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(Accepted 11 November 1994)

Higher mortality in deprived areas: community or personal disadvantage?

Andrew Sloggett, Heather Joshi

See editorials by Davey Smith and Judge and pp 1465, 1475, 1481, 1487

Abstract

***Objective*—To investigate the association between level of social deprivation in electoral wards and premature mortality among residents, before and after allowing for levels of personal deprivation.**

***Design*—Longitudinal study of the Office of Population Censuses and Surveys.**

***Setting*—England.**

***Subjects*—Random sample of nearly 300 000 people aged between 16 and 65 at the 1981 census and followed up for nearly nine years.**

***Main outcome measure*—Death from all causes between ages of 16 and 70.**

***Results*—Without allowance for personal disadvantage, both sexes showed a clear, significant, and roughly linear positive relation between degree of deprivation of the ward of residence in 1981 and premature death before 1990. For men, this association was effectively explained away once allowance was made for individual socioeconomic circumstances. For women living in wards of above average deprivation, the association was also effectively removed, but the situation for other women was less clear.**

***Conclusion*—The excess mortality associated with residence in areas designated as deprived by census based indicators is wholly explained by the concentration in those areas of people with adverse personal or household socioeconomic factors. Health policy needs to target people as well as places.**

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BMJ 1994;309:1470-4

Introduction

Indicators of social deprivation, as pioneered by Townsend,[1] have been shown to be useful in explaining differences in mortality.[1 2] A recent study confirmed a positive association between levels of social deprivation in a ward and premature mortality.[3] But studies based entirely on data aggregated at a particular geographical level (ecological studies) necessarily assume homogeneity among individuals or households within the area of study. This study investigates the association between mortality and deprivation at ward level in a longitudinal study and how that association is affected when information about deprivation is also known at the personal level.

The longitudinal study managed by the Office of Population Censuses and Surveys is a record linkage study based on a sample of the population of England and Wales. Sampling was started at the time of the 1971 census and includes anyone born on one of four dates of any year. This yields a sample of roughly 1% of the population, effectively randomly selected, with at any one time records of about 500 000 living people in England and Wales (the study members) and records of former members who have died or emigrated. The sample is regularly updated to include new members. Details of deaths of study members are incorporated with the help of the NHS central register. At the time of this analysis deaths up to the end of 1989 were recorded. A range of small area statistics are available on the dataset, from which deprivation measures for the ward of residence of each study member can be calculated. The study is available to academic researchers subject to strict confidentiality.

Methods

The survival status of study members aged between 16 and 65 on the day of the 1981 census was analysed in a multiple logistic regression model. This model estimated summary risks of dying (estimated by odds ratios) stratified by age (eight age groups) and time period (1984-6 and 1987-9). Deaths during 1981-3 were excluded to diminish health selection effects existing at time of enumeration.[4] Residents in institutions were excluded from the analysis. Certain older age groups were excluded in the second time period to approximate censoring on reaching age 70. This statistical model was developed by Weatherall and has been satisfactorily tested with data from the longitudinal study.[5 6] Age specific risks of dying, calculated

for each sex from appropriate regression models, were almost identical with those of life tables for the same period published by the Office of Population Censuses and Surveys.[7] Multilevel modelling techniques were not feasible under present arrangements for access to data.

Deprivation was assessed with an index based on those of Townsend and Carstairs.[8] The four components of our index were the proportion of the labour force who were unemployed, the proportion of households with no access to a car, the proportion of households not owner occupied, and the proportion of employed men and women in socioeconomic groups IV and V. The measure of overcrowding used in the Townsend index was not used because of the increasingly small proportion of dwellings that can be so described. The index was constructed by summation of normal scores of the four components, after log transformation in the case of proportions of unemployed people.[1] The result was an index scoring from −8·4 to 13·5, with a mean of zero. Higher values indicate more disadvantage. The standard deviation of the index for England and Wales was 3·51, similar to that reported by Eames *et al.*[3] Since these researchers analysed data for England only, we did so for comparability. The score was rounded to the nearest integer and grouped into 10 categories. Grouping was not by decile but by the following procedure, which preserved the distributional characteristics of the continuous variable. The central 16 integer values of the index were simply recoded in pairs, into eight categories, and coded with a mid-range value. The extreme scores were coded into one category on each tail of the distribution using a population weighted mid-range value. Grouped values for England ranged from −7 to 10·7, with a mean of 0·4.

Having derived a measure of social deprivation, we first determined the relation between premature mortality and deprivation. We then investigated how this relation was affected by personal or household characteristics of individual residents, especially characteristics that were counterparts of variables used to construct the deprivation index. Analysis was by multiple logistic regression with the statistical package STATA. Explanatory variables that described individual or household characteristics were chosen because of their established use as indicators of deprivation or

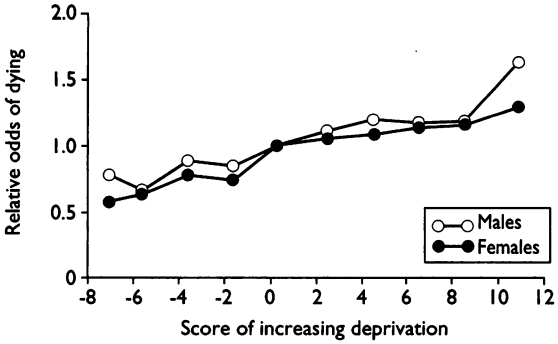

FIG 1—*Association between mortality and deprivation score. (The base for relative odds is the score group that has mean and median value of deprivation score)*

because of their known importance as controlling factors. Similar variables have been shown to be associated with low income.[9] Women who were not employed were classified by whether they had dependent children, as previous work suggests a "healthy mother" effect whereby mothers with young children show reduced mortality risks.[6]

To make the results of the analysis more tangible, life table measures were synthesised. A life table for England and Wales for the period 1986-8 (already shown to fit the mortality pattern of the sample) was taken to represent mortality risks up to adult ages. Beyond this the risks of dying from the life table were adjusted according to the odds ratios of suitable regression models, and life expectancy from age 25 was reassessed. This was done primarily to show relative orders of magnitude of different effects.

Results

Figure 1 shows the positive relation of mortality with deprivation score after standardisation for age and time period. Because the relation seemed linear we treated deprivation score as a continuous variable. Mortality risk increased by a factor of 1·04 in men and by 1·05 in women for each unit increase in deprivation score.

Table I shows the results of the full regression models for main effects. The outcome was the odds of dying between the ages of 16 and 70, and all regressions were adjusted for age and time period. In the presence

TABLE I—*Multiple logistic regression models of risk of death (main effects results with age and time period controls not shown). Outcome measure is risk of death between ages 16 and 70*

	Males		Females	
Explanatory variable	No of subjects	Odds ratio (95% confidence interval)	No of subjects	Odds ratio (95% confidence interval)
Deprivation score	146 093	1·00 (0·99 to 1·01)	146 767	1·02 (1·01 to 1·03)
		*Zone of residence**		
South	72 773	1·00	74 201	1·00
North	73 320	1·17 (1·11 to 1·24)	72 566	1·12 (1·04 to 1·20)
		Economic activity and social class		
Working full or part time:				
Socioeconomic group I-III	92 663	1·00	56 069	1·00
Socioeconomic group IV or V	25 328	1·11 (1·03 to 1·19)	22 256	1·15 (1·02 to 1·29)
Socioeconomic group unclassified	1 958	1·04 (0·73 to 1·50)	798	1·27 (0·73 to 2·22)
Unemployed†	13 380	1·24 (1·12 to 1·37)	5 413	1·48 (1·17 to 1·89)
Not working‡:				
Male	8 816	1·34 (1·17 to 1·54)	—	—
Female with dependent children§	—	—	35 593	1·14 (0·99 to 1·32)
Female without dependent children§	—	—	24 500	1·67 (1·51 to 1·85)
Sick‖	3 948	2·77 (2·52 to 3·04)	2 138	3·73 (3·17 to 4·38)
		Presence of spouse		
Spouse in household	126 064	1·00	121 752	1·00
No spouse	20 029	1·29 (1·20 to 1·38)	25 015	1·06 (0·98 to 1·16)
		Housing tenure and access to car		
Owner occupied with car access	80 210	1·00	78 279	1·00
Owner occupied without car access	11 119	1·32 (1·22 to 1·42)	13 299	1·34 (1·22 to 1·48)
Rented with car access	32 837	1·27 (1·14 to 1·41)	29 891	1·43 (1·27 to 1·60)
Rented without car access	21 927	1·54 (1·42 to 1·67)	25 298	1·56 (1·41 to 1·72)

*North and south zones formed from health regions above and below a line running roughly from the Severn estuary to the Wash.
†Waiting for work or seeking work.
‡Economically inactive, including early retirement.
§Children aged under 16 or aged under 18 in full time education.
‖Not working because of ill health.

of all the variables shown the odds ratio per unit of deprivation score became indistinguishable from unity for men and was strongly attenuated for women.

Diminishing material circumstances, as portrayed by housing tenure and access to a car, was associated with increasing risk. Residence in the north of England was associated with increased mortality, a persistent effect which probably reflected socioeconomic factors not captured elsewhere by the model but which might also have been cultural or environmental.

As a group, the effects of economic activity and social class on the deprivation effect were substantial but were less pronounced for women than for men. Compared with employed persons in socioeconomic groups I-III, being of lower social class carried a small excess risk for both sexes. Being unemployed carried a substantial excess risk which appeared higher for women (48%) than men (24%). Among non-workers, only 8% of women described themselves as unemployed compared with 51% of men. Because many women had the alternative of being classified as housewives, those reported as unemployed might have formed a more homogeneous disadvantaged group. Not being employed (as distinct from unemployed) also carried excess risk, probably because this group included people retiring early because of poor health. Being out of the labour market for reasons of sickness in 1981 resulted in heavily increased mortality in later years, as expected. For men, having no spouse was associated with increased risk, as noted elsewhere.[10]

Tables II and III show the odds ratio for mortality per unit of deprivation score for progressively more complicated models. Adjusting solely for age and time period resulted in a 4-5% increase in mortality risk per unit increase in deprivation score. The magnitude of this deprivation effect is similar to that reported by Eames *et al*[5] and confirms their finding that the effect is apparent throughout the range of deprivation states. Adjusting for broad regional zone reduced the deprivation effect slightly. The factors that were strongest in attenuating the effect of deprivation were access to a car and housing tenure. These, with regional zone, effectively explained away the deprivation effect for men. For women, the adjustments attenuated the deprivation effect, but it still remained significant (table III, model 5).

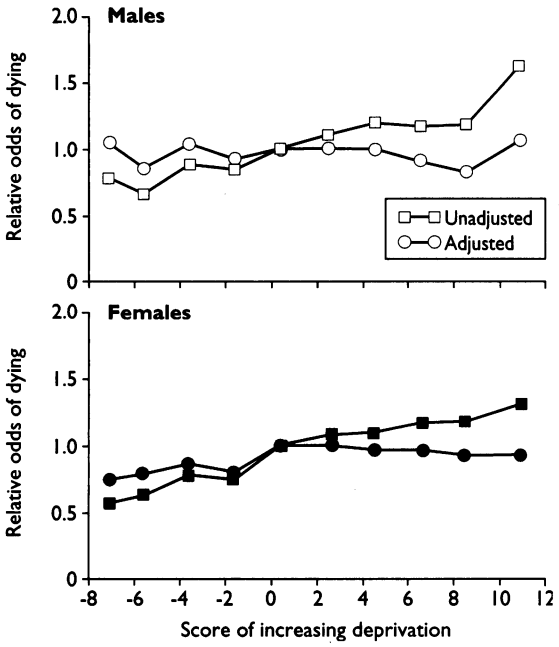

FIG 2—*Association between mortality and deprivation score before and after adjustment for individual or household factors. (Base for relative odds is score group that has mean and median value of deprivation score)*

Figure 2 shows the association between mortality and deprivation for each sex before and after adjustment by the model for main effects (table I). For men, adjustment accounted for the association across the full range of the deprivation score. For women, adjustment accounted for the association for above average deprivation but was less effective elsewhere.

We further investigated the model for women by interaction of the deprivation score with a term that separated affluent and deprived wards, by dichotomising the deprivation score below the mean. The small improvement to the model suggested that women in the less deprived wards did have a somewhat lower risk of death than those in wards of mean deprivation or above (odds ratio between groups=0·81; 95% confidence interval 0·70 to 0·94). However, within these two groups the deprivation effect was not apparent in adjusted models (both groups: odds ratio

TABLE II—*Net effect of deprivation score on mortality for 146 093 men after adjustment for individual or household factors by multiple regression analysis*

		Deprivation score		Likelihood ratio statistic for improvement on previous model		
Model	Explanatory variables	Odds ratio (95% confidence interval)	P value	Statistic	df	P value
M1	Deprivation score, age, and time period	1·04 (1·03 to 1·05)	<0·001	118·8*	1	<0·001
M2	M1 and regional zone	1·04 (1·03 to 1·04)	<0·001	36·7	1	<0·001
M3	M2, economic activity, and social class	1·02 (1·01 to 1·03)	<0·001	540·3	5	<0·001
M4	M3 and presence of spouse	1·02 (1·01 to 1·03)	<0·001	70·8	1	<0·001
M5	M4, car access, and housing tenure	1·00 (0·99 to 1·01)	0·987	113·1	3	<0·001
M6	M2, car access, and housing tenure	1·01 (1·00 to 1·01)	0·267	262·5†	3	<0·001

*Previous model=M0 (explanatory variables age and time period). †Previous model=M2.

TABLE III—*Net effect of deprivation score on mortality for 146 767 women after adjustment for individual or household factors by multiple regression analysis*

		Deprivation score		Likelihood ratio statistic for improvement on previous model		
Model	Explanatory variables	Odds ratio (95% confidence interval)	P value	Statistic	df	P value
M1	Deprivation score, age, and time period	1·05 (1·04 to 1·06)	<0·001	98·3*	1	<0·001
M2	M1 and geographical zone	1·05 (1·03 to 1·06)	<0·001	9·1	1	0·003
M3	M2, own economic activity, and social class	1·04 (1·03 to 1·05)	<0·001	311·3	6	<0·001
M4	M3 and presence of spouse	1·03 (1·02 to 1·04)	<0·001	29·8	4	<0·001
M5	M4, car access, and housing tenure	1·02 (1·01 to 1·03)	0·004	73·9	3	<0·001
M6	M5 and interaction†	0·99 (0·97 to 1·01)‡	0·383	12·2	2	0·002
M7	M2, car access, housing tenure, and interaction†	0·99 (0·97 to 1·01)‡	0·472	138·0§	3	<0·001

*Previous model=M0 (explanatory variables age and time period).
†Interaction of term dividing wards of below mean deprivation score from others, with deprivation score.
‡Slope for wards of mean deprivation score and above.
§Prevous model=M2 with interaction.

per unit of deprivation score=1·0; 0·96 to 1·05). Figure 2 confirms this visually. It may be that there is a ward environment effect between the two groups, but it is more likely that the variables used to adjust for socioeconomic factors were less suited to distinguishing degrees of affluence than degrees of disadvantage.

In the regression models differences in access to a car and housing tenure appeared as a four level interaction of the two dichotomised variables. Compared with owner occupiers with access to a car, all other groups had substantially raised odds of dying and the most disadvantaged group (rented accommodation, no access to a car) had a roughly 55% excess risk regardless of sex. The two intermediate groups were not significantly different from each other, effectively forming a single intermediate group. These findings confirmed housing tenure and access to a car as powerful predictors of mortality, as found in previous studies.[11]

Table IV shows the years of life lost from age 25 under various scenarios of disadvantage calculated using the life table technique described previously.

TABLE IV—*Estimated years of life lost from age 25 according to various scenarios of disadvantage*

Scenario	Male	Female
*Estimates based on index score alone**		
Living in deprived ward:		
Average index score for most deprived fifth of population (score=5·6 units above mean)	2·6	3·0
Average index score for most deprived 2% of population (score=8 units above mean)	3·7	4·2
Estimates based on fully adjusted model†		
Living in ward with average index score for most deprived fifth of population	0·0	1·1
Living in north of England *v* south	1·8	1·3
Unemployed *v* employed	2·4	4·3
Rented accommodation without car access *v* owner occupied with car access	4·8	4·8

*Model adjusted for age and time period only.
†See table I for details.

When information about social deprivation of the ward of residence only was used (top section of table) the life expectancy of the fifth of the population in the most deprived wards was about three years shorter than in wards of mean social deprivation. For the 2% of the population resident in "highly deprived" wards, this loss of life expectancy was about four years. When individual and household information was also taken into account (bottom section of table) the average years of life lost from living in a deprived ward was reduced—to zero for males. Instead, measures of personal disadvantage were associated with the larger reductions in life expectancy. The largest effect was for groups in rented accommodation and with no access to a car compared with owner occupiers with access to a car (about 16% and 54% of the population respectively): this difference in socioeconomic circumstances translated into a loss of life expectancy approaching five years—higher than that indicated by residence even in highly deprived wards under simpler models.

Discussion

This study used specific census based indicators to define levels of deprivation in all wards of England. The concept of deprivation used here could be considered rather narrow by comparison with the popular concept of depressed inner city communities, with concomitant crime, traffic pollution, etc. However, it is census based indicators, along the lines of the index used here, that are being used increasingly in the planning of policies and the allocation of resources.

This research builds on previous work[3,12] and confirms a continuum of association between area deprivation and mortality. But the finding that the association is, in most cases, completely outweighed by personal factors introduces some limitations. The evidence does not confirm any social miasma whereby the shorter life expectancy of disadvantaged people is further reduced if they live in close proximity to other disadvantaged people. This raises important questions of equity for interventions that may be targeted on the basis of census based measures of deprivation. If we define the personally disadvantaged as those unemployed or working in jobs of socioeconomic groups IV and V, living in rented accommodation, and with no access to a car and define the worst wards as those containing the fifth of the population with the worst deprivation scores we find 45% of the personally disadvantaged inhabiting the worst wards. Since it is these worst wards that are most likely to benefit from any index based targeting, this means that 55% of target individuals will be outside target areas. A similar point has been made previously by Holtermann.[13] Where information at the personal level is available it is more efficient and more equitable to use this directly.

CONTRADICTORY RESULTS

Some previous studies seem to contradict this conclusion. A comparison with two previous studies is pertinent. The Alameda County study compared mortality in a "designated poverty area" and a normal area of the city of Oakland, California.[14] Mortality rates of adults over nine years (1965-74) were higher for residents of the poverty area, and the effect persisted despite adjustment for a range of personal characteristics. However, our study was much larger, with national coverage, and investigated mortality throughout the whole range of our deprivation measure. The relatively small Alameda study of two districts predetermined the levels of deprivation by categorising subjects as simply resident in or out of a poverty area. The definition of the poverty area was based partly on contiguity considerations, presumably to identify compact target areas for the county's "economic opportunity programs," rather than for objective research needs. There may even have been a belief that a concentration of poor housing reduces the quality of inhabitants' lives rather more than when it is scattered.

We specifically set out to challenge the components from which the deprivation score was constructed by including similar factors at an individual level. This was not done explicitly in the Alameda study—for example, housing condition was used to define the poverty area but was not tested at the level of individual households. Income, employment status, and education variables were only tested one at a time in regression models, in addition to baseline adjusting variables, and therefore multiple factors of disadvantage were not explored in the same way as we did. In our study housing tenure and access to a car together were sufficient to outweigh the effects of area deprivation score, and we attribute this effect to individual low income. Therefore, the fact that the Alameda study found no effect of income is an important difference that is hard to reconcile. The range of comments given above and health selection effects may account for this, but, quite apart from these, the Alameda study does not really contradict our findings. We do not say that in certain settings of severe deprivation there is no ecological effect. We do conclude that the rather cursory identification of deprived areas by census variables and boundaries is certainly not precise enough to detect such an effect systematically.

The second study worth comparison is that of Carstairs and Morris concerning the Scottish population.[2] These authors found that a deprivation score (similarly calculated to ours and with similar range and dispersion) held a stronger association with mortality

Key messages

- Death rates in England and Wales are known to be higher in areas of social deprivation
- Thus study demonstrates that higher death rates in areas identified as deprived by use of census variables occur because a disproportionate number of socially disadvantaged individuals live there
- Similarly disadvantaged individuals have higher mortality risks wherever they live, and, conversely, the mortality risk of individuals who are not disadvantaged is not increased by living in a deprived area
- Reduction of premature mortality may be most efficiently achieved by tackling disadvantage in individuals, wherever they live
- Targeting health or economic interventions at deprived areas may be convenient but carries a degree of inequity

than did grading by socioeconomic group. Moreover a deprivation effect was still apparent after standardising for socioeconomic group. Their study was not longitudinal in design, but our results do not conflict. We included information about the socioeconomic group of individual people as part of a composite variable which also gave details of their economic activity (thus challenging two components of our deprivation score). This variable failed to outweigh the association of deprivation with mortality. Our study confirms that deprivation measures are indeed useful indicators of mortality and require allowance for more than one measure of social disadvantage before the association is outweighed. It is outweighed, however, by a combination of pieces of information which represent personal counterparts of the score.

Our study deals with mortality only. It is quite possible that certain morbidities such as psychological stress, and the resultant workload on health services, could be compounded by an ecological effect existing in highly deprived areas. We can only say that mortality does not appear to be disproportionately high.

CONCLUSION

With the increasing popularity of deprivation indices for targeting health and social policy, care should be taken not to read too much into them. In particular, no location specific, ecological factor that affects mortality could be identified in areas defined as deprived by the census based index used here. For men, the increased risks of death associated with living in such areas were entirely explained by the levels of personal disadvantage experienced by each individual. The deprivation effect was therefore entirely due to the concentration of disadvantaged men in the area. Individuals living in deprived areas who were not disadvantaged did not experience excess risk. Conversely, disadvantaged individuals did not seem to receive any protection from risk by living in areas of relative affluence. For women, some residual area effect remained but only showed benefit for women living in relatively advantaged areas. This might have been an artefact of the deprivation measure used. For women living in areas of average deprivation or above, the results were as for men.

Deprivation indices may be gainfully used to identify areas of relative concentration of disadvantage, in the absence of data at the personal level, or where the fact of geographic concentration is pertinent (such as assessment of estate housing or estimation of general practitioners' workload). But disadvantaged people also live elsewhere and could be excluded in large numbers if interventions were planned purely on the basis of local, census based, deprivation score. Deprivation appears to be adequately assessed by personal or household circumstances, which are themselves associated with income. Area based measures of deprivation are not efficient substitutes. For maximum effectiveness, health policy needs to target people as well as places.

We thank the Economic and Social Research Council for funding this work as part of the LSHTM programme "Health inequalities among women and their families." The longitudinal study is used by permission of the Office of Population Censuses and Surveys, and we thank them for their cooperation. We thank Brian Dodgeon of the Social Statistics Research Unit, City University, for his valuable technical advice.

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(Accepted 10 November 1994)

ONE HUNDRED YEARS AGO

FEATS OF PERIL *v.* FEATS OF DARING.

The death of an unhappy man by diving into the Thames from one of the highest points of the Tower Bridge again calls attention to the curious perversion of taste in a large section of the British public which leads them to put a high and fictitious value upon the performance of feats of peril, whilst it often allows true heroism to be its own reward. There appears to be little doubt that in the present instance the repetion of the high dive had literally turned the brain of the performer, and it would be interesting to know the effects of such repeated shocks upon the central nervous system as must have been experienced by this man. He had been engaged as a respectable and hard-working assistant in the wholesale fish trade for a period of twenty years, until during the last year he had jumped twice a day into a tank filled with water from a height of 130 feet. He gradually came to believe himself capable of diving from the greatest heights, and the police were so much on the alert to prevent his folly that he found it necessary to disguise himself on the last occasion, as two previous attempts had been frustrated. He was an ardent spiritualist, too, and there is reason to suppose that he believed himself to be under the especial protection of certain spirits with whom he was acquainted. It is surely time after such a catastrophe that exhibitions of crazy people should be put a stop to by the responsible authorities, for so long as they are a commercial success it cannot be expected that the managers of places of public entertainment will exercise much self-control in the matter. The taste is a degrading one, and the exhibitions subserve no good purpose. They do not even encourage hardihood. (*BMJ* 1894;ii:1259.)