Interaction term‡	−2.67×10-4	−0.0018 to 0.0012	0.73

*Deaths are expressed as number of deaths per 30 day month. †Influenza incidences are national estimates per 100 000 of population per year. ‡The interaction term is the product of mean temperature and Townsend score.

Results

DESCRIPTIVE EPIDEMIOLOGY OF SEASONAL MORTALITY AND INEQUALITIES IN MORTALITY

The seasonality ratio for Croydon for 1990 to 1995 was 119.7 (95% CI 116.1 to 123.4). In other words, mortality rates were 20% higher in the winter months of December to March compared with the rest of the year. This represents an additional 1084 deaths. Four hundred and sixty (42%) of these deaths were attributable to cardiovascular disease and 364 (34%) were attributable to respiratory causes. Overall mortality showed marked variation between affluent and deprived wards (table 1). This effect was stronger after exclusion of residential and nursing home deaths.

SEASONALITY RATIOS AND DEPRIVATION

There was no evidence of a relation between Townsend scores and age standardised seasonality ratios (Kendall's τ = −0.066, p=0.63) (table 2). These results were not modified by exclusion of nursing and residential home deaths (Kendall's τ = −0.037, p=0.79) (table 2). Analysis of cardiovascular and respiratory deaths alone showed no evidence of a relation (Kendall's τ = 0.16, p=0.24 for cardiovascular deaths and τ = 0.15, p=0.29 for respiratory deaths).

TEMPERATURE DEPENDENT VARIATION IN MORTALITY AND DEPRIVATION

A model was developed that included average monthly temperature and Townsend score as predictors (table 3) There was no evidence of an interaction between temperature and deprivation in this model (table 3). In other words, the effect of temperature on mortality was not modified by deprivation. After exclusion of nursing and residential home deaths, this result was not changed (p= 0.83). A model that included an additional quadratic temperature term also showed no evidence of an interaction.

Discussion

This study confirms the relation between overall mortality and deprivation and the marked rise in mortality in winter but shows no evidence of a relation between deprivation and excess winter mortality. The study was based on the mortality experience of two million person years and should have been able to detect effects of the magnitude previously described in social class based analysis.[1]

This is the first detailed study that has examined the relation between deprivation and excess winter mortality and it tackles some of the potential problems in national analysis. In particular, this study is not subject to problems of geographical dispersion of the study population and was able to examine the effect of a number of confounders. The main design issues are the validity of Townsend scores as a measure of fuel poverty and the adequacy of control for confounding factors.

VALIDITY OF THE MEASURE OF FUEL POVERTY

The hypothesis tested in this study is that socioeconomic deprivation predisposes to excess winter mortality. Socioeconomic deprivation is used as a proxy for fuel poverty that describes the inability of households to maintain adequate indoor temperatures because of economic and material circumstances. Seasonal mortality is primarily a phenomenon that affects older people while measures of deprivation, such as Townsend scores, relate to the experience of younger people. However, in this study, Townsend scores were used ecologically and the assumption of this study is that areas defined as deprived contain a greater proportion of older deprived people subject to fuel poverty. The consistency of Townsend scores between censuses and low levels of migration by older people are likely to make this assumption valid.[22 23] Ideally, the measure of deprivation used in this study should reflect the determinants of fuel poverty, that is income, housing conditions and house size, among older people. Possible sources of such data in the United Kingdoms are social security benefit claims and data from housing condition surveys conducted by local authorities.

Irrespective of the validity of the measure used, ecological studies cannot definitively prove or disprove relation at the individual level. However, evidence from studies of deprivation and mortality in the United Kingdom suggest that relations at the ecological level reflect relations at the individual level.[24]

CONFOUNDING

This study was able to examine the confounding effects of age, sex, and nursing and residential home deaths. The potential importance of nursing home deaths as confounders in the relation between deprivation and health has been previously described.[18] Control for these factors did not affect the findings of this study. Possible unmeasured confounders in this study are air pollution and social isolation.

The relation between air pollution and seasonal mortality has been explored by other authors. They suggest that controlling for air pollution has little impact on temperature dependent variations in mortality.[25] Furthermore, in our study area, deprived areas were urban areas, which are likely to experience higher levels of air pollution. Thus, the confounding effects of air pollution would increase any positive relation between deprivation and winter mortality.

Social isolation is a potential risk factor for excess winter mortality but, in our population, the proportion of older people living alone was positively associated with deprivation measured by the Townsend Score (Kendall's $\tau=0.37$, $p=0.006$). Thus, social isolation would act as a positive confounder in this study.

> KEY POINTS
>
> - This study confirms the well established relation between deprivation and mortality and the importance of excess winter mortality as a contributor to overall mortality.
> - There is no evidence that excess winter mortality is greater in deprived areas compared with affluent areas.
> - Better measures of deprivation and fuel poverty in older populations are needed.
> - The uncertainties over the determinants of excess winter mortality mean that interventions must continue investigating indoor and outdoor cold exposure and behavioural responses to cold weather as well as fuel poverty.

IMPLICATIONS

The findings of this study are discordant with individual based studies and this may be the result of better control of confounding factors and the ecological study design. The results are, however, consistent with an analysis that failed to find a relation between central heating availability and seasonal mortality.[5] Similarly, a study of older people with unlimited access to home heating found that they experienced excess winter mortality to the same extent as other older people.[16]

The simplest interpretation of our findings is that deprivation and fuel poverty do not predispose to excess winter mortality as outdoor exposure to the cold or responses to cold indoor temperatures, which are not related to deprivation, are more important determinants. This is consistent with findings from the Eurowinter study and studies of cold related mortality in Russia.[26] However, an alternate explanation is that people in deprived areas are more likely to adopt individual protective measures in response to fuel poverty that reduce its impact or that smaller, crowded accommodation in deprived areas may allow maintenance of adequate indoor temperatures.

There is a need for further study to understand the social and economic determinants of excess winter mortality. Individual based studies with large sample sizes are needed to detect differences in excess winter mortality between study groups. It is possible that existing datasets from large cohort studies may permit analysis of excess winter mortality by factors such as income or housing conditions including access to central heating with adequate control for confounding.

In conclusion, our study highlights that the determinants of excess winter mortality in the

UK are still not adequately understood and that the potential for resolving inequalities in health through action on fuel poverty is not clear. An understanding of the determinants of excess winter mortality is important to guide policy initiatives that aim to improve the health and well being of older people.

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Tolerance and reconciliation: the spiritual prerequisites to health

"Tolerance is the most important consequence of education: in earlier times people fought for and died for their convictions, but many centuries had to pass by before they understood another form of courage; that is—to recognise the convictions of their close ones and their right to the freedom of conscience. Tolerance is the highest law of each community and it is that spiritual factor which protects all that is best in the thinking of people. No loss from flood, no fire, neither destruction of cities and churches by the inimical forces of nature—has not robbed humanity from so many noble lives and intentions as it was destroyed by mutual intolerance."

Helen Keller (*Optimizam*, 1931)

Hate is the biggest danger to health and the quality of life. Health workers and health services of all countries and in all communities have the responsibility to inform people about the health consequences of hate and to stimulate them to tolerance and reconciliation—reconciliation is also needed between people and the natural environments to which they owe their sustenance.

Any analysis of our world today shows the enormous presence and spread of hatred as a major force of destruction, suffering and death. It also shows how weak is the ability of the health and other sectors to cure hatred once it has been unleashed. If hatred grows even further, the gap between needs and possibilities for health will grow.

Hate is the most dangerous inner pollution; it is the pollution of the spirit.

Hate can take different forms, hatred in the family through the abuse of children, women and old people, as hatred and abuse of other people because of their political or religious beliefs, because of their (ethnic origin), nationality, physical or medical condition or as universal hate of others. Tolerance towards everybody is the most important spiritual prerequisite to health.

Health workers individually, through health services and organisations have a prime duty and responsibility to spread tolerance and do all that is possible to prevent and combat hatred in any form it manifests itself and to work towards reconciliation.

Tolerance is not just the absence of hate. Tolerance is a positive inner, spiritual feeling of security, a desire and willingness to live in peace with all people. Freedom, democracy, human rights, respect, justice, solidarity and reconciliation are the tools evaluating our social relations, inner spirit and consciousness. They are mutually dependent and supportive. Nowhere can tolerance be developed for all times. Everybody should develop, promote, practice, cherish and sustain tolerance. Tolerance includes respect and support for all in freely choosing and living their own way of life. Tolerance also includes co-operation among groups and nations based on the principles of equity, solidarity and respect for all.

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JOHN ASHTON

Healthy Cities Conference, Stockholm, 1990