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Dying younger in Scotland: Trends in mortality and deprivation relative to England and Wales, 1981–2011

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ABSTRACT

Given previous evidence that not all Scotland's higher mortality compared to England & Wales (E&W) can be explained by deprivation, the aim was to enhance understanding of this excess by analysing changes in deprivation and mortality in Scotland and E&W between 1981 and 2011. Mortality was compared by means of direct standardisation and log-linear Poisson regression models, adjusting for age, sex and deprivation. Different measures of deprivation were employed, calculated at different spatial scales. Results show that Scotland became less deprived compared to E&W between 1981 and 2011. However, the Scottish excess (the difference in mortality rates relative to E&W after adjustment for deprivation) increased from 4% higher (c.1981) to 10% higher in 2010–12. The latter figure equates to c. 5000 extra deaths per year. The increase was driven by higher mortality from cancer, suicide, alcohol related causes and drugs-related poisonings. The size and increase in Scottish excess mortality are major concerns. Investigations into its underlying causes continue, the findings of which will be relevant to other populations, given that similar excesses have been observed elsewhere in Britain.

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1. Introduction

Scotland's mortality rates are the highest in Western Europe and, given their relatively slower rate of improvement, will soon be higher than those of a number of Eastern European countries as well (McCartney et al., 2012a; Whyte and Ajetunmobi, 2012). Traditional explanations have focussed, correctly, on higher levels of poverty and deprivation, driven by the underlying effects of post-industrial decline (Carstairs and Morris, 1989; Scottish Office, 1999; Scottish Executive, 2000; Scottish Council Foundation, 1998). These explanations are important: the link between poverty and poor health is profound and much documented (Carstairs and Morris, 1989; Bartley, 1994; Dorling, 2009a; Townsend, 1987; Townsend et al., 1988), and across all Europe, mortality tends to be highest in deindustrialised regions (Riva et al., 2011; Champion and Townsend, 1990; Beynon et al., 1999; Mitchell et al., 2000; Walsh et al., 2010a; Taulbut et al., 2011). Indeed, at the start of the 1980s, most of Scotland's higher mortality compared to England &

Wales was explained by the country's worse socio-economic profile (Carstairs and Morris, 1989; Hanlon et al., 2005).

However, a considerable amount of research published since then has questioned the extent to which this is an entirely satisfactory explanation (Walsh et al., 2010a, 2010b; Taulbut et al., 2011; Hanlon et al., 2005; Popham et al., 2010; Popham and Boyle, 2011; McCartney et al., 2015, 2012a, 2012b; Mok et al., 2013; Graham et al., 2012; Stanners et al., 2015). By 2001, socio-economic deprivation explained considerably less of the difference in mortality between Scotland and rest of Great Britain. After adjustment for differences in area deprivation, mortality in Scotland in 2001 was approximately 8% higher than in England & Wales, and this unexplained excess was notably higher for particular causes of death: for example, adjusted mortality rates for cerebrovascular disease, lung cancer and suicide were, respectively, 24%, 26% and 41% higher (Hanlon et al., 2005). Mortality was shown to be higher, and to be improving more slowly, in West Central Scotland (the area of the country most affected by deindustrialisation) than in other, similarly deindustrialised, regions across the UK and mainland Europe, including many with higher rates of poverty (Walsh et al., 2010a; Taulbut et al., 2011). Comparisons of Scotland's largest city, Glasgow, with Liverpool,

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Manchester and Belfast, cities with similar histories of deindustrialisation and decline, and with comparable current levels of poverty, showed that in the mid-2000s premature mortality was approximately 30% higher in the Scottish city (after adjustment for any remaining differences in neighbourhood deprivation) (Walsh et al., 2010b; Graham et al., 2012). Further national analyses have demonstrated that this excess is observed among males and females, across all social classes and adult age groups, and persists when analysed in terms of both area-based, and individual, measures of socio-economic status (SES), and even when additionally controlling for a range of behavioural (e.g. smoking, diet, physical activity) and biological (e.g. body mass index, blood pressure) risk factors (Hanlon et al., 2005; Popham et al., 2010; Popham and Boyle, 2011; McCartney et al., 2015).

The principal aim of this study was to investigate how changes in deprivation have impacted on all-cause and cause specific mortality in Scotland compared to England and Wales between 1981 and 2011. A supplementary aim was to assess the extent to which the results were altered by the use of a different measure of area deprivation, calculated at a smaller geographical unit (i.e. and so less prone to the so-called 'ecological fallacy' (Piantadosi et al., 1988; Diez Roux, 2002)).

2. Methods

2.1. Mortality data

Individual mortality records were obtained from the National Records of Scotland (NRS) and the Office for National Statistics (ONS) for the years 1981–2012. Data were for residents of Scotland, England and Wales. Analyses were undertaken for all-cause deaths, as well the nine causes of death listed in Box 1 below.

2.2. Deprivation

To allow comparative analysis over the whole 30 year time period (1981–2011), the Carstairs & Morris index of area deprivation was used (Carstairs and Morris, 1989). The score is based on four standardised (using the mean and standard deviation values for all areas in Great Britain) census variables measured in each of the four census years (1981, 1991, 2001, 2011): adult male unemployment; lack of car ownership; low social class; overcrowding. The methodology replicated previous comparative analyses of the Carstairs index for Scotland and England and Wales, including adjustment for overcrowding in Scotland in 1981 and the use of a proxy for male social class in 2001 and 2011 (Hanlon et al., 2005). The scores were calculated for census wards for England and Wales (mean population size in 2011: 6540) and postcode sectors in Scotland (mean population size in 2011: 5600) for each of the four time points.

To assess the impact of a different measure of deprivation, 'employment deprivation' was additionally used for 2001 (the earliest period for which data were available) and 2011. The definition of this measure was that used in the Scottish Index of Multiple Deprivation (SIMD) in 2004 and 2012: derived from UK Department of Work & Pensions (DWP) data, it is calculated as the percentage of the working age population who are receipt of a number of employment-related social security ('welfare') benefits. These combine unemployment related benefits (e.g. Jobseekers' Allowance) and sickness-related benefits (Incapacity Benefit, Severe Disability Allowance). The definition changed slightly between the 2004 and 2012 SIMD, but is deemed to be comparable between those time points (Scottish Government, 2012; Dickie, 2014). This measure of deprivation is highly correlated with both the overall SIMD score (e.g. 2012: $R=0.97$) and the overall score of the English Index of Multiple Deprivation (e.g. 2010: $R=0.94$).

For Scottish areas, the data were accessed directly from the SIMD website (Scottish Government, 2012). For English and Welsh

Box 1—causes of death (and associated ICD codes^a)

Cause	ICD9 code(s)	ICD10 code
Respiratory disease	460–519	J00–J99
Ischaemic heart disease	410–414	I20–I25
Cerebrovascular disease	430–438	I60–I69
All malignant neoplasms	140–208	C00–C97
Lung cancer (malignant neoplasm of trachea/bronchus/lung)	162	C33–C34
Intentional self-harm (including events of undetermined intent)	E950–E959, E980–E989	X60–X84, Y10–Y34
External causes	E800–E999	ICD10 V01–Y98
Alcohol related causes ^b	291, 303, 305.0, 425.5, 571.0–571.5, 571.8, 571.9, E860	
Drug related poisonings ^c	304, 305.2–305.9, E850–E858, E950.0–E950.5, E9620, E980.0–E980.5	F11–F16, F18, F19, X40–X44, X60–X64, X85, Y10–Y14

Note that there are overlaps between a number of categories e.g.: all cancers and lung cancer; all external causes, intentional self-harm and drug-related poisonings, Corkery.

^a ICD9 codes were used in Scotland between 1980 and 1999 and in England between 1979 and 2000; ICD10 codes have been used thereafter.

^b These are the groups of codes agreed by NRS and ONS 2006. (Piantadosi et al., 1988)

^c These are the set of codes deemed most comparable between Scotland and England & Wales (Walsh et al., 2010; Diez Roux, 2002)

areas, identical data were obtained from the Department of Work & Pensions (DWP). The geographical unit of analysis for England and Wales was Lower Super Output Area (LSOA).¹ In Scotland the equivalent administrative geography (and the spatial unit at which SIMD data are published) is the datazone ([Scottish Executive Office of The Chief Statistician Scottish, 2004](#); [Scottish Neighbourhood Statistics Guide, 2015](#)). Datazones are approximately half the size of LSOAs²; thus, to achieve a comparable spatial unit of analysis, specialist computer software (the AZ Tool ([Cockings et al., 2011](#); [Martin, 2003](#))) was used to merge pairs of neighbouring Scottish datazones. This was done separately for 2001 and 2011, and for each of Scotland's 32 local authority areas, based on analysis of each datazone's level of deprivation, population size, number of households, and urban-rural classification. This resulted in the creation of a geographical unit with an mean population size in 2011 of 1618, very similar to the mean population size of LSOAs in England and Wales (1614). (For 2001, the mean population sizes were 1524 and 1514 respectively).

2.3. Statistical analyses

Analyses were carried out using both direct standardisation, and Log-linear Poisson regression models (with 95% confidence intervals calculated from the latter). In both cases mortality rates (calculated at small-area geographies³ over three year periods around each census point⁴) between Scotland and England and Wales were compared, adjusting for ten-year age band, sex and population-weighted GB deprivation decile. Excess mortality was defined as the difference in rates after adjustment for deprivation, and was expressed as the absolute difference, the absolute number of deaths, and the relative percentage. Analyses were carried out for all-cause deaths, and for the nine separate causes of death listed above, using the two different measures of deprivation: Carstairs scores calculated for wards (England & Wales) and postcode sectors (Scotland) (1981, 1991, 2001, 2011); and employment deprivation for LSOAs (England & Wales) and merged datazones (Scotland) (2001 and 2011).⁵ Additional analyses were stratified by sex, age, GB deprivation decile, and local authority of residence. Previous analysis of Scottish excess mortality ([Hanlon et al., 2005](#)) used the 1981 Scottish population as the standard population; however, as this had become less fit for purpose by 2011, the new European standard population was used in all analyses instead ([Eurostat, 2013](#)).

3. Results

3.1. Population trends

Between 1981 and 2011, the Scottish population increased by approximately 2% from 5,180,200 to 5,295,403. However, this masks a 2% decrease in total population size between 1981 and 2001, followed by a notable increase of approximately 5% between 2001 and 2011. In contrast, the population of England & Wales

increased at every 10-year time point, from 49,634,500 in 1981 to 56,075,912 in 2011 (a 13% increase overall). As in Scotland, the biggest increase was between 2001 and 2011 (almost 8%). The percentage increases over the period in the elderly population (65 years and above) were similar in Scotland and England & Wales. However, the reduction in the number of children (0–14 years) was much greater in Scotland (approximately 22% compared to 2%). Despite this, the age structures of the populations were broadly similar in the countries at all time periods analysed.

3.2. Deprivation profiles over time

[Fig. 1](#) shows trends in the four components of the Carstairs and Morris index between 1981 and 2011 for Scotland compared to England and Wales. Based on these observations, Scotland was more deprived than England and Wales across the whole time period for three of the four variables. The exception is overcrowding which in 2011 was, for the first time, higher in England & Wales than in Scotland. A narrowing of the gap over time between Scotland and England and Wales is also evident in relation to low social class and, especially, lack of access to a car. Thus, based on these measures, Scotland as a country has become relatively less deprived compared to England and Wales over the last 30 years. The same is also true of employment deprivation between 2001 and 2011: this decreased in England and Wales from 11.0% to 9.2% of the working age population (a decrease of 16%), while in Scotland it fell from 13.8% to 10.7% (decrease of 22%).

This change in relative deprivation can also be seen in [Web Fig. 1](#), showing the distribution of the population by Carstairs deprivation decile (1981–2011) and, separately, by employment deprivation decile (2001 and 2011). The relative shift in deprivation, as measured by Carstairs, is such that while in 1981 the percentage of the Scottish population in the most deprived GB decile was more than three times higher than the equivalent figure for the English & Welsh population (and twice as high in the second most deprived decile), by 2011 the figures were very similar (with bigger differences observed in deciles 6–8). However, it is also noticeable that comparing GB deciles based on employment deprivation (rather than Carstairs), calculated for smaller geographical units, results in a different picture in 2001 and 2011, with a considerably higher percentage of the Scottish population in the most deprived GB decile in 2011 (although as with Carstairs, the figure has reduced over time).

3.3. Mortality analyses

[Table 1](#) presents directly standardised all-cause mortality rates for Scotland compared to England and Wales, by age group, sex and year, for the period 1981–2011. Rates are shown standardised by age and sex, and then by age, sex and Carstairs deprivation decile. Mortality rates decreased over time in both Scotland and England & Wales. However, they did so to a slightly greater degree in England & Wales than in Scotland. After adjustment for age and sex only, the absolute difference in rates decreased (from 18.2 to 15.0), but the relative difference increased (from 11% to 15%). After further adjustment for Carstairs deprivation, the absolute difference fluctuated over time (with the biggest increase between 1981 and 1991); however, the relative difference (the percentage excess) increased in each period from 4% higher in c.1981 to 10% higher in c.2011. The 10% figure for the period around 2011 equates to an average annual excess of almost 5000 deaths in Scotland compared to England and Wales.⁶ The percentage excess for all

¹ Lower super output area (LSOA) is an administrative geography used in England and Wales with an mean population size of approximately 1600 people. It is the geography at which (English) Index of Multiple Deprivation data, and a range of other administrative statistics, are published in England.

² Datazones have an mean population size of 750 people.

³ i.e. Postcode sector/electoral ward, or LSOA/merged datazone.

⁴ 1981–83, 1990–92, 2000–02, 2010–12. 1981–83 was used instead of 1980–82 because English deaths data were not available for 1980. This also replicated the analyses by Hanlon et al. cited above.

⁵ As stated, analyses were also undertaken (but not reported here) based on Carstairs scores for LSOAs (England and Wales) and merged datazones (Scotland) (for 2001 and 2011).

⁶ Note that although the quoted figure for c. 5000 excess deaths was derived from direct standardisation using a European reference population, it was also

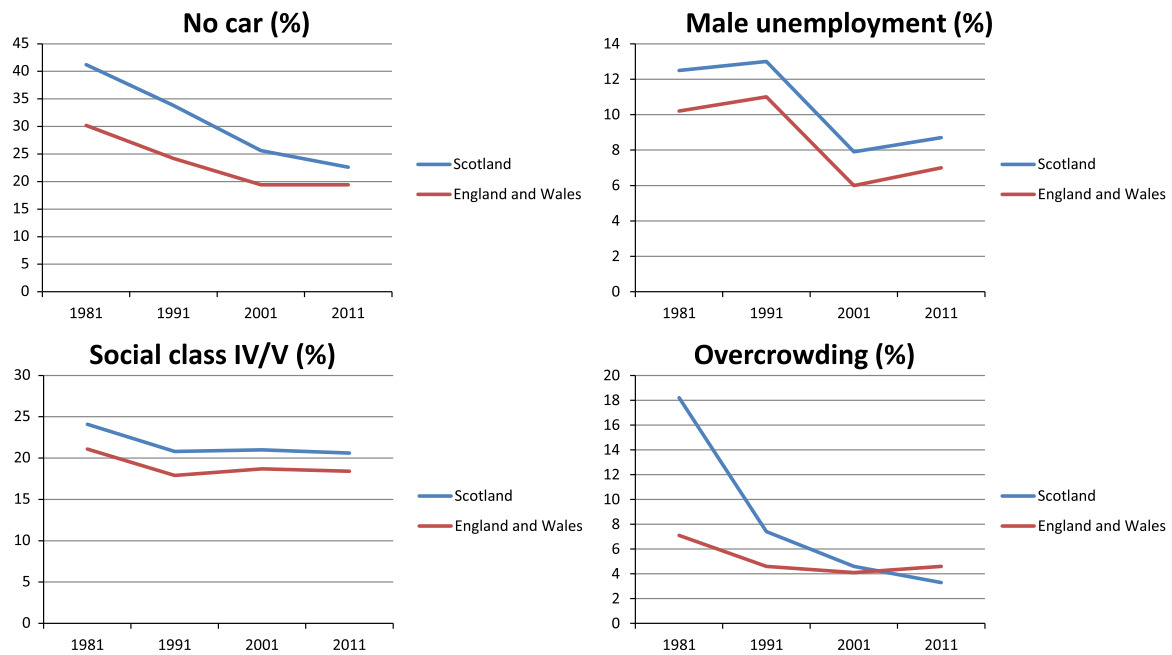


Fig. 1. Comparison of the components of the Carstairs and Morris area deprivation index, showing the percentage of individuals in each category, between Scotland and England, 1981–2011.

ages was similar among males and females.

Web Fig. 2 graphically presents the absolute and relative differences in rates over the period.

Excess premature mortality (0–64 years) for Scotland compared to England and Wales increased by more than three-fold between 1981 and 2011, from 6% to 20%, with a similar excess for both males (21%) and females (19%). For males, the excess doubled between 1991 and 2001; however, among females the greatest increase took place between 2001 and 2011. The excess was greatest among those of younger working age (15–44 years) for both males and females, having increased notably from 10% to 48% (males) and from 3% to 34% (females). However, mortality among children (0–14 years) was consistently lower in Scotland compared to England and Wales over the 30 year period analysed once differences deprivation were accounted for.

The results presented in Table 1 for 2001 and 2011 are broadly similar to those obtained using employment deprivation, although the excess tended to be slightly lower. For example, in 2011 for deaths at all ages, the excess was 8.6% (compared to 9.8% based on Carstairs), and for premature mortality (0–64 years) the figure was 17% (18% for males, 16% for females) compared to 20% (21% and 19% respectively) for calculations based on Carstairs (data not shown).

Fig. 2 presents the percentage excess mortality by deprivation decile, comparing Carstairs deciles for 1981–2011, and additionally comparing Carstairs deciles with employment deprivation deciles for 2001 and 2011. The data are for deaths at all ages (Fig. 2a), and deaths under 65 years (Fig. 2b).

For deaths at all ages, the comparisons by Carstairs deciles over time show that Scottish excess mortality has been observed across all levels of deprivation, but that in the most recent period, the excess has been greatest in the most deprived neighbourhoods (Decile 10). However, the use of employment deprivation shows a different picture for 2011, with the excess much more evenly distributed across neighbourhood types (deciles). For premature

mortality (Fig. 2b) the Carstairs-measured excess has become more associated with more deprived neighbourhoods over time, and for the most recent period (2011) there is a clear deprivation gradient, no matter what measure of deprivation is used – although again the excess in the most deprived decile is much lower when employment deprivation is used.

Web Fig. 3 presents the same results, but also better reflects the differences in the size of the Scottish population resident in each decile.⁷

Table 2 shows the excess mortality for each of the different causes of death analysed. The results are presented for each of the four time periods, and after adjustment for age, sex and Carstairs deprivation decile. The results are also stratified by sex. Note that the results obtained based on adjusting for employment deprivation deciles for 2001 and 2011 were very similar and are thus not shown here.

Significant excesses were observed for all causes examined with the exception of respiratory disease, for which there has been a negative excess in most periods (the positive excess c.1991 has been attributed to an artefact in the recording and interpretation of deaths from respiratory disease in England & Wales in the mid-1980s to early 1990s (Hanlon et al., 2005)). The results show little change in the excess for cardiovascular conditions: the excess for cerebrovascular disease was approximately 24% between 1991 and 2011, and the excess for ischaemic heart disease remained constantly around 13–15% over the 30 year period (1981–2011). The excess for all cancers increased from around 1% in 1981–11% in 2001, with lung cancer also increasing (from 3% to 28%). Even more striking increases are evident for suicide (the excess having risen from being negligible in 1981–74% higher in 2011), other external causes (rising from 32% to 45%) and, in particular, drugs related poisonings: for the latter the excess was negative in 1981, but almost 250% higher by 2011. The excess for alcohol related deaths fluctuated considerably, but remained high in all four time

(footnote continued)

confirmed based on indirect standardisation, comparing the 'expected' and 'observed' figures for Scotland relative to England and Wales.

⁷ In each period each decile contains 10% of the GB population: however, in 1981 only 3% of the Scottish population were resident in the least deprived GB decile, while 26% were resident in the most deprived decile. By 2011 the figures were 6% and 11% respectively.

Table 1.
Directly standardised all cause mortality rates (per 10,000 population), standardised for age, sex and Carstairs deprivation decile, Scotland compared to England and Wales.

A) All Standardisation	All ages				0–64				0–14				15–44				45–64				65+			
	1981	1991	2001	2011	1981	1991	2001	2011	1981	1991	2001	2011	1981	1991	2001	2011	1981	1991	2001	2011	1981	1991	2001	2011
Age and sex																								
England and Wales	161.5	140.9	123.4	100.9	35.7	29.0	23.4	18.6	9.5	6.6	4.7	3.8	9.5	8.9	8.6	6.9	89.1	71.1	55.8	44.2	680.7	603.0	536.3	440.9
Scotland	179.7	158.7	140.0	115.9	44.3	36.1	30.9	24.2	9.8	6.8	4.7	3.4	12.0	10.8	11.7	10.6	111.3	90.0	74.2	56.1	738.8	664.7	590.2	494.9
Difference in rates	18.2	17.8	16.6	15.0	8.6	7.1	7.5	5.6	0.3	0.2	0.0	−0.4	2.5	1.9	3.1	3.7	22.2	18.9	18.4	11.9	58.1	61.7	53.9	53.9
Excess deaths per year	7115	7095	7098	7160	3005	2527	2846	2433	30	24	4	−29	449	397	655	751	2525	2106	2187	1711	4110	4569	4252	4727
Percentage excess (%)	11.3	12.6	13.4	14.9	23.9	24.6	32.2	30.1	3.3	3.0	0.6	−11.3	26.1	20.9	36.6	53.8	24.9	26.5	32.9	27.0	8.5	10.2	10.1	12.2
Age, sex and carstairs deprivation																								
England and Wales	162.8	142.0	125.0	103.3	36.3	29.6	24.2	19.2	9.6	6.5	4.6	3.7	9.8	9.1	8.6	6.9	90.4	72.9	58.3	46.2	685.2	606.3	541.5	450.8
Scotland	169.6	152.3	133.9	113.4	38.5	32.5	27.9	23.0	9.0	6.2	4.3	3.2	10.5	9.7	10.3	9.8	96.4	81.0	67.4	53.9	710.7	646.8	571.7	486.8
Difference in rates	6.8	10.2	8.9	10.1	2.2	2.9	3.7	3.9	−0.6	−0.3	−0.3	−0.5	0.7	0.6	1.6	3.0	6.0	8.1	9.1	7.8	25.5	40.5	30.2	35.9
Excess deaths per year	2989	4415	4387	4975	1059	1255	1736	1809	−88	−29	−25	−39	199	211	483	683	949	1074	1277	1165	1930	3160	2651	3167
Percentage excess (%)	4.1	7.2	7.1	9.8	6.1	9.7	15.3	20.1	−5.8	−4.5	−7.4	−14.1	7.5	6.5	19.0	43.0	6.6	11.1	15.6	16.9	3.7	6.7	5.6	8.0
B) Males																								
Age																								
England and Wales	195.2	167.0	140.4	111.2	45.3	36.2	28.9	22.5	10.8	7.5	5.2	4.2	11.9	11.7	11.3	8.9	113.9	88.8	68.4	53.2	814.2	706.8	600.5	476.9
Scotland	216.8	187.9	160.8	128.5	56.4	45.1	39.4	29.7	11.2	8.0	5.4	3.8	15.5	14.3	16.1	14.2	142.4	111.7	93.3	67.4	879.2	777.4	662.0	536.5
Difference in rates	21.6	20.9	20.4	17.3	11.1	8.9	10.5	7.1	0.4	0.5	0.1	−0.4	3.6	2.6	4.8	5.3	28.5	23.0	24.9	14.2	65.0	70.6	61.6	59.6
Excess deaths per year	3652	3606	3975	3769	1899	1533	1958	1516	21	23	5	−18	329	273	498	532	1549	1238	1454	1002	1753	2073	2018	2253
Percentage excess (%)	11.1	12.5	14.6	15.6	24.6	24.5	36.3	31.5	3.4	6.0	2.1	−9.0	29.9	21.9	42.6	59.7	25.0	25.9	36.4	26.7	8.0	10.0	10.3	12.5
Age and Carstairs Deprivation																								
England and Wales	197.1	168.7	142.7	114.2	46.0	37.1	30.0	23.3	10.9	7.4	5.1	4.1	12.2	12.0	11.4	8.8	115.6	91.1	71.6	55.6	821.1	711.7	607.8	489.7
Scotland	203.6	178.9	152.5	125.7	48.9	40.3	35.2	28.1	10.3	7.2	4.8	3.6	13.5	12.7	14.0	13.0	123.0	100.0	84.0	64.6	842.0	750.9	636.8	528.3
Difference in rates	6.4	10.3	9.9	11.4	2.9	3.2	5.2	4.8	−0.6	−0.2	−0.3	−0.5	1.2	0.7	2.6	4.2	7.4	8.9	12.3	9.0	21.0	39.2	29.0	38.6
Excess deaths per year	1088	1881	2297	2552	640	694	1223	1126	−64	−17	−16	−25	172	135	377	487	532	576	861	665	448	1187	1075	1426
Percentage excess (%)	3.3	6.1	6.9	10.0	6.3	8.7	17.4	20.8	−5.4	−2.3	−6.2	−13.0	10.1	5.9	22.9	48.0	6.4	9.8	17.2	16.1	2.6	5.5	4.8	7.9
C) Females																								
Age																								
England and Wales	127.7	114.8	106.4	90.7	26.2	21.7	17.8	14.6	8.2	5.7	4.2	3.4	7.1	6.2	5.8	4.9	64.3	53.5	43.3	35.2	547.1	499.25	472.1	404.9
Scotland	142.5	129.5	119.1	103.4	32.1	27.1	22.4	18.7	8.5	5.7	4.1	2.9	8.5	7.4	7.3	7.0	80.3	68.3	55.2	44.9	598.4	552.11	518.4	453.2
Difference in rates	14.8	14.7	12.7	12.7	6.0	5.4	4.6	4.1	0.3	−0.1	−0.1	−0.5	1.4	1.2	1.5	2.1	16.0	14.8	11.9	9.6	51.3	52.9	46.2	48.3
Excess deaths per year	3462	3490	3123	3392	1105	993	889	917	9	1	−1	−11	120	124	157	220	977	868	733	708	2357	2496	2234	2475
Percentage excess (%)	11.6	12.8	11.9	14.0	22.8	25.0	25.7	27.9	3.0	−1.1	−1.7	−14.5	19.4	19.4	24.9	43.1	24.9	27.6	27.4	27.3	9.4	10.6	9.8	11.9
Age and Carstairs Deprivation																								
England and Wales	128.5	115.4	107.4	92.4	26.5	22.1	18.4	15.0	8.3	5.6	4.1	3.3	7.3	6.3	5.9	4.9	65.2	54.6	44.9	36.7	549.4	500.8	475.16	412.0
Scotland	135.6	125.6	115.3	101.2	28.1	24.6	20.5	17.9	7.8	5.2	3.8	2.8	7.6	6.7	6.5	6.6	69.8	61.9	50.8	43.3	579.4	542.6	506.55	445.2
Difference in rates	7.1	10.2	7.9	8.8	1.5	2.6	2.2	2.9	−0.5	−0.4	−0.4	−0.5	0.2	0.5	0.7	1.7	4.7	7.3	5.9	6.6	30.0	41.8	31.4	33.3
Excess deaths per year	1902	2534	2089	2423	420	561	513	683	−24	−12	−9	−13	27	76	107	196	417	498	416	500	1482	1973	1577	1741
Percentage excess (%)	5.5	8.8	7.3	9.5	5.8	11.6	11.9	19.0	−6.2	−7.7	−8.5	−15.9	3.1	7.5	11.4	34.3	7.2	13.4	13.1	18.0	5.5	8.4	6.6	8.1



Fig. 2. Scottish excess mortality (expressed as a percentage) by (a) Carstairs deprivation decile (based on English census wards and Scottish postcode sectors), 1981–2011, and (b) Employment deprivation decile (based on English LSOAs and Scottish merged datazones) 2001–2011. Note different scale of x axis between charts in (a) and (b).

periods; in 2011 the excess was 54%, approximately half the equivalent figure for 2001, but comparable to the 1991 level.

Broadly similar patterns were observed for males and females. However, the excess for suicide was notably higher among females compared to males, while the excess for both alcohol and drugs related causes of death was higher among males (but still notably high among females).

Web Table 1 shows each cause's contribution to the overall number of excess deaths. This shows that in 2011, despite the high relative excess figures for alcohol, drugs and suicide, it was the more common, chronic, conditions that contributed most: almost 70% of the excess related to deaths from stroke, heart disease and cancer. Alcohol and drugs related causes accounted for 15% of the total. Seven percent related to suicide. As shown in Box 1, there is an overlap between the definitions of suicide and drugs related poisonings, and thus we cannot show a cumulative total for all three causes mentioned here.

However, when restricting the analysis to premature mortality (0–64 years), a different picture emerges: one third of the excess related to alcohol (17%) and drugs related (16%) causes alone, and the contribution of suicide was considerable – 19% of all the excess premature deaths were from suicide. For this age group, cardiovascular diseases and all cancers accounted for just under one third of the total number of excess deaths (32%).

Fig. 3 presents the excess premature mortality by Scottish local authority area. This is shown both as a standard map, and in a cartogram to better reflect the size of the resident population. The maps highlight two important features of the excess mortality phenomenon: first, that an excess is observed across most parts of Scotland; and second, that it tends to be greatest, and most concentrated, in and around Glasgow and the post-industrial West Central Scotland (WCS) region.⁸ Web Table 2–4 list, for each local authority area, the excess figures for all deaths and deaths occurring under 65 years, and for the different measures of deprivation used in these analyses. These tables confirm the higher excess in

and around Glasgow, but also show notable increases between 2001 and 2011 for other parts of the country (e.g. Aberdeenshire, Dundee).

4. Discussion

These new analyses of deprivation and mortality within Great Britain highlight a number of important issues. First, Scotland became relatively less deprived compared to England and Wales between 1981 and 2011. This narrowing of the deprivation gap has not been matched by a narrowing in the mortality gap, meaning that the Scottish excess (the high level of mortality not explained by differences in deprivation) has increased over the period. By 2010–12 the excess stood at 10%, equating to 5000 extra deaths each year in the three year period analysed. This excess was similar for males and females, and observed across all age groups, but notably highest among those of younger working ages (15–44 years). The excess was seen across all Scotland, but greatest in and around the Glasgow/WCS conurbation; it was also observed in comparison of all neighbourhood types (deprived and non-deprived) – but highest in comparison of the poorest areas, in particular in relation to premature mortality (deaths < 65 years). The increase in the excess has been driven in particular by greater relative contributions from deaths from cancer, suicide, alcohol related causes and drugs-related poisonings. In the most recent period of analysis, almost 70% of the total number of excess deaths at all ages related to cardiovascular disease and cancer; however, for premature mortality (< 65 years), the biggest contributions were from alcohol and drugs related deaths, as well as suicide and other 'external' causes. Although the use of a new measure of deprivation calculated at a smaller neighbourhood size did not impact on the size of the overall excess, it did, however, impact on the size of the excess in the most deprived areas, suggesting it is a potentially more sensitive measure in that regard.

A number of limitations are associated with the analyses. First, they were based on area-based measures of deprivation and many authors argue for the need for both area and individual measures in analyses of this type (Smith et al., 1998; Jackson et al., 2008; Turrell et al., 2007; Bentley et al., 2008). Second, some would argue that the Carstairs index of deprivation is now out of date

⁸ WCS is an approximate, descriptive term, rather than an officially used administrative geography. However, in previous epidemiological analyses (Walsh et al., 2010a), it has been defined by 11 local authority areas: East Ayrshire, East Dunbartonshire, East Renfrewshire, Glasgow City, Inverclyde, North Ayrshire, North Lanarkshire, Renfrewshire, South Ayrshire, South Lanarkshire, and West Dunbartonshire.

Table 2.
Cause specific excess mortality rates for Scotland expressed as a percentage relative to England and Wales based on log-linear regression models, adjusted for age, gender and Carstairs and Morris deprivation decile, 1981–2011.

All	1981		1991		2001		2011	
	Excess (%)	(95% confidence intervals)	Excess (%)	(95% confidence intervals)	Excess (%)	(95% confidence intervals)	Excess (%)	(95% confidence intervals)
Respiratory Disease	–24.0	(–24.9 to –23.0)	12.5	(11.2–13.7)	–16.3	(–17.3 to –15.4)	–0.4	(–1.5 to 0.7)
Cerebrovascular Disease	29.6	(28.2–30.9)	22.6	(21.3–23.9)	24.0	(22.6–25.5)	23.9	(22.5–25.4)
Ischaemic Heart Disease	12.8	(12.0–13.6)	11.9	(11.1–12.7)	11.5	(10.5–12.5)	15.5	(14.4–16.7)
Malignant Neoplasms	0.9	(0.0–1.9)	3.0	(2.1–3.9)	11.3	(10.4–12.3)	10.6	(9.7–11.5)
Lung Cancer	2.8	(1.4–4.1)	13.9	(12.4–15.4)	25.3	(23.6–27.1)	28.3	(26.6–30.0)
Intentional self-harm and events of undetermined intent	1.2	(–1.8 to 4.2)	14.5	(11.4–17.8)	49.3	(45.5–53.3)	73.9	(69.5–78.4)
External causes	32.3	(29.5–35.1)	31.1	(28.3–33.9)	33.8	(31.1–36.6)	45.1	(42.3–48.1)
Alcohol related causes	107.8	(102.5–113.3)	61.2	(57.1–65.4)	99.9	(95.8–104.0)	54.1	(50.7–57.5)
Drugs-related poisonings	–10.4	(–13.5 to –7.1)	11.3	(7.8–14.9)	84.2	(79.5–89.1)	248.4	(239.6–257.4)
Males								
Respiratory Disease	–21.8	(–23.1 to –20.4)	8.4	(6.6–10.2)	–4.8	(–7.2 to –2.4)	–2.5	(–4.0 to –0.9)
Cerebrovascular Disease	28.3	(26.2–30.5)	20.5	(18.5–22.6)	21.6	(19.5–23.8)	22.5	(20.1–25)
Ischaemic Heart Disease	10.9	(9.7–12.0)	10.8	(9.6–12.0)	7.4	(6.1–8.7)	12.5	(11–13.9)
Malignant Neoplasms	–1.2	(–2.5 to 0.0)	2.3	(1.0–3.5)	12.0	(10.4–13.7)	9.3	(8.1–10.6)
Lung Cancer	–0.6	(–2.2 to 1.1)	10.0	(8.2–12.0)	20.4	(18.3–22.6)	21.6	(19.4–23.9)
Intentional self-harm and events of undetermined intent	4.6	(0.6–8.8)	16.2	(12.0–20.5)	51.2	(46.1–56.5)	67.7	(62.0–73.5)
External causes	25.6	(22.0–29.4)	19.6	(16.1–23.2)	30.9	(27.3–34.7)	48.9	(44.9–53.0)
Alcohol related causes	120.4	(112.8–128.2)	64	(58.3–69.8)	111.1	(105.5–116.8)	58.5	(54.0–63.2)
Drugs-related poisonings	–13.1	(–17.3 to –8.6)	11.4	(6.7–16.4)	86.6	(80.4–93.1)	276.4	(263.9–289.4)
Females								
Respiratory Disease	–26.2	(–27.6 to –24.7)	16.4	(14.6–18.2)	–18.1	(–19.3 to –16.9)	0.8	(–0.7 to 2.4)
Cerebrovascular Disease	30.3	(28.6–32.1)	23.8	(22.1–25.5)	25.3	(23.4–27.3)	24.7	(22.6–26.8)
Ischaemic Heart Disease	15.3	(14.1–16.5)	13.2	(12.0–14.4)	16.4	(15.0–17.9)	18.3	(16.9–19.7)
Malignant Neoplasms	3.4	(2.1–4.8)	3.8	(2.6–5.1)	11.0	(9.8–12.2)	12.0	(10.7–13.3)
Lung Cancer	12.4	(9.7–15.1)	21.6	(19.0–24.2)	32.6	(29.8–35.5)	36.3	(33.7–38.9)
Intentional self-harm and events of undetermined intent	–4.6	(–8.9 to –0.2)	10.1	(5.2–15.3)	44.6	(38.4–51.1)	93.4	(85.5–101.6)
External causes	42.0	(37.9–46.2)	52.6	(48.0–57.3)	38.8	(34.6–43.1)	39.1	(35.0–43.3)
Alcohol related causes	90.3	(83.1–97.8)	56.8	(50.9–63.0)	78.6	(72.6–84.7)	45.5	(40.3–50.8)
Drugs-related poisonings	–7.7	(–12.3 to –3)	11.1	(5.8–16.6)	78.6	(71.1–86.4)	202.4	(190.5–214.8)

(McCartney et al., 2012c; Reid, 2008), and the size of the geographical unit at which it is usually measured in Scotland and England & Wales is less than optimal. Even the new geographical unit employed in these analyses is twice the size of unit at which analyses of deprivation are currently undertaken in Scotland: this thereby places the research at more risk from issues such as ecological fallacy (Piantadosi et al., 1988; Diez Roux, 2002).

However, individual measures of poverty or income linked to mortality and covering the whole population of Great Britain are not available: thus the best available measures and methodology were employed. Furthermore, previous analyses have shown similar levels of Scottish excess mortality when based on both area and individual measures (Hanlon et al., 2005; Popham and Boyle, 2011). The analyses were based not only on the Carstairs index but also, for comparison, with a more up to date measure of deprivation that has been shown to be very highly correlated with the best available measurements of multiple deprivation in both Scotland and England. Although the weakness in terms of the size of neighbourhood is acknowledged, at the same time it can be argued that the new geographical spatial units employed in the analyses are in fact a core strength of the work: by basing the analyses on smaller and equivalently sized units, the analyses were undertaken at a much finer spatial level than was previously possible, and the analyses represent the first time that a core component of recent British indices of multiple deprivation have

been employed across Scottish, English and Welsh settings in this way.

It is difficult to compare the scale of the excess (10% for all ages, 20% excess for < 65 years) shown here with that calculated in other studies as the latter have often been based on different time periods, age groups, standard populations and methodologies. Nonetheless, it is broadly comparable with many other analyses. For example Connolly et al. showed a 15% excess mortality around 2001 for Scottish born residents of Northern Ireland aged 15–74 years compared to those born locally 43, while Popham et al. showed a 20% excess for native-born residents of Scotland aged 35–74 compared to those living in (and born in) England & Wales in the period 2001–07 (Popham and Boyle, 2011). The size of the excess is smaller than that observed in comparisons of Scotland's largest city, Glasgow, with other UK post-industrial cities (Walsh et al., 2010b; Graham et al., 2012), but the overall findings – in terms of the increasing size of the excess, its profile in relation to age, sex, neighbourhood type and cause of death, and the observed distinctions between all-age and premature (< 65 years) mortality – are very similar. The size of the excess is also smaller to that shown in comparison of national Scottish and English survey respondents (29% for ages 16+ years) but the latter figure was deemed to be influenced by the English sample being less representative (healthier) compared to the wider population than was the case for the Scottish sample (McCartney et al., 2015).

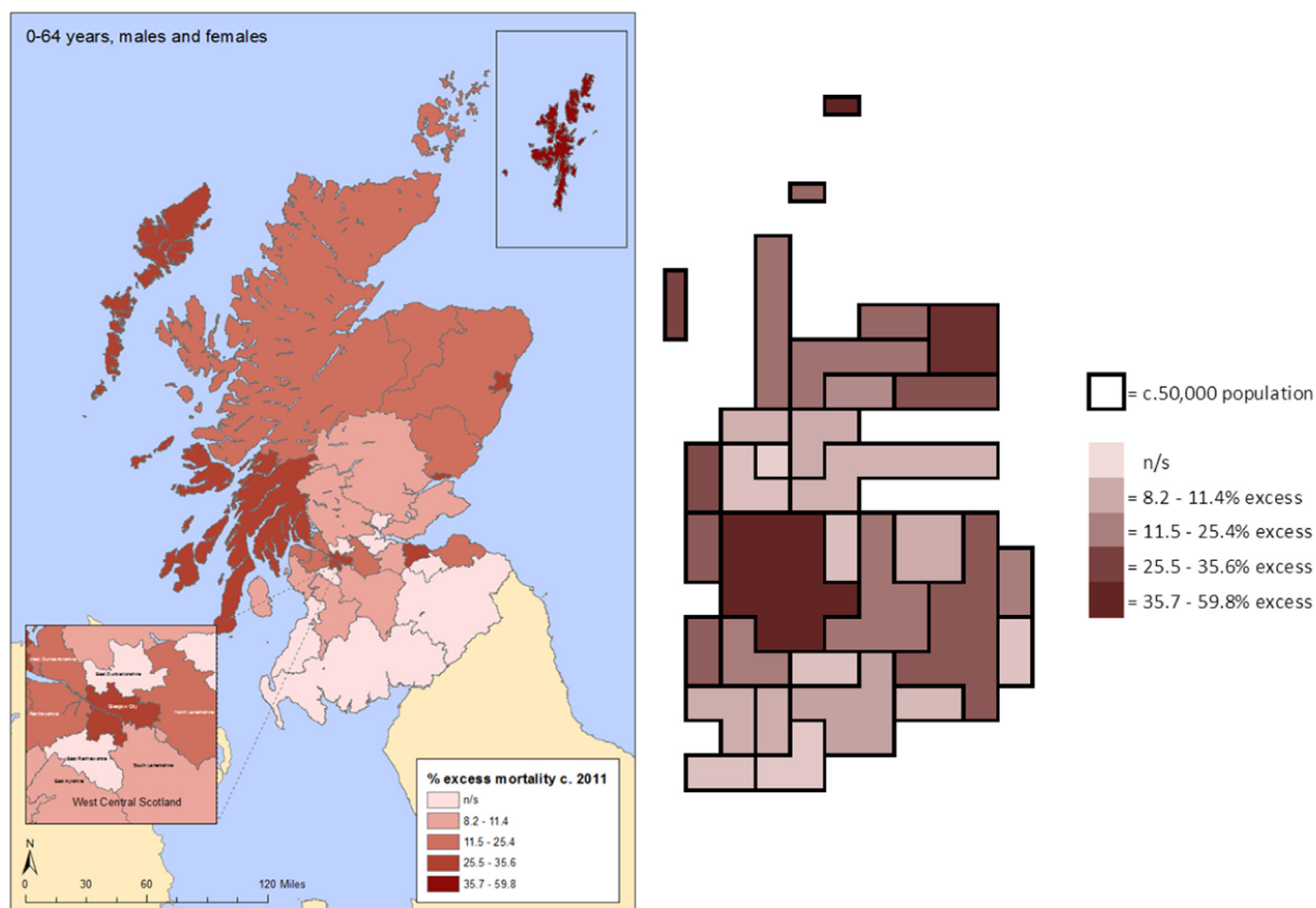


Fig. 3. Scottish excess premature (0–64 years) mortality, expressed as a percentage relative to England & Wales, by Scottish local authority area, after adjustment for age, gender and employment deprivation decile, c. 2011. The left hand map shows the actual size of Scottish local authority areas. The 'cartogram' on the right hand side displays the same data, but with the local authority areas adjusted for the size of the resident population. 'n/s' = Excess mortality rate not found to be statistically significant ($p < 0.05$).

The finding that the excess is observed across all parts of Scotland is of interest. Some studies have shown that mortality differentials *within* Scotland are largely explained by deprivation (Seaman et al., 2015; Gray, 2007), although that is not true of all facets of mortality (Gray, 2007), nor of other health outcomes (Landy et al., 2012). The ubiquitous nature of the excess in comparison with England & Wales suggests that intra-Scotland comparative analyses of this type may represent a slightly different epidemiological issue.

The scale of the excess in Scotland relative to England & Wales is clearly a concern, as is the increasing nature of it. However, the decrease in the size of the alcohol excess (reflecting a considerable fall in alcohol related deaths in Scotland since the mid-2000s (Beeston et al., 2014; Shipton et al., 2013)) perhaps provides some grounds for optimism, as do suggestions that the high rate of drugs deaths may soon decline (National Records of Scotland (NRS), 2015). Suicide rates have also fallen in Scotland in recent years – although not across all age groups – but the complex nature of Scottish excess mortality is highlighted by the fact that despite this, and despite a decline in deprivation over the 30 year period analysed, the excess suicide mortality has increased dramatically. This has been demonstrated by other researchers, for example Mok et al. who showed suicides to be almost 80% higher in Scotland between 2001 and 2006, and attempted to assess the influence of a range of area-based characteristics on these differences. They concluded that almost 60% of the excess could be explained by such measures, in particular rates of prescriptions for

psychotropic drugs (used as a proxy measure of mental ill health). However, the contribution of socio-economic deprivation following adjustment for these other area measures was shown to be 'relatively small' (Mok et al., 2013).

As evidence of this type of excess mortality has also been demonstrated outside Scotland (e.g. in comparison of northern English cities and regions (Whynes, 2008; Phillimore and Morris, 1991; Barker and Osmond, 1987)), explanations for the excess are likely to be relevant to other populations. To date, a great number of potential explanations have been proposed, 17 of which were summarised, and their plausibility assessed, in research published in 2012 (McCartney et al., 2012c). These included topics as diverse as 'social capital', the effects of climate, genetics, and more negative childhood environments. A comprehensive discussion of the merits, or otherwise, of all these hypotheses is beyond the scope of this paper. However, two are particularly worth highlighting here.

First, it has been previously proposed that the excess levels of mortality may, in part, be explained by outward migration (i.e. healthier Scots leaving the country). However, this hypothesis is not supported by the existing evidence base. Scottish migrants elsewhere in the UK have been shown to display a mortality pattern very similar to that of the non-emigrating population and retain their higher mortality rates compared to native residents: this has been shown for migrants to England & Wales (Popham et al., 2010; Popham and Boyle, 2011), and to Northern Ireland (Connolly et al., 2011).

Second, reflecting the discussion above of whether the

Carstairs measure is now out of date, it has been argued that excess mortality may simply be a reflection of the inadequate measurement of poverty and deprivation – and therefore an inadequate understanding of potential differences in life circumstances between Scottish and English populations. This is potentially a very important point. Research has highlighted the complex nature of poverty and deprivation: it encompasses many diverse and overlapping dimensions (Bailey et al., 2003). It is therefore unlikely that any routine administrative indicators (e.g. be they derived from census questions or from social security systems) can fully capture those many different facets. Furthermore, over the 30 year period of analysis presented in this paper, major changes have taken place in UK society including a dramatic widening of socio-economic inequalities. The ‘social exclusion’ and marginalisation of sections of the population have been highlighted in research undertaken over that time, (Shaw et al., 1999; Dorling et al., 2007, 2009b; Gordon et al., 2000; MacInnes et al., 2015; Palmer, 2016): there will therefore have been changes in the experience of relative deprivation over that period that will not have been captured by indicators such as Carstairs. Those decades have also been characterised by the emergence of higher mortality rates in Scotland from more socially-determined causes: alcohol, drugs and suicide i.e. what might be described as the ‘diseases of despair’ associated with people living with, and attempting (or failing) to cope with, extremely difficult circumstances. It can certainly be argued that the complexity of – and changes in – these aspects of relative poverty, and the associated ‘lived experiences’ of those who have suffered it, lie beyond measurement by censuses and routine administrative recording systems.

That said, this is still a complex picture, not least because excess mortality has been observed in Scotland among non-deprived, as well as deprived, populations, and no matter what measure (individual or area based) has been used. Thus, this is not the full explanation and further research (probably involving ethnographic methodologies) would be required to better understand both the unmeasured aspects of deprivation and their potential impact on excess mortality.

The investigations into the underlying causes of the excess are still ongoing. Emergent results point to a complex set of interconnected underlying causes. These do include the inadequate measurement of the true “lived experience” of poverty and deprivation in Scotland discussed above, but also a number of historical processes and events which have rendered sections of the Scottish population more vulnerable to potentially damaging political and economic processes (Walsh et al., forthcoming). Given the scale and increasing nature of the excess that this paper has highlighted, it is of paramount importance that public health achieves a consensus on the causes of, and therefore the most appropriate policy responses to, this phenomenon as quickly as possible.

Declarations

None.

Competing interests

None declared.

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Contributions

DW originally conceived the study. The research questions and analysis plan were agreed by all authors. LS undertook analyses with support from DW, RM-A, DB, RL and MA. Additional mapping analyses were carried out by DW and GM. DW drafted the manuscript. All authors provided substantial critical input to improve the manuscript and all authors approved the final draft.

Ethical approval

Not required.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.healthplace.2016.05.007](https://doi.org/10.1016/j.healthplace.2016.05.007).

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