Deprivation indices: their interpretation and use in relation to health

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Abstract

Study objective **– To examine the use of deprivation indices in relation to health.**

Design **– This paper reviews selected publications which illustrate the diversity of use of deprivation indices in the past decade. Most of this work is based in the major routine databases which exist in this country: the census, population, mortality, cancer register, and health service records all now incorporate a postcode identifier which permits the derivation of data at small area level, and thus the examination of health events in relation to the characteristics of that area – usually ward or postcode sector. The small area approach provides a valuable tool both in deprivation and in other epidemiological studies which examine the influence of the environment on health.**

Setting **– The setting is various journals and official publications.**

Main results **– The link between deprivation and health has been clearly demonstrated in a number of studies, with populations living in deprived areas exhibiting levels of mortality, particularly below the age of 65, which vastly exceed those in affluent areas. In the decade 1981–91, these differentials increased in Scotland and the Northern Health Region and inequalities in health are shown to have widened. Analysis shows that particular causes of death and sites of cancer are more likely to reflect the influence of socioeconomic factors. The work so far mostly shows the associations between these factors and health measures and more investigation is required into the determinants of health, which are likely to reside as much in past as in current circumstances. A measure of deprivation has proved of value in excluding the likely variation in the incidence of disease in studies directed towards determining the influence of the physical environment on populations living in the vicinity of possible harmful industrial processes. A deprivation measure has been adopted by the Department of Health as a basis for making enhanced payments to general practitioners for patients living in these areas, but the resource allocation formula for allocating funds to regional authorities has failed to incorporate such a measure in the formula.**

Conclusions **– An area measure of deprivation has proved a valuable tool in examining differentials in health and death and is likely to prove of continuing value to health authorities in planning the delivery of health care. Future work should strive to examine the determinants of health as well as the associations, although this is unlikely to be possible through the routine databases which have provided the main basis for analysis so far.**

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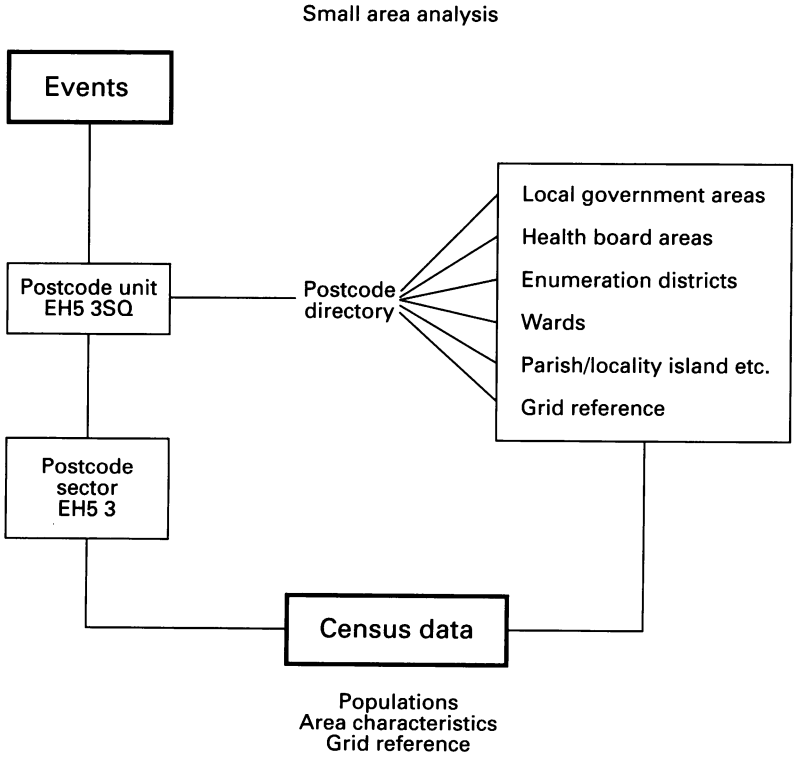

Table 1 Derivation of data at small area level.

Methods of small area statistics are so fundamental to the development of deprivation indices that some reference to these provides an introduction to the main substance of this paper. Although there was some early work on the relation between socioeconomic measures and health, using an area base and data from the 1971 census, most of the important work follows from the improved geographical base provided by the 1981 census[1] (fig 1) and the more consistent use of postcodes as a basis for determining the area of residence in routine statistical records systems. As a result the past decade has seen an increasing use of small area based approaches in health care, many of which focus on issues of health and deprivation.

Table 1 General practitioners weightings of factors affecting demand for primary care services

	Percent	Weight
1	Elderly living alone	6·62
2	Age under 5 years	4·64
3	Unskilled workers	3·74
4	Unemployed	3·34
5	One parent families	3·01
6	Overcrowded	2·88
7	Migrants	2·68
8	Ethnic minorities	2.50

Source: ref[2]

Table 2 Correlation of mortality with deprivation

	1979–83		
	Townsend	Carstairs	
	0–64 y	0–64 y	65+ y
Deprivation*	0·62	0·75	0·53
Unemployed	0·61	0·70	0·51
Overcrowded	0·55	0·64	0·49
Lacking car	0·61	0·74	0·50
Head in low social class	0·57	0·62	0·39
Not in owner-occupier housing	0·39	—	—

* Definitions differ; see[5 6]

The small area approach may be categorised in terms of increasing sophistication in analysis. At the simplest, descriptive level, small area statistics can illustrate aspects of a population relevant to health planning – demography, social circumstances, mortality, and morbidity. The smaller area level (postcode sector or ward) displays greater variation in many characteristics and provides a more sensitive basis for the identification of need and delivery of care than the health district.

An advance in methodology combines selected variables into an overall index for an area, using various techniques. Still at the descriptive level, an important example is the combination of demographic and social factors into the Jarman underprivileged area (UPA) score.[2] The individual factors are given weightings based on the opinions of general practitioners (table 1) about the influence of the various factors on their workload (with some subsequent validation). The UPA8 score (containing eight variables), developed to identify "needs for primary care", has been adopted by the Departments of Health for the purpose of making additional payments to GPs for populations living in areas with high scores on that index. In Scotland the score is now calculated at enumeration district (ED) level, since the postcode sector was considered to obscure some important differences within populations. The score has been the focus of a number of criticisms[3 4] but it has the merit of being acceptable to general practitioners.

Enquiries examining the association between socioeconomic area characteristics and health events have, in the main, made use of the postcode sector (in Scotland) or ward (in England) as the area base. Much of the work has focussed on using a measure of "deprivation" – that is, a score composed of a number of social variables from the census. A deprivation score of this kind, producing a continuous variable (albeit artificial), has the benefit of offering opportunities for statistical analysis that are not available from the use of categories such as ACORN, which derives descriptive categories intended to discriminate between populations but which do not have ranking qualities.

Work by Townsend *et al* in the Northern Health Region[5] and Carstairs and Morris in Scotland[6] exemplify this approach and provide strong evidence of the link between area deprivation and mortality, in particular at younger ages. (table 2, fig 2). A more recent paper has also shown similar gradients in mortality in five health regions of England, for all causes and for specific causes (fig 3). Given sufficient numbers of events, the approach can also provide information on the association between specific causes of death, or illness, and social factors (table 3).

Not the least of the benefits of the small area approach is that it permits the extension of our understanding of inequalities in health beyond the measure of mortality, using the traditional approach of social class. Only the death record contains information on occupation, and other health records have not been susceptible to this approach. Using the postcode unit to allocate a record to an area level (or a grid reference) brings other health information into the area of interrogation, with the cancer registers providing a particularly rich source of information on morbidity (fig 4).

Birth weight, perinatal and infant deaths, and temporary and permanent sickness (from the census) have all yielded information illustrating the diversity of health experience between affluent and deprived areas.[5 6]

Since the completion of the 1991 census, some monitoring of trends in relation to inequalities has become possible. Data both for Scotland[8] and for the north of England[9] show a widening of the gap in mortality between those living in affluent compared with deprived areas (figs 5 and 6). Of course death rates fell

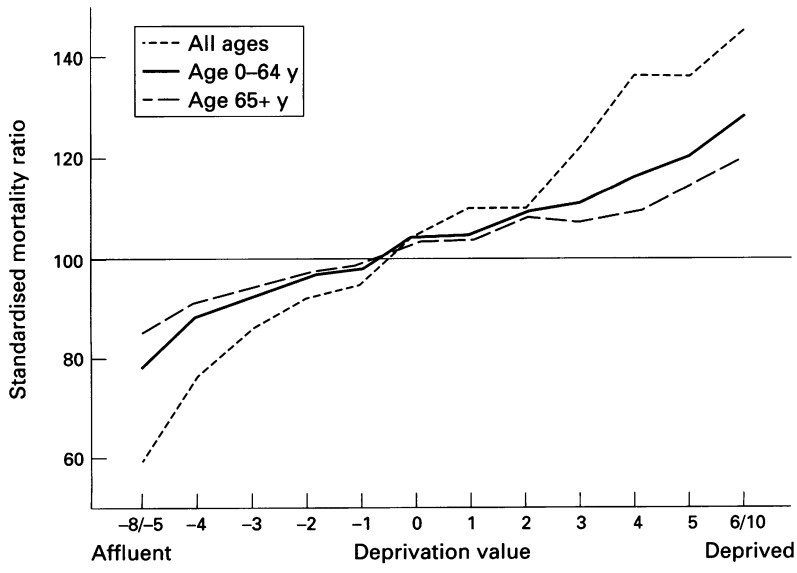

Figure 2 Standardised mortality ratios (all causes) plotted against deprivation value, Scotland 1980–82.

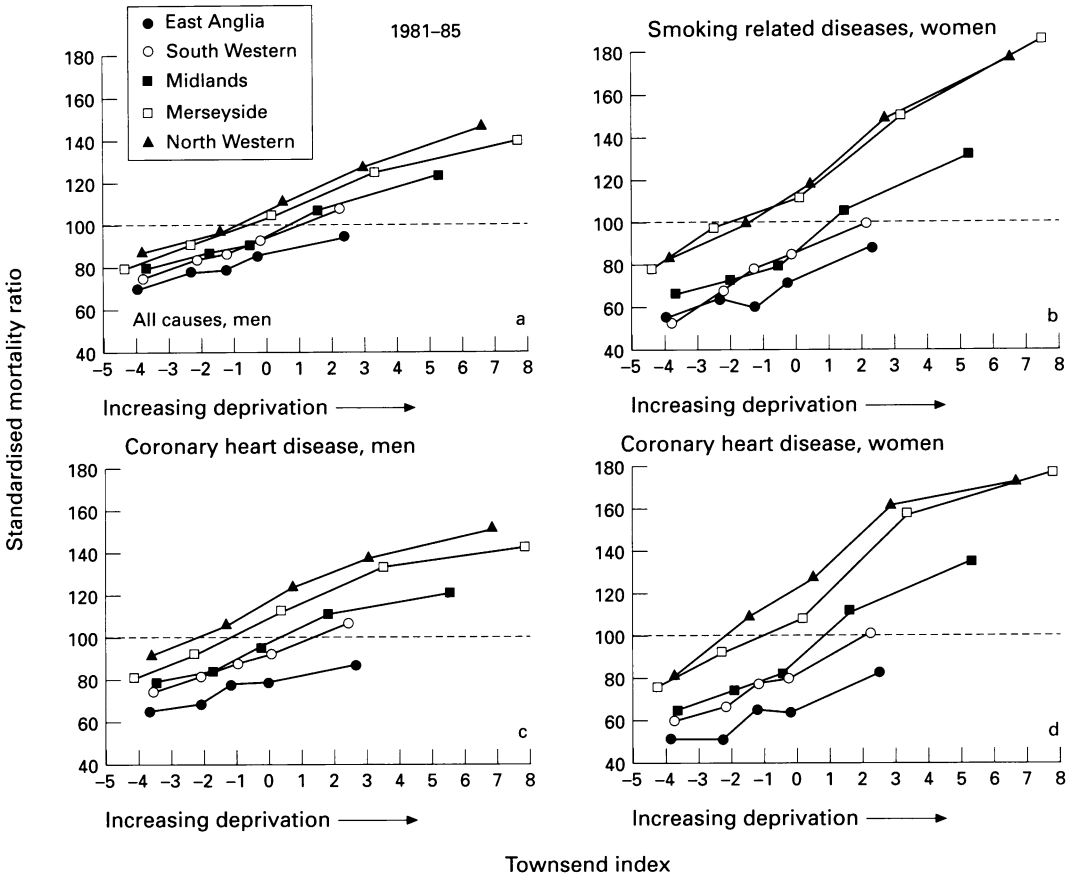

Figure 3 Relation between premature mortality from different causes in men and women by the degree of deprivation divided into fifths for five representative health regions. Source: ref[7].

*Table 3 Mortality in relation to cause and socioeconomic factors in Scotland 1980–85 (correlation coefficients)**

Cause	*Age (y)*	*Men unemployed*	*Low social class*	*No car*	*Overcrowding*	*DEF score*
All causes	0–64	·72	·61	·74	·62	·76
Chronic respiratory	0–64	·67	·52	·69	·61	·69
Carcinoma, lung	0–64	·61	·60	·66	·57	·65
Heart disease	0–64	·56	·50	·54	·55	·59
Hypertension/stroke	0–64	·41	·34	·41	·37	·42
Acute respiratory	0–74	·42	·31	·39	·38	·41
Carcinoma, stomach	All	·36	·30	·38	·37	·39
Carcinoma, cervix	All	·23	·22	·22	·22	·25
Non-traffic accidents	All	·22	·23	·23	·19	·24
Road traffic accidents	All	·02	·12	−·04	·04	·04
Carcinoma breast	0–74	−·06	−·06	−·05	−·04	−·06

Correlation over 56 LGDs
* Source: ref[6]

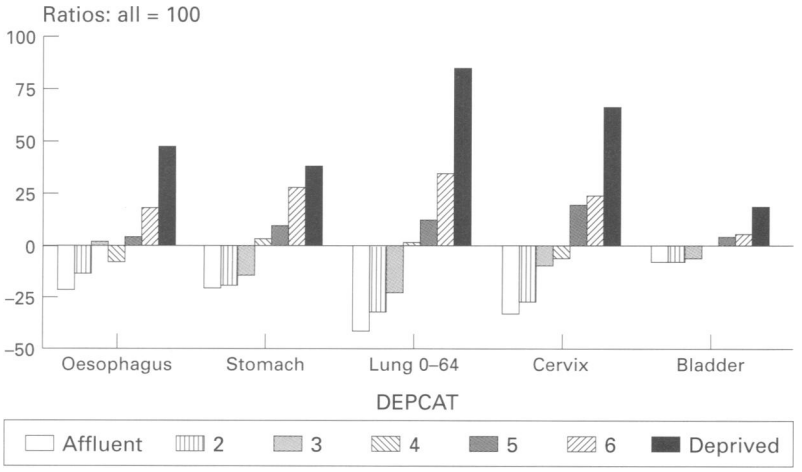

Figure 4 Cancer registrations for 1979–82 in Scotland in relation to deprivation category (DEPCAT). Source: ref[5].

overall, but affluent areas made greater gains in the decade than those living in deprived areas in Scotland (as illustrated by two specific causes: table 4), while in the Northern Health Region ratios increased in the most deprived wards in all age groups, and with one exception fell in the most affluent (table 5).

(Under-reporting in the 1991 census has presented some problems in the computation of rates for specific age groups, but these analyses address this problem and show that the gradients in mortality are not unduly influenced by the shortfall.)

Many examples exist of the use of deprivation measures at local level within health authorities but there is not space here to review these.[10]

All of these analyses tell us about the association between health events and deprivation measures, but so far there is little

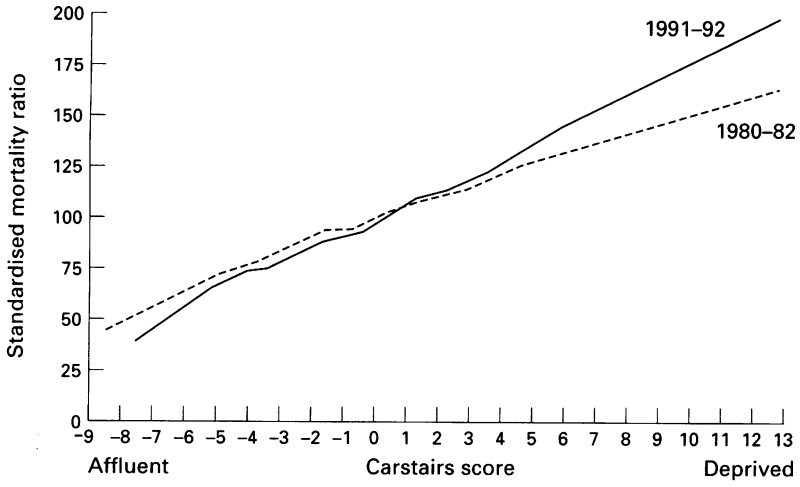

Figure 5 LOWESS curves showing the relationship between age and sex standardised mortality ratios (ages 0–64 years) and Carstairs deprivation score. Source: ref[8].

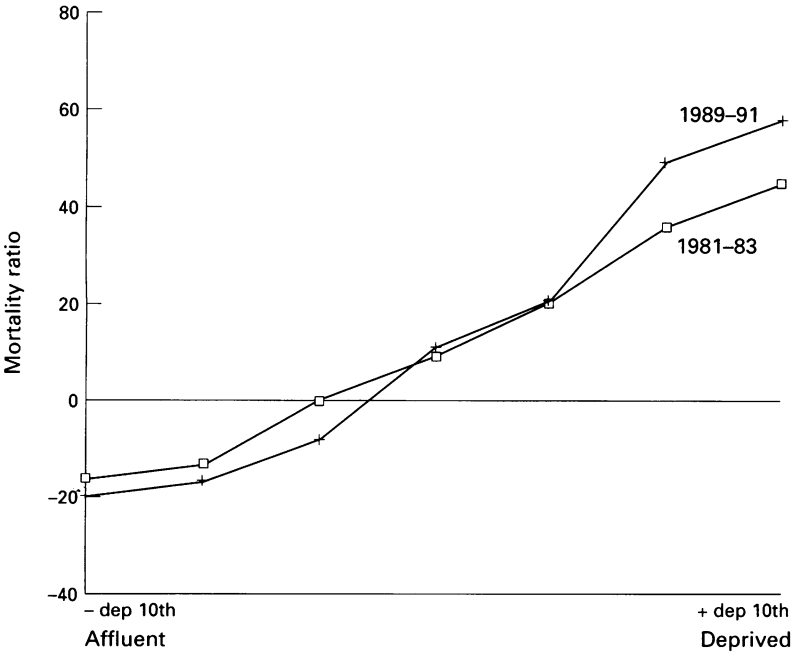

Figure 6 Mortality ratios for those aged <65 years in the Northern Health Region between 1981–83 and 1989–91. Source: ref[9].

Explaining differences in health

Inborn characteristics	Early experience
– genetic	– illness
– acquired	– nutrition
Environment – physical	Environment – social
– air pollution	– living conditions
– work hazards	– life events
– lead in water	– stress
– radiation	– lifestyles
– etc.	– health behaviour

Figure 7 Factors that explain differences in health.

*Table 4 Percentage change in mortality ratios for ischaemic heart disease (IHD) and cancer of the lung between 1980–82 and 1990–92 in people aged 40–64 years in Scotland**

1981 Depcat group	*IHD*	*Ca lung*
1–2 Affluent	−40	−28
3–5	−31	−17
6–7 Deprived	−20	−11

* Source: ref[8]

*Table 5 Change in mortality ratios in northern England between 1981 and 1991**

Age (y)	*Most deprived (fifth)*		*Least deprived (fifth)*	
	1981	*1991*	*1981*	*1991*
0–14	116	130	80	77
15–44	117	128	86	77
45–54	130	162	79	83
55–64	145	151	92	87
65–74	123	133	94	88

* Source: ref[9]

evidence about the processes involved (fig 7). In Scotland some relevant evidence comes from the Scottish heart health study, carried out at local government district level[11] which reports levels of smoking, dietary, and even biological factors which are more favourable in affluent than in deprived areas (table 6).

It is also the case that all of these analyses use data relating to current circumstances whereas current health (and death) is likely to be a product of life long circumstances, perhaps even conditions before birth; a number of enquiries in recent years have begun to explore these links.[12]

One important example of small area analysis concerned with equity rather than epidemiology is that carried out for the Department of Health to provide an empirical basis for the development of the resource allocation formula.[13,14] At least one major finding was subsequently incorporated into the formula[15] – that of a reduction in the weighting in respect of the standardised mortality rate (SMR) for a region which acts to increase or diminish the allocation of resources for specific components of the formula, originally by 1% for each point of the SMR above or below 100. The analysis found that a weighting below unity was a better predictor of variation in the hospital discharge rates at ward level (other factors taken into account) that was accepted as a measure of need for health care. A notable omission, however, was failure to take on board the findings in respect of levels of deprivation which were shown to make a contribution over and above that of mortality in explaining the variation in the need measure. Despite recent changes in the organisation of the health service, methods of resource allocation provide a continuing topic for debate.[16] A more comprehensive and up to date analysis has subsequently been commissioned, and has been reported to the Department of Health: full details are not yet publicly available, although some information on method has been published.[17]

*Table 6 Health characteristics of local government districts for men aged 40–59 years**

	DEP score	% smokers	% not eating		SMR smoking	BP diastolic
			Fruit	Greens		
Most affluent						
Eastwood	−5·65	29	8	15	68	84
Inverness	−2·08	38	13	20	88	83
Perth & Kinross	−2·05	32	9	18	84	83
Stirling	−1·79	35	8	16	93	81
E Lothian	−1·58	38	8	19	89	83
Roxburgh	−1·55	33	7	15	86	84
Most deprived						
Hamilton	0·52	39	16	24	104	87
Renfrew	0·62	43	7	26	113	88
Cunninghame	0·85	42	10	20	106	85
Dundee	0·89	41	12	21	100	84
Monklands	2·95	51	15	22	113	86
Glasgow	4·06	52	20	30	124	87

* Source: ref[6]

Table 7 Incidence of cancer (Ca) of the larynx and lung around waste disposal incinerators

	Ratios: O/E	
	Without Carstairs	With Carstairs
Ca larynx		
Lag 5 y		
0–3 km	1·08	1·04
3–10 km	1·07	1·04
Lag 10 y		
0–3 km	1·05	1·08
3–10 km	0·87	0·94
Ca lung		
Lag 5 y		
0–3 km	1·01	0·97
3–10 km	1·03	1·00
Lag 10 y		
0–3 km	0·92	0·94
3–10 km	0·92	0·98

The lower limit of confidence intervals is <1 in all except one instance. There is no evidence of a difference from unity.
Source: ref[23]

The small area approach has also been used in a number of studies designed to assess the impact of the physical environment on health. (That is, those seeking to establish a causal effect.) An early example is that which examined health statistics in the vicinity of a waste disposal plant in Scotland[18] (no longer in operation). The area was assembled by the aggregation of enumeration districts to create a circle with a radius of 5 km from the plant, a strategy which has provided the basis for much subsequent enquiry.[19] The results were inconclusive, and underlined the lack of a data base concerned with less serious aspects of morbidity than appear in the present statistical systems.

More well known examples are those enquiring into the possibility of a raised incidence of leukaemia in young people in the neighbourhood of nuclear processing plants at Sellafield[20] and Dounreay.[21] Studies attempting to establish the differences between cases and controls have followed, as have studies of other clusters in the population, with much stimulus being given to the development of statistical methods in the analysis and interpretation of the small cluster phenomenon.[22] These early enquiries presage the work programme now undertaken by the Small Area Health Statistics Unit; this has taken a step forward in methodology by the incorporation of a deprivation measure to allow for the effects of social factors in examining the incidence of disease in relation to environmental influences. An example (table 7) comes from an examination of cancer incidence around waste disposal incinerators: the differences between the ratios without and with the Carstairs score indicate the extent of social influence on the rates,[23] which could serve to confound the interpretation of the data if not taken into account.

The small area approach has many benefits – but also many problems – which I do not have space to examine. Deprivation measures are also subject to criticism, in terms of the selection of variables and ways of combining these into a score, and proponents of this approach are by no means in agreement. Nevertheless, the explanatory power in relation to health events seems robust, and variations in method are not critical, although the Jarman (UPA) score, if identified as a measure of deprivation, shows weaker correlation with health events than with health service use,[24] probably because of the inclusion of demographic variables.

The lack of population and social data, except at 10 yearly intervals, presents a real practical problem to researchers in this field. Can we expect that the family practitioner registers will eventually become reliable enough to provide usable population information between censuses? This is not impossible, but the comprehensive collection of morbidity data from this source is probably precluded by the size of the necessary database.

What of the future?

Small area data on both social and health factors are likely to remain of value to health authorities in their efforts to direct resources in relation to need, and will continue to prove of value in determining the relationships between these factors and in monitoring trends over time. Studies based on routine statistics are unlikely, however, to yield more revelations about health inequalities since they can rarely do more than describe the associations. In time, however, the recommendations of the Chorley committee[25] may result in enhancements to the database in respect of some physical features of the environment. Some measure of deprivation will continue to provide a basis for excluding the socioeconomic factors which confound examination of the distribution of disease in relation to the physical environment. It seems

likely that we can expect little further progress in looking at the relationship between social factors and health events. What is needed is more information on the determinants of health, and so far such data are notable by their absence in studies using routine statistics. The inclusion of the question on long standing illness and disability in the 1991 census may enhance possibilities of analysis, although levels reported differ from those found in the general household survey[26] and problems in relation to people's perceptions of ill-health will raise questions about the validity of these measures. The surveys being carried out by the Department of Health, in England[27] and now in Scotland, will provide more objective information at an individual level, on the health state and its variation in the population. This is to be welcomed, although identification and measurement of many of the determinants is likely to continue to prove elusive.

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Open discussion

ELLIOTT – You talked, Dr Carstairs, about the difference between 1981 and 1991 and the widening of the gap in mortality between the affluent and deprived. How much of that do you think is real and how much a measurement problem – that is, the notion that the deprivation index might be measuring something different in each census.

CARSTAIRS – Those who have done the analyses[1 2] have considered the measurement problem closely and, at least for Scotland, the analysis for 1991–92 has used the 1981 deprivation score for the postcode sectors to examine differences over the decade, so that there is no difference between the two. I might add that under-reporting in the 1991 census has of course created great problems for computation of rates because of the shortfall in populations in particular age groups. But these analyses[1 2] have examined that issue very carefully and have come to the conclusion that the shortfall does not have an undue effect on the variations that are reported.

DRAPER – You showed a graph (fig 3) of standardised mortality rates in relation to deprivation index and to health region. It seemed to me that there were considerable differences, almost to the extent that in some regions the rate at the lowest level of deprivation was almost equal to the rate at the highest level in another region. What is the explanation? Are there geographical factors that matter? Are both deprivation and region in a sense measuring some sort of index but doing so incompletely? Or is there an alternative explanation – that there is some sort of interaction – that deprivation indices matter differently in different places?

CARSTAIRS – I think the importance of the deprivation index may vary in different regions. It is also the case, however, as we find in Scotland too, that there is much greater variation in mortality in areas which exhibit greater variability in socioeconomic conditions.

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