Explaining the excess mortality in Scotland compared with England: pooling of 18 cohort studies

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ABSTRACT

Background Mortality in Scotland is higher than in the rest of west and central Europe and is improving more slowly. Relative to England and Wales, the excess is only partially explained by area deprivation. We tested the extent to which sociodemographic, behavioural, anthropometric and biological factors explain the higher mortality in Scotland compared with England.

Methods Pooled data from 18 nationally representative cohort studies comprising the Health Surveys for England (HSE) and the Scottish Health Survey (SHS). Cox regression analysis was used to quantify the excess mortality risk in Scotland relative to England with adjustment for baseline characteristics.

Results A total of 193 873 participants with a mean of 9.6 years follow-up gave rise to 21 345 deaths. The age-adjusted and sex-adjusted all-cause mortality HR for Scottish respondents compared with English respondents was 1.40 (95% CI 1.34 to 1.47), which attenuated to 1.30 (95% CI 1.26 to 1.34) with the addition of the baseline socioeconomic and behavioural characteristics.

Cause-specific mortality HRs attenuated only marginally to 1.43 (95% CI 1.38 to 1.49) for ischaemic heart disease, 1.37 (95% CI 1.32 to 1.42) for stroke, 1.41 (95% CI 1.36 to 1.46) for all cancers, 3.43 (95% CI 3.37 to 3.49) for alcohol-related poisoning and 4.64 (95% CI 4.57 to 4.72) for suicide deaths. With an accompanying increase in rates of alcohol-related deaths over subsequent decades, the mortality pattern now has parallels to that observed in eastern Europe.2,3,6,16

Relative to England and Wales, mortality rates in Scotland were 12% higher in 1981, increasing to 15% higher in 2001. The proportion of this excess, which could be explained by area-based socioeconomic deprivation, declined from 62% to 47% during the same period. Individual measures of socioeconomic status revealed similar findings for coronary heart disease.7 This apparently inexplicable excess mortality, over and above that explained by area deprivation, has been dubbed the ‘Scottish Effect’.3

There is therefore a need to explain why Scotland experiences higher rates of mortality than the rest of west and central Europe, why area deprivation is increasingly less able to explain the excess in comparison to England and Wales and why inequalities in mortality within Scotland are relatively high.9–11 To date, there have been at least 17 hypotheses suggested to explain these phenomena.12–13 But the investigation of many of these has been limited by a lack of comparable individual data linked to health outcomes, and where these data have been available, they may not be generalisable.14 Although it is clear that some health behaviours are implicated in the higher mortality (particularly alcohol14–16 and illicit drugs16), the prevalence of many others are relatively similar in Scotland to other areas.17 18 This has raised the possibility that other factors may be an important explanation.9 Furthermore, simple explanations that include only health behaviours without some understanding of the ‘causes of the causes’ are insufficient, and so hypotheses relating to deindustrialisation, unemployment, economic and social policy20 21 (not least the neoliberal approach seen in the UK) have been proposed.1 11 12 22–25 Further research is therefore required in order to design policy and practice with the aim of alleviating the human suffering associated with the higher mortality rates.

Major population health surveys conducted from the mid-1990s in Scotland and England, whose respondents have been linked to subsequent cause-specific mortality, have created powerful, well-characterised cohort studies which draw on random population samples.26 27 Much of the data collected in the health surveys are directly comparable and there have now been a sufficient number of deaths to facilitate comparative pooled analyses of mortality in England and Scotland. Thus, this study aims to ascertain the extent to which any of the baseline risk factors explain the higher mortality in Scotland, beginning with social position,
given the earlier finding from ecological and individual studies of an excess after adjustment for deprivation.\(^7\) \(^8\)

**METHODS**

**Data sources**

We used the data collected in a series of 18 independent studies conducted between 1995 and 2003 (the Scottish Health Surveys, SHS) and 1994–2008 (the Health Surveys for England, HSE). Consenting survey respondents have been linked to the National Health Service registries up until the first quarter of 2011 for data on cause-specific mortality (the proportion consenting in each cohort study is given in table 1 (mean 86%, range 72–96%)). These cohort studies have been described in detail elsewhere.\(^26\) \(^27\) Briefly, random, stratified, population-based samples of the Scottish population aged 16–64, 16–74 and ≥16 years were taken in 1995, 1998 and 2003, respectively. In England, random population samples were drawn from the population aged ≥16 years in each year from 1994 to 2008. At the interview, data were collected on occupational social class, educational attainment, health behaviours (such as diet, smoking and alcohol consumption), pre-existing morbidity, self-assessed health and the 12-item General Health Questionnaire.\(^28\) During a subsequent nurse visit, weight, height, spirometry and blood pressure were objectively measured; blood samples were taken from a subsample.

The end points of interest were all-cause mortality and mortality from: CVD (International Classification of Diseases (ICD)-9 codes 390-459 and ICD-10 chapter I); ischaemic heart disease (ICD-9 codes 410-414 and ICD-10 codes I20-I25); stroke (ICD-9 codes 430-438 and ICD-10 codes I60-I69); all cancers (ICD-9 codes 140-239 and ICD-10 codes C00-D48); individual cancers; smoking-related cancers (ICD-9 codes 141-151, 155.0, 157.0, 160.0, 160.2-160.9, 161, 162.2-162.9, 180, 188, 189 and 205 and ICD-10 codes C01-C04, C15-C16, C30.0, C31, C32, C34, C53, C64, C65, C66 and C92, in line with WHO definitions\(^29\) \(^30\)); alcohol-related causes (ICD-9 codes 291, 303.0, 305.0, 425.5, 571.0, 571.1, 571.2, 571.3, 571.4, 571.5, 571.8, 571.9 and E860 and ICD-10 codes F10, G31.2, G62.1, I42.6, K29.2, K70, K73, K74.0, K74.1, K74.2, K74.6, K86.0, X45, X65 and Y15); illicit drug-related causes (ICD-9 codes 304-305 (not 305.1), 965-71, E935-41, E950.0-E950.5, E962 and E980.0-E980.5 and ICD-10 codes F11-F16, F18, F19, X40-X44, X60-X64, X85 and Y10-Y14); and external causes (ICD-9 codes 800-999 and ICD-10 codes V00-Y98; for both intentional external deaths (identified by any mention of ICD-9 codes E950-E959 and E980-E989 or ICD-10 codes X00-X84 and Y10-Y34 associated with an underlying external cause of death) and unintentional external deaths (all deaths where the underlying cause of death was external and had no mention of the ICD codes indicating an intentional motivation)).

**Analyses**

We examined log(−log(survival)) plots for total mortality to confirm that the proportional hazards assumption was valid. Cox proportional regression\(^31\) was then used—with calendar time in months elapsed from survey date as the time scale—to compute HRs with accompanying 95% CIs for the relation of country of residence (based on survey) with mortality experience. We also performed a sensitivity analysis using age as the timescale for the analysis rather than age-adjusted calendar time.

Having tested that gender did not modify the residence–mortality relation, these HRs were initially adjusted for age and sex. This was followed by the individual addition of occupational social class, educational attainment, smoking status, frequency of alcohol consumption, self-assessed health and long-standing illness. Finally, we adjusted for all factors simultaneously. In planned sensitivity analyses, these analyses were repeated for all-cause mortality for restricted age strata (16–45 and ≥45 years) and by occupational social class strata to investigate the suggestion of higher mortality among young adults\(^11\) \(^14\) \(^32\) \(^33\) and in more deprived neighbourhoods.\(^11\) \(^14\) \(^32\) \(^33\) For selected outcomes, we also examined the impact of controlling for height in addition to a much wider range of individual baseline survey and clinical measurement data for which there were more than 20% of data missing. These were: doctor-diagnosed CVD and hypertension; and doctor-diagnosed diabetes; portions of fruit and vegetables eaten on a day prior to the survey; antidepressant use; anxiolytic use; physical activity\(^34\); psychological distress measured by the 12-item General Health Questionnaire (GHQ-12); objectively measured body mass index; systolic blood pressure; diastolic blood pressure; forced vital capacity (FVC); forced expiratory volume in 1 s (FEV1); and peak flow rate. Where individuals had missing data, we excluded them from the relevant analyses.

Finally, to empirically assess the degree to which the linked HSE and SHS cohort studies were representative of the English and Scottish populations, we also tabulated the denominator populations and number of deaths for each 5-year age–sex stratum for each year of follow-up and created an equivalent table for the English and Scottish populations overall using routine administrative data. We then performed a negative binomial regression using R \(^\text{V2.15.2}\) to compare the relative all-cause mortality rates between the pooled surveys and their corresponding overall populations. All other analyses used PASW Statistics \(\text{V18.0}\).

**RESULTS**

There were 222 829 individuals in the 18 cohort studies, of whom 193 873 had sufficiently complete data to facilitate analysis (172 139 in HSE and 21 734 in SHS, web figure 1). Fifteen English cohort studies for each year between 1994 and 2008 were available, as were three Scottish cohort studies from 1995, 1998 and 2003. Over a period of time, the proportion of people consenting to participate in the survey and to mortality linkage declined, as did smoking prevalence. There were also secular rises in the socioeconomic status of study members as evidenced by the proportion in non-manual occupational social classes and those leaving school aged >16 years (table 1). Relative to study members who declined to consent to linkage to mortality records, participants who did were somewhat more likely to be healthy, be from a non-manual social class, have higher educational attainment and be less likely to smoke or have a long-term limiting illness; web table 1).

The baseline characteristics of the pooled English and pooled Scottish cohort studies are given in web table 2. The proportion of the sample in the English studies of the non-manual social class and with greater educational attainment was slightly higher than that in the Scottish studies, while the prevalence of smoking was substantially higher in Scotland compared with England (32.8% vs 25.3%). The prevalence of psychological distress at baseline in the Scottish and English studies was broadly similar (with 59%, 26%, 8% and 7% in the HSE studies and 59%, 24%, 8% and 8% in the SHS studies with GHQ-12 scores of 0, 1–3, 4–6 and 7–12, respectively).

The age-adjusted and sex-adjusted HR for mortality in the pooled Scottish studies compared with the English studies for all-cause mortality was 1.40 (95% CI 1.34 to 1.47). Additional adjustment for occupational social class, educational attainment,
Table 1  Characteristics of study participants according to individual cohort studies: follow-up of 18 cohort studies from the Health Survey for England and Scottish Health Survey (N=193 873)

<table>
<thead>
<tr>
<th></th>
<th>Health Survey for England</th>
<th>Scottish Health Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults irrespective of consent status</td>
<td>N</td>
<td>15 804</td>
</tr>
<tr>
<td>Household response</td>
<td>%</td>
<td>71</td>
</tr>
<tr>
<td>Estimated adult interview response</td>
<td>%</td>
<td>95.6</td>
</tr>
<tr>
<td>Consented to mortality linkage</td>
<td>N</td>
<td>15 113</td>
</tr>
<tr>
<td>Follow-up (years)</td>
<td>Mean</td>
<td>15.0</td>
</tr>
<tr>
<td>SD</td>
<td>3.9</td>
<td>3.6</td>
</tr>
<tr>
<td>Deaths from all causes</td>
<td>Mean</td>
<td>46.0</td>
</tr>
<tr>
<td>SD</td>
<td>18.6</td>
<td>18.5</td>
</tr>
<tr>
<td>Female</td>
<td>%</td>
<td>54.4</td>
</tr>
<tr>
<td>Non-manual occupational social class (I–III/NM)</td>
<td>%</td>
<td>54.1</td>
</tr>
<tr>
<td>Left school ≥16 (approximates to compulsory education)</td>
<td>%</td>
<td>61.8</td>
</tr>
<tr>
<td>Current smoker</td>
<td>%</td>
<td>27.4</td>
</tr>
<tr>
<td>Drinks alcohol at least weekly</td>
<td>%</td>
<td>62.2</td>
</tr>
<tr>
<td>Self-assessed general health good or very good</td>
<td>%</td>
<td>76.4</td>
</tr>
<tr>
<td>Long-standing illness</td>
<td>%</td>
<td>39.5</td>
</tr>
</tbody>
</table>

*The sample design in 1995 selected only one adult randomly per household at random.

frequency of alcohol consumption, self-reported health or long-standing illness did little to attenuate the relationship, whereas only adding smoking to the model had an appreciable effect (HR=1.31, 95% CI 1.25 to 1.37). Adjustment for all these factors combined resulted in a raised risk of total mortality of 29% (HR 1.29, 95% CI 1.23 to 1.36) in the Scottish studies relative to the English studies (table 2).

For all cancers combined, the age-adjusted and sex-adjusted HR for the Scottish studies was 1.54 (95% CI 1.42 to 1.66), which was only partially explained by smoking (HR 1.42, 95% CI 1.31 to 1.53) and not substantially by occupational social class, educational attainment, frequency of alcohol consumption, self-assessed general health or long-standing illness (multiply adjusted HR 1.41, 95% CI 1.30 to 1.53; table 2). Web table 3 shows the HRs for smoking-related cancers and a range of site-specific cancers. The multiply adjusted HR for smoking-related cancers was 1.62 (95% CI 1.45 to 1.81) and for non-smoking-related cancers 1.22 (1.09 to 1.37). Particularly high multiply adjusted HRs were observed for lung cancer (1.67, 95% CI 1.43 to 1.94), oesophageal cancer (2.23, 1.60 to 3.09), bladder cancer (1.62, 1.04 to 2.54), cancer of the central nervous system (1.74, 1.12 to 2.72), leukaemia (2.32, 1.45 to 3.71), multiple myeloma (1.60, 0.81 to 3.13), liver cancer (2.54, 1.37 to 4.73) and mesothelioma (2.04, 1.06 to 3.93). The multiply adjusted models explained a very small additional proportion of the excess mortality compared with the age-adjusted and sex-adjusted models for each of these specific cancers. There was no evidence of an excess mortality for prostate or pancreatic cancer, or for non-Hodgkin’s lymphoma.

A similar pattern to all-cause mortality was observed for CVD, ischaemic heart disease and stroke, where the multiply adjusted HRs were 1.27 (95% CI 1.16 to 1.38), 1.43 (1.28 to 1.60) and 1.37 (1.15 to 1.63), respectively (table 3). For intentional external causes (ie, intentional self-harm, violence or events of undetermined intent), the multiply adjusted HR was 1.68 (95% CI 1.07 to 2.64), and for unintentional external causes (ie, all other accidents, assaults, medical/surgical complications, or other external causes of death) it was similar in the Scottish studies compared with the English studies (HR 0.88, 95% CI 0.62 to 1.24; table 4).

The age-adjusted and sex-adjusted alcohol-related mortality in the Scottish studies was more than five times higher than that in the English studies (HR 5.43, 95% CI 4.20 to 7.02). This was only marginally explained by the baseline risk factors (in particular smoking), giving a multiply adjusted HR of 4.64 (95% CI 3.55 to 6.05). Similarly, the age-adjusted and sex-adjusted drug-related poisoning mortality in the Scottish studies was almost four times higher than that in the English studies (HR 3.86, 95% CI 2.15 to 6.94), which again was only marginally explained by the baseline risk factors (multiply adjusted HR 3.43, 95% CI 1.85 to 6.36; figure 1 and table 5).

Web table 4 shows the all-cause HRs stratified into broad age categories to investigate whether the excess mortality in the Scottish studies was greater among young adults, as has been shown in previous studies, and whether this is explained by the baseline risk factors. For those aged 16–44 and 45–64 years, the age-adjusted and sex-adjusted HRs were higher than those for all ages (HR 1.68, 95% CI 1.44 to 1.97 and 1.71, 95% CI 1.59 to 1.83), which adjusted to (HR 1.54, 95% CI 1.30 to 1.81 and 1.47, 95% CI 1.37 to 1.58) with the addition of the baseline risk factors.

Web table 5 shows the HRs for residency in relation to all-cause mortality stratified by occupational social class. This shows that the excess age-standardised and sex-standardised mortality is present across all occupational social class categories except for social class I where the multiply adjusted HR was in fact imprecisely lower in the Scottish studies (0.85; 0.59 to 1.23). The multiply adjusted HRs for the Scottish studies were 1.20 (95% CI 1.08 to 1.34) in social class II, 1.32 (1.18 to 1.47) in social class IIINM, 1.31 (1.20 to 1.43) in social class III, 1.27 (1.14 to 1.41) in social class IV and 1.40 (1.22 to 1.61) in social class V. The HR for the interaction between country and social class was 1.05 (p=0.12).

Web table 6 gives the subgroup analyses of the models adjusted using a wider range of baseline characteristics that were available for a smaller proportion of linked survey respondents. This shows that few of the additional baseline factors offer much additional explanatory power, with the exception of FVC, FEV1 and peak flow. Notably, neither pre-existing morbidity, blood pressure, physical activity, portions of fruit and vegetables eaten, body mass index, antidepressant use nor anxiolytic use explained any substantial proportion of the standardised excess.

**DISCUSSION**

**Main results**

Mortality rates in the Scottish studies were 40% higher than in the English studies for all causes. The mortality rates for almost all specific causes of death were higher, although with some

**Table 2**  **HRs (95% CI) for all-cause mortality, and deaths from cancer: Scotland relative to England (N=193 873)**

<table>
<thead>
<tr>
<th>Model*</th>
<th>All-cause mortality</th>
<th>Cancer†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deaths</td>
<td>N</td>
</tr>
<tr>
<td>Age-adjusted and sex-adjusted (basic model)§</td>
<td>21 345</td>
<td>193 873</td>
</tr>
<tr>
<td>Occupational social class</td>
<td>20 410</td>
<td>183 043</td>
</tr>
<tr>
<td>Educational attainment</td>
<td>21 318</td>
<td>193 733</td>
</tr>
<tr>
<td>Smoking status</td>
<td>21 309</td>
<td>193 068</td>
</tr>
<tr>
<td>Frequency of alcohol consumption</td>
<td>21 311</td>
<td>191 531</td>
</tr>
<tr>
<td>Self-assessed general health</td>
<td>21 339</td>
<td>193 835</td>
</tr>
<tr>
<td>Long-standing illness</td>
<td>21 341</td>
<td>193 829</td>
</tr>
<tr>
<td>Multiply adjusted†</td>
<td>20 330</td>
<td>181 560</td>
</tr>
</tbody>
</table>

* Covariates selected from potentially relevant variables because data for these variables were missing in less than 20% of participants.
† ICD-9 codes 140-239 and ICD-10 codes C00-D48.
‡ Model adjusted for age, sex, occupational social class, educational attainment, smoking status, frequency of alcohol consumption, self-assessed general health and long-standing illness.
§The unadjusted HR suggests that death rates are lower in Scotland but the age distributions of the two samples are different—the HSE cohorts are older.
HSE, Health Surveys for England; ICD, International Classification of Diseases; SHS, Scottish Health Survey.
Table 3

<table>
<thead>
<tr>
<th>Model</th>
<th>Deaths</th>
<th>HR</th>
<th>95% CI</th>
<th>p Value</th>
<th>Deaths</th>
<th>HR</th>
<th>95% CI</th>
<th>p Value</th>
<th>Deaths</th>
<th>HR</th>
<th>95% CI</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age-adjusted and sex-adjusted (basic model)</td>
<td>7372</td>
<td>193 873</td>
<td>1</td>
<td>1.37 (1.26 to 1.48)</td>
<td>&lt;0.001</td>
<td>3555</td>
<td>193 873</td>
<td>1</td>
<td>1.54 (1.41 to 1.68)</td>
<td>&lt;0.001</td>
<td>1792</td>
<td>193 873</td>
</tr>
<tr>
<td>+Occupational social class</td>
<td>7025</td>
<td>183 043</td>
<td>1</td>
<td>1.35 (1.25 to 1.47)</td>
<td>&lt;0.001</td>
<td>3406</td>
<td>183 043</td>
<td>1</td>
<td>1.52 (1.39 to 1.66)</td>
<td>&lt;0.001</td>
<td>1680</td>
<td>183 043</td>
</tr>
<tr>
<td>+Educational attainment</td>
<td>7363</td>
<td>193 733</td>
<td>1</td>
<td>1.36 (1.25 to 1.47)</td>
<td>&lt;0.001</td>
<td>3550</td>
<td>193 733</td>
<td>1</td>
<td>1.52 (1.39 to 1.66)</td>
<td>&lt;0.001</td>
<td>1792</td>
<td>193 733</td>
</tr>
<tr>
<td>+Smoking status</td>
<td>7365</td>
<td>193 068</td>
<td>1</td>
<td>1.29 (1.19 to 1.40)</td>
<td>&lt;0.001</td>
<td>3551</td>
<td>193 068</td>
<td>1</td>
<td>1.52 (1.39 to 1.66)</td>
<td>&lt;0.001</td>
<td>1792</td>
<td>193 068</td>
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<tr>
<td>+Frequency of alcohol consumption</td>
<td>7362</td>
<td>191 531</td>
<td>1</td>
<td>1.35 (1.25 to 1.47)</td>
<td>&lt;0.001</td>
<td>3546</td>
<td>191 531</td>
<td>1</td>
<td>1.52 (1.39 to 1.66)</td>
<td>&lt;0.001</td>
<td>1791</td>
<td>191 531</td>
</tr>
<tr>
<td>+Self-assessed general health</td>
<td>7370</td>
<td>193 835</td>
<td>1</td>
<td>1.36 (1.25 to 1.47)</td>
<td>&lt;0.001</td>
<td>3554</td>
<td>193 835</td>
<td>1</td>
<td>1.52 (1.39 to 1.66)</td>
<td>&lt;0.001</td>
<td>1793</td>
<td>193 835</td>
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<tr>
<td>+Long-standing illness</td>
<td>7372</td>
<td>193 829</td>
<td>1</td>
<td>1.38 (1.28 to 1.48)</td>
<td>&lt;0.001</td>
<td>3555</td>
<td>193 829</td>
<td>1</td>
<td>1.52 (1.39 to 1.66)</td>
<td>&lt;0.001</td>
<td>1793</td>
<td>193 829</td>
</tr>
</tbody>
</table>

Study strengths and weaknesses

The cohort studies formed from the linked health surveys (HSE and SHS) are designed to be representative of the adult population in England and Scotland and utilise stratified random sampling methods to achieve this goal. Other examinations of explanations for the Scottish-English mortality differentials have often utilised data from cohort studies of working populations, thus affecting the generalisability of any findings. It is most likely that almost all deaths will have been captured in the death registries, making the estimated mortality rates internally valid. The cohort studies also provide premorbid, individual risk factor data not available for routine data, which allows a wider range of potential explanatory factors to be tested with adjustment for confounding.

Despite the survey sample frame being representative of the adult non-institutionalised population, the declining response rates to the baseline surveys and subsequent linkage, the non-coverge of some institutional populations in the sample frame and the consequent potential for non-representativeness are real. Both HSE and SHS normally present their results after inverse probability weighting to adjust for non-response bias. We have not weighted our data because: such weighting factors are available for the most recent years only; there are inherent difficulties of using different weights for different years; and because responders are intrinsically different from non-responders and simply up-weighting the responders’ data does not adequately adjust for non-response. Previous comparisons of HSE and SHS data found that weighting did not change the overall results (Rich Mitchell, personal communication). We did not have comparable measures of area deprivation in the data set and using only individual measures of socioeconomic status may have left some residual confounding. We assumed no loss to follow-up in the analyses, which could have
higher excess in this age group).2
shows larger HRs for younger adults (which
mated by 33% for men and 20% for women.37 The all-cause
deaths are approximately twice as high in the Scottish popula-
tions, respectively . Routine data suggest that alcohol-related
mortality rates in the linked HSE and SHS studies here were
important given the differences in the baseline ages of the
cohorts). W eb table 7 provides a sensitivity analysis using age as
indirect causes, but was beyond the scope of this paper.
Comparison with the existing literature and implications
The excess age-standardised and sex-standardised mortality in
the Scottish studies in this study is 40%, more than double that
seen using routine data for all ages around 2001 when the dif-
ference was 15%.8 Just under half of the excess in 2001 could
be explained by area deprivation, but very little of the excess in
this study could be explained by individual occupational social
class or educational attainment. A recent review of the potential
explanations for the excess mortality in Scotland suggested that
behavioural factors were unlikely by themselves to explain the
differences, and this is confirmed by these analyses—with only
smoking explaining a substantial proportion (about a quarter) of
the excess. This analysis also concurs with the finding of a
greater excess mortality among young adults, and that the
excess is seen across most of the socioeconomic spectrum, but is
skewed towards the more deprived groups.20 21 32 40 41
Self-rated health in Scotland has been shown to be worse than
in England and Wales and worse in Greater Glasgow as compared
with a range of other European metropolitan areas. Unlike in this
study, in those analyses, the excess in Scotland could entirely be
accounted for by differences in economic activity, but the excess
in Glasgow could not be explained by social class and educational

Table 4 HRs (95% CI) for deaths from external causes, intentional and unintentional: Scotland relative to England (N=193 873)

<table>
<thead>
<tr>
<th>Model</th>
<th>External (intentional)*</th>
<th></th>
<th>p Value</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deaths†</td>
<td>N</td>
<td>HSE HR</td>
<td>SHS HR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age-adjusted and sex-adjusted (basic model)</td>
<td>122</td>
<td>193 873</td>
<td>1</td>
<td>1.85 (1.18 to 2.89)</td>
<td>0.007</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+Occupational social class</td>
<td>119</td>
<td>183 634</td>
<td>1</td>
<td>1.86 (1.19 to 2.91)</td>
<td>0.007</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>+Educational attainment</td>
<td>119</td>
<td>193 733</td>
<td>1</td>
<td>1.85 (1.18 to 2.89)</td>
<td>0.007</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>+Smoking status</td>
<td>122</td>
<td>193 068</td>
<td>1</td>
<td>1.65 (1.05 to 2.58)</td>
<td>0.030</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>+Frequency of alcohol consumption</td>
<td>122</td>
<td>191 531</td>
<td>1</td>
<td>1.86 (1.19 to 2.91)</td>
<td>0.007</td>
<td></td>
<td></td>
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<tr>
<td>+Self-assessed general health</td>
<td>122</td>
<td>193 835</td>
<td>1</td>
<td>1.82 (1.16 to 2.84)</td>
<td>0.009</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>+Long-standing illness</td>
<td>122</td>
<td>193 829</td>
<td>1</td>
<td>1.82 (1.18 to 2.89)</td>
<td>0.007</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully-adjusted†</td>
<td>119</td>
<td>181 151</td>
<td>1</td>
<td>1.68 (1.07 to 2.64)</td>
<td>0.025</td>
<td></td>
<td></td>
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</table>

*Intentional deaths were identified by any mention of ICD-9 codes E950-E959 (intentional) and E980-E989 (undetermined intent) or ICD-10 codes X60-X84 (intentional) and Y10-Y34 (undetermined intent) associated with an underlying external cause of death (ICD-9 codes 800-999 or ICD-10 codes V00-Y98).
†HSE deaths 98; SHS deaths 24.
‡Model adjusted for age, sex, occupational social class, educational attainment, smoking status, frequency of alcohol consumption, self-assessed general health and long-standing illness.

HSE, Health Surveys for England; ICD, International Classification of Diseases; SHS, Scottish Health Survey.

biased the results if experienced differentially between HSE and
SHS. Although unlikely, it is possible that differential measure-
ment bias (eg, in previous smoking) might have underestimated
the impact of some of the explanatory variables in the model. A
mediation analysis approach may have facilitated a more
detailed consideration of the role of confounding, direct and
indirect causes, but was beyond the scope of this paper.

We used the standard approach to Cox modelling of using
time since baseline and treating age as a confounder (which is
important given the differences in the baseline ages of the
cohorts). Web table 7 provides a sensitivity analysis using age as
the timescale in the models rather than age-adjusted calendar
time. This inflates the HRs in the Scottish population across all
causes of death, but the patterning is similar. The age ranges in
the cohorts differ slightly and we have chosen to adjust for age
rather than restrict those included in the analysis to preserve the
sample size. However, to expose the differences across the age
range, we have stratified the samples in web table 4, which
shows larger HRs for younger adults (which fits with the known
higher excess in this age group).2

Preliminary analyses of the age-standardised all-cause mortal-
ity rates in the linked SHS compared with the rates derived
from routine deaths data suggest that the rates may be underesti-
ated by 33% for men and 20% for women.37 The all-cause mortal-
ity rates in the linked HSE and SHS studies here were
31% and 21% lower than in the English and Scottish popu-
lations, respectively. Routine data suggest that alcohol-related
deaths are approximately twice as high in the Scottish popula-
tion as in England and Wales,38 yet the age-adjusted and sex-
adjusted HR in the Scottish studies compared with the English
studies was over five. These all suggest that the healthy respond-
ent effect may be more acute for the English studies.
Furthermore, the Scottish data are for a slightly earlier period.
Both of these factors will have inflated the HRs comparing the
Scottish with the English studies.

Comparison with the existing literature and implications
The excess age-standardised and sex-standardised mortality in
the Scottish studies in this study is 40%, more than double that
seen using routine data for all ages around 2001 when the dif-
fERENCE was 15%.8 Just under half of the excess in 2001 could
be explained by area deprivation, but very little of the excess in
this study could be explained by individual occupational social
class or educational attainment. A recent review of the potential
explanations for the excess mortality in Scotland suggested that
behavioural factors were unlikely by themselves to explain the
differences, and this is confirmed by these analyses—with only
smoking explaining a substantial proportion (about a quarter) of
the excess. This analysis also concurs with the finding of a
greater excess mortality among young adults, and that the
excess is seen across most of the socioeconomic spectrum, but is
skewed towards the more deprived groups.20 21 32 40 41

Figure 1 Multiply adjusted HRs for Scotland relative to England.
attainment. The value of self-rated health as an outcome measure in investigating the mortality phenomena in Scotland is therefore unclear, particularly since there are socioeconomic, demographic and cultural factors which may lead to artefactual differences between population groups. Further work is therefore required to explore factors which are not routinely collected in health surveys or administrative data, which might explain the excess mortality in Scotland. This includes more sensitive measures of the lived experience of poverty, the role of social support within communities, greater understanding of the impact of historical and cultural influences and the differential impact of local and national politics on health outcomes. Further work is also required to examine why psychological distress appears to be more toxic to health in Scotland than in England.

### Table 5 HRs (95% CI) for deaths related to alcohol* or drugs†: Scotland relative to England (N=193 873)

<table>
<thead>
<tr>
<th>Model†</th>
<th>Alcohol-related deaths*</th>
<th>Drug-related poisonings†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deaths</td>
<td>N</td>
</tr>
<tr>
<td>Age-adjusted and sex-adjusted (basic model)</td>
<td>252</td>
<td>193 831</td>
</tr>
<tr>
<td>+Occupational social class</td>
<td>246</td>
<td>183 004</td>
</tr>
<tr>
<td>+Educational attainment</td>
<td>251</td>
<td>193 691</td>
</tr>
<tr>
<td>+Smoking status</td>
<td>249</td>
<td>193 026</td>
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<tr>
<td>+Frequency of alcohol consumption</td>
<td>251</td>
<td>191 489</td>
</tr>
<tr>
<td>+Self-assessed general health</td>
<td>252</td>
<td>193 793</td>
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<tr>
<td>+Long-standing illness</td>
<td>252</td>
<td>193 787</td>
</tr>
<tr>
<td>Fully-adjusted§</td>
<td>241</td>
<td>181 521</td>
</tr>
</tbody>
</table>

* Covariates selected from potentially relevant variables because data for these variables were missing in less than 20% of participants.
† Covariates selected from potentially relevant variables because data for these variables were missing in less than 20% of participants.
‡ Model adjusted for age, sex, occupational social class, educational attainment, smoking status, frequency of alcohol consumption, self-assessed general health and long-standing illness.
§ Model adjusted for age, sex, and ICD-10 codes F10, G31.2, G62.1, K70, K73, K74.0, K74.1, K74.2, K74.6, K86.0, X45, X65 and Y15.

### What is already known on this subject

Mortality in Scotland is higher than in the rest of west and central Europe and is improving more slowly. Relative to England and Wales, the excess is only partially explained by area deprivation.

### What this study adds

Mortality was 40% higher in Scottish cohort members than in English cohort members, and only around a quarter was explicable by socioeconomic, behavioural, anthropological or biological factors.
Research report

Hygiene and Tropical Medicine & Public Health Institute for Scotland, 2003. http://www.scotpho.uk.com/health/InternationalComparisons/int...


Explaining the excess mortality in Scotland compared with England: pooling of 18 cohort studies

Gerry McCartney, Tom C Russ, David Walsh, Jim Lewsey, Michael Smith, George Davey Smith, Emmanuel Stamatakis and G David Batty

J Epidemiol Community Health published online September 12, 2014

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