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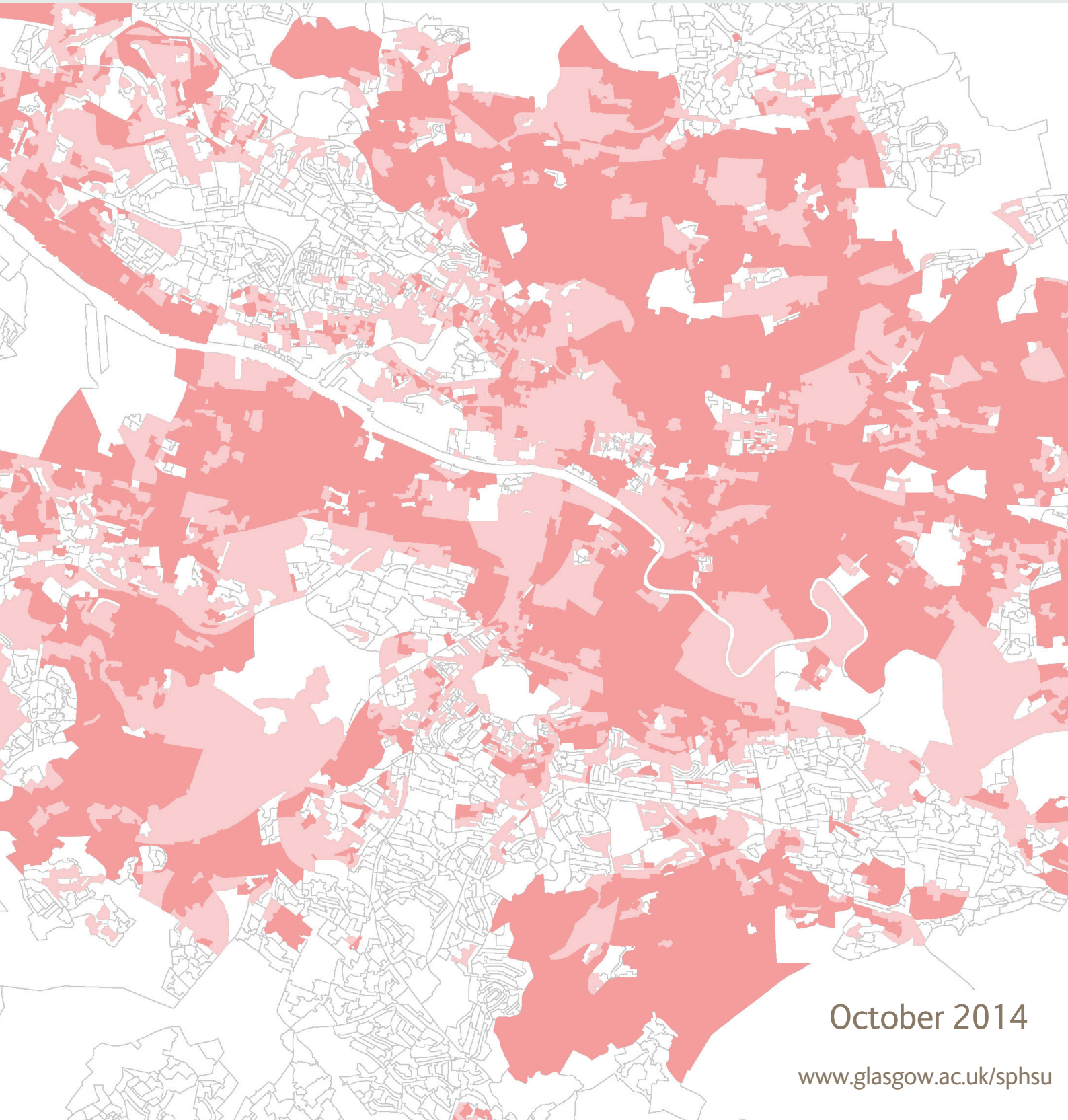
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Carstairs Scores for Scottish Postcode Sectors, Datazones & Output Areas from the 2011 Census

Denise Brown, Mirjam Allik, Ruth Dundas, Alastair H Leyland



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Executive summary

Carstairs scores were originally created for Scottish postcode sectors in 1981 as a measure of material deprivation. The scores were created from four census variables: car ownership, male unemployment, overcrowding and low social class. Since then, scores have been updated decennially. Although there have been changes in some of the census variable definitions over time, the variables used in subsequent years have been kept as similar as possible to those used in 1981.

This report details the creation of the 2011 Carstairs scores. As in previous years, each census variable is standardised to ensure that it has an equal influence on the final score and the final score is just the sum of the standardised values of the four variables. Carstairs scores for postcode sectors range from -7.53 to 13.24 (with high positive values indicating a materially deprived area and high negative values indicating an area with low levels of material deprivation). Population-weighted quintiles are used here instead of deprivation categories (DEPCATs) which were used more commonly in previous Carstairs reports. Population-weighted quintiles for 2011 Carstairs scores are ordered from quintile 1 (most deprived) to quintile 5 (least deprived). This is in line with the ordering of quintiles in the Scottish Index of Multiple Deprivation. The data files associated with this report do, however, include DEPCATS, population-weighted quintiles, population-weighted deciles, and most and least deprived 15% of the population.

The report highlights the high concentration of materially deprived areas within Greater Glasgow & Clyde health board (NHS Greater Glasgow & Clyde was formed in 2006, following a merger of Greater Glasgow with part of NHS Argyll and Clyde). Nearly 44% of the population of Greater Glasgow & Clyde live in the most deprived quintile. At council area level, nearly 64% of the population in Glasgow City and 55% of the population in Dundee City live in the most deprived quintile.

The relationship between Carstairs deprivation scores and all-cause mortality remains strong. As in previous decades, all-cause mortality rates decreased between 2001 and 2011 for those aged 0-64. In the past, the tendency has been for rates to decline across all Carstairs quintiles but with the largest decreases seen in the least deprived quintiles. Between 2001 and 2011, however, rates of decline have been similar across all deprivation quintiles (around 20-22% for all people aged 0-64). Despite this, mortality rates for those aged under 65 were still higher in the most deprived quintile in 2011 (320 per 100,000 population) than in the least deprived quintile in 1981 (284 per 100,000 population).

There is some discussion around the choice of variables used to construct the Carstairs score as the validity of some variables has been questioned in recent years. The prevalence of overcrowding, for example, has decreased to just 3% of the population. The methodological issues around creating the deprivation score are also considered. A measure of uncertainty based on varying the weights attached to each of the four census variables is provided along with a measure of uncertainty due to population size.

For this first time, scores have been created for datazones and output areas in addition to postcode sectors. This allows deprivation, based on Carstairs scores, to be examined at a much smaller geography than in previous years. As areas become geographically smaller, inequalities in all-cause mortality rates between the most and least deprived populations appear greater. This could be due to smaller areas being more homogenous in nature. The creation of scores at datazone level has also allowed for an initial comparison to the Scottish Index of Multiple Deprivation (SIMD) to be carried out. There are some geographical differences in the boundaries of SIMD datazones and the census datazone output (which is provided on a best-fit basis from census output areas). Despite this, findings suggest that there is reasonably good agreement (59%) in terms of the categorisation of SIMD and Carstairs scores into quintiles at datazone level for those areas where the SIMD datazones and best-fit census datazones overlap by at least 95%.

Overall, despite questions about the validity of some of the variables used in the construction of the Carstairs deprivation score, the score remains a good predictor of all-cause mortality in Scotland. The addition of scores at datazone and output area level is an important development and allows users to choose which small area level they wish to analyse their data.

MRC/CSO Social and Public Health Sciences Unit,
University of Glasgow,
200 Renfield Street,
Glasgow,
G2 3QB

Tel: 0141 353 7500

email: sphsu-enquiries@glasgow.ac.uk

*The front page shows a map of output areas in the Glasgow area. Output areas in red lie in the most deprived population-weighted quintile. Output areas in pink lie in the second most deprived population-weighted quintile.

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Introduction

The Carstairs score

Carstairs deprivation scores are used as a measure of material deprivation and aim to reflect access to “those goods and services, resources and amenities and of a physical environment which are customary in society” (Carstairs and Morris, 1991). The scores tend to be constructed at postcode sector level and provide a summary measure of area based deprivation rather than individual level deprivation. Postcode sectors (with an average population of around 5,000 people) were chosen as they were believed to be of sufficient size to provide reasonably reliable rates in respect to most health events.

1981 Census

Carstairs deprivation scores were originally created in 1981 although their creation was based, in part, on an earlier analysis of 1971 census data for Glasgow and Edinburgh. Four variables, each thought to represent or be a determinant of material disadvantage, were selected for inclusion in the calculation of the 1981 scores. These were overcrowding, male unemployment, low social class and no car ownership.

1991 Census

Similar variables, to those used in 1981, were used in the construction of 1991 Carstairs scores (McLoone, 1994). There were changes, however, to the way overcrowding was defined in the census after 1981. Kitchens of at least two meters wide were now included within the census room count and so overcrowding decreased substantially between 1981 and 1991. Despite this, there was a high correlation between Carstairs scores in 1981 and 1991 (correlation coefficient $r=0.958$) with most areas having little change in their scores over the 10-year period.

2001 Census

As near as possible, the census variables used in 1981 and 1991 were used to construct 2001 Carstairs scores (McLoone, 2004). Variables that were not available in standard 2001 census output were commissioned from National Records of Scotland (NRS), formerly the General Register Office for Scotland (GROS). The main change to variables between 1991 and 2001 was the move from Social Class based on Occupation (formerly Registrar General’s Social

Class) to the National Statistics Socio-economic Classification (NS-SeC), which was coded using the Standard Occupational Classification (SOC). NS-SeC moved away from the concept of the manual/non-manual divide that characterised the old Social Class scheme with the aim of reflecting employment relations and conditions. To overcome changes in classifications, the Office for National Statistics (ONS) recommended aggregating operational categories of the SOC2000 version of NS-SeC to produce approximated Social Class based on Occupation. These approximations achieved a high (87%) continuity rate.¹ The concept of a household reference person was also introduced in 2001, replacing the traditional concept of a head of household.

Creating the score from the 2011 Census

Variables used in constructing the score

As in previous years, Carstairs scores for 2011 have been calculated from a combination of four variables derived from the 2011 census. The four variables used here are as similar as possible to those used in the 1981 census by Carstairs and Morris, and in following censuses, and are defined in Table 1. Variables which were not available in standard census output were commissioned from NRS. See Appendix A for the list of census variables used to create 2011 Carstairs scores. The NS-SeC Operational Categories used to create the low social class variable used in construction of the 2001 and 2011 Carstairs scores are shown in Table 2.

Population-weighted summary

Population-weighted mean percentages and standard deviations (SD) are calculated for each component variable. The weights, used to take into account differences in population size, are based on the total number of people in each postcode sector, that is, the total number of people in a postcode sector is divided by the total population of Scotland. This ensures consistency with scores weighted previously. Alternative weights can be used (e.g. household population-weights or weights based on the number of people economically active), however making these changes to the weights has only a small effect on the overall weighted means and SDs obtained.

The number of postcode sectors, or part-postcode sectors ², at each census in 1981, 1991, 2001 and 2011 were 1,011, 1,001, 1,010 and 1,012 respectively. The percentage of people living in households with no access to a car or van has consistently decreased over time,

¹<http://www.ons.gov.uk/ons/guide-method/classifications/current-standard-classifications/soc2010/soc2010-volume-3-ns-sec-rebased-on-soc2010-user-manual/index.html>

²See Appendix B for more details about part-postcode sectors.

Table 1: Census variables used to create Carstairs scores

Variable	Description
No car ownership	Persons living in private households with no car, as a proportion of all people in private households
Male unemployment	Economically active males seeking or waiting to start work, as a proportion of all economically active males
Overcrowding	Persons living in private households at a density of more than one person per room, as a proportion of all people in private households
Low social class	Persons living in private households with the household reference person in social class IV or V, as a proportion of all people in private households with an economically active household reference person

from 41.2% in 1981 to 22.7% in 2011 (Table 3). The percentage of overcrowding has also decreased, to just 3.3% of the population in 2011. Both male unemployment and low social class have increased slightly since 2001. While male unemployment also saw an increase between 1981 and 1991, this is the first time that the percentage of those in low social class households has increased over the four-decade period, although it is still lower than it was in 1981 and 1991. Variation has decreased since 2001 for each variable, with the exception of low social class which saw a slight increase between 2001 and 2011.

Note that the wording of the question relating to economic activity (used in creating the male unemployment variable) changed a little between the 2001 census and 2011 census in order to improve clarity, and this may have caused slight differences in the responses given. There were also some changes to how NS-SeC (used in creating the low social class variable) was coded between 2001 and 2011.³

The relationship between the four variables is shown in Figure 1. Postcode sectors with less than 1,000 residents have been excluded from the plots to reduce the effect of outlying values and so plots are based on 850 postcode sectors.⁴ The correlation coefficients for the 850 postcode sectors range from 0.62 to 0.84 so for each pair of variables there is evidence of a positive association (the correlation coefficients for the relationship between the variables for

³In 2001 NS-SeC was coded using SOC2000, while in 2011 it was coded using SOC2010. Also, anyone without occupation details was put into the 'not classified' category (19% of the total population) in 2001. In 2011, however, rules were used to estimate a NS-SeC category. These changes mean that caution should be taken when making comparisons between the two censuses.

⁴Figures 1 and 4 are based on the 850 postcode sectors with populations less than 1,000 excluded. Unless otherwise specified, all other Figures and Tables are based on all 1,012 2011 postcode sectors.

Table 2: NS-SeC operational categories used to construct a measure of low social class (*Source: ONS*)

National Statistics Socio-economic Classification Operational Categories		Approximate Social Class
L11.2	Lower technical process operative	IV - Semi-skilled
L12.2	Semi-routine service	IV - Semi-skilled
L12.4	Semi-routine operative	IV - Semi-skilled
L12.5	Semi-routine agricultural	IV - Semi-skilled
L12.7	Semi-routine childcare	IV - Semi-skilled
L13.1	Routine sales and service	IV - Semi-skilled
L13.2	Routine production	IV - Semi-skilled
L13.4	Routine operative	V - Unskilled
L13.5	Routine agricultural	IV - Semi-skilled

all postcode sectors ranges from 0.54 to 0.80). The relationships are not necessarily linear, however, and there are several postcode sectors with particularly high levels of overcrowding.

Table 3: Population-weighted mean percentages and standard deviations (SD) for each component variable used to create the Carstairs scores

	1981		1991		2001		2011	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
No car ownership	41.2	18.5	33.8	17.8	25.6	14.9	22.7	13.9
Male unemployment	12.5	7.3	13.0	8.4	7.9	4.6	8.5	4.2
Overcrowding	25.3	11.4	7.4	4.4	4.6	2.6	3.3	1.9
Low social class	24.1	10.4	20.8	8.6	18.2	7.8	18.8	7.9
Carstairs score	0.0	3.6	0.0	3.5	0.0	3.6	0.0	3.5

Standardisation and z-scores

The deprivation scores are an unweighted combination of the four census variables. To ensure that all components have an equal influence on the final score, each variable was standardised to have a population-weighted mean of zero and a variance of one (Carstairs and Morris, 1991). Standardising involves subtracting the population mean from each variable and dividing the result by the SD (z-score method).

The Carstairs score for each postcode sector is the sum of the standardised values of the components. An example of how the score is derived for a single postcode sector, G12 8, is given in Table 4. Shown is the observed value of each variable, the overall population-weighted mean and SD, and the calculation of the standardised values. The score for G12 8 is the sum of the standardised values: $1.89 + (-0.46) + 0.19 + (-1.12) = 0.50$.

The percentage of the population in G12 8 with no access to a car or van is more than twice that of the Scottish population-weighted mean. There is a slightly higher prevalence of overcrowding, a lower prevalence of male unemployment and the percentage of people living in households with the household reference person in social class IV or V is around half that of the Scottish mean. Scores may be negative or positive, with a negative score indicating an area with low levels of deprivation and a high positive score indicating very deprived areas. The average score in Scotland in 2011 was -0.60 . A score of 0.50 would suggest that G12 8 is slightly more deprived than the Scottish average. Scores were calculated for each of the 1,012 postcode sectors in Scotland in 2011 (see Appendix B).

Table 4: Observed percentages and z-scores for postcode sector G12 8

	Observed percentage	Mean	SD	Standardisation (z-score)
No car ownership	49.00	22.71	13.88	$(49.00 - 22.71)/13.88 = 1.89$
Male unemployment	6.55	8.50	4.24	$(6.55 - 8.50)/4.24 = -0.46$
Overcrowding	3.61	3.26	1.86	$(3.61 - 3.26)/1.86 = 0.19$
Low social class	9.94	18.77	7.90	$(9.94 - 18.77)/7.90 = -1.12$

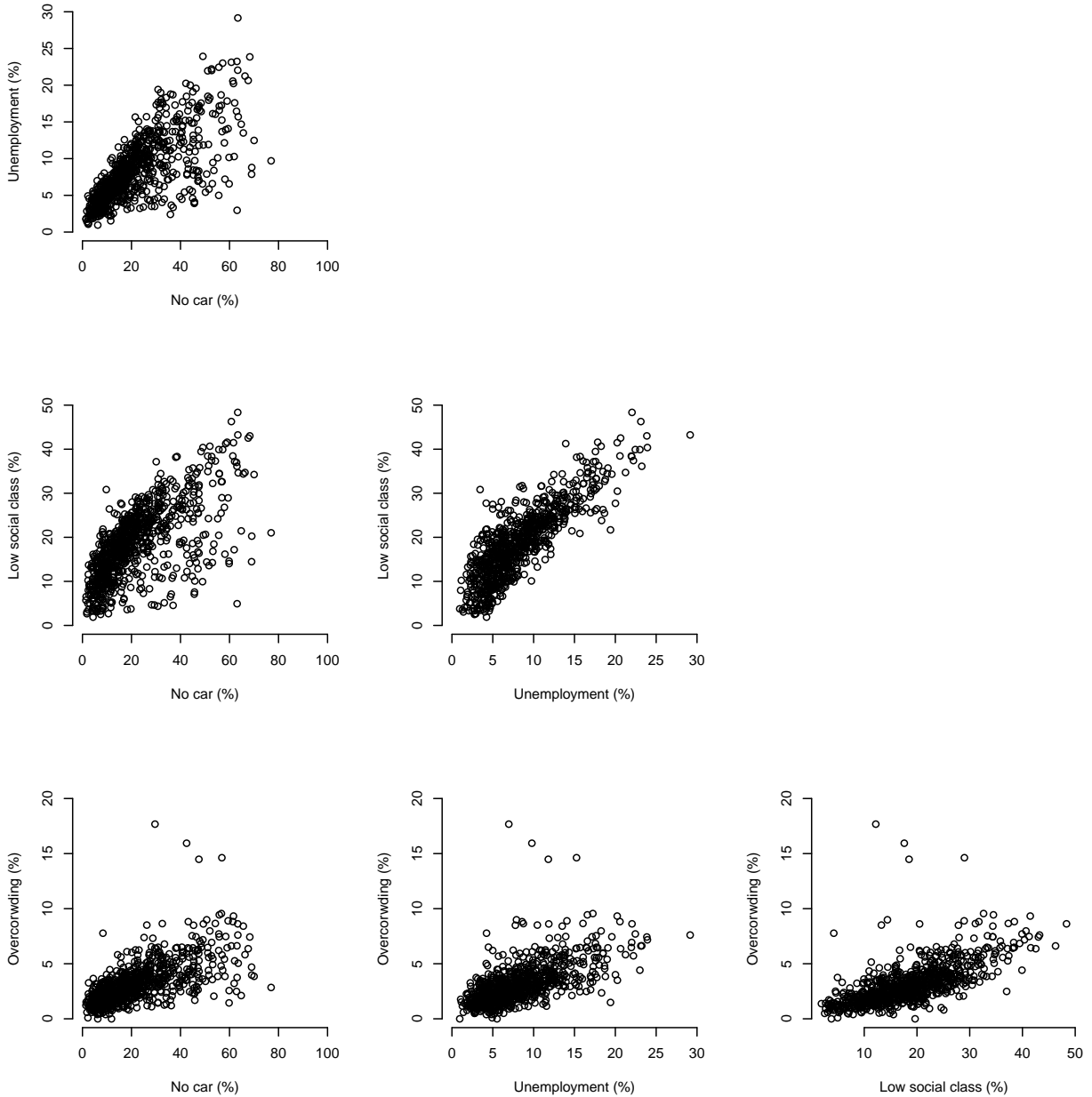


Figure 1: The four Carstairs component variables plotted against each other. Each point represents a postcode sector. Postcode sectors with less than 1,000 residents have been excluded (n=850 postcode sectors included)

The distribution of Carstairs deprivation scores

The distribution of 2011 Carstairs scores for Scottish postcode sectors is shown in Table A3 in Appendix C. Scores ranged from -7.53 to 13.24 with the middle 50% of scores lying between -3.28 and 1.45. The long tail of high positive scores indicates that the distribution is skewed towards more highly deprived areas.

Table 5 shows the distribution of Scottish NHS Board populations in 2011 by population-weighted quintile, where quintile 1 is the most deprived quintile and quintile 5 the least deprived.⁵ NHS Boards listed first are those which have the highest proportion of deprived populations. In NHS Greater Glasgow & Clyde almost 44% of the population are in the most deprived quintile. NHS Greater Glasgow & Clyde was formed in 2006, following a merger of NHS Greater Glasgow and part of NHS Argyll & Clyde (the other part merged with NHS Highland). The two NHS Boards with the next highest percentage of their population in the most deprived quintile are Tayside and Ayrshire & Arran (26.3% and 22.4% respectively). Three NHS Boards (Borders, Shetland, and Orkney) have no population in the most deprived quintile.

Table 6 shows the distribution of Scottish council area populations in 2011 by population-weighted quintiles. Again, council areas that are listed first are those with the highest proportion of deprived populations. Both Glasgow City and Dundee City have more than half their population in the most deprived quintile, followed by Inverclyde, West Dunbartonshire and North Ayrshire which each have at least a third of their population in the most deprived quintile. Aberdeenshire, East Dunbartonshire and Shetland Islands all have more than half of their populations in the least deprived quintile.

Carstairs scores have historically been divided into seven deprivation categories (DEPCATs) with DEPCAT 1 being the least deprived category and DEPCAT 7 the most deprived category. DEPCATs were designed in 1981 to maintain the discriminatory features of the distribution of scores. Rather than having an equal population within each category, DEPCATs were structured in such a way that most of the population of Scotland were allocated to the middle deprivation categories and between just 6-7% to the two extremes of the distribution. Since then, DEPCATs for Carstairs scores have been obtained by dividing the distributions into a similar number of DEPCATs, each containing the same proportion of the population as in 1981. Although not used here, Carstairs DEPCATS have been provided for each postcode sector (see Appendix B).

⁵This is in line with the current ordering of quintiles in the Scottish Index of Multiple Deprivation (SIMD 2009, SIMD 2012 and future releases).

Table 5: The distribution of 2011 Scottish NHS Board populations by 2011 Carstairs quintile of deprivation. The % shown is the percentage of the total NHS Board (or whole of Scotland) population within each population-weighted quintile

NHS Board	Carstairs quintile of deprivation									
	Most deprived						Least deprived			
	1		2		3		4		5	
	n	%	n	%	n	%	n	%	n	%
Greater Glasgow & Clyde	497,455	43.8	190,483	16.8	134,176	11.8	154,845	13.6	158,999	14.0
Tayside	107,687	26.3	43,148	10.5	40,836	10.0	110,284	26.9	107,943	26.3
Ayrshire & Arran	83,562	22.4	119,567	32.0	55,825	14.9	77,908	20.8	36,850	9.9
Lanarkshire	108,327	16.6	201,008	30.9	200,232	30.7	89,726	13.8	52,264	8.0
Lothian	133,091	15.9	161,789	19.4	215,919	25.9	152,323	18.2	171,526	20.6
Dumfries & Galloway	16,509	10.9	17,079	11.3	36,260	24.0	60,985	40.3	20,491	13.5
Forth Valley	28,049	9.4	72,136	24.2	73,820	24.8	40,571	13.6	83,103	27.9
Fife	33,941	9.3	109,275	29.9	114,287	31.3	57,090	15.6	50,605	13.9
Grampian	46,836	8.2	77,054	13.5	78,683	13.8	101,524	17.8	264,964	46.6
Western Isles	291	1.1	2,594	9.4	7,226	26.1	15,653	56.5	1,920	6.9
Highland	1,080	0.3	52,988	16.5	75,276	23.5	122,524	38.3	68,430	21.4
Borders	-	-	11,789	10.4	17,456	15.3	62,241	54.7	22,384	19.7
Shetland	-	-	-	-	8,436	36.4	432	1.9	14,299	61.7
Orkney	-	-	-	-	-	-	12,162	57.0	9,187	43.0
Scotland	1,056,828	20.0	1,058,910	20.0	1,058,432	20.0	1,058,268	20.0	1,062,965	20.0

Table 6: The distribution of 2011 Scottish council area populations by 2011 Carstairs quintile of deprivation. Shown is the percentage of the total council area population within each population-weighted quintile

Council Area	Carstairs quintile of deprivation				
	Most deprived			Least deprived	
	1	2	3	4	5
Glasgow City	63.6	14.9	13.0	6.3	2.2
Dundee City	55.4	13.6	10.8	5.8	14.3
Inverclyde	40.5	27.1	8.7	14.2	9.6
West Dunbartonshire	36.8	31.3	21.4	10.5	-
North Ayrshire	35.0	32.3	11.1	18.8	2.8
North Lanarkshire	27.3	46.7	14.0	7.9	4.1
Renfrewshire	25.3	24.7	6.3	26.1	17.6
Edinburgh City	23.5	16.4	19.6	16.5	24.0
South Ayrshire	16.9	7.2	26.8	27.6	21.4
Aberdeen City	16.8	24.0	11.5	8.6	39.1
Perth & Kinross	13.8	3.0	6.3	33.7	43.3
East Ayrshire	13.1	54.4	8.3	17.0	7.1
Clackmannanshire	12.5	24.4	50.8	-	12.3
Dumfries & Galloway	10.9	11.3	24.0	40.3	13.5
Stirling	9.4	19.7	7.4	21.9	41.6
Fife	9.3	29.9	31.3	15.6	13.9
East Dunbartonshire	8.6	-	4.5	34.2	52.6
Falkirk	8.4	26.8	26.3	13.4	25.2
West Lothian	8.2	22.9	38.0	14.3	16.6
Midlothian	7.8	24.1	40.9	15.6	11.6
South Lanarkshire	5.1	13.8	48.8	20.0	12.2
Angus	5.0	16.1	13.5	45.1	20.1
Aberdeenshire	3.7	6.5	6.7	19.1	64.1
Eilean Siar	1.1	9.4	26.1	56.5	6.9
East Renfrewshire	0.5	9.6	16.3	16.3	57.3
Highland	0.4	17.4	18.0	41.5	22.7
Argyll & Bute	0.1	14.3	38.1	29.6	17.9
East Lothian	-	23.8	21.8	35.8	18.7
Scottish Borders	-	10.4	15.3	54.7	19.7
Moray	-	7.8	38.6	36.7	16.8
Shetland Islands	-	-	36.4	1.9	61.7
Orkney Islands	-	-	-	57.0	43.0
Scotland	20.0	20.0	20.0	20.0	20.0

Comparison of 2011 scores with previous years

The comparison of Carstairs scores over time can provide important insights into changes in material deprivation in Scotland. A couple of important points should be kept in mind before proceeding with the comparison. First, the Carstairs score is a relative, not an absolute measure of deprivation. In other words, if a postcode sector receives a score of zero in both 2001 and 2011 the area is average in relation to others, but the absolute level of deprivation may have changed over time. For this reason comparing the average Carstairs scores over time makes little sense. Another option, and one that is considered here, is to compare the spread of the distribution over time, particularly at the extremes, to see if the differences between the most and least deprived areas in Scotland have increased or decreased.

Secondly, postcodes change and so do postcode sectors, meaning that the areas for which the scores are provided do not stay constant. This makes comparisons across time methodologically unsound as any change in the deprivation score could result from changes in the postcode sector's geography and not in actual socioeconomic conditions of the people in those places. A valid over time analysis is only possible for those postcode sectors that have experienced little change across censuses. Using census boundary files for 1991, 2001 and 2011 ⁶, 431 postcode sectors that have remained largely unchanged have been identified. The analysis of these postcode sectors will be the second focal point here.

Table 7: Percentage of individuals in areas as defined by the areas' Carstairs deprivation score, 1981-2011

	Low levels of deprivation			High levels of deprivation			
	(-10, -6]	(-6, -2]	(-2, 2]	(2, 6]	(6, 10]	(10, 14]	(14, 18]
1981	2.5	28.2	44.1	18.5	5.5	1.3	0.0
1991	1.2	29.5	45.0	17.3	5.4	1.5	0.0
2001	0.4	31.5	43.7	18.1	4.6	1.5	0.1
2011	0.4	31.1	43.8	18.6	5.1	1.0	0.0

Figure 2 shows the distribution of Carstairs scores for the first (most deprived) and fifth (least deprived) quintiles over four decades. Between 1981 and 2001 the distribution shifted slightly towards more extreme deprivation. In the most deprived quintile the range and interquartile range increased, meaning that there were more areas that were very deprived compared to the Scottish average. On the other hand, the range and interquartile range of the least deprived quintile decreased meaning that fewer areas were less deprived compared to the average. Between 2001 and 2011 there has been less change in the overall distribution, but there is some evidence of decreasing numbers of extremely deprived postcode sectors.

⁶Boundary files for 1981 census were not available.

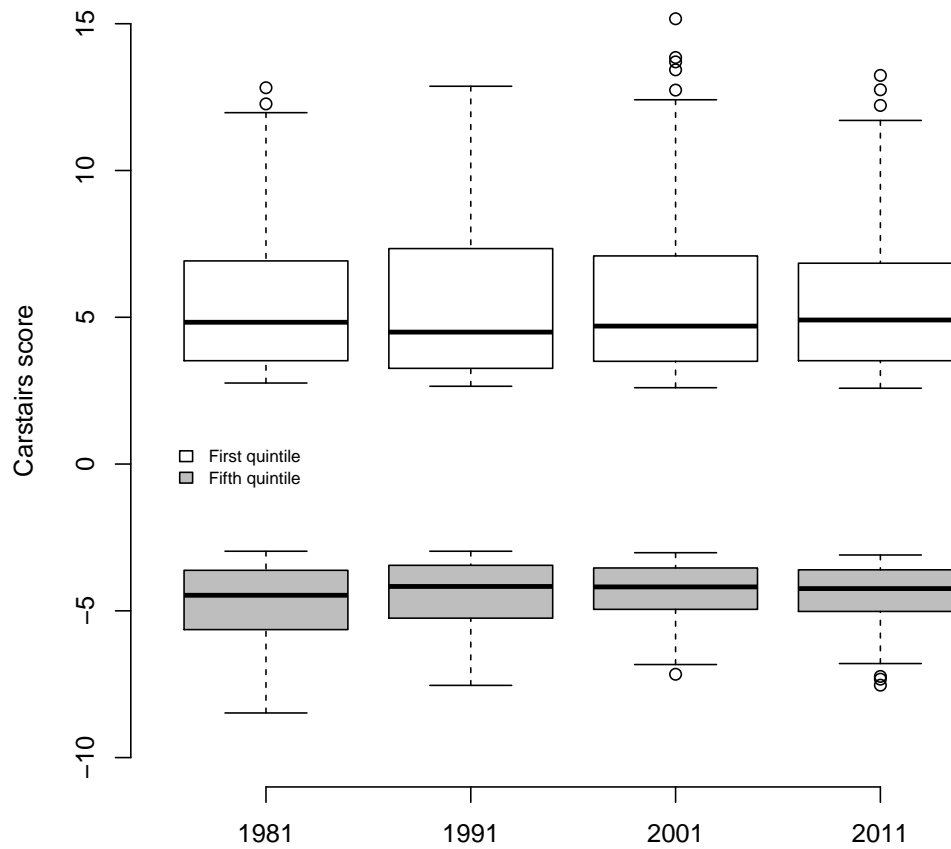


Figure 2: Distribution of Carstairs scores among the first (most deprived) and fifth (least deprived) quintiles of deprivation, 1981-2011

Table 7 shows the distribution of individuals living in areas with various levels of deprivation. In 1981, 2.5% of people lived in the least deprived areas (Carstairs score range -10 to -6). By the next decade this percentage had decreased to 1.2 and by 2001 to 0.4, where it has stayed since. At the other end of the scale (Carstairs score ranges 10 to 14 and 14 to 18) there was a slight increase between 1981 and 2001 in the percentage of people who lived in very deprived areas. In 2011, the trend reversed and fewer people now live in areas with a Carstairs score above 10.

The above comparison of scores over time shows that by 2011 areas have become slightly less extreme in terms of deprivation. Fewer people live in what could be considered very deprived or much less deprived areas compared to the Scottish average. Changes in deprivation over the four decades are only noticeable at the extremes of the distribution and the

percentage of people living in average areas (Carstairs score range -2 to 2) is roughly 44% across all four time periods. Finally, from these results it is not possible to say that there is more or less deprivation now than 30 years ago, but rather it appears that the areas people live in today are somewhat more diverse in terms of economic conditions.

Carstairs scores of individual postcode sectors from 1991 to 2011 were also analysed. Only those postcode sectors that remained roughly similar across the three censuses were included. A postcode sector was classified as similar across time if the union (i.e. the overlapping area across the three time points 1991, 2001 and 2011) was more than 90% of the postcode sector area at each of the three time points. Using census boundary files, 431 postcode sectors (approximately 43%) were identified that met this criteria. While the number of similar postcode sectors is sufficiently large for quantitative analysis, it should be kept in mind that the majority of postcode sectors can not be reliably compared across time.⁷

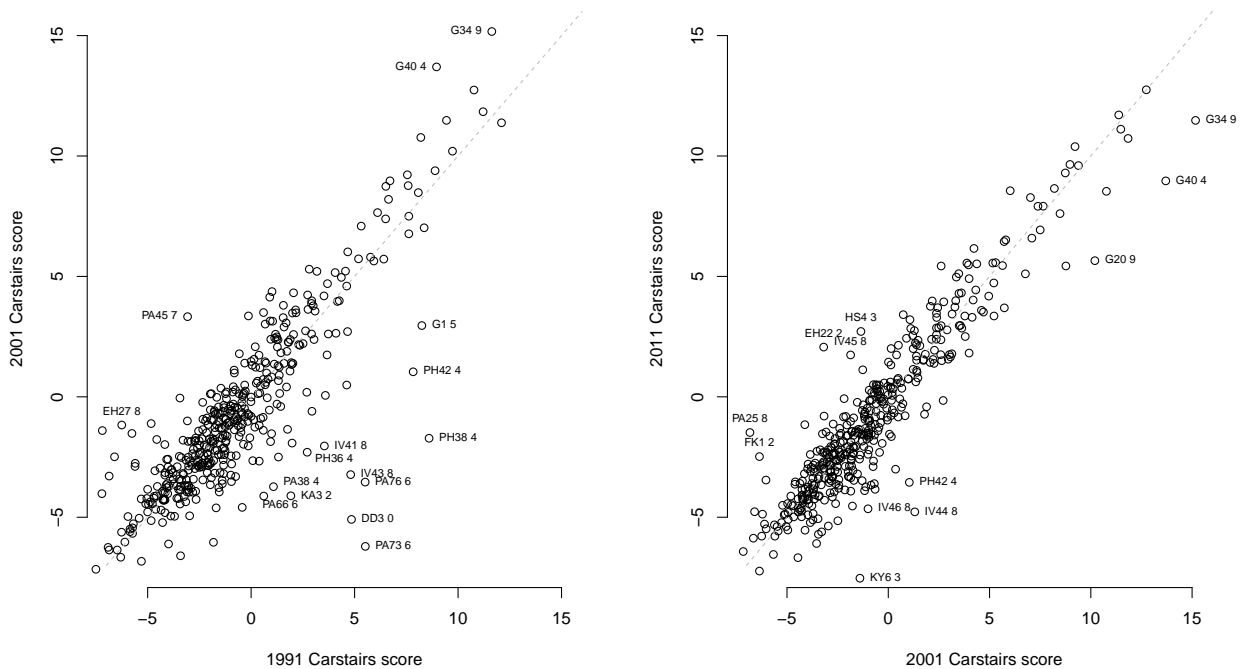


Figure 3: Carstairs scores for the 431 largely unchanged postcode sectors, 1991-2011

Figure 3 compares 1991 Carstairs scores to 2001 scores (left plot), and 2001 Carstairs scores to 2011 scores (right plot). Table 8 also shows the quintile comparisons for the same years. All changes should again be interpreted in relative terms, with respect to the Scottish average. Both Figure 3 and Table 8 show that most areas have roughly the same Carstairs score and deprivation quintile across the three time points. The correlation

⁷A brief technical note on the ‘comparison of postcode sectors over time’ will be made available online alongside this report.

coefficient between 1991 and 2001 scores is 0.85, between 2001 and 2011 scores is 0.93, and between 1991 and 2011 scores is 0.82. Comparing 1991 and 2001 Carstairs scores, Table 8 shows that the majority of postcode sectors fall either into the same or to a similar quintile (65% of postcode sectors fall on the diagonal and 28% are only one quintile apart). For 2001 and 2011 scores, both percentages are higher (67% and 29% respectively). Thus, most areas have remained at roughly the same level of deprivation with respect to the Scottish average.

Table 8: Comparison of Carstairs quintiles, 1991-2011

Carstairs quintile		2001					2011						
		1	2	3	4	5	1	2	3	4	5		
Most deprived	1	48	4	3	3	4	56	8	1	0	0		
	2	15	37	9	7	3	11	33	8	1	2		
	3	1991	1	13	49	20	4	2001	0	10	50	21	6
	4	0	1	22	62	19	1	2	12	66	30		
Least deprived	5	1	0	4	19	83	0	1	2	25	85		

A small percentage of postcode sectors have experienced visible shifts in deprivation (e.g. PA73 6, PH38 4 and KY6 3) between 1991 and 2001 and between 2001 and 2011. These tend to be fairly small areas, with a population of around 100-300 in most cases. For small areas, the uncertainty around the Carstairs score is often quite large and even sizable increases or decreases in the score might be within uncertainty bounds (see the subsection “Robustness and uncertainty”). Some variation in scores may be observed over time, but this could be caused by the uncertainty in the measure, rather than actual change in levels of material deprivation. A closer analysis of these postcode sectors (e.g. looking at the changes in each of the four Carstairs components) should be conducted before determining whether significant increases or decreases in deprivation have occurred.

Relationship with all-cause mortality

There has always been a strong association between deprivation and mortality in Scotland (see e.g. Carstairs and Morris, 1989). Figure 4 shows the relationship between all-cause mortality (2010-2012) and 2011 Carstairs scores for those aged under 65. Standardised rates in postcode sectors with less than 1,000 residents were not plotted, since mortality rates are often unstable in small populations. There is evidence of a positive linear association, with mortality rates increasing as the deprivation score increases. Some postcode sectors with relatively high mortality rates have been identified. These are all areas with a higher than average percentage of communal establishment residents and all had high mortality rates at the time of the census in 2001, that is mortality rates in these postcode sectors were all within the top ten highest mortality rates for all postcode sectors in Scotland in the three-year period 2000-2002. The only exception is ML7 5 (part) postcode sector (in West Lothian). This part-postcode sector has no communal establishment residents and had average mortality around the time of the last census.

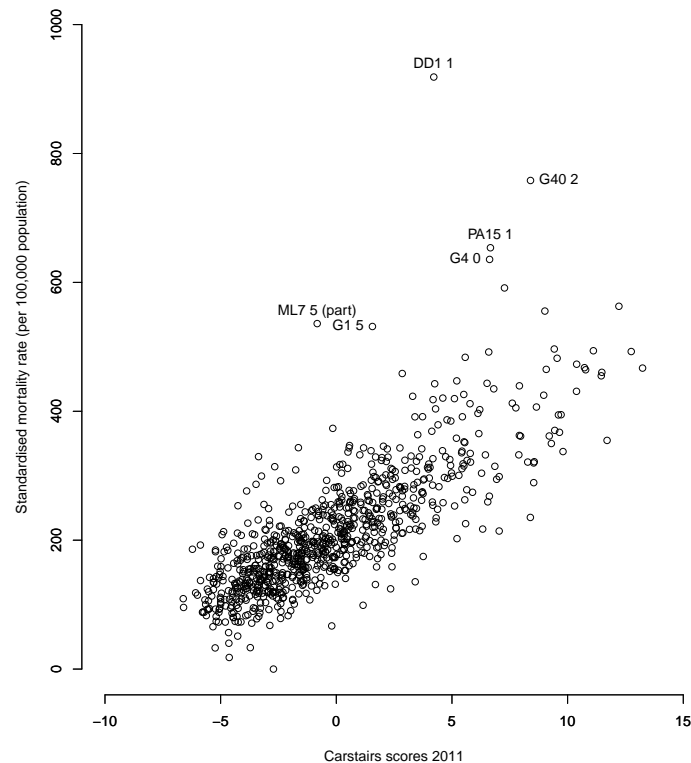


Figure 4: Postcode sector age- and sex-standardised all-cause mortality rates (per 100,000 population) for all people aged 0-64 (years 2010-2012) by 2011 Carstairs scores. Postcode sectors with less than 1,000 residents have been excluded (n=850 postcode sectors included)

The correlation coefficient is 0.79 for the 850 postcode sectors plotted. This is a slight decrease on the 2001 correlation coefficient of 0.81 (based on 840 postcode sectors with populations of at least 1,000 in 2001).

Table 9 shows age-standardised all-cause mortality rates for males and females, and age- and sex-standardised all-cause mortality rates for all people aged 0-64 grouped within Carstairs population-weighted quintiles. Rates are shown for 1980-82, 1991-92⁸, 2000-02 and 2010-12. All-cause mortality rates for all people, aged under 65, decreased by 21% between 1981 and 1991, by 13% between 1991 and 2001 and by 22% between 2001 and 2011. Much of the reduction in rates between 2001 and 2011 has been driven by lower mortality in males with the reduction in the most deprived quintile being particularly high (26%), following a slight increase between 1991 and 2001.

Table 9: Age-standardised all-cause mortality rates (per 100,000 population) for males, females and all people aged 0-64 within population-weighted quintiles

		Death rate per 100,000 population				% change			
		1980-82	1991-92	2000-02	2010-12	81 to 91	91 to 01	01 to 11	81 to 11
<i>Males</i>									
Most deprived	1	642	538	550	407	-16	2	-26	-37
	2	533	434	387	298	-19	-11	-23	-44
	3	476	365	318	241	-23	-13	-24	-49
	4	439	329	270	202	-25	-18	-25	-54
Least deprived	5	364	260	195	152	-29	-25	-22	-58
All Scotland		491	384	340	256	-22	-11	-25	-48
<i>Females</i>									
Most deprived	1	367	316	281	235	-14	-11	-16	-36
	2	310	250	214	181	-19	-14	-15	-42
	3	274	218	189	156	-20	-13	-17	-43
	4	260	187	157	133	-28	-16	-15	-49
Least deprived	5	213	172	131	107	-19	-24	-18	-50
All Scotland		285	229	193	160	-20	-16	-17	-44
<i>All</i>									
Most deprived	1	498	423	411	320	-15	-3	-22	-36
	2	416	338	298	238	-19	-12	-20	-43
	3	371	289	252	198	-22	-14	-21	-47
	4	346	256	213	167	-26	-17	-22	-52
Least deprived	5	284	214	163	130	-25	-24	-20	-54
All Scotland		383	304	264	207	-21	-13	-22	-46

⁸Some postcodes in the Grampian region were restructured in 1990. As a result, it was not possible to assign death records to the new sector boundaries so deaths in 1990 were excluded from analysis.

Figure 5 shows, graphically, the change in age-standardised all-cause mortality rates for males and females, aged 0-64, over the last decade. Rates are grouped within Carstairs population-weighted quintiles. Between 2001 and 2011, there was a decrease in mortality rates across quintiles for both males and females. Although the reduction in rates was broadly similar across all quintiles, for males the percentage reduction in rates was highest in the most deprived quintile (26%) and for females the percentage reduction in rates was highest in the least deprived quintile (18%).

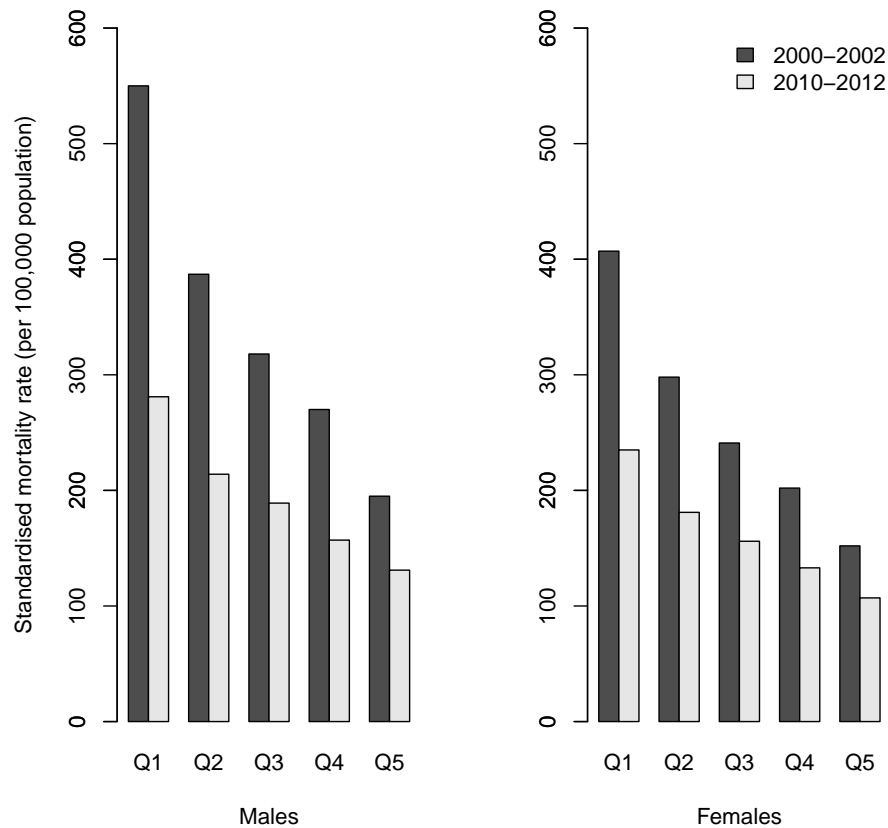


Figure 5: Age-standardised all-cause mortality rates for males and females aged 0-64 years within postcode sectors ranked by Carstairs scores and grouped into population-weighted quintiles (Q1: most deprived quintile, Q5: least deprived quintile)

Methodological issues

Choice of variables

The four variables that make up the Carstairs score were chosen as they captured concepts that closely relate to material deprivation (Carstairs and Morris, 1991). However, as societies change, so too does what could be considered as being materially deprived. Today the Carstairs score may be less reflective of deprivation than it once was.

Overcrowding now affects a very small percentage of people (Table 3), meaning that it may not capture material deprivation as well as it used to. The distribution of overcrowding is also heavily skewed with a small number of postcode sectors having a high percentage of people living in overcrowded homes. Skewness affects the relative contribution of overcrowding to the final score. The left hand panel of Figure 6 shows the effect overcrowding has on the final score by comparing the original Carstairs score to one where overcrowding is excluded. When overcrowding is excluded, the overall range of the Carstairs score distribution decreases, but the relative positions of most postcode sectors experience little change. There are, however, some noticeable exceptions, such as the Glasgow postcode sectors G42 7, G42 8, G41 1 and G41 2 which are all in the first quintile (most deprived) based on the original Carstairs score. When overcrowding is excluded G41 2 falls into the third quintile and G41 1 into the second quintile. While G42 7 and G42 8 are still in the first quintile, their ranking changes from the 6th and 26th most deprived to the 45th and 140th most deprived.

The percentage of people in households with no car has steadily decreased and is now just over 20%, half of what it used to be in 1981. Some authors have also contested the theoretical suitability of car ownership, because in rural areas owning a car is not so much an indication of wealth, but rather a necessity (see e.g. Farmer, Baird and Iversen, 2001; Martin, Brigham, Roderick, Barnett and Diamond, 2000), and in urban areas not having a car might be a lifestyle choice. The right-hand panel of Figure 6 shows the effect no car ownership has on the Carstairs score. Some postcode sectors, mostly in Glasgow, Edinburgh and Dundee city centres, that appear as average or slightly deprived based on the original score have very low levels of deprivation when excluding car ownership.

Changes in the labour market may also need to be considered in defining current material deprivation. Women's entry into the labour force in large numbers means that female unemployment could be as useful an indicator of deprivation as male unemployment. This and other changes in the labour market have meant that the statistical classifications of Social Class based on Occupation and Socio-economic Groups have become conceptually outmoded and have since been replaced with the NS-SeC (Rose and Pevalin, 2005). For the Carstairs score this means that retaining the old definition of low social class has become technically more difficult as well as theoretically less suitable. Work is currently under way to update the current Carstairs deprivation score.

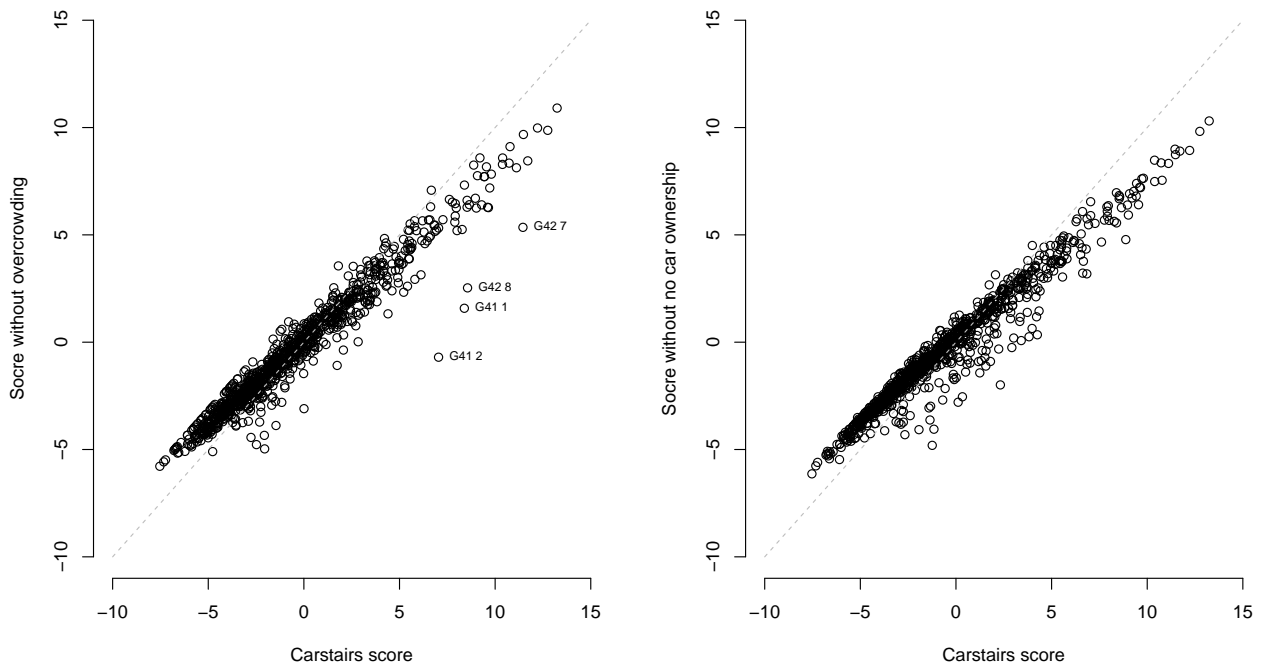


Figure 6: The effect of excluding overcrowding (left plot) and no car ownership (right plot) from the original Carstairs score

Robustness and uncertainty

As with most measures, there is some degree of uncertainty around the Carstairs score. In other words, it is not possible to say that the deprivation score for EH14 4 is exactly -6.62 and for AB12 5 in Aberdeenshire it is -6.60, making the former area less deprived than the latter. A number of sources of uncertainty enter into the measure of deprivation, from potential coding errors to the relative contribution of each of the variables on deprivation.

There are various ways to investigate uncertainty. Here two sources of uncertainty are considered: the effect of weights and the population size of the area of interest. In the first case the effect on the Carstairs score when the weight attached to each variable is varied is investigated. The Carstairs score standardizes the variables in an attempt to give them equal weight on the final score; the weight for each of the variables is one and the sum of the weights is four. However, standardization does not control for situations where the distribution of the data is extremely skewed. As shown, the skewed distribution of overcrowding affects its contribution to the final score. When the weights are varied the influence of some variables are reduced while the influence of others is increased. If the change in the weights, i.e. the influence of individual variables, does not affect the score much there is more confidence in the estimated level of deprivation.

To do this four random weights were drawn from a uniform distribution and then constrained to sum to four. These weights can lie anywhere from zero to four for each variable but the sum of these weights must be four, for each of the random draws. The new weights were assigned to each of the variables and a new score calculated. This procedure was repeated 1,000 times to provide 1,000 new randomly weighted Carstairs scores for each postcode sector. To assess the extent of variation 2.5th and 97.5th percentiles of the generated scores were observed. These percentiles give the intervals between which 95% of the generated scores will fall, giving a likely deprivation score range for all areas.

Figure 7 shows the scores and their likely range for ten of the most and least deprived areas. While postcode sectors EH14 4 and AB12 5 in Aberdeenshire have slightly different Carstairs scores, EH14 4 does not differ to AB12 5 due to the uncertainty around the measure. Indeed, it is not possible to say that any of the ten least deprived areas is less deprived than another. Similarly, while G15 7 has the highest Carstairs score it is not possible to say that it is definitely more deprived than G51 3. However, the ten least and most deprived areas are clearly distinguished, even when taking account the uncertainty around the weights.

The extent of uncertainty can also be analysed by comparing the Carstairs scores quintiles to the quintiles calculated based on the lower and upper bounds of uncertainty. Table 10 shows that for the majority of cases uncertainty is small enough to reliably use quintiles as a categorical measure of deprivation. About 80% of postcode sectors fall into the same quintile based on the score and the lower bound, and 83% of postcodes are on the diagonal when comparing the Carstairs quintiles to the quintiles based on the upper bound. However, in

around 1.2% of cases the uncertainty bounds of the postcode sector falls two quintiles above or below the Carstairs score quintile. Thus, for a small number of areas the measure is unreliable.

Table 10: Comparison of the Carstairs score quintiles to the quintiles defined by the lower and upper bounds of uncertainty

	Carstairs quintile	Lower uncertainty bound					Upper uncertainty bound				
		1	2	3	4	5	1	2	3	4	5
Most deprived	1	151	20	2	0	0	163	10	0	0	0
	2	13	107	29	3	0	18	119	15	0	0
	3	0	20	121	35	8	4	26	141	13	0
	4	0	0	18	168	44	0	8	27	181	14
Least deprived	5	0	0	0	14	259	0	0	0	33	240

Similar variations in uncertainty are also displayed in Figure 7, where the postcode sector G42 7 has a visibly higher uncertainty range than the others. Uncertainty is highest for areas with extremely high values on one of the four components. For example, the four areas with very high overcrowding in Figure 6, including G42 7, also have the highest range for uncertainty. This again highlights the impact of extreme values and the problems they create in interpreting the value of the final score.

Secondly, uncertainty in the Carstairs score due to the population size of the postcode sectors was considered. Estimates, such as the percentage unemployed or living in overcrowded households, can be unreliable if based on a small number of cases. This is universal to all small area measures and thus some type of statistical method is often used to increase the robustness of the estimated scores. Here confidence intervals have been provided to take account uncertainty in instances where the number of cases are small. Random samples of 1,000 draws were taken from a binomial distribution for each of the four census component variables, and used to calculate 1,000 new Carstairs scores.⁹ This was done for all 1,012 postcode sectors. Just as before, the 2.5th and 97.5th percentiles of the generated scores were observed and these provided the 95% confidence intervals for each area.

Figure 8 shows the ten most and least deprived areas with the 95% confidence intervals added. Again, it is not possible to distinguish the most deprived areas from each other, nor can the ten least deprived areas be easily distinguished. The uncertainty around the score for the most deprived areas (especially G42 7 and G15 7) is much smaller in Figure 8 than it was in Figure 7. This is because these are very large areas with a population of over

⁹For all four variables the denominator was used as the number of Bernoulli trials and the observed proportion as the success rate. For areas where the numerator was zero (e.g. there were no unemployed men in an area) the numerator was given the value of 0.5.

4,000 (G40 3 has a population of 2,519). To the contrary, uncertainty for six of the 10 least deprived areas is relatively high because the total population in these areas is very small (around 100, or less).

Finally, Table 11 shows the quintile by quintile comparison between the Carstairs quintile and the upper and lower confidence intervals. Approximately 90% of cases fall on the diagonal, meaning that the uncertainty due to population size is small enough to confidently place postcode sectors into deprivation quintiles. For 13 postcode sectors (1.3%) the Carstairs quintile and the quintile based on either the upper or lower confidence interval lie more than one category apart. These are all very small postcode sectors with the number of residents ranging from 60 to 167. For the most part, though, the Carstairs score quintile is a reliable indicator of deprivation.

Table 11: Comparison of the Carstairs scores quintiles to the quintiles based on the lower and upper confidence intervals

	Carstairs quintile	Lower confidence interval					Upper confidence interval				
		1	2	3	4	5	1	2	3	4	5
Most deprived	1	168	5	0	0	0	171	2	0	0	0
	2	0	138	13	1	0	10	139	3	0	0
	3	0	2	155	26	1	0	24	157	3	0
	4	0	0	2	185	43	1	7	20	197	5
Least deprived	5	0	0	0	3	270	0	0	3	36	234

Together these two methods of assessing uncertainty show that consideration has to be taken when interpreting the Carstairs score, particularly if any of the four components take on an extreme value or if the population of the area is very small (e.g. less than 1,000 people). Both types of uncertainty estimates have been provided for each postcode sector (see Appendix B).

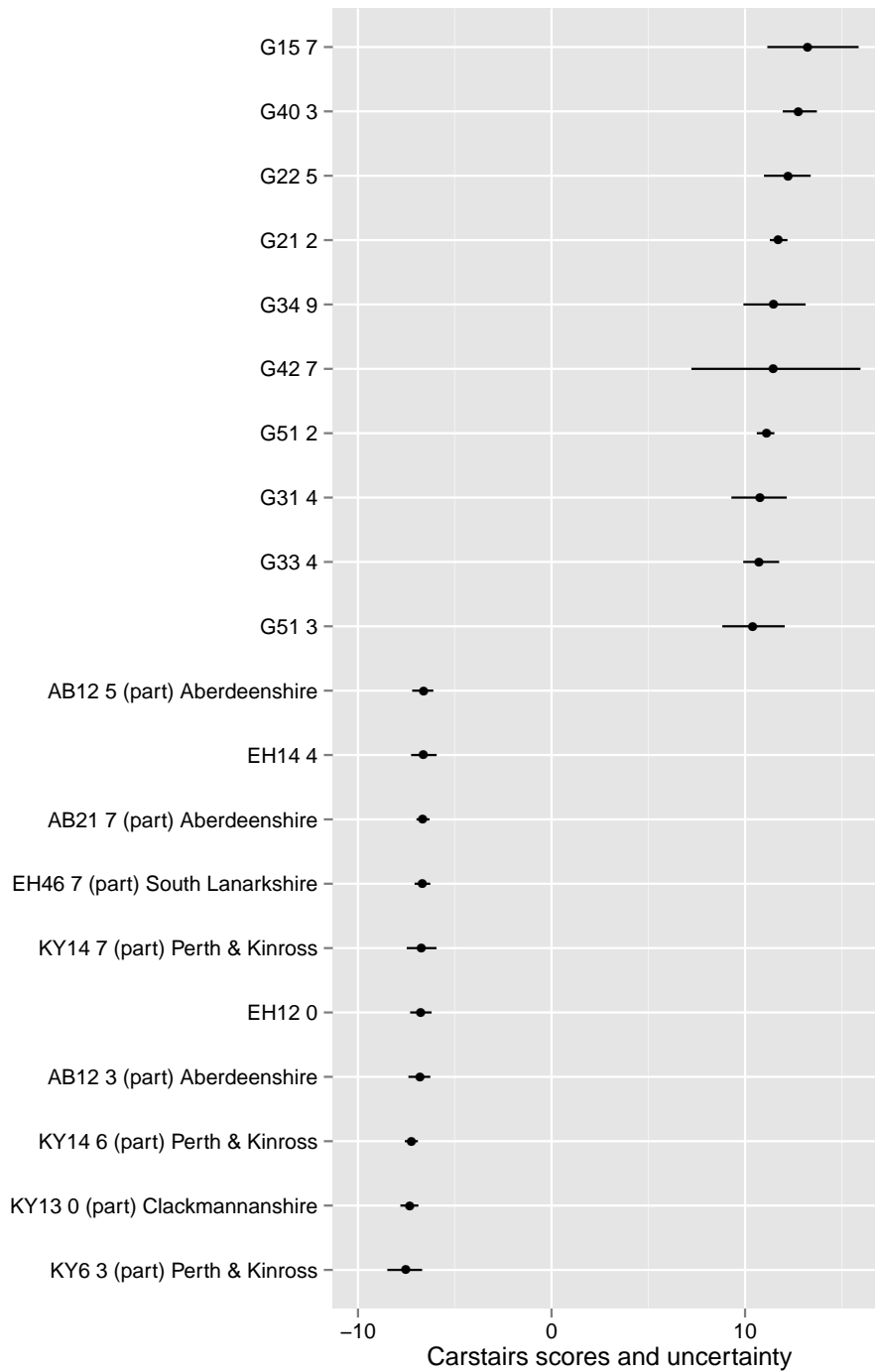


Figure 7: Uncertainty based on varying the weights attached to each variable for the ten most deprived (top) postcode sectors and ten least deprived (bottom) postcode sectors

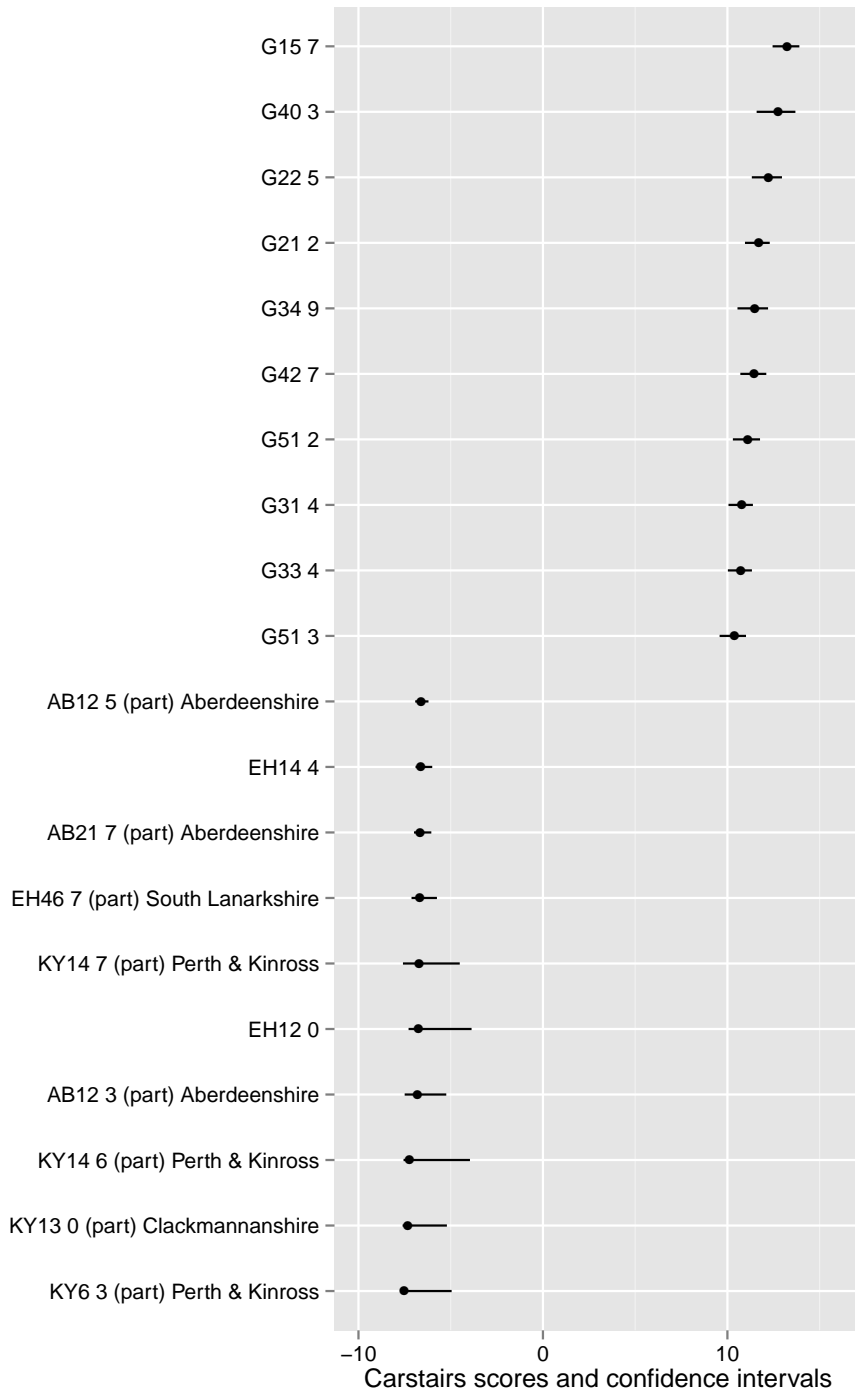


Figure 8: Confidence intervals for the uncertainty due to population size for the ten most deprived (top) postcode sectors and ten least deprived (bottom) postcode sectors

What do deprivation scores identify?

Carstairs deprivation scores use aggregated census data about people in small areas to quantify relative differences in material deprivation in those areas. Area-based measures of deprivation are often used to target deprived individuals; however, it is important to note that not all residents of a deprived area are deprived, and conversely, not all deprived people live in deprived areas. Areas are not necessarily homogenous and those that contain a mix of both deprived and less deprived individuals will have deprivation scores in the mid-range (see Figure 9). Heterogeneous populations are more likely to be found in rural areas and therefore area-based deprivation scores may provide a better account of deprivation in urban areas. Postcode sectors vary considerably in size, both in terms of geographical area and population density. This means that even where an area has been categorised in the mid-range of the deprivation scale, it could contain more deprived individuals than areas classified as being very deprived.

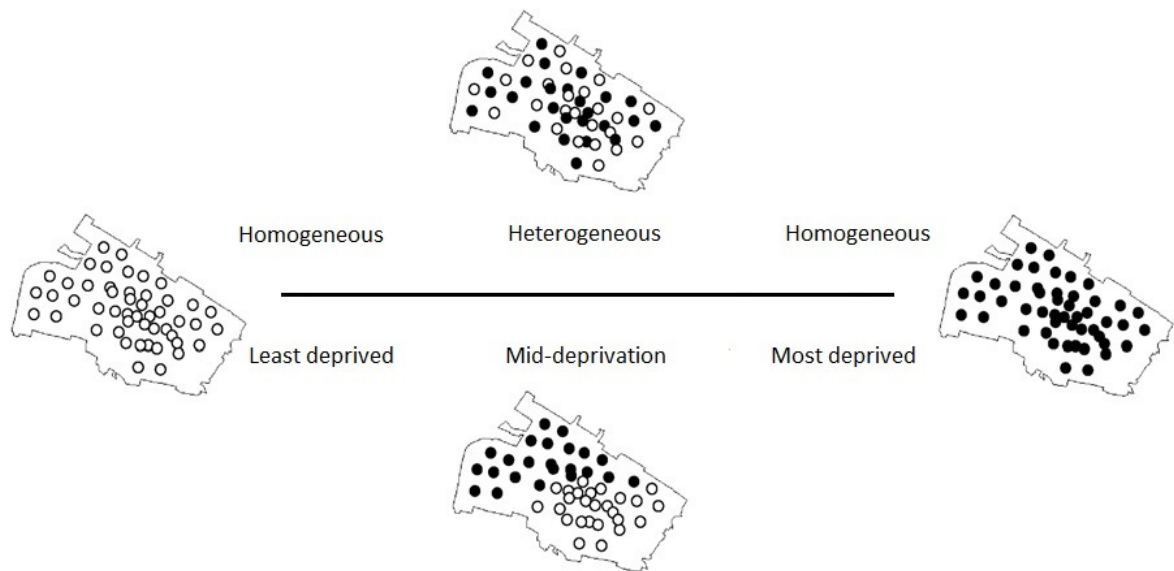


Figure 9: Illustration of four homogenous/heterogenous areas ranked by deprivation. Dark circles represent presence of indicators of deprivation and white circles absence

Homogeneity increases when individuals within areas share similar characteristics. As a result, homogeneous areas are more likely to lie at the extremes of the deprivation scale. It may be reasonable to expect that smaller areas (in terms of population size) will be more homogenous than larger areas. Geographic boundaries, however, tend not to be defined on the basis of the characteristics of the populations within them and so this might not be necessarily true.

Carstairs deprivation scores at datazone and output area level

In addition to census postcode sectors, Carstairs deprivation scores have been calculated in 2011 for census datazones (best-fitted from 2011 census output areas) and census output areas. This is important as it has the potential to provide useful data at a much smaller geography. Datazones and output areas have an average population size of 815 and 114 respectively, compared to an average population size of 5,233 in postcode sectors. As areas become geographically smaller in size, it becomes possible to identify small pockets of deprivation. The maximum deprivation score at postcode sector level is 13.2 compared to 17.7 at output area level (see Table 12). The variation in the distribution of scores decreases with area size, although there is no trend in how the range of scores varies with area level.

Table 12: Descriptive statistics of 2011 Carstairs deprivation scores by area level

Area level	Descriptive Statistics					
	N	Median	SD	Min	Max	Range
Postcode sector	1,012	-1.33	3.62	-7.53	13.24	20.77
Datazone	6,500 ¹	-0.54	3.43	-5.45	17.27	22.71
Output area	46,351	-0.43	3.11	-4.29	17.65	21.94

¹ There are 6,505 datazones best-fitted from 2011 census output areas. However, five datazones (S01002296, S01003031, S01003319, S01003505 and S01003548) have 0 population and so Carstairs deprivation scores have been calculated for 6,500 datazones in total.

Carstairs deprivation scores have been provided for every small area at postcode sector, datazone and output area level. Some of these areas are extremely small and not all variables can be calculated reasonably for every area (there are 18 output areas with 0 economically active males and therefore no male unemployment). Caution should be taken when interpreting Carstairs deprivation scores for individual areas, at any area level. See Appendix B for details about Carstairs deprivation scores and associated output, calculated for the three area levels.

Figure 10 shows the distribution of Carstairs deprivation scores at each area level. Although there is a shift towards higher, more deprived, scores in smaller areas, there are also many more small areas classified as having low levels of deprivation. At datazone and output area level, the distribution of scores are highly positively skewed with long tails of extreme deprivation.

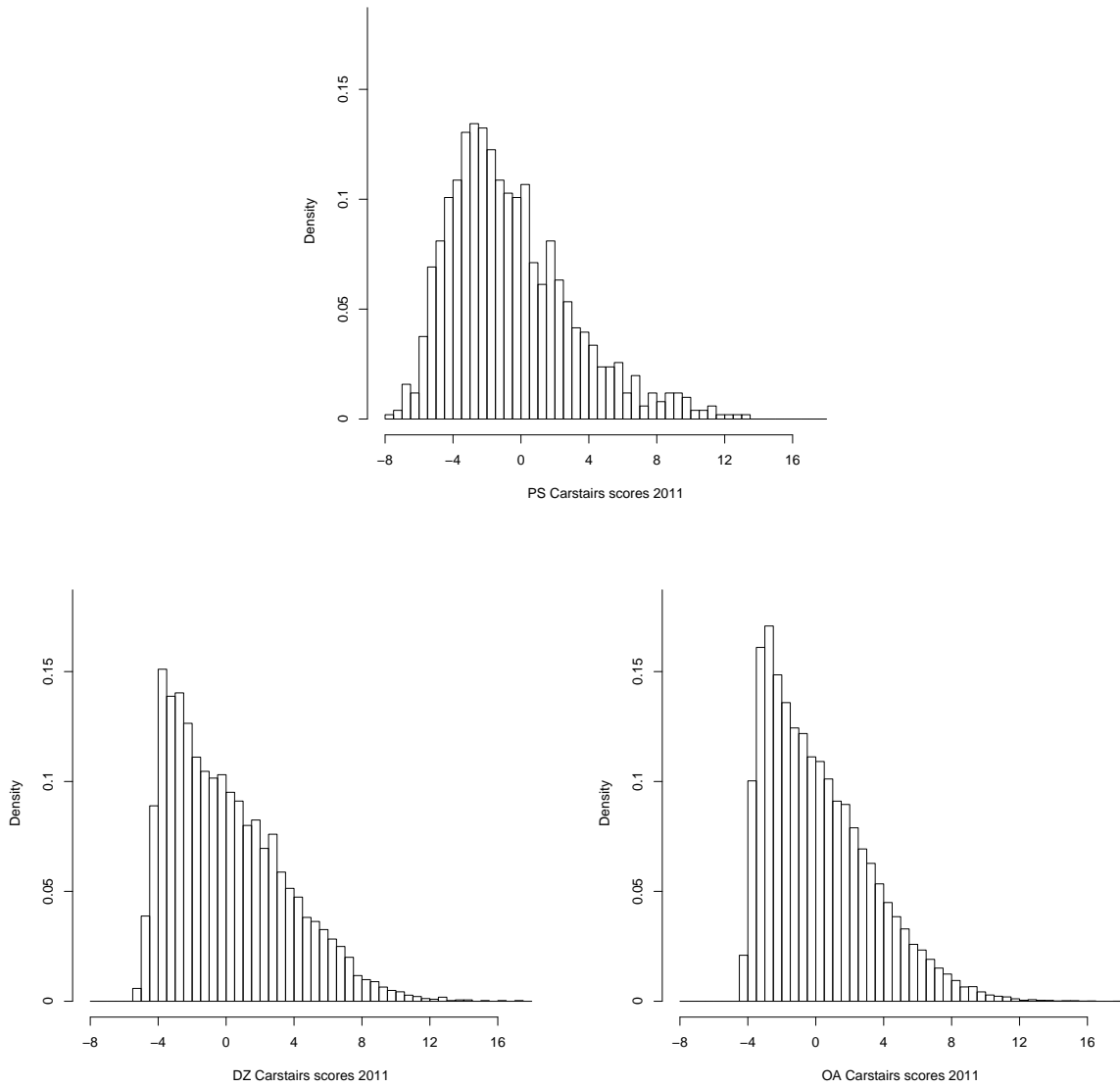


Figure 10: Distribution of 2011 Carstairs deprivation scores at postcode sector (PS) level, datazone (DZ) level and output area (OA) level

Table 13 shows age-standardised all-cause mortality rates for males, females and all people aged less than 65 grouped within population-weighted quintiles at each of the three area levels. Rates are shown for 2010-2012. For all people, the rate ratio at postcode sector level is 2.5. This means that all-cause mortality rates, for all people aged less than 65, were 2.5 times as high in the most deprived postcode sectors compared to the least deprived. At datazone level the rate ratio increases to 3.2 times as high and at output area level to 3.4 times as high. Greater health inequalities are observed as areas become geographically smaller in size. At datazone and output area level there is very little difference in mortality rates in the least deprived areas but in the most deprived areas all-cause mortality rates are higher in output areas. Rate ratios are higher for males than females at each area level.

Table 13: Age-standardised all-cause mortality rates (per 100,000 population) for males and females aged 0-64 within population-weighted quintiles for each area level 2010-2012

	Population-weighted quintile					Rate Ratio ¹
	Most deprived		Least deprived			
	1	2	3	4	5	
<i>Males</i>						
Postcode sector	407	298	241	202	152	2.7
Datazone	457	315	235	179	127	3.6
Output area	489	315	228	161	127	3.9
<i>Females</i>						
Postcode sector	235	181	156	133	107	2.2
Datazone	260	193	149	120	97	2.7
Output area	273	197	148	109	98	2.8
<i>All</i>						
Postcode sector	320	238	198	167	130	2.5
Datazone	356	253	191	149	112	3.2
Output area	380	254	187	135	112	3.4

¹ Ratio of the all-cause mortality rate in the most deprived quintile to the all-cause mortality rate in the least deprived quintile.

Comparison to the Scottish Index of Multiple Deprivation (SIMD)

While widely used, the Carstairs score is not the only means to measure small area level deprivation. The Scottish Index of Multiple Deprivation (SIMD) is produced and used by the Scottish Government to identify deprived areas in Scotland. While the SIMD and Carstairs score capture some similar elements of deprivation, such as (un)employment, they are also quite different, as the SIMD includes crime statistics, education, health and geographical access in the final score. To date, the Carstairs scores and the SIMD have been issued for different geographic units, the former for postcode sectors and the latter for datazones, ruling out a comparison between the two. To fill this gap Carstairs scores for datazones have now been produced.

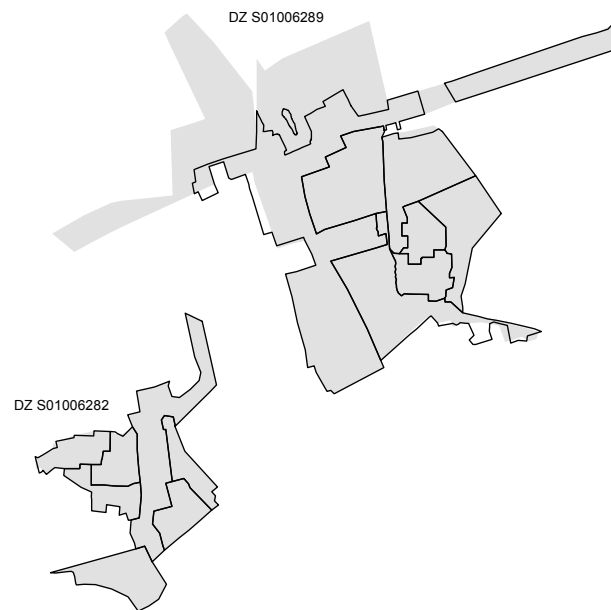


Figure 11: Two 2001 (SIMD) datazones (gray) with the 2011 output areas (black) used to recreate them overlaid

The SIMD uses the 2001 datazone boundaries. Since the census output for datazones is provided on a best-fit basis the geographic areas covered by the datazones in the SIMD dataset and in the census data may differ. For some datazones this difference is small, but for others it can be more substantial. Figure 11 shows two 2001 datazones and the 2011 output areas that are used to recreate them. The 2001 datazone S01006282 and the 2011 output areas used to recreate it overlap almost exactly, posing no problems for comparisons. However, the datazone S01006289 and the output areas used to reconstruct it do not overlap as well. In general the overlap for most areas is good, but for some the differences are substantial. For this reason caution should be taken when drawing final conclusions from the comparison of the two measures.

The quintile by quintile comparison in Table 14 generally shows good agreement between the measures (61% cases fall on the diagonal), but also substantial disagreement over the level of deprivation for some areas (3.5% cases are 2-3 quintiles apart). This may, in part, be caused by the boundary differences of the datazones used in the census and SIMD, but in many cases the two measures also disagree when the datazones have a close geographical overlay.¹⁰ For the datazones with a close geographical overlay the percentage of datazones for which the two measures do not agree is even higher (4.4% of cases are 2-3 quintiles apart) while the level of agreement is 59%.

Table 14: Comparison of 2011 Carstairs quintiles and SIMD 2012 quintiles

	Carstairs quintile	SIMD 2012 quintile									
		All datazones					Close geographical overlay				
		1	2	3	4	5	1	2	3	4	5
Most deprived	1	1096	236	17	1	0	519	127	11	1	0
	2	238	767	266	35	17	100	401	142	22	10
	3	7	302	622	285	73	5	148	316	160	43
	4	0	22	321	604	333	0	15	206	338	195
Least deprived	5	0	1	52	328	877	0	1	48	212	505

Differences also arise due to the variables used in the construction of the two deprivation measures. A correlation analysis of ranks for all the components and the Carstairs and SIMD scores are shown in Table 15. While the two deprivation measures correlate highly overall, some components are only weakly related to the overall scores. Both no car ownership and overcrowding have a correlation coefficient of less than 0.8 with SIMD. Removing no car ownership and overcrowding from the Carstairs score visibly increases the agreement between the two measures. In Table 16, 63.3% of cases fall on the diagonal and only 2% are 2-3 quintiles apart.

While for most datazones the two different measures of deprivation seem to provide very similar results, the reasons why 2% of cases are two or more quintiles apart is unclear. Further analysis showed that the two measures are most likely to disagree for rural areas and large urban areas. After removing overcrowding and car ownership the agreement between the measures increased noticeably for both of these areas, but remained visibly weaker for remote areas. While some of this discrepancy is due to the SIMD including the access to services domain, this cannot explain all differences between the two measures as the access domain has a small impact on the overall SIMD rank. A more detailed analysis may help to explain better the causes of disagreement between the two measures of deprivation.

¹⁰Close geographical overlay is defined here as cases where the overlapping area covers 95% or more of the original and the recreated datazone. By this definition 54.2% of data zones have a close geographical overlay.

Table 15: Correlation between the deprivation scores (2011 Carstairs and SIMD 2012) and individual variables (Carstairs) and domains (SIMD)

Variable	2011 Carstairs score	SIMD 2012
2011 Carstairs score	1.00	0.91
SIMD 2012	0.91	1.00
<i>Carstairs variables</i>		
No car	0.90	0.78
Overcrowding	0.77	0.63
Low class	0.91	0.90
Male unemployment	0.88	0.85
<i>SIMD domains</i>		
Income	0.91	0.97
Employment	0.90	0.97
Health	0.84	0.91
Education	0.90	0.92
Access	-0.42	-0.23
Crime	0.73	0.72
Housing	0.77	0.70

Table 16: Comparison of the reduced 2011 Carstairs quintiles (excluding overcrowding and car ownership variables) and SIMD 2012 quintiles

	Carstairs quintile (reduced)	SIMD 2012 quintile									
		All datazones					Close geographical overlay				
		1	2	3	4	5	1	2	3	4	5
Most deprived	1	1121	242	9	0	0	517	119	2	0	0
	2	212	813	295	22	1	103	425	153	10	1
	3	8	252	655	339	33	4	132	356	178	19
	4	0	20	286	603	344	0	15	183	350	182
Least deprived	5	0	1	33	289	922	0	1	29	195	551

Conclusions

Carstairs scores provide a summary measure of relative material deprivation in areas. As far as possible the same four census variables have been used to construct Carstairs scores each decade since 1981. The measure comprises an unweighted combination of four standardised census indicators: male unemployment, overcrowding, lack of car ownership and low social class. Summing together the standardised values of the four components gives the Carstairs score for each area. Based on the distribution of scores, areas are then divided into Carstairs deprivation categories, quintiles or other population-weighted groups.

As in previous years, Carstairs scores for 2011 have a distribution which is skewed towards more highly deprived areas. NHS Greater Glasgow Board, which merged with parts of NHS Argyll & Clyde in 2006 to form NHS Greater Glasgow & Clyde Board, continues to have a large proportion of population in the most deprived quintile. Nearly 44% of the population in NHS Greater Glasgow & Clyde Board belongs to the most deprived 20% of the Scottish population. Both Glasgow City council and Dundee City council have more than half its population in the most deprived quintile.

There continues to be a strong relationship between area-based deprivation scores and all-cause mortality. Mortality rates have continued to fall since 1981. For both males and females aged under 65, the rate of decrease in mortality between 2001 and 2011 was broadly equivalent across all quintiles, although highest overall for males in the most deprived quintile. This followed a period of little change in mortality rates for males in the most deprived quintile. For all people, aged under 65, the reduction in all-cause mortality rates between 2001 and 2011 was the largest reduction across a decade since 1981.

This report considers methodological issues that are important in creating Carstairs deprivation scores. There is some discussion about the choice of variables used to capture material deprivation. Prevalence of overcrowding in Scotland has fallen to a very low rate so its usefulness as a current indicator of material deprivation is in doubt. There has also been much discussion over previous decades as to the inclusion of the car ownership variable. For many in rural areas, a car is essential and may not best represent access to material resources. Measures of uncertainty around each area's deprivation score are provided.

For the first time, Carstairs deprivation scores have been provided at datazone and output area level. Both these areas types are smaller than postcode sectors and enable small pockets of extreme deprivation to be captured. Traditionally, area-based deprivation at the datazone level has been captured using the SIMD. The SIMD combines a number of (mainly) non-census indicators across a number of domains. This report compares Carstairs deprivation scores at datazone level with the SIMD. Despite some differences in the geographical construction of census datazones and SIMD datazones, findings suggest that there is reasonably good agreement between the two approaches in terms of areas falling into equivalent quintiles of deprivation.

Carstairs deprivation scores remain an important measure of area level material deprivation. The production of Carstairs deprivation scores in 2011 at postcode sector level ensures continuity over time, while the inclusion of scores at datazone and output area level allows users to analyse levels of deprivation at much smaller area levels than previously.

References

- Carstairs, V. and Morris, R. (1989). Deprivation: explaining differences in mortality between Scotland and England and Wales, *BMJ: British Medical Journal* **299**(6704): 886.
- Carstairs, V. and Morris, R. (1991). *Deprivation and health in Scotland*, Aberdeen University Press, Aberdeen, UK.
- Farmer, J. C., Baird, A. G. and Iversen, L. (2001). Rural deprivation: reflecting reality, *The British Journal of General Practice* **51**(467): 486.
- Martin, D., Brigham, P., Roderick, P., Barnett, S. and Diamond, I. (2000). The (mis) representation of rural deprivation, *Environment and Planning A* **32**(4): 735–752.
- McLoone, P. (1994). Carstairs scores for Scottish Postcode Sectors from the 1991 Census. Public Health Research Unit, University of Glasgow, UK.
- McLoone, P. (2004). Carstairs scores for Scottish Postcode Sectors from the 2001 Census. MRC Social & Public Health Sciences Unit, University of Glasgow, UK.
- Rose, D. and Pevalin, D. (2005). *The National Statistics Socio-economic Classification: Origins, Development and Use*, Basingstoke: Palgrave Macmillan.

Appendix A

Table A1: Census tables used to calculate 2011 Carstairs scores

	Census Table	Census Table Heading
Population	KS101SC	Usual resident population
No car ownership	CCO_004a_2014 ¹	Car or van availability
Male unemployment	KS602SC	Economic activity - Males
Overcrowding	QS410SC	Persons per room - People
Low social class	CCO_004b_2011 ¹	NS-SeC of the HRP

¹ These tables were commissioned from NRS and are for all people in households. They are available from Scotland's Census website at <http://www.scotlandscensus.gov.uk/ods-web/data-warehouse.html>

Appendix B

As in previous years, Carstairs deprivation scores have been provided for each postcode sector in Scotland (see file ‘Carstairs_scores_PS2011.csv’ which is available online alongside this report). True postcode sectors overlap council area boundaries so census postcode sectors are created which respect council area boundaries.¹¹ In census output, postcode sectors that cross council areas are split and each is treated as a postcode sector in its own right. For example, the postcode sector G46 7 is split across Glasgow City council area and East Renfrewshire council area. Postcode sectors that are split are indicated by a ‘(part)’. Note that, where a postcode sector is split, knowledge of the council area is required so that the correct part-postcode sector can be identified. Carstairs deprivation scores will be made available (on request) for ‘complete’ postcode sectors (i.e. those postcode sectors where split parts have been merged). This may be useful in cases where the council area is unknown.

For the first time, Carstairs deprivation scores for 2011 are also provided at datazone (see file ‘Carstairs_scores_DZ2011.csv’) and output area (see file ‘Carstairs_scores_OA2011.csv’) level. See Table A2 for a description of the data available at each area level.

¹¹A postcode to 2011 output area (and 2011 output area to higher areas, including 2011 postcode sectors) lookup table is provided at <http://www.gro-scotland.gov.uk/geography/geo-prods/census-datasets/2011-census/2011-indexes/index.html>

Table A2: Description of the data in the postcode sector (Carstairs_scores_PS2011.csv), datazone (Carstairs_scores_DZ2011.csv) and output area (Carstairs_scores_OA2011.csv) files

	Column heading	Description
A	Postcode Sector/Datazone/Output Area	Census geographical area
B	Health Board	2014 Health Board Area
C	Council Area	2011 Council Area ¹
D	Total population	2011 Census population count
E	People in households	2011 Census household population count
F	People in communal establishments	2011 Census communal establishment resident count
G	Quintile	Population-weighted quintiles
H	Decile	Population-weighted deciles
I	DEPCAT	Carstairs DEPCATs
J	Most deprived 15%	Indicator for the most deprived 15% of the population
K	Least deprived 15%	Indicator for the least deprived 15% of the population
L	Total population weight	Area population / Total population of Scotland
M	% Overcrowding	Percentage of overcrowding in area
N	% Male Unemployment	Percentage of male unemployment in area
O	% No Car	Percentage of no car ownership in area
P	% Low Social Class	Percentage of low social class in area
Q	Z-score overcrowding	z-score for overcrowding
R	Z-score male unemployment	z-score for male unemployment
S	Z-score no car	z-score for no car ownership
T	Z-score low social class	z-score for low social class
U	Carstairs score	2011 Carstairs scores
V	Lower 95% uncertainty bound	Based on varying the weights attached to each variable
W	Upper 95% uncertainty bound	Based on varying the weights attached to each variable
X	Lower 95% confidence interval	Uncertainty due to population size
Y	Upper 95% confidence interval	Uncertainty due to population size
Z	PS Code	Unique postcode sector identifier (PS file only)
AA	PS Name	Postcode sector in 2011 census format (PS file only)

¹ Note that in the datazone (Carstairs_scores_DZ2011.csv) file three census datazones do not fall neatly into one single council area. The datazones are S01003502, S01001422 and S01000215. For each of these datazones the council area listed is the one where most census output areas within the datazones lie. For S01003502, four output areas lie in North Lanarkshire and nine in Glasgow city so Glasgow city is listed as the council area. For S01001422 one output area lies in East Renfrewshire and four in East Ayrshire so East Ayrshire is listed as the council area. For S01000215 one output area lies in Aberdeenshire and eight in Aberdeen city so Aberdeen city is listed as the council area.

Appendix C

Table A3: The distribution of Carstairs deprivation scores in 2011 for postcode sectors

	Score Range	Postcode Sectors			Total Population		
		Number	%	Cumulative %	Number	%	Cumulative %
Low levels of deprivation	(-8, -7]	3	0.30	0.30	266	0.01	0.01
	(-7, -6]	14	1.38	1.68	20,167	0.38	0.39
	(-6, -5]	54	5.33	7.01	201,424	3.80	4.19
	(-5, -4]	92	9.09	16.1	389,383	7.35	11.54
	(-4, -3]	121	11.96	28.06	487,301	9.20	20.74
	(-3, -2]	135	13.34	41.4	569,288	10.75	31.49
	(-2, -1]	117	11.56	52.96	613,616	11.59	43.08
	(-1, 0]	103	10.18	63.14	583,242	11.01	54.09
	(0, 1]	90	8.89	72.03	608,179	11.49	65.58
	(1, 2]	72	7.11	79.14	512,712	9.68	75.26
	(2, 3]	59	5.83	84.97	408,342	7.71	82.97
	(3, 4]	41	4.05	89.02	243,063	4.59	87.56
	(4, 5]	29	2.86	91.88	177,873	3.36	90.92
	(5, 6]	25	2.47	94.35	156,107	2.95	93.87
	(6, 7]	16	1.58	95.93	101,507	1.92	95.79
	(7, 8]	9	0.89	96.82	59,054	1.12	96.91
(8, 9]	10	0.99	97.81	47,002	0.89	97.80	
(9, 10]	11	1.09	98.90	63,732	1.20	99.00	
(10, 11]	4	0.40	99.30	20,356	0.38	99.38	
High levels of deprivation	(11, 12]	4	0.40	99.70	19,657	0.37	99.75
	(12, 13]	2	0.20	99.90	7,341	0.14	99.89
	(13, 14]	1	0.10	100.00	5,791	0.11	100.00
		1,012	100.00		5,295,403	100.00	

**MRC/CSO Social and Public Health Sciences
Unit, University of Glasgow**
200 Renfield Street,
Glasgow, G2 3QB

Tel: 0141 353 7500

email: sphsu-enquiries@glasgow.ac.uk

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