

# Why is mortality higher in Scotland than in England and Wales? Decreasing influence of socioeconomic deprivation between 1981 and 2001 supports the existence of a 'Scottish Effect'

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## Abstract

**Objectives** To determine the degree to which changing patterns of deprivation in Scotland and the rest of Great Britain between 1981 and 2001 explain Scotland's higher mortality rates over that period.

**Design** Cross-sectional analyses using population and mortality data from around the 1981, 1991 and 2001 censuses.

**Setting** Great Britain (GB).

**Participants** Populations of Great Britain enumerated in the 1981, 1991 and 2001 censuses.

**Main outcome measures** Carstairs deprivation scores derived for wards (England and Wales) and postcode sectors (Scotland). Mortality rates adjusted for age, sex and deprivation decile.

**Results** Between 1981 and 2001 Scotland became less deprived relative to the rest of Great Britain. Age and sex standardized all-cause mortality rates decreased by approximately 25% across Great Britain, including Scotland but mortality rates were on average 12% higher in Scotland in 1981 rising to 15% higher in 2001. While over 60% of the excess mortality in 1981 could be explained by differences in deprivation profile, less than half the excess could be explained in 1991 and 2001. After adjusting for age, sex and deprivation, excess mortality in Scotland rose from 4.7% (95% CI: 3.9% to 5.4%) in 1981 to 7.9% (95% CI: 7.2% to 8.7%) in 1991 and 8.2% (95% CI: 7.4% to 9.0%) in 2001. All deprivation deciles showed excess indicating that populations in Scotland living in areas of comparable deprivation to populations in the rest of Great Britain always had higher mortality rates. By 2001 the largest excesses were found in the most deprived areas in Scotland with a 17% higher mortality rate in the most deprived decile compared to similarly deprived areas in England and Wales. Excess mortality in Scotland has increased most among males aged <65 years.

**Conclusions** Scotland's relative mortality disadvantage compared to the rest of Great Britain, after allowing for deprivation, is worsening. By 1991 measures of deprivation no longer explained most of the excess mortality in Scotland and the unexplained excess has persisted during the 1990s. More research is required to understand what is causing this 'Scottish effect'.

**Keywords:** deprivation, inequalities in health, mortality

## Introduction

The stimulus for this study was the observation that standardized mortality ratios for Scotland relative to England and Wales had risen during the 1980s and that the rise was particularly large for middle-aged men.<sup>1</sup> Since life expectancy was improving in both populations, this widening gap represented a relative rather than absolute decline for the Scottish population but its size and speed of change suggested the need for further investigation. Historically, Scotland's poorer health has been attributed to higher levels of deprivation<sup>2</sup> but more recent analysis<sup>3</sup> appeared to show that, by the early 1990s, deprivation was accounting for less of Scotland's excess mortality, a phenomenon that was called the 'Scottish Effect'.<sup>4</sup> The purpose of this study is, therefore, to determine the degree to which changing patterns of deprivation in Scotland and the rest of Great Britain between 1981 and 2001 explain Scotland's higher mortality rates over this period.

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## Methods

Mortality rates were calculated for all wards in England and Wales and postcode sectors in Scotland for census populations in 1981, 1991 and 2001.<sup>5</sup> Mortality records were linked to wards and postcode sectors of usual residence for deaths registered during the 3-year period around each census year. (Since it was not possible to obtain ward information for deaths records in 1980, the period 1981–1983 was chosen for the 1981 census.) Primary cause of death was coded using ICD9<sup>6</sup> and, from 2000, ICD10.<sup>7</sup> Mortality rates were analysed for all causes and for selected major causes (respiratory, cerebrovascular and ischaemic heart disease, all cancers, lung cancer and intentional self-harm).

Area-based deprivation scores for 1981, 1991, and 2001<sup>8</sup> were derived for wards in England and Wales and postcode sectors in Scotland using the method of Carstairs and Morris.<sup>9</sup> This score is based on four standardized census variables: adult male unemployment, lack of car ownership, low social class and overcrowding. Each census deprivation variable was standardized, within each census year, using the mean and standard deviation for all areas of Great Britain. Since the number of rooms per house was defined differently in the 1981 census in Scotland compared to England and Wales, and to subsequent censuses in both Scotland and England and Wales, a correction factor was applied to the overcrowding variable for Scottish postcode sectors based on analysis of 1981 and 1971 census data.<sup>10</sup> At the time of investigation the Social Class variable used in the calculation of the 2001 Carstairs score (i.e. the proportion of all persons in private households with an economically active head with head of household representing the old social class IV or V) was not available at this level from the England and Wales census. A proxy variable for Social Class was found in both the Scotland and England and Wales censuses (i.e. the proportion of all people aged 16 to 74 representing the old social class IV and V) and used instead. Deprivation scores were used to categorize Great Britain into deprivation deciles by population.

Direct standardization, by 10-year age category, sex and deprivation decile, was used to compare the mortality rates for Scotland with the rest of Great Britain. The 1981 Great Britain population was used as the reference population. Published 2001 small-area census populations were prior adjusted for a known undercount. Since undercounts were also a feature of the two previous censuses,<sup>11</sup> separate populations for both Scotland and England and Wales were uniformly scaled up to the revised mid-year population estimates<sup>12,13</sup> for 1981 and 1991 by age and sex.

Log-linear Poisson regression models were fitted<sup>14,15</sup> to mortality rates among wards and postcode sectors to obtain confidence intervals for excess mortality in Scotland that reflected variation at the small-area level of measurement of deprivation. Regression models were fitted using Genstat Version 5 Release 4.2 software.<sup>16</sup> To test the durability of the Carstairs deprivation score, rank scores for Scottish wards were compared to

ranks obtained from the new Scottish Index of Multiple Deprivation<sup>17</sup> using Spearman rank correlation.

## Results

### Populations and mortality data

The average population size of 9,000 wards in England and Wales and 1,000 postcode sectors in Scotland was similar at 5000–6000. The adjustment for undercounts added approximately 2% to the total Great Britain population obtained from census output tables in 1981 and 1991. The proportions of deaths excluded because they could not be matched to postcodes in Scotland were: 0.9, 1.3 and 0.8% for 1981, 1991 and 2001, respectively, but these figures were only slightly higher than for England and Wales (maximum difference of +1.2% in 1991).

### Deprivation trends

Table 1 shows the means of the four component variables of the Carstairs deprivation score across Great Britain between 1981 and 2001. For each variable, at every census, Scotland had higher values than the rest of Great Britain but all variables decreased in value between 1981 and 2001, in Scotland as well as in England and Wales, reflecting an absolute reduction in deprivation across the whole population.

Analysis of deprivation deciles for Great Britain at each census (Figure 1) shows that although the Scottish population was distributed more towards the deprived end of the Great Britain spectrum in each census, Scotland became relatively less deprived over time. For example, whereas 26% of the Scottish population lived in the most deprived decile in 1981, that figure had almost halved to 14% by the 2001 census.

**Table 1** Comparison of Carstairs deprivation variables from census data for England and Wales (E&W) and Scotland

Variable		Census		
		1981	1991	2001
No car (%)	E&W	30.2	24.2	19.4
	Scotland	41.2	33.8	25.6
Adult male unemployment (%)	E&W	10.2	11.0	6.0
	Scotland	12.5	13.0	7.9
Social Class IV and V (%)*	EandW	21.1	17.9	18.7
	Scotland	24.1	20.8	21.0
Overcrowding (%) <sup>†</sup>	EandW	7.1	4.6	4.1
	Scotland	18.2	7.4	4.6

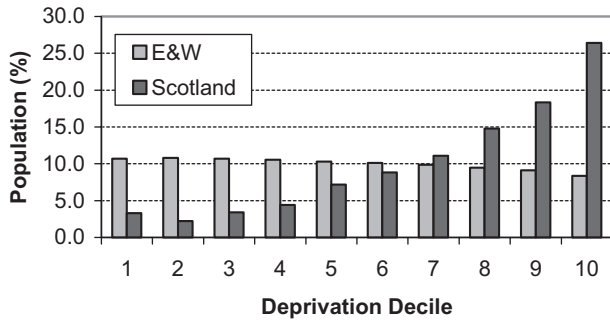
Variables are aggregated across all wards in England and Wales and all postcode sectors in Scotland.

\*2001 census data is based on the new NS-SEC classification mapped back to Social Class.

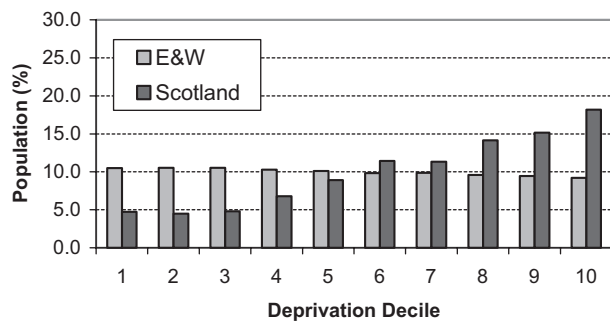
<sup>†</sup>For the 2001 census Social Class was replaced by the National Statistics Socio-economic Classification (NS-SEC). This classification was back-mapped to the Social Class classification using a correspondence table provided by ONS.

Available at [http://www.statistics.gov.uk/methods\\_quality/ns\\_sec/continuity.asp](http://www.statistics.gov.uk/methods_quality/ns_sec/continuity.asp)

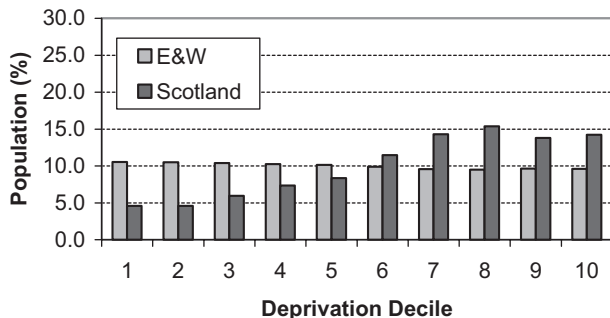
a) 1981



b) 1991



c) 2001



**Figure 1** Comparison of the relative deprivation profiles of England and Wales (E&W) and Scotland using GB deprivation deciles.

**Directly standardized mortality rates**

Age and sex standardized all-cause mortality rates decreased by approximately 25% across Great Britain, including Scotland, between the 1981 and 2001 censuses (Table 2). However, compared to England and Wales, the rates in Scotland were 12% higher in 1981 rising to 14% higher in 1991 and 15% higher in 2001. After standardising also for deprivation, this

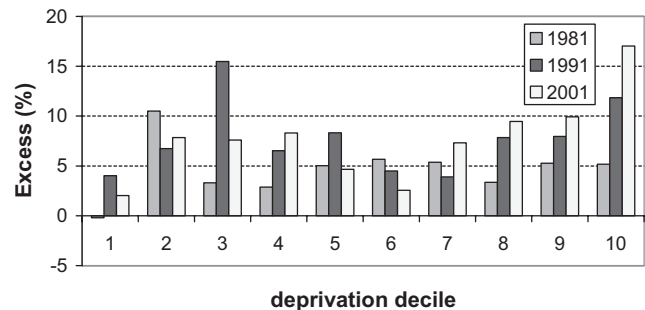
**Table 2** Comparison of directly standardized mortality rates (per 10,000 population), standardized for age, sex and deprivation decile, showing the ratio of Scotland relative to England and Wales (E&W)

Standardization	Year		
	1981	1991	2001
Age and sex			
E&W	115.7	101.0	88.3
Scotland	130.0	114.9	101.6
Ratio (%)	112.4	113.8	115.1
Age, sex and deprivation			
Ea&W	116.4	101.6	89.4
Scotland	121.9	109.6	96.6
Ratio (%)	104.7	107.8	108.0

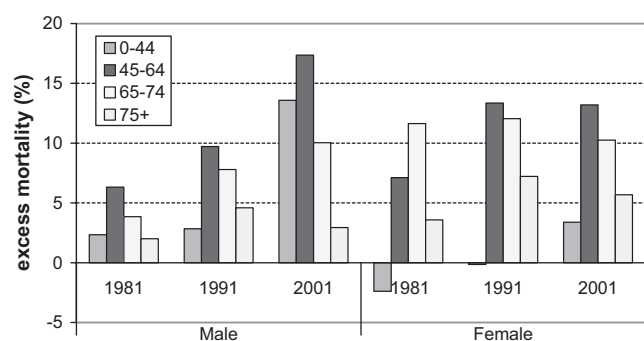
excess mortality decreased at all three census periods but important differences emerged over time (Table 2). While in 1981 over sixty percent of the excess mortality could be explained by differences in deprivation profile, less than half could be explained in 1991 and this changed little at the 2001 census.

**Mortality comparisons by deprivation**

Figure 2 shows how excess mortality in Scotland was distributed across deprivation deciles. Most deciles in 1981, and all deciles in 1991 and 2001 showed an excess indicating that populations in Scotland living in areas of comparable deprivation to populations in the rest of Great Britain had higher death rates. However the excess was not evenly distributed across deciles. In 1981 and 1991 the excess was as high in low deprivation areas as in higher deprivation areas. However by the 2001 census, the largest excesses were found in the most deprived areas. Those residing in the most deprived decile in Scotland had on average a 17% higher mortality rate than those residing in similarly deprived areas in England and Wales.



**Figure 2** Comparison of directly standardized mortality rates, standardized for age and sex, showing the excess mortality in Scotland as a percentage of mortality in England and Wales by deprivation decile.



**Figure 3** Comparison of directly standardized mortality rates, standardized for deprivation, showing the excess mortality in Scotland as a percentage of mortality in England and Wales by sex and age group.

### Mortality comparisons by age and sex

Excess all-cause mortality in Scotland was unevenly distributed among age groups (Figure 3). Since 1981 excess male mortality in Scotland has increased most markedly among those under 65. The male 0–44 age group has shown the most noticeable increase, approximately 6-fold, from 2.3% in 1981 to 13.6% in 2001 whereas the male 45–64 age group showed an approximate 3-fold increase from 6.3% in 1981 to 17.4% in 2001. There was also evidence of increasing divergence among males aged 65–74. Among females the trend of excess mortality in Scotland increasing through time was evident among those aged 0–44, although excess mortality was not as high as for males. Among older age groups the increasing trend was less marked.

### Mortality comparisons by cause of death

‘All causes’ and most of the ‘cause specific’ mortality rates declined in absolute terms in Scotland and the rest of Great Britain between 1981 and 2001. Table 3 summarizes the ratio of mortality rates in Scotland relative to the rest of Great Britain expressed as the percent excess mortality in Scotland, adjusted for age, sex and deprivation using log-linear models for ward and

postcode sector rates. The all cause excess mortality after full adjustment increased from 4.7% (95% CI: 3.9–5.4%) in 1981 to 7.9% (95% CI: 7.2–8.7) in 1991 and 8.2% (95% CI: 7.4–9.0%) in 2001. Comparison of the confidence intervals indicates that there is insufficient evidence to say that there was a change in the size of the effect during the 1990s.

The pattern in Table 3 is that cause specific mortality mirrors the pattern described for all cause mortality (i.e. a relative decline in Scotland’s position), with two exceptions. Respiratory Disease is the only category where the rest of Great Britain has an excess over Scotland but that excess declined between 1981 and 2001. The apparent excess in 1991 was an artefact of the change in the interpretation of primary and secondary causes on death records in England and Wales during the period 1984–1993<sup>18,19</sup> which resulted in a decrease in the deaths attributed to pneumonia and other respiratory diseases as the primary cause. The trend for self-harm and events of undetermined intent show mortality rates rose in Scotland but not in England and Wales confirming trends that have been reported previously.<sup>20,21</sup> However, it is difficult to attribute Scotland’s rising excess all cause mortality to differential trends in cause specific mortality.

### Durability of Carstairs deprivation scores

The effect of deprivation decile on small-area mortality rates was highly significant ( $P < 0.001$ ) in regression models for all three census periods. A marked gradient in mortality rates from the least deprived decile to the most deprived decile was evident in all three periods. Relative to the least deprived decile, mortality rates were 39% higher in the most deprived decile in 1981 and 45% higher in 2001. There was also a strong positive correlation between the 2001 Carstairs scores calculated at ward level in Scotland and the Scottish Index of Multiple Deprivation (2003) with a Spearman rank correlation coefficient with the index was 0.925 ( $P < 0.001$ ). Using only the income domain of the index the rank correlation was 0.948 ( $P < 0.001$ ). These results suggested that the Carstairs deprivation score remained a robust predictor of variation in small-area mortality rates across the time period.

**Table 3** Cause-specific mortality rates for Scotland expressed as a percent excess relative to England and Wales based on log-linear regression models adjusted for age, sex and deprivation decile

Cause	ICD 9 codes	1981		1991		2001	
		Excess (%)	95% CI	Excess (%)	95% CI	Excess (%)	95% CI
All causes	001–999	4.7	(3.9, 5.4)	7.9	(7.2, 8.7)	8.2	(7.4, 9.0)
Respiratory disease	460–519	–23.9	(–25.3, –22.5)	12.7	(10.9, 14.5)	–15.2	(–16.6, –13.8)
Cerebrovascular disease	430–438	29.8	(27.9, 31.7)	22.9	(21.0, 24.7)	23.9	(22.0, 25.9)
Ischaemic heart disease	410–414	12.6	(11.5, 13.8)	12.3	(11.1, 13.4)	11.7	(10.4, 13.0)
All malignant neoplasms	140–208	0.6	(–0.6, 1.7)	3.3	(2.2, 4.4)	10.8	(9.6, 11.9)
Lung cancer	162	2.2	(0.4, 4.1)	14.2	(12.2, 16.4)	25.9	(23.5, 28.2)
Intentional self-harm and events of undetermined intent	950–959, 980–989	1.2	(–2.5, 5.0)	15.1	(11.2, 19.1)	41.3	(36.9, 45.8)

## Discussion

The central finding of this study is that differences in the Carstairs deprivation distribution explain less of the widening gap in mortality between Scotland and England and Wales as we move from 1981 to 2001. This phenomenon implies that factors have influenced Scotland differentially over this period.

It may be that the Carstairs variables have over time become a less meaningful measure of deprivation. However, our analysis confirms that a strong contemporary relationship remains between Carstairs deprivation score and mortality rates. We also established a high correlation between Carstairs score and more recently developed measures of deprivation. The 'Scottish effect' may, of course, still be due to deprivation effects that are simply not associated with the four Carstairs variables. While this explanation cannot be discounted, if it were true it would have to be the case that social class, overcrowding, car ownership and unemployment have developed systematic differences in either measurement or impact in Scotland and England and Wales and that this divergence has increased over the past 20 years. Such a possibility seems unlikely.

While genetic differences between the Scottish and English populations may account for some of the excess mortality that existed in 1981, it is simply implausible that genetics can be responsible for a phenomenon that has emerged over a 20 year period. However, differential migration and fertility patterns cannot be discounted as easily.

Increasing income is linked with better health<sup>22</sup> but although Scotland has experienced a lower per capita Gross Domestic Product (GDP) than England for the past two decades, GDP per capita has increased throughout the UK, including Scotland. The levels of increase are broadly similar for England and Scotland.<sup>23</sup> During the period of this study, income inequality has widened dramatically<sup>24</sup> but income inequality remains greater in England than in Scotland.<sup>25</sup>

One possible explanation is that Scots in an equivalent deprivation category have higher levels of personal risk factors. In this context it is informative to compare results from the Scottish Health Survey 1998<sup>26</sup> and the Health Survey for England 1998.<sup>27</sup> In Scotland, overall, alcohol consumption is higher, smoking is more prevalent (also, Scottish smokers report heavier daily smoking) and there are lower levels of physical activity. Data on total cholesterol, hypertension and obesity show no differences that could account for the Scottish effect. It is possible that factors like smoking may, in part, account for the Scottish effect. However, since behaviours like smoking show a strong social gradient and Scotland has higher levels of deprivation one would expect there to be higher overall levels of smoking. Unfortunately, data on risk factors are not available to compare risks and outcomes in comparatively deprived smaller areas north and south of the border. Also, modelling of such risks and outcomes would have to take account of the time delay between exposure and outcomes. However, a recent analysis of the Scottish and English health surveys demonstrates

the persistence of substantially and significantly higher risk of ischaemic heart disease amongst Scottish respondents, despite controlling for a wide range of risk factors.<sup>28</sup>

The delay between exposure to risks and the onset of illness and then death is a further complicating factor. The need to understand risk and disease in term of the life course is now well established.<sup>29</sup> Unfortunately, the scope of this study did not allow such a perspective but it is possible that the higher mortality in Scotland observed in this study is a reflection of higher risks, brought about by deprivation and other factors, experienced earlier in the life course.

Could the 'Scottish effect' be the result of cultural factors? In the 19th and early 20th centuries Scotland became one of the most industrialized regions on earth. Since then it has suffered profound de-industrialization. The poorest parts of Scotland, centred on Glasgow and its hinterland, suffered the worst effects. In the immediate post war period this was most evident through obvious material deprivation, such as poor housing and unemployment. In recent decades some of the worst manifestations of material deprivation have improved but the psychological and cultural scars remain. Some have suggested that Scots face a crisis of confidence.<sup>30</sup>

The truth is that we do not know what is causing this phenomenon. Nor is it likely that it will be confined to Scotland. The north of England and Wales may well show similar findings. It is clear, however, that Scotland needs to discover why its improvement in mortality rates is lagging behind its economic development.

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