Scottish Indices of Deprivation 2003

Social Disadvantage Research Centre
Department of Social Policy and Social Work
University of Oxford
Barnett House
Wellington Square
Oxford
OX1 2ER
The Social Disadvantage Research Centre

The members of SDRC who worked on this project were Michael Noble, Gemma Wright, Myfanwy Lloyd, Chris Dibben, George Smith, Andrew Ratcliffe, David McLennan, Maria Sigala and Chelsie Anttila from the University of Oxford, with support from Gillian Raab at Napier University Edinburgh.

Acknowledgements

The research team would like to thank the project Steering Group, the project’s statistical advisor Professor Gillian Raab at Napier University Edinburgh, Dr Tarani Chandola of University College London and David Avenell SDRC’s GIS consultant.

About this Report

The research team at Oxford University’s Department of Social Policy and Social Work was contracted in 2002 by the Scottish Executive to construct Indices of Deprivation for Scotland.

This report presents the domains and indicators for the Scottish Indices of Deprivation. It also sets out the methodology for combining the indicators into Domain Indices and for combining the domains into an overall ward level Scottish Index of Multiple Deprivation (SIMD 2003). This report also describes the results and presents maps of the domains and SIMD. The analysis is based on the ward and local authority boundaries which were in place in April 1999. As far as has been possible, the indicators use data from April 2001.
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Background

The need for information about the geographical distribution of relative deprivation in Scotland has long been recognised. The most recent official study was completed in 1998 and resulted in the Scottish Area Deprivation Index for Scottish Postcode Sectors (Central Research Unit, 1998).

However, advances in the collection and use of non-census data sources, such as administrative data, have allowed analysis of deprivation at small area level in the inter-censal period. Such advances have also released the analysis from using proxy indicators from the Census in favour of using direct measures of deprivation, such as low income. In addition, recent work (see Noble, Smith, Wright et al., 2000; Noble, Smith, Penhale et al., 2000; and Noble, Smith, Wright et al., 2001) has developed the conceptualisation of multiple deprivation and its component parts, and this has been built in to the construction of the new Scottish Indices of Deprivation.

Poverty and Multiple Deprivation

In his account of Poverty in the United Kingdom, Townsend (1979, p. 31) sets out the case for defining poverty in terms of relative deprivation. Thus, ‘Individuals, families and groups can be said to be in poverty if they lack the resources to obtain the types of diet, participate in the activities and have the living conditions and amenities which are customary, or at least widely encouraged or approved in the societies to which they belong’. Though ‘poverty’ and ‘deprivation’ have often been used interchangeably, many have argued that a clear distinction should be made between them. It could be argued that the condition of poverty means not having enough financial resources to meet needs. Deprivation on the other hand refers to unmet need, which is caused by a lack of resources of all kinds, not just financial. Atkinson (1998, pp. 1-20) notes that in recent debates on ‘Social Europe’, the terms poverty and social exclusion have been used on occasions interchangeably, but defines poverty as a ‘lack of money or material possessions’. Townsend himself concurs. In his article ‘Deprivation’, Townsend (1987, pp. 131 and 140) argues that ‘people can be said to be deprived if they lack the types of diet, clothing, housing, household facilities and fuel and environmental, educational, working and social conditions, activities and facilities which are customary …’. People are in poverty if they lack the resources to escape deprivation.

In his 1987 article Townsend elaborates on the distinctions between social and material deprivation. Social deprivation, which he acknowledges as more difficult to measure, is defined as ‘providing a useful means of generalising the condition of those who do not or cannot enter into ordinary forms of family or other relationships’. In this he is anticipating some aspects of what one might now call ‘social exclusion’. The more easily measured material deprivation relates to diet, health, clothing, housing, household facilities, environment and work (Townsend, 1987, p.136). Townsend also lays down the foundation for articulating multiple deprivation as an accumulation of single deprivations - a concept which is developed further in the design of the new Scottish Indices of Deprivation.

Though Townsend’s work mainly (though not entirely) referred to individuals experiencing deprivations - single or multiple – the arguments can, in modified form, extend to area based measures. However, data availability inevitably means that some of the sophistication of his original concept is lost. At an area level it is very difficult to measure the percentage of the population experiencing one, two or more
deprivations. It is possible to look at single deprivations at an area level and state that a certain proportion of the population experiences that deprivation, a proportion experiences some other form of deprivation etc., and at an area level describe the combination of single deprivations as area level multiple deprivation. This says little of the individual experience of multiple deprivation.

The Social Disadvantage Research Centre (SDRC) has developed the earlier work in Scotland and moved forward the measurement of multiple deprivation both conceptually and practically. The current approach is to conceptualise multiple deprivation as a composite of different dimensions or domains of deprivation. However, each dimension is measured independently using the best indicators available to generate a score or Domain Index for each aspect of deprivation. These domain scores are then combined with explicit weighting to generate an Index of Multiple Deprivation which is an aggregate of the component domains. As will be discussed, the availability of new data has allowed these domains to be described with more precision, and in a more robust and consistent way than has been possible before.

This approach allows the separate measurement of different dimensions of deprivation, such as income deprivation, education deprivation and health deprivation. There is a question as to whether there should be an additional domain for low income, or one that measures the lack of socially perceived necessities (e.g. adequate diet, consumer durables, ability to afford social activities etc.). To follow Townsend, within a Multiple Deprivation Index only the deprivations flowing from a low income would be included so low income itself would not be a component, but socially perceived necessities would. However, there are no readily available small area data on the lack of socially perceived necessities and therefore low income is an important indicator for these aspects of material deprivation. Moreover, there are arguments that measures of consumption are themselves problematic as the lack of certain items may be by choice rather than due to the inability to pay for them. Therefore, it is appropriate to measure low income itself rather than the possession of certain items.

The research team recognise income deprivation in its own right but would not argue that it should be the only measure of area deprivation. Many dimensions of deprivation are measured in the Scottish Indices of Deprivation more directly than before. The other dimensions of deprivation contribute crucial further information about an area. However, low income remains a central component of the definition of multiple deprivation for the Scottish Indices of Deprivation. As Townsend (1987, p.131) writes ‘while people experiencing some forms of deprivation may not all have low income, people experiencing multiple or single but very severe forms of deprivation are in almost every instance likely to have very little income and little or no other resources.’

Multiple deprivation is not a separate form of deprivation. It is simply a combination of more specific forms of deprivation, which themselves can be more or less directly measurable. It is an empirical question whether combinations of these different forms of deprivation are more than the sum of their parts, that is, they are not simply additive but interact and may have more impact, if found in certain combinations.

This perspective accommodates the reality of varying combinations of deprivation and disadvantage in different types of areas, which has been a persistent finding on the geographical distribution of different forms of deprivation and disadvantage since the pioneering work of Richard Webber in Liverpool in the 1970s. But it does raise questions about the addition of items to form an Index of ‘multiple deprivation’. And if multiple deprivation cannot be directly quantified then there are problems in technically validating any overall Multiple Deprivation Index as ‘validation’ requires something against which the Multiple Deprivation Index can itself be measured. If this is correct, then the question of how components in the overall Multiple Deprivation Index might be weighted rightly becomes a central question.
**Individual, Household and Area Level Deprivation**

Measuring different aspects of deprivation and combining these into an overall Multiple Deprivation Index raises a number of questions about the links between different forms of deprivation at the individual, household and area level. First, how far do individuals and families experiencing deprivation in fact cluster together geographically, and how far are other individuals and families who are not experiencing deprivation affected by the overall level of deprivation in their area? Though much of the data collected may, in the final analysis, be based on individual or household levels of deprivation, the results in any composite Index are likely to be presented in the form of an area level aggregate score. However, this may combine deprivations experienced by many different groups within that area.

**The approach to measuring multiple deprivation**

This brief debate on poverty and deprivation has underlined the importance of the financial component in any overall measurement of deprivation. This theme runs through the research team’s approach to multiple deprivation and the basis for weighting the components in any overall multiple deprivation measure.

The debate also confirms the idea of separate ‘domains’ of deprivation, which any individual may experience singly or in combination. The intention has been to find ways of assessing the major forms of deprivation to create a robust deprivation Index for each domain - that is for income, unemployment, education etc. separately.

This approach implies rather more items in total than in earlier overall measures of deprivation. It also requires ‘domain specific’ items (and not what often happens when for example, ‘educational deprivation’ is measured by a mix of education, social and economic factors in combination). It also requires procedures for combining items within any Domain Index according to clear rules.

**Particular Issues**

In a country with large rural areas there is a particular need for indicators to capture the deprivation experienced by people living in rural areas. Several features of the Scottish Indices of Deprivation address these concerns. Firstly, all indicators included in the Scottish Indices of Deprivation had to be applicable to the whole of Scotland, so that fair scores and comparisons between areas could be made. This means that all of the indicators in the Scottish Indices of Deprivation are applicable to both rural and urban areas. For example, high rates of unemployment can in principle occur in both rural and urban wards, and would then be captured by the rate of people claiming the relevant benefits. Second, indicators which have different ‘meanings’ depending on their location have not been included. Thus, car ownership, which has previously been used as a proxy for low income, has not been included, as in some areas people might choose to make other financial sacrifices because they need a car to get to work if there is limited public transport. Low income itself is measured directly in the Income Domain by the inclusion of counts of people claiming benefits. It is also appreciated that ‘rural’ areas do not necessarily share all the same characteristics, and that these differences will be revealed in the ward scores and ranks. This is of course also true of the differences between and within ‘urban’ areas.

**The Geographical Scale of the Indices of Deprivation**

An ideal measure of area deprivation would be able to quantify deprivation at the level of ‘neighbourhoods’ or small areas with a homogeneity of characteristics and a standard population size.
Such a measure would be able to offer to policy makers and funding programmes a robust method of describing the geographic distribution of deprivation.

This raises several issues for a potential index of multiple deprivation. First, the possible availability of data and population estimates for small areas; second, the problem of the variation in population size between areas and third, the heterogeneity of areas.

The availability of data for small areas in the inter-censal period had been considerably advanced by the increasing accessibility of benefits and other data at a sub-local authority level. Population estimates at ward level for mid-2000 were made available to the project by the General Register Office for Scotland (GROS). Denominators have been constructed for the indicators using these estimates. An adjustment was made to construct estimates for children under the age of 16, and to obtain a working-age population (16-59).

In order to compare concentrations of deprivation between areas it is necessary to calculate rates in order to standardise for differences in the size of the population. Although wards vary in population size, the problem of varying sizes is inherently much greater for local authorities. This raises the problem of the heterogeneity or homogeneity of an area, in terms of the intensity of deprivation. Rates for large areas, such as a whole city, may mask a great variation within it. This means that because of the heterogeneity within local authorities, as well as the variations in population size, comparisons of the intensity of deprivation at the local authority level are problematic. The ward level thus presents the most robust small area option for the Index of Multiple Deprivation.

Because of the availability of small area data, and the techniques advanced by the research team to harness other data sets, it was possible to construct the Scottish Indices of Deprivation at ward level. The Indices are based on the 1999 electoral ward geography. Ward boundaries in Scotland changed significantly in 1999 and the Indices have been constructed to reflect these revisions. The thirty-two local authorities were largely unchanged at this time.
Chapter 2: Domains and Indicators

Following on from the conceptualisation of multiple deprivation outlined in Chapter 1 the new Scottish Indices of Deprivation comprise indicators which are combined to form domains of deprivation. This process produced a score for each of the domains - a Domain Index - which has been ranked across Scotland to give a relative picture of each dimension of deprivation. The Domain Indices were then combined into an overall Scottish Index of Multiple Deprivation (SIMD).

An introduction to Domains and Indicators

Domains

The domains in the Scottish Index of Multiple Deprivation are Income Deprivation, Employment Deprivation, Health Deprivation and Disability, Education, Skills and Training Deprivation, and Geographical Access to Services.

Each Domain is presented as a separate Domain Index. Each domain reflects a particular aspect of deprivation. Thus the Employment Domain captures exclusion from the world of work and conditions of work – not the low income that may flow from it. The Income Domain can be used separately from the SIMD to examine low income alone. The Education Domain represents educational disadvantage and does not include markers of income deprivation such as ‘children in receipt of free school meals’, as children living in low income families are measured within the Income Domain. This approach avoids the need to make any judgments about the complex links between different types of deprivation (for example the links between poor health and unemployment), and enables clear decisions to be made about the contribution that each domain should make to the overall SIMD.

While the domains represent distinct dimensions of deprivation, it is perfectly possible, indeed likely, that the same person could be captured in more than one domain. So, for example, if someone was claiming Income based Job Seekers Allowance and had no qualifications, they would be captured in both the Income and Education Domains. This is entirely appropriate because one individual can experience more than one type of deprivation at any given time.

Indicators

Each Domain Index contains a number of indicators. The criteria for these indicators were that they should be:-

- ‘domain specific’ and appropriate for the purpose (as direct as possible measures for that form of deprivation)
- measuring major features of that deprivation (not conditions just experienced by a very small number of people or areas)
- up-to-date
- capable of being updated on a regular basis
- statistically robust
- available for the whole of Scotland at a small area level in a consistent form

The intention was to include a parsimonious collection of indicators that comprehensively captured the deprivation for each domain, within the constraints of data availability.
The indicators that were included in the Scottish Indices of Deprivation have been constructed using a range of techniques. Some of the data were obtained at individual level (with due regard to issues of confidentiality) and aggregated to ward level; some were obtained at other levels (e.g. Labour Force Survey Local Authority data) and then ‘modelled down’ to ward level. Postcoded data were assigned to 1999 wards using a postcode lookup table supplied by GROS. The assumption had to be made that postcodes supplied were correct and accurate and they were therefore used as given. As far as possible, all the data included in the Indices relate to April 2001.

The small numbers problem and the shrinkage technique

One problem which had to be addressed at the outset of the construction of the SIMD was the question of how the indicators should be scored or scaled (if at all) to allow fair comparisons between areas and appropriate combination with other indicators. The data were not all in the same units of measurement and if the raw data had been used the results would have largely been driven by the size of the population. For these reasons it was not possible to count the numbers of people experiencing each deprivation and add them together. Instead where possible, rates, or some other standard form of measurement were used which allow areas of different sizes to be compared.

In some areas of Scotland, particularly where populations at risk are small, data can be unreliable with particular wards getting unrepresentatively low or high scores on variables in certain domains. The extent of a score’s ‘unreliability’ can be measured by calculating its standard error.

This problem emerged in the construction of other Indices of Deprivation in the past and this has prompted the use of the signed chi squared statistic (see DETR, 1998; NISRA, 1994). However, this technique has been much criticised for its use in this context because it conflates population size with levels of deprivation (Connolly and Chisholm, 1999). Given the problems with the signed chi squared approach, another technique - ‘shrinkage estimation’ - has been used subsequently to deal with the problem (see Noble, Smith, Wright et al, 2000; Noble, Smith, Penhale et al, 2000; Noble, Smith, Wright et al, 2001).

Shrinkage involves moving ‘unreliable’ ward scores (i.e. those with a high standard error) towards another more robust and appropriate figure e.g. the mean score of the local authority within which the ward is located. This may be towards more deprivation or less deprivation.

The actual mechanism of the procedure is to estimate deprivation in a particular ward using a weighted combination of (a) data from that ward and (b) data from another more robust source (for example the local authority mean). Using this method the estimate for any ward would then, for example, move towards the local authority mean by taking a weighted average of the ward and local authority values, thus reducing any ward-level ‘noise’ caused by small numbers. By this device the unreliability of the ward-level indicator is reduced by ‘borrowing strength’ from a more reliable source thus minimising the effect of random fluctuations and other sources of error. This methodology has a sound statistical basis and avoids the problem of indicator values being linked to the size of the area (scale dependency).

Although all scores move a fraction, only ‘unreliable’ scores, that is those with a large standard error, move significantly. The amount of movement depends on both the size of the standard error and the amount of heterogeneity amongst the wards in a local authority. The shrinkage procedure and formulae are presented in more detail in Appendix 1.
Combining the indicators into Domain Indices

For each domain of deprivation (Income, Employment, etc.) the aim is to obtain a single summary measure whose interpretation is straightforward in that it is, if possible, expressed in meaningful units (e.g. proportions of people or of households experiencing that form of deprivation). In some domains (i.e. the Income and Employment Domains) where the underlying metric is the same and where the indicators are non overlapping the indicators can be simply summed. Where there are several indicators within a single domain that have different underlying metrics and cannot therefore be straightforwardly combined (i.e. the Health and Education Domains), a statistical procedure, factor analysis, can be used to identify weights for each indicator. Factor analysis was also applied to the Access Domain. The domain score is then a combination of the component indicators weighted according to the factor analysis results. For further details on factor analysis see Appendix 2.

Income Deprivation

Income Deprivation: Indicators

- Adults in Income Support households (DWP, April 2001)
- Children in Income Support households (DWP, April 2001)
- Adults in Income Based Job Seekers Allowance households (DWP, April 2001)
- Children in Income Based Job Seekers Allowance households (DWP, April 2001)
- Adults in Working Families Tax Credit households below a low income threshold (DWP, April 2001)
- Children in Working Families Tax Credit households below a low income threshold (DWP, April 2001)
- Adults in Disability Tax Credit households below a low income threshold (DWP, April 2001)
- Children in Disability Tax Credit households below a low income threshold (DWP, April 2001)

Purpose of Domain

The purpose of this domain is to capture the extent of income deprivation in an area.

Background

Income deprivation is now often measured at national level as the proportion of households below a particular low-income threshold. International comparisons frequently use the proportion of households living below fractions of median or mean income (see Bradbury and Jantti 1999). Thus Eurostat has adopted a definition of income deprivation as those living in households below 60% of median income. National and regional estimates of households below fractions of median/mean income invariably derive from large scale surveys. However, such surveys, even those having a reasonably large sample size do not allow reliable small area estimates. Further data on consumption (and wealth) are collected in a variety of social surveys, but not with sample sizes that would allow reliable small area estimates.
However, despite the lack of comprehensive data on income distribution at a small area level, robust data on means tested social security benefits are available which give valuable insights into low income at very small spatial units. The indicators in this domain are in the form of non-overlapping counts of people living in families in receipt of certain means tested benefits. This domain is presented as the proportion of the population of a ward living in families in receipt of these benefits.

**Indicators**

Means tested benefits may be divided into ‘out of work’ benefits, ‘in work’ benefits and benefits which support housing costs.

‘Out of work’ benefits comprise Income Based Job Seekers Allowance (JSA(IB)) for those who are unemployed and Income Support (IS) for other groups such as older people, those with a disability or lone parents. Data for April 2001 were obtained from the Department for Work and Pensions (DWP) for these benefits.

‘In work’ support derives from Working Families Tax Credit (WFTC) and Disability Tax Credit (DTC). WFTC is paid to those in low paid work who have children (both lone and couple parents) as a top up to their earnings. DTC is equivalent to WFTC but for disabled people. Eligibility for WFTC/DTC extends much further up the income distribution than did their predecessors Family Credit/Disability Working Allowance (FC/DWA). Whilst one could argue that all those in receipt of FC/DWA should be counted as income deprived, such an argument is not so easily sustainable for WFTC. However, it is possible to calculate in a modified way whether a particular family has an equivalised income within a particular fraction of national ‘benefit unit’ equivalised mean/median income. The WFTC data as currently extracted has reliable information on earned income and tax credit in payment. No information is available on housing costs or housing benefits. It was nevertheless possible at this stage to calculate equivalised income for ‘benefit units’ based on earnings plus WFTC plus Child Benefit, but excluding housing benefit and other income, and presenting the results before housing costs. The DWP Households Below Average Income (HBAI) Unit were approached to run a national profile on HBAI data using both the modified definition of income and on ‘benefit units’ as distinct from households. In this way they were able to supply a ‘cut off’ level to enable the inclusion within the domain of the population of those ‘benefit units’ below 60% median income before housing costs. Ward level data for April 2001 of WFTC and DTC recipients and their dependants below the 60% median income threshold were obtained from the DWP.

For JSA(IB), IS, and those WFTC/DTC cases below the low income threshold, the population (claimant, any partner plus any dependent children) reliant on the benefit were included in the domain and expressed as a percentage of the total population for the area in question.

In general, the in work and out of work benefits do not overlap. There is a very small contingent of IS/JSA-IB recipients who continue to receive WFTC if they become unemployed during the currency of a WFTC award but these account for very few people and can reasonably be ignored.
Combining the indicators

The indicators in this domain were summed in order to generate the percentage of the total population living in such families. The confidence interval of the proportion was such that ‘shrinkage’ was not necessary in this domain, and the Income Domain score is the unadjusted rate.

Other Issues Considered

Benefit take-up
One of the acknowledged problems of producing a measure of income deprivation using benefits data is that of take-up. The data can easily be adjusted for non take-up provided reliable small area data on take-up are available. Take-up can vary by the type of benefit, the area, the population group (such as pensioners), and over time. The DWP provide data on take-up for different claimant groups at Great Britain level. The latest figures are for 1999-2000 and are not broken down to sub GB level (DWP, 2002). Scotland specific work which is potentially much more useful has also been undertaken (Bramley, Lancaster and Gordon, 2000). Unfortunately this work was carried out on the Scottish House Condition Survey 1996 which pre-dates both the introduction of JSA-IB and WFTC. In sum adjustments for non-take-up could be useful but there are presently the following potential problems:

- Transparency would be lost. Currently this domain represents actual rates of reliance on the benefits in question.
- There are no estimates of take up rates for WFTC – an important component of this domain.
- There are no estimates for Scotland for 2001. The most recent GB estimates are for 2001, the most recent Scottish ones are for 1996.

For these reasons it was decided not to adjust the domain for non take-up, though this issue should be reviewed in possible future revisions.

Benefits relating to Housing Costs
Means tested benefits to support housing costs are Housing Benefit (HB) and Council Tax Benefits (CTB). Most of the recipients of these benefits will be recipients of JSA(IB), IS, WFTC or DTC. There will, however be some who are not, and an investigation was carried out as to whether they could be included in the domain. The Housing Benefit Matching Service of DWP now collects HB/CTB data from almost all local authorities at individual level. These data were obtained from the DWP but after a thorough quality check were found to be not of sufficient quality to include in the domain.
Employment Deprivation

Employment Deprivation: Indicators

- Unemployment claimant count of those aged under 60 (ONS, April 2001)
- Incapacity Benefit recipients aged under 60 (DWP, April 2001)
- Severe Disablement Allowance recipients aged under 60 (DWP, April 2001)
- Compulsory New Deal participants - New Deal for the under 25s and New Deal for 25 + not included in the unemployment claimant count (DWP, April 2001)

Purpose of Domain

This domain seeks to measure enforced exclusion from the world of work. The domain does not seek to capture income deprivation to which joblessness leads, since this is tackled in the Income Deprivation Domain. ‘Employment deprived’ people are thus defined as those who want to work but are unable to do so through unemployment, sickness or disability.

Background

Conventionally employment deprivation is captured by the monthly claimant count. Whilst this is a good starting point it has become increasingly apparent that it does not tell the whole story.

There has been growing concern that measures based on the unemployed claimant count substantially under-estimate the numbers who would work if work were available. Such groups are referred to as the ‘hidden unemployed’. They include those (particularly women) who are seeking work but not registered as unemployed. Some of these people may be captured at Scotland level through the International Labour Organisation (ILO) definition of unemployment contained in the Labour Force Survey. There are also those people on New Deal options who do not appear on the count but who would do so if the New Deal had not been in operation. There are also those people who have taken early retirement. Another group who might be considered are those people who are carers. One of the most significant groups are those people who have moved on to sickness and disability related benefits in the absence of any realistic prospect of finding work (Beatty *et al*, 2002).

Data to tap into some aspects of ‘hidden unemployment’, such as those excluded from the claimant count but within the ILO definition, have proved difficult to obtain at the ward level. However, it is possible to count those people incapable of work through sickness and those on New Deal Options.

Indicators

The ONS supplied claimant count data for April 2001 and the DWP supplied data for the same time point (April 2001) for those on New Deal options.

Those who are workless through sickness can be captured by counting those on Incapacity Benefit (IB) and those in receipt of Severe Disablement Allowance (SDA). If the intention is to measure only ‘hidden unemployment’ then a proportion could be calculated. Otherwise the entire group could be incorporated on the basis that these people all face exclusion from work, whether due to sickness alone or some combination of sickness and labour market conditions. The latter option was selected.
Because men over 60 who are unemployed can choose to receive Income Support rather than Income Based Job Seekers Allowance,¹ the claimant count for men aged 60-64 is an undercount. Women aged 60-64 are not included in the claimant count. Moreover until the publication of the 2001 Census it is impossible to derive a reliable denominator at ward level which distinguishes women 60-64. For these reasons all indicators in the domain have been restricted to people aged 16-59. Furthermore because the domain is wider than simply those conventionally regarded as ‘economically active’ the denominator is all persons aged 16-59.

Combining the indicators

As with the Income Domain, the indicators in this Domain constitute non overlapping counts of those excluded from the labour market through unemployment or ill health. A simple rate was therefore constructed – those people aged 16-59 who are unemployed, on a compulsory New Deal (under 25s or 25+), on Incapacity Benefit/Severe Disablement Allowance, are presented as a proportion of all those aged 16-59.

The small size of confidence intervals across the domain did not suggest that the shrinkage technique needed to be applied and the Employment Domain score is the unadjusted rate.

Other Issues Considered

Lone parents

There is a question as to whether lone parents should be incorporated into the Domain. Lone Parents who are not working have traditionally been regarded as ‘economically inactive’. They are not required to ‘sign on’ to get benefit until their youngest child is aged 16. Those claiming benefit do not therefore count as ‘unemployed’.

This domain is defined to include those who are involuntarily out of employment. Given the formal position of lone parents, how should those on Income Support be treated? Are they voluntarily or involuntarily out of employment? If the former they have no place in this domain. If the latter they should be counted. This is a sensitive issue. It is impossible to tell whether a particular lone parent on IS has decided that she cannot go to work because her children need her care or whether she cannot go to work because she cannot find an appropriate job or childcare (see Evason et al, 1998). Because the position cannot be known with certainty it was decided not to include Lone Parents on IS in this domain though they are, of course, included in the Income Domain.

Regarding participants in the New Deal for Lone Parents the situation is slightly different. On the face of it, such participation need not signify a wish to re-enter the labour market. However, since April 2000 the initial job-focused interview is now compulsory. Though the full NDLP is still ‘voluntary’, this compulsory element re-introduces ambiguity – does a participant lone parent really regard herself as involuntarily out of the labour market or is she going though NDLP because she sees it as essential to guarantee benefit receipt? On this occasion it was decided to exclude lone parent participants of NDLP from the Employment Domain.

¹ This makes no difference to the amount of money they receive, but they no longer have to sign on every fortnight, look for work, or risk being sanctioned.
Health Deprivation and Disability

Health Deprivation and Disability: Indicators

- Comparative Mortality Factor (CMFs) for under 75s (ISD, 1997-2001)
- Hospital episodes related to alcohol use (ISD, 1997-2001)
- Hospital episodes related to drug use (ISD, 1997-2001)
- Comparative Illness Factor (CIF) (DWP, 2001)
- Emergency admissions to hospital (ISD, 1997-2001)
- Proportion of population being prescribed drugs for anxiety or depression or psychosis (ISD, 2001)
- Proportion of live singleton births of low birth weight (<2,500g) (ISD, 1997-2001)

Purpose of Domain

This domain identifies areas with relatively high proportions of people who are losing years of life because of premature death or whose quality of life is impaired by poor health.

Background

While ill health is closely intertwined with other aspects of deprivation, it is also an important aspect of deprivation in its own right. It may require unique policy responses and service provision. It is therefore useful to be able to specifically identify geographical areas of health deprivation.

There is a long history of mapping health. However, this work has tended to focus on mortality and certain acute illnesses. There has been far less work carried out on the small area mapping of chronic illnesses, disabilities and health behaviours. The challenge is therefore to update the traditional indicators with new measures. This has largely been achieved through an exploration of various administrative data systems such as prescription, hospital and social security benefit databases.

A number of techniques have been developed to deal with particular problems encountered when constructing indicators of poor health for geographical areas with varying demographies and populated by small numbers of people. These methods include age-sex standardisation and the shrinkage technique. The latter is used for improving the estimate of a rate in an area with a small population.

Indicators

Comparative Mortality Factor for under 75s

When calculating measures of mortality and morbidity for wards, it is necessary to standardise the measures for age and sex to avoid them simply reflecting local demographic profiles. Traditionally indirect standardisation has frequently been used to produce, in the case of mortality measures, a Standardised Mortality Ratio (SMR). However, the literature has consistently pointed out the problems associated with using indirect standardization (see Yule, 1934; Kilpatrick, 1959; Freeman and Holford, 1990; Julious et al, 2001; Sutton et al, 2002). Direct standardization methods have been employed in this Domain to produce a Comparative Mortality Factor. Appendix 3 outlines the arguments and procedures for adopting this approach. This indicator was constructed for people under 75.
Hospital episodes related to alcohol use
Excessive alcohol consumption has both short and long-term health consequences on an individual’s mental and physical health. In order to measure alcohol abuse rather than use, acute and psychiatric discharges from Scottish hospitals that could be linked specifically to alcohol were extracted from hospital episode statistics (HES). This included, for example, cases of mental and behavioural disorders due to the use of alcohol, poisoning and exposure to alcohol, and foetal alcohol syndrome. It is possible that this measure is affected spatially by service provision and could over or under count all users; however it should not do so for seriously ill users which is the focus of this indicator. The relevant hospital discharges across Scotland were assembled for a 5 year period. The discharges were linked to ward of residence, and a rate was calculated for the estimated resident population in 2000.

Hospital episodes related to drug use
Drug abuse has a significant physical and psychological impact on individuals. It is an especially significant health hazard for younger people, and a major cause of premature death (General Register Office for Scotland, 2001; Jackson, 2002). A count of those admitted to hospital because of their drug use was calculated. Again, it is possible that this measure is affected spatially by service provision, so for example, if drug services are developed differently in different areas, fewer users might then be hospitalised. The advantage of using the hospital data for a measure of the health impact of drug use is that it is known that all those counted are in a poor state of health. Hospital data may lead to an over or under count of all users but not of seriously ill users. The relevant hospital discharges across Scotland were assembled for a 5 year period. The discharges were linked to ward of residence, and a rate was calculated for the estimated resident population in 2000.

Comparative Illness Factor
There are few small area measures of chronic health conditions and yet they affect a large proportion of the population. The census count of long term limiting illness introduced in 1991 represented a major step forward in the measurement of this important aspect of health deprivation. Unfortunately the only indicator available to this project was the 1991 Census which was felt to be too out-of-date to be used. Instead a new measure using health related benefits was created. This combined information on people receiving Disability Living Allowance (DLA), Attendance Allowance (AA), Incapacity Benefit (IB) and Severe Disablement Allowance (SDA).

DLA is a benefit for those severely disabled people under 65 needing help with personal care or with mobility needs. AA is an equivalent cash benefit for people aged 65 or over who need help with personal care but not for mobility needs. People over 65 can receive DLA for mobility needs providing that they were receiving it before they were aged 65. IB is a non-means tested benefit paid to people who are unable to work due to ill health but have paid sufficient National Insurance contributions. SDA is a similar benefit given to people who have paid insufficient contributions to qualify for IB.

Because the sets of benefits overlap, it is not possible simply to combine the counts into a single measure. This would lead to individuals being double counted. It would have been possible to calculate two rates for individuals receiving health and disability related benefits: one to measure the proportion of economically active individuals who could not work because of their health, and the other to measure the number of people who received benefits because of their care and mobility needs. However,

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2 For a full list of the cases covered, see Appendix 4.
3 SDA is no longer available to new applicants.
improvements in the health related social security data available mean that a single non-overlapping count of individuals receiving one or more health related social security benefit can now be calculated. Individual records were linked and those identified as receiving more than one benefit were counted only once.

The counts produced were then age and sex standardised using the direct method outlined in Appendix 3, generating the Comparative Illness Factor (CIF).

**Emergency admissions to hospital**
Emergency admissions into hospitals capture, amongst other things, two important aspects of health deprivation: externally caused injuries (e.g. accidents or violence) and poorly responding or untreated conditions. The fact that they are emergency admissions is an indicator of their immediate severity.

The measure used was based on a count of those admitted to Scottish hospitals over five years. Discharges, excluding transfers within hospital or to another hospital, from this group were then linked to their resident wards and rates were calculated based on the resident population in 2000.

**Proportion of population being prescribed drugs for anxiety or depression or psychosis**
Mental health problems affect a large minority of people across Scotland. In some wards over half the population will be experiencing some form of mental ill health. It is therefore an important element of health deprivation to measure. ISD hold a dataset containing a list of drugs that were prescribed by GPs during 2001. From this, all prescriptions relating to anxiety, depression and psychosis were extracted. An average daily quantity (Defined Daily Doses - a World Health Organisation standard) for each drug was used to calculate, from the weight of the total prescriptions, an average count of people being prescribed any one of these drugs. The one year of data was treated as a sample from time. If, for example, a person was given a one week prescription by their GP they should appear 52 times within the year. Each prescription would therefore be counted as 1/52 of a person. By summing the whole year one person would be counted. The method of attributing prescription information to ward level involved linking the individual prescription to a GP practice, and calculating a rate of drug prescription for the practice. This practice rate was then distributed to each person attached to the practice using ISD’s practice to patient lookup. The ward level score for this indicator was produced by aggregating the practice rates (now linked to an individual) to a ward, and calculating the mean rate for each ward.

**Proportion of live singleton births of low birth weight**
Low birth weight (under 2500 grams) is linked to increased morbidity and mortality in infancy. It is also linked to long-term health problems, such as hypertension, coronary heart disease and type II diabetes. Low birth weight is therefore a useful indicator of health deprivation amongst the very young and is also linked to poor maternal health.

The indicator used here combined 5 years of data and was a count of all singleton births that were less than 2500 grams. The denominator was all singleton births. The resulting proportion had the shrinkage technique applied to it.
Combining the Indicators

Combination followed two steps:

All the variables were converted to the standard normal distribution based on their ranks. These new scores were then factor analysed (using the Maximum Likelihood method) deriving weights for their combination.

The variable’s ranks were transformed rather than using their raw values, to avoid outliers, possibly resulting from measurement error, having a disproportionate affect on the overall ward scores. The standard normal distribution was chosen as the suitable distribution because there was no ‘natural’ distribution amongst the variables and because factor analysis (as a parametric based technique) assumes a normal distribution. The first factor explained 57% of the variance and appeared to be a suitable summary measure across all the indicators.

The weights that were derived from the analysis are shown below.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMF</td>
<td>0.13</td>
</tr>
<tr>
<td>Alcohol abuse</td>
<td>0.12</td>
</tr>
<tr>
<td>Drug abuse</td>
<td>0.11</td>
</tr>
<tr>
<td>CIF</td>
<td>0.39</td>
</tr>
<tr>
<td>Emergency admissions to hospital</td>
<td>0.10</td>
</tr>
<tr>
<td>Depression, anxiety and psychosis</td>
<td>0.08</td>
</tr>
<tr>
<td>Low Birth Weight</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Other Issues Considered

Cancer registration
Cancer registrations were considered as a possible health deprivation indicator. Cancer is not only a major cause of premature death in Scotland, it is also an illness that causes considerable physical and psychological distress to those suffering from it. However because premature deaths caused by cancer would be included in the CMF calculation and individuals who could not work or needed care because of cancer would be counted in the CIF, it was decided that a separate measure was not needed.

Smoking
It can be argued that smoking is an important aspect of health deprivation because of its impact on health – half of long-term smokers will die from conditions related to their habit – losing some 20 to 25 years of life (Bobak et al, 2000). There are no comprehensive datasets on smoking behaviour at a small area level. Any data collected at a primary care level is not gathered centrally and no surveys are large enough to estimate local rates. However women, at the start of their pregnancy, are asked whether they smoke or not. The use of this data was explored for use in the Index. Unfortunately, although this data appeared to present good proxy information on smoking across Scotland, recording errors in a few areas meant that, even had it been considered as an appropriate indicator of health deprivation, it could not be used within the Health Domain.
Education, Skills and Training Deprivation

Education, Skills and Training Deprivation: Indicators

- Pupils aged 16+ who are not in full time education (DWP, 2001)*
- Proportions of the 17+ population who have not successfully applied to Higher Education (UCAS, 1999-2001)*
- Pupil performance on SQA at Stage 4 (SQA, 2001)
- Secondary level absences (Scottish Executive, 2000/1)

* These two indicators were combined

Purpose of Domain

The central purpose of the Education, Skills and Training Domain is to measure in as consistent a way as possible the key educational characteristics of the local area that might contribute to the overall level of deprivation and disadvantage. Many previous attempts to measure educational deprivation at the local level have tended to include both social and educational measures, typically using indicators such as free school meals as a proxy for income deprivation. On the basis of the approach that has been adopted for the Scottish Index of Multiple Deprivation, ‘free school meals’ is not needed in the Education Domain, as the Income Domain captures children in families receiving Income Support (IS) or Income-Based Job Seekers Allowance (JSA(IB)), which are the eligibility criteria for receiving free school meals. Low income is certainly a correlate and probably, in part, a cause of educational deprivation but it is not a direct measure of educational deprivation as such.

Background

Most measures of educational deprivation have tended to focus predominantly on the school age population. Yet pupils at school represent only one part of the population, which might contribute to the overall educational deprivation of the area. Results from school examinations cover only one particular age cohort, many of whom are likely to move out of the area once they become adults. For this reason the aim of this Domain was to extend the scope to include some measure of the adult population’s educational capacity.

Many of the items that were reviewed for the education domain dealt with educational performance, measured by examinations and qualifications. The debate on the meaning of educational disadvantage has increasingly focused on educational results, rather than other possible indirect proxies for educational quality (e.g. pupil teacher ratios). Inevitably the final choice of indicators is in part constrained by what is currently measured and assessed. Though there is some legitimate debate about ways of measuring educational performance, conventional measures of educational attainment and formal qualifications are clearly not only valued within education, but also by the job market and wider society.

It may be argued that to include data on educational performance in this Domain could penalise schools in disadvantaged areas that do well, or conversely reward under-performing areas and their schools. While there may be some unfairness here (effort is not rewarded), the objective fact is that, if - for whatever reason - one area has better educational results than another that may be less disadvantaged in other respects, then this area is less educationally deprived. This has to be correct for the Education Domain. Other forms of economic and social deprivation will be picked up by other domains and measures.
In many cases measures of provision, such as preschool facilities, teacher numbers etc. are themselves influenced by existing allocation policies that may provide extra resources for disadvantaged areas. They are thus likely to be poor indicators of such deprivation.

**Indicators**

Data for the Education Domain came from a number of different sources. It can be grouped into three types: data from outside the school system, individual level information about pupils which can be directly attributable to the local level, and school level aggregate information that has to be allocated to the local area.

**Data from outside the school system**

*Working age adults with no qualifications*

Four separate annual extracts (1996-2000) of the national Labour Force Survey (LFS) at individual level, with a local authority level flag (the so called ‘LFSLA’), were combined into a single data set. A regression model was developed to predict the proportion of working age adults with no qualifications. The model was then applied to 1991 Census data at ward level, substituting the LFS variables with the appropriate variables from the 1991 Census. The resulting estimates at ward level were converted to the 1999 ward boundaries and adjusted to fit the local authority level estimates obtained from the LFS. The measure used is the estimate of the proportion of the adult population of working age (25-59) who have no qualifications.

The 2001 Census contains a direct measure of adult qualifications. This could, in due course, replace these ward level LFS derived estimates.

*Pupils aged 16+ who are not in full time education*

Child Benefit (CB) continues to be paid to carers of pupils in full time non-advanced education (school and Further Education college) up to the age of 18. The declining numbers of young people aged 16+ getting this benefit is thus an indicator of the numbers staying on in full time education above the statutory age in each area. However there are some problems with the data. First, it is difficult to ascertain whether young people aged 16 years in this data set are above or below compulsory school leaving age. The response in other Indices for other parts of the UK has therefore been to focus on those aged 17 and 18. However, a significant proportion of this age group in Scotland will have entered Higher Education. For these reasons it was decided to use the 16+ numbers on Child Benefit as the numerator. The denominator is also derived from the Child Benefit system, but is based on a younger age group as a ‘proxy’.

The final indicator used is the negative of the direct measure (i.e. those NOT staying on), on the grounds that this represents a measure of how far pupils in the area persist in education beyond the minimum level. This indicator was merged with the indicator of the proportions of the 17 and over population who have not successfully applied to higher education, before being factor analysed.

*Proportions of the 17+ population who have not successfully applied to Higher Education*

Data from the University and Colleges Admissions Service (UCAS) covering all applicants to Higher Education from postcodes in Scotland were obtained for three successive years at individual level (1999, 2000, 2001). This data is very well postcoded. A small number of cases were added in from England (as having a home postcode in the relevant country was the criteria - rather than national identity). Only successful applicants were retained (the acceptance rate varies at around approximately 80%). Also, those
applying from institutional postcodes were removed. This process in fact removes relatively few cases in Scotland, typically less than 2% of successful applicants in any year. There are between 25,000 (1999) and 27,000 (2001) successful applicants of all ages each year.

UCAS applications cover the full age range. As mature students would be more likely to apply from their own address, the upper age point was set at a point that included the majority of entrants straight from secondary level. Setting the upper age point at 19 years (i.e. under 20) includes 72% of all successful applicants in Scotland. Again the denominator at local ward level has drawn on the Child Benefit data for 2001, and last three year groups of compulsory schooling have been used to match the three years of UCAS data.

The final indicator used is the negative of the direct measure (i.e. those NOT getting into Higher Education). This indicator was merged with the indicator of the pupils aged 16 and over not in full time education, before being factor analysed.

**Postcoded School Data**

**Pupil performance on SQA at Stage 4**

Data for the total SQA (Scottish Qualification Agency) results (all age groups) was obtained for the year 2001 in individual format from the SQA, with detailed results and a computed points score using the ‘Unified Points Scoring System’. This data was very well postcoded, principally to a home address (or domestic postcode). In the final stages a small number of cases which had identical postcodes to their own school were excluded, as were others with clear institutional addresses. Pupils with postcodes outside Scotland and from overseas (e.g. in the Independent sector) were also excluded.

Results for different Stages were examined to see whether younger or older age cohorts should be included. It was decided to focus on Stage 4, as younger pupils who take SQA assessments at earlier stages appeared to have lower points scores (suggesting that they were only taking some preliminary examinations). Older age groups might have been those adding to or enhancing earlier scores. Using Stage 4 pupils only meant that the SQA results contained some 61,000 cases. All SQA cases also had a school (centre) code.

Data was obtained on individual school rolls and other details for Stage 4 pupils in academic year 2000-2001 for all Scottish secondary schools, including independent and special schools. This data was then matched with the school aggregate information obtained from the SQA data to see how far there were pupils in Stage 4 in these schools who did not appear in the SQA results. This comparison allows some account to be taken of the residual ‘non-exam’ group. This needs to be taken into account, as it is possible that schools in some areas could submit a smaller proportion of their pupils for SQA. Though it is not possible to identify where these ‘non exam’ pupils reside, it is possible to weight the results according to the proportion of Stage 4 pupils not appearing in the SQA 2001 results for that particular school.

**Special schools:** A proportion of pupils from special schools take SQA qualifications. They make up less than 1% of the total in the SQA data. Typically these pupils turn out both to have rather low scores and also, when they are linked to school level data, the proportions in their school in Stage 4 appearing in the SQA data is also often low. After reviewing several options it was decided to retain the results for the pupils in special schools with SQA results, but to take no account of the non-exam pupils in such schools as the effect on a few wards was very substantial.

**Independent Schools:** a larger group of pupils in the SQA data are from the independent sector (including a few independent special schools). There are 2,600 such pupils in the 2001 data set (4.3%). Schools were
excluded which contained no or very few pupils who took the SQA.\textsuperscript{4} In addition schools that had apparently high take up rates of SQA but very low results (suggesting partial take up of SQA only) were excluded by cutting out those where the school aggregate score was less than the SQA average for all secondary schools (160 points on the unified points score). This procedure cuts out only a small number of additional cases. In the retained cases, pupils in independent schools were also set to a weight of 1. As with special schools, this meant that the pupils not entered for exams were ignored.

The average unified points score for each ward was the indicator used.

**School Level Aggregate Information**

*Secondary level absences*

Data was obtained on secondary levels absence details for all maintained Scottish secondary schools for academic year 2000-2001. Independent schools were not included in this data. This data takes the form of ‘authorised’ and ‘unauthorised’ absences and is also expressed in terms of the average number of half-day absences per pupil. The data covers S1-S5, but was only available as a school aggregate score. It was decided to use both the authorised and unauthorised absence figures combined, as both in some senses constitute missing education. The method used to ‘unbundle’ this information to local ward was based on the postcoded SQA data. The school average absences (combining both authorised and unauthorised absences) were allocated pro rata to the wards in which the S4 SQA pupils were located. The ward score is the combined aggregate of these individual pupil values. One issue with this data is that as it is not recorded at all for Independent schools, a few wards are based on very small numbers of pupils. Independent pupils constitute about 4% of pupils overall in the SQA data. A large number of wards have close to zero percent of such pupils, while a small number have more than 35% (and up to 70% in one case). For some of these wards the absentee rate may therefore be based on scores for a minority of pupils, who may be atypical of others in the same ward. However such wards are less likely to be at the deprived end of the distribution.

**Combining the Indicators**

Shrinkage estimation was applied to all indicators in the Education Domain, with the exception of the adults with no qualifications. This indicator has already been ‘shrunk’ to a notional local authority score as part of the estimation procedure.

The indicators have varying distributions so they were ranked and then transformed to a standard normal distribution.

Factor analysis was then undertaken on the five candidate variables in their ‘shrunk’ format. All five variables had significant correlations at ward level. The association between the UCAS data and staying on at school was among the highest correlations, with the absentee data having a lower value. As the UCAS data and the staying on rate had different enumerators but the same denominator (Child Benefit) it was decided to combine these into a single variable in the final step of the factor analysis. The argument was that if in areas with small populations this denominator either understated or overstated the correct figure then the combined effect of both variables could have a powerful effect on the final position. It was finally decided to proceed with the five variables reduced to four, by combining the UCAS and staying on rates variables on the grounds that they represent very similar measures and use the same denominators.

\textsuperscript{4} Such schools were identified using the Scottish Executive Statistical Bulletin (27 November 2002) *Examination Results in Scottish Schools 2000-2002* Table 5 for Independent Schools.
The factor analysis indicates a robust single factor solution, with no evidence of a second factor. This single factor explains approximately 60% of the variance and has strong correlation with all the variables in the domain.

Using the results from the factor analysis, the indicators were then combined using the weights derived from the factor analysis. The weights that were derived from the analysis are shown below.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary level absences</td>
<td>0.06</td>
</tr>
<tr>
<td>Pupil performance on SQA at Stage 4</td>
<td>0.65</td>
</tr>
<tr>
<td>Working age adults with no qualifications</td>
<td>0.13</td>
</tr>
<tr>
<td>Proportions of the 17+ population who have not successfully applied to Higher Education combined with pupils aged 16+ who are not in full time education</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Other Issues Considered

Consideration was restricted to strictly educational variables. As noted, ‘resource based’ measures were not included, as their distribution might already reflect policies to distribute resources differentially to more disadvantaged areas or schools.

A number of school level variables were also considered. These could in principle have been ‘unbundled’ to local ward using the distribution of SQA candidates, though they would therefore have to have been restricted to secondary level. However several of these (exclusions, special needs) cover only a small proportion of pupils, and it is difficult to be sure how these should be attributed to local neighbourhoods.

With individual pupil level information being collected across all schools in Scotland in autumn 2002, including a full pupil postcode, there will, in future, be increased scope to use such school based information routinely to measure the characteristics of local areas. This was not available for the present study.
Geographical Access to Services

Geographical Access to Services: Indicators

- Road distance to a GP surgery or health centre (ISD, 2002)
- Road distance to a general stores or supermarket (Market Scan, 2002)
- Road distance to a primary school (Scottish Executive, 2001)
- Road distance to a petrol station (Retail Locations, 2002)
- Road distance to a bank or building society (Retail Locations and Market Scan, 2002)
- Road distance to community internet facilities (Scottish Executive, 2001)

Purpose of Domain

The purpose of this domain is to measure the extent to which people have poor geographical access to key local services. The indicators selected relate to health, food, finance, education, fuel and communication.

Background

Poor geographical access to services is treated here as a component of multiple deprivation as it captures an additional aspect of what it is to be multiply deprived. This domain has also been included in the most recent Indices of Deprivation for England, Wales and Northern Ireland.

The domain measures aspects of access deprivation that are relevant to all people. It is important to be able to access key local services in both rural and urban areas.

As a relative newcomer to the measurement of multiple deprivation, this domain could be refined in the future, to take into account the availability of public and private transport in some way, for example. However, even without such refinements it is already a robust and important component of the Scottish Index of Multiple Deprivation. The datasets of the location of services represent the best available at the time (for further details see Scottish Executive, 2002b).

Indicators

Road distance to a GP surgery or health centre

It is essential that people have easy access to a GP surgery or health centre. These provide people with vital primary health care and are often the first ports of call for people with health queries. Over a thousand such sites were used for this indicator.

Road distance to general stores or supermarkets

All households need access to a general store or supermarket for their food and other household provisions. This enables people to sustain a healthy diet. Over three thousand sites were included for this indicator.

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5 Bramley and Ford (2001) found that doctors, supermarkets and banks/building societies were used by virtually all households, and petrol stations by almost 80%.
Road distance to a primary school

Primary schools are a key service for all children aged 5-8. If children have to travel a long distance to their primary school it adds significantly to the length of their day. Also, though school buses are often provided, it remains difficult for parents to collect their children at other times in the day, for example at the end of an after school club. Over 2000 primary schools were included for this indicator.

Road distance to a petrol station

Access to petrol stations is essential for car owners as a source of fuel, but petrol stations often also sell other commodities such as basic food and health related items (e.g. milk, bread, pain killers). Because of their location, petrol stations can be particularly important for people who live in small rural settlements or in places where there are no alternative outlets that provide similar services. Just under 700 petrol stations were included for this indicator.

Road distance to a bank or building society

Banks and building societies offer a variety of financial services and help people, in general, to manage their financial affairs more effectively. About 1400 banks or building societies were used for this indicator.

Road distance to a community internet facility

Although a luxury commodity some years ago, the internet has become a very useful source of information and services, as well as an increasingly used method of communication. The high cost of PCs prohibits some households from obtaining computers and internet access within the home, making the internet facilities provided for community use particularly important. The Scottish Executive supplied the locations of over 650 community internet facilities within Scotland for this indicator.

Distance Measurement

The distance to the nearest service of each type was measured from the population weighted centroid of each Output Area (OA) in Scotland.6 Distance was measured by road, and was rounded to the nearest 10 metres. The distance was measured on the basis that the shortest travel time is preferable, so motorways, A roads and B roads were prioritised over unclassified roads – in practice for most cases the quickest distance was also the same as the shortest distance.

For islands which do not possess a particular service, the road distance was measured to the island’s port; the sea distance from that port to the port of the nearest place that does possess the service was measured, using ferry route data supplied by the Scottish Executive; and then the road distance from this port to the service was measured. This was as refined as it was possible to make the model: in practice though, people on unserviced islands will also be dependent on regular ferries or air travel (and indeed on the weather conditions).

Ward level indicators were created by averaging the distances from each OA centroid within a ward to a particular service.

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6 OA centroids were created by averaging the x and y coordinates of the grid references of residential address postcode centroids which fell within the OA. OAs were assigned to the ward in which their population weighted centroid fell. In total, 37,743 OAs were used in the analysis.
Combining the Indicators

The indicators were ranked, transformed to a normal distribution and combined using weights which were generated by factor analysis. This was a single factor model, with 68% of the variance explained by the first factor. The weights are as follows:

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road distance to a GP surgery or health centre</td>
<td>0.187</td>
</tr>
<tr>
<td>Road distance to a general stores or supermarket</td>
<td>0.251</td>
</tr>
<tr>
<td>Road distance to a primary school</td>
<td>0.122</td>
</tr>
<tr>
<td>Road distance to a petrol station</td>
<td>0.110</td>
</tr>
<tr>
<td>Road distance to a bank or building society</td>
<td>0.184</td>
</tr>
<tr>
<td>Road distance to a community internet facilities</td>
<td>0.145</td>
</tr>
</tbody>
</table>

Other Issues Considered

Indicators held by the Scottish Executive that were not included

The Scottish Executive possess data on a range of other services. The services that were included within the domain were selected by the research team and the Steering Group as key services of relevance to all people within Scotland.

Access to Private Transport

Data on car ownership were considered. However, further analysis would need to be undertaken to gauge the meaning of such an indicator or weight. For example, by treating non ownership of a car as a form of access deprivation, this runs counter to the efforts in many areas to reduce car use by improving public transport provision. Conversely, a recent ONS report found that the proportion of people who claim to have some difficulty in households without a car is nearly twice as great as those with a car (Ruston, 2002).

Access to public transport

Public transport is a key service used by the population at large. Moreover, good access to public transport for everyone reduces demands on the road networks and encourages more environmentally friendly practices. Local buses are the cheapest modes of public transport. Nevertheless, measuring access to local bus services is a complicated task since it involves looking at different aspects of one’s journey such as walking distance to the nearest bus stop, total travelling time to destination including changes, frequency of bus services to certain destinations, and so on.

The 1999, 2000 and 2001 Scottish Household Surveys were investigated for information about the transport habits of adults in Scotland, in the hope that an appropriate measure of access to local buses could be calculated. Though the ‘travel diary’ section contained detailed questions about frequency of buses and distance to bus stops, an indicator (or weight) could not be created for a number of reasons. For example, there were only a very small number of respondents in some wards; a ward level measure of this sort would fail to take into account variation in bus routes and provision (including frequency) within wards; there was not sufficient information to determine an appropriate cut-off point for respondents in a ward saying that they had frequent buses, nor for the weight to be assigned to wards with infrequent buses.
However, a database is in the process of being constructed which will contain the grid references of all bus stops in Scotland. This will be a useful source of information for future attempts to measure access to public transport in Scotland.

**Options for Measuring Distance**

Alternative ways for measuring distance to services have been explored. For example, the measurement of drive time rather than road distance was considered. The Scottish Executive and SEGIS could have provided information on drive time in the form of travel time zones around services. However this package is limited in the amount of data it can process at any one time. Also, it was decided that it would be best to retain the detail of the actual distance that needed to be travelled.

**Non Geographical Barriers to Access**

Non geographical barriers to access were considered. Access issues relating to mobility and language were considered as well as the provision of culturally appropriate services. However it was not possible to obtain adequate indicators for inclusion in the Domain.
Other Domains Considered

Housing Deprivation

There is rightly a great concern to measure housing deprivation, to help to inform policy, and to target particular groups of people. There is more than one potential approach to the measurement of housing deprivation, and many possible indicators. One approach might be to focus on the provision and accessibility of housing, while another might be to identify poor quality housing. Indicators might include measures relating to vulnerability in the housing market, access to suitable housing, and the special needs of certain groups to have safe and appropriate housing (children and disabled people for example), as well as housing in need of urgent repair, or in a potentially health-damaging condition. However, up to date data to address these issues were not available at ward level for the whole of Scotland and as a result, no housing domain was produced for the Index. This chapter describes previous approaches to measuring housing deprivation in Scotland, and the data sources investigated for the new Index.

The most recent Scottish Area Deprivation Index was commissioned by the Scottish Office in 1998 and completed by the Department of Urban Studies at Glasgow University. This built on the existing Index of 1995, which was wholly derived from the 1991 Census. The 1998 Index included both census indicators, and more up to date and direct measures of deprivation, and was constructed at postcode sector level. The housing related indicators in the 1998 update were overcrowding (households in permanent buildings who are below the occupancy norm relative to all households in permanent dwellings, 1991 Census); lack of amenities (households in permanent buildings lacking exclusive use of bath/shower/insider WC relative to all households in permanent dwellings, 1991 Census); and vacant dwellings (household spaces classified as vacant accommodation or other, relative to all household spaces, 1991 Census). However, due to the procedure used in constructing the Index, in the final multiple deprivation measure, of the housing related indicators, only the overcrowding measure contributed to the overall score.

With the release of data from the 2001 Census, it will be possible to update the variables used in the 1998 Index. However, although comprehensive, the Census by its nature is not capable of being updated as frequently as might be useful for policy and planning initiatives. Over the next two years housing related neighbourhood statistics will be developed under the guidance of the Neighbourhood Statistics Housing Working Group, part of the Built Environment Statistics Advisory Committee of the Scottish Executive. It is planned that this will result in a substantial number of valuable indicators becoming available at sub-local authority level, such as the number of dwellings in each ward by council tax band, the number of vacant and void houses, housing demand, social rented sector rents, houses in multiple occupancy, tenure, and age of dwelling. These data will help in many areas of planning, regeneration, and social justice. Some of this information will be made available with the release of data from the 2001 Census. However, much of it will need to be collected from local authorities or other local organisations. This means that the projected timetable for the collection of the data does not anticipate completion before 2004.

Clearly, not all of the indicators collected will be measures of ‘housing deprivation’, although each may contribute to the development of housing deprivation indicators. In addition, even when more data are available, future versions of an Index of Multiple Deprivation will need to address which sorts of housing deprivation are best combined together. For example, it may not be best to combine a measure of poor condition housing with a measure of affordability, as the first indicator is a gauge of the housing stock, whereas the second reflects access to housing, or even the relative desirability of an area. The coherence of the measures will need to be carefully considered.
Data sources considered

Because the data from the 2001 Census will be released in 2003, it was not considered appropriate to incorporate housing indicators from the 1991 Census in the housing deprivation measure. Several other issues were considered in relation to housing in Scotland.

The Scottish House Condition Survey
In the Welsh Index of Multiple Deprivation and the Northern Ireland Multiple Deprivation Measures the housing domain was conceptualised as housing ‘stress’ and focused on the condition of the housing, rather than the situation of the residents. These domains therefore measured key aspects of poor housing, which may or may not ‘map onto’ other aspects of deprivation. It was judged that whatever the tenure of the house, or the status of the household, living in housing which is in a poor state was itself a deprivation. By showing that a ward contains housing with a low ‘Housing Stress’ score, there was no implication that this ward (and individuals within the ward) was not deprived in other ways, or that the ward was privileged.

Analysis was therefore undertaken using the 1996 Scottish House Condition Survey (SHCS) to see if indicators from the survey could be used to form a ‘housing stress’ domain for the Scottish Index. Before the release of the 2001 Census the survey is the most up to date data that covers the whole of Scotland, and it has relevant information about the condition of housing across all of the housing types and tenures. The survey carried out a household interview and in a large proportion of cases a physical inspection. This analysis followed work for the Northern Ireland Multiple Deprivation Measures’s Housing Stress Domain where indicators from the Northern Ireland House Condition Survey were used to provide estimates of poor housing at ward level (see Noble, Smith, Wright et al, 2001; Northern Ireland Housing Executive, 1998).

However, after the results were extensively reviewed by Communities Scotland and the Scottish Executive, the indicators used in the analysis were dropped. None of the indicators was felt to be sufficiently robust to be used as a measure of housing deprivation. Also, the number of sample points in some areas was too low to be confidently used at ward level to measures housing stress. In addition, as the survey is over five years old, significant changes in the housing stock have occurred in parts of Scotland, and this invalidated the results in several areas.

Homelessness
Local authorities in Scotland produce figures for housing applications for their area every quarter. These figures are published and publicly available. However, no sub-local authority level data are available for housing applications. A new initiative has been set up whereby for each application for housing, the postcode of the applicant’s last dwelling will be collected. When it becomes available, this information will give a good picture of the areas in which households are experiencing difficulties in securing housing, or where homeless households have come from, at a sub-local authority level.

If data on households in temporary accommodation were available, this might go someway to establishing the extent of homelessness in an area, such as a local authority. In fact, households in temporary accommodation are difficult to record as they may only be in one locality for a short time. In addition, as it is often the case that households find temporary accommodation in areas away from their initial home, at small area level a figure of households in temporary accommodation might be more a reflection of the availability of temporary housing, or local policy.
Affordability
The lack of affordable housing in many areas is an increasing concern. Not only does it restrict the ability of people to live near work or family, but it can also contribute to household overcrowding. However, it is very difficult to compose a standard measure of affordability, as it relates to several factors: the composition of the dwelling stock, the costs of renting or buying a house, and household income. This is also being addressed by the Neighbourhood Statistics Housing Working Group.

Scottish Household Survey
The latest Scottish Household Survey was carried out in 2001 and is therefore relatively up-to-date. It contains variables relating to tenure, household composition, shared amenities and room to person ratios. However, although this would potentially provide information about some aspects of housing deprivation at a local authority level, because of the sample design employed, it is not possible to produce unbiased scores below the LA level. In the absence of ward level indicators, it is not possible to model down any LA scores to the ward level.

Crime and Social Order
Crime and social order are important elements in measuring deprivation at the small area level. Ideally, they would be included in an index of multiple deprivation to help to inform policy and local initiatives. Unfortunately, robust small area data on crime or social order for the whole of Scotland were not available to enable the inclusion of this domain in the Index of Multiple Deprivation. Numerous possible data sets and methodologies were explored. A number of developments are in progress to improve the standardising of crime recording practices, and it is hoped that these advances will enable future updates of the Index to incorporate crime and social order indicators.

Although police data is clearly an important indicator of levels and trends in crime and disorder, other partner agencies also collect a great deal of data relevant to this domain. Ideally, any Crime and Social Order Domain would include data relating to the occurrence of crimes and incidents (i.e. where, when and what type), the offender (who and where) and the victim (who and where). Another valuable input would be data relating to fear of crime and the perception of community disorder.

Police Data
Although advances in the standardised recording of police data are underway, there are still several difficulties to be addressed before the data will be available at small area level for the whole of Scotland. These include questions of geography, recording and access to sensitive information.

Police data on crime is collected at local authority level for the whole of Scotland and published by the Scottish Executive at national level. However, similar data at electoral ward level are not available in a consistent form across the eight Police Forces in Scotland. The aggregation of recorded crimes to geographies other than beat areas is not undertaken regularly and beat boundaries themselves are not normally contiguous with ward boundaries.

Even if police data were available at ward level, there are issues on how best the data could be interpreted. The process of recording a crime – from it being reported by a member of the public or a Police Officer, to it being a recorded crime statistic – is not consistent across Forces. A number of stages are involved in the process, and these stages are not presently standardised across Scotland. For instance, the degree and accuracy of geo-coding of crimes varies across the eight Police Forces, and varies by crime type. Some Forces task one or more officers with manually amending incorrect geographical
information. This can involve simply correcting the police beat code to which the crime is allocated. The accuracy of the grid-reference attributed to a case may also be variable.

Investigations were also made into the availability and quality of ‘Command and Control’ data (a record of each crime and incident reported by a member of the public over the telephone). It was not possible to access this data for the whole of Scotland and there is evidence that the data are not of sufficient quality to incorporate into an index at present. The data suffers from variability in the accuracy and consistency of geographical coding. In addition, it is not representative of actual crime levels. For instance, a Force’s ‘Command and Control’ system may record a car backfiring once as gunshots (if several people report it).

All UK Police Forces are in a state of transition from the fragmented data management structure of the past to the new centrally coordinated National Intelligence Model (NIM). The NIM promotes the sharing of intelligence between Forces to combat not only localised crime, but also cross-border and international crime. The outcome of the NIM, the National Intelligence Database, is expected to be fully operational within 2-3 years. Access to data collected in this way would be of great benefit to future updates of the Index.

Fire Service Data

Data on the occurrence of malicious fires and false call-outs were identified as good indicators of social disorder. Previous research has shown that, when combined together, malicious property fires, malicious vehicle fires, malicious small fires (e.g. rubbish fires) and malicious false call-outs, correlate well with other crime and social order indicators at small-area level.7

Several Scottish Fire Services were contacted and requests submitted for data. However, due to the protracted Fire Brigades Union strike action during 2002, the Fire Services were unable to extract, format and provide the data to the Index Team within the specified time period. It is hoped that future updates of the Index would be able to utilise such data within a Crime and Social Order Domain.

Offender Data

Offender data has been considered as a possible source of indicators for a Crime and Social Order domain. The incorporation of offender data into the domain might be a valuable addition as it locates the offender in terms of their home (or temporary) address rather than the location of the crime itself. Offender data therefore avoids the problem often encountered with recorded crime of certain crime types being concentrated in city/town centres. For example, violent crime (such as wounding) is often alcohol-related and occurs at night in city/town centres. A further example is car crime, which may be concentrated in particular city/town centre car parks or retail centre car parks.

The Scottish Executive publishes annual statistical bulletins containing information on criminal proceedings in Scottish courts. The information relates to the types of crime or offence addressed in court proceedings, sentencing outcomes and the characteristics of convicted offenders. These data are compiled from returns to the Scottish Criminal Record Office (SCRO). Unfortunately, the SCRO data are not designed for statistical purposes, and therefore are not suitable for inclusion in the Index.8

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8 For the limitations of these data see Criminal Proceedings in Scottish Courts, Scottish Executive, November 2001, Statistical Bulletin CrJ/2002/9.
The Scottish Executive also publishes annual statistical bulletins on Social Enquiry Reports, Community Service Orders, Probation Orders and Supervised Attendance Orders in Scotland. These reports contain valuable information on the risk factors associated with re-offending. The results are based on aggregated returns provided to the Scottish Executive by local authorities. However, these data are only collected and released at local authority level and even if they were considered to be suitable indicators, would therefore not be available at ward level for inclusion in the Index.

Victim Data

Another source of information on who is affected by crime or social disorder is data on ‘victims’. This data, like offender data, locates crimes in terms of the individuals involved, rather than the place of occurrence. The primary source of information on victims of crime is cross-sectional crime surveys, with the Scottish Crime Survey (SCS) being the largest undertaken in Scotland. The most recent sweep of the SCS for which results are available occurred in the year 2000, with around 5000 participants. This survey investigated not only victimisation, but also included questions on fear of crime, perception of community disorder, attitudes to the Police, and self-reported drug misuse.

Unfortunately, although these data are available at national level, it was not possible to model them down to ward level with any confidence. The Criminal Justice Research Branch of the Scottish Executive is currently in the process of undertaking a Fundamental Review of the SCS, the results of which should be published at the end of February 2003. This Fundamental Review will address issues such as the geographic level to which data can be disaggregated, and it is hoped future data will be released with local authority codes.

Insurance Data

Previous research into the use of home contents insurance premium data as a potential indicator of crime and disorder has revealed a number of weaknesses in this approach (see Noble, Smith, Penhale et al, 2000, p.47). For instance, insurance premiums are affected not just by the predicted likelihood of experiencing criminal victimisation, but also by factors such as local environmental conditions, local economic conditions and local insurance take-up rates. A substantial proportion of households do not have household insurance, and therefore would not be reflected in the premiums. Insurance premium data was not, therefore, deemed to be of sufficient reliability or relevance to be included in the Index.

Physical Environment

Poor physical environment is widely acknowledged to be important, both as a determinant of health, as well as more general well-being. Unfortunately, indicators relating to the impact of the physical environment at small area level, are extremely difficult to construct. Though it was not possible to obtain data and therefore construct a Domain for this Index, the situation regarding data is set to improve. The Environmental Health Surveillance System for Scotland (EHS3) is currently gathering information from a wide variety of sources, including local authorities, the Water Authorities, the Scottish Environment Protection Agency and NHS Board Areas, to interpret environmental data in Scotland. Future versions of the Index will benefit if such data become available in a utilisable form.
Chapter 3: Combining the Domain Indices into an overall ward level Index of Multiple Deprivation

Standardising and Transforming the Domain Indices

Having obtained a set of Domain Indices these needed to be combined into an ‘overall’ Scottish Index of Multiple Deprivation. In order to combine Domain Indices which are each based on very different units of measurement there needed to be some way to ‘standardise’ the scores before any combination could take place. A form of standardisation and transformation was required that met the following criteria. First it must ensure that each domain has a common distribution; second, it must not be scale dependent (i.e. conflate size with level of deprivation); third, it must have an appropriate degree of ‘cancellation’ built into it (discussed below); and fourth, it must facilitate the easy identification of the most deprived wards. Having considered other options, the exponential transformation of the ranks best met these criteria.

Other procedures such as z-scores or untransformed ranks are alternative methods of standardisation. Using the ranks for each domain would solve some problems but would introduce others. Ranks would certainly put domains on to the same metric. The problem is that the distance between each of the scores underlying the ranks is not equal. Once ranked this ‘distance’ is made equal and some of the information of the data is lost. The symmetrical nature of ranks, and ‘z scores’ of normally distributed data, means that a ‘good’ score on one domain could fully cancel out a ‘bad’ score on another. This means that a relative lack of deprivation in one domain, would have had a major impact on a more severe deprivation in another domain, when combined into an overall deprivation result. The model of multiple deprivation proposed instead is cumulative and a ‘good’ score on one domain should not fully cancel out a ‘bad’ score on another domain. Z-scores of normally distributed data or untransformed ranks will not therefore serve as standardisation mechanisms.

The exponential distribution used here has a number of properties. First it transforms each domain so that all domains have a common distribution, the same range and identical maximum/ minimum value, so that when the domains are weighted and combined into a single Index of Multiple Deprivation, the impact of the weights is absolutely clear and explicit. Second, it is not affected by the size of the ward’s population. Third, it effectively spreads out that part of distribution in which there is most interest - that is that part which contains the most deprived wards in each domain. Fourth, it enables one to determine the desired cancellation properties.

The exponential transformation involves ranking the scores in each domain. The ranking standardises the domain scores (between 1222 for the most deprived and 1 for the least deprived for the purposes of the calculation). These ranks are then transformed to an exponential distribution, using the formula presented in Appendix 5. This has the effect of transforming the ranked domain scores to a value between 0 (least deprived) and 100 (most deprived), on an exponential basis, that is larger (more deprived) scores are given greater emphasis.

The exponential transformation stretches out the distribution at the deprived end of the scale so that greater levels of deprivation score more highly. The most deprived 10% of wards have values between 50 and 100 after exponential transformation.

This issue of cancellation is clearly important for understanding the nature of multiple deprivation. As has been noted in Chapter 1, the approach in the Scottish Indices of Deprivation is to conceptualise the various deprivations as measured by each domain as separate and distinct, though they may have cumulative effects in an area (or for any individual). Thus to be poor and in ill-health is clearly a worse
state than experiencing just one of these deprivations on their own. It would be conceptually inappropriate for someone who is poor but healthy to have their income deprivation ignored because they are fortunate enough to be in good health.

The significant advantage of the exponential transformation is that it gives control over the extent to which lack of deprivation in one domain cancels or compensates for deprivation in another domain. In particular, it allows precise regulation (though not the elimination) of these cancellation effects. The exponential transformation has been used in a way that reflects a level of cancellation appropriate to this approach to multiple deprivation.

The exponential transformation formula selected gives approximately 10% cancellation. This means that in the extreme case, a ward which was ranked top on one domain but bottom on another would overall be ranked at the 90th percentile in terms of deprivation (if the two domains were equally weighted). This compares with the 50th percentile if the untransformed ranks or a normal distribution had been used instead. For example a ward that was the most deprived in terms of income deprivation but was least deprived on the Education Domain would still be at the 90th percentile (top 10%) if these two domains were combined with equal weights. In fact income deprivation is weighted more highly, which would further reduce the impact of the non-deprived result for the Education Domain.

**Weighting the domains**

Weighting always takes place when elements are combined together. Thus if the domains are summed together to create an Index of Multiple Deprivation, this means they are given equal weight. It would be incorrect to assume that items can be combined without weighting.

How can one attach weights to the various aspects of deprivation? That is, how can one determine which aspects are more important than others? As has been shown, simply summing indicators can itself lead to weighting which may be driven more by the availability of indicators rather than from any conceptual model of multiple deprivation.

There are five possible approaches to weighting:

- driven by theoretical considerations
- empirically driven
- determined by policy relevance
- determined by consensus
- entirely arbitrary

**Weights driven by theoretical considerations**

In the theoretical approach, account is taken of the available research evidence which informs the theoretical model of multiple deprivation and weights are selected which reflect this theory.

**Empirical approaches to weighting**

There are two sorts of approaches that might be applicable here. First, a commissioned survey or re-analysis of an existing survey might generate weights. Here one might construct a proxy for multiple deprivation or exclusion – perhaps in terms of ‘socially perceived necessities’ and use multivariate predictive modelling to derive weights. A possible recent data set for re-analysis in this way is The
Millennium Poverty and Social Exclusion Survey (Gordon et al, 2000). Second one might apply a technique such as factor analysis to extract a latent ‘factor’ called ‘multiple deprivation’ assuming, that is, that the analysis permitted a single factor solution (see Senior, 2002).

Weights determined by policy relevance

It might be that only the individual domain scores could be released and weighted for combination in accordance and (proportion) to the focus of particular policy initiatives or weighted in accordance with public expenditure on particular areas of policy.

Weights determined by consensus

Policy makers and other ‘customers’ or experts could simply be asked for their views and the results examined for consensus.

Weights that are entirely arbitrary

Simply choosing weights without reference to the above considerations, or even selecting equal weights in the absence of empirical evidence, would come into this category.

Weights for the SIMD

For the SIMD 2003, theoretical considerations prevailed. However – there was a modification to this. For domains with less robust indicators a decision was taken to reduce the weight. A different approach could have been that if the robustness of indicators didn’t warrant inclusion with the full desired weight then the domain should be excluded.

The Income and Employment Domains were regarded as the most important contributors to the concept of multiple deprivation and the indicators comprising the domains were very robust. Hence it was decided that they should carry more weight than the other domains. The weightings of the domains is supported by the research team’s work, the consultation process with the steering group and, where available, the wider academic literature.

On the second criterion it is important to stress that only indicators which are sufficiently robust have been included within the SIMD 2003. Nonetheless, some indicators are more robust than others, but only those which are sufficiently robust, as well as meeting the other criteria (‘domain specific’, measuring major features of that deprivation, up-to-date, capable of being updated on a regular basis, available across Scotland at a small area level) have been selected.

Based on these criteria the following weights have been used (weights must total 100%):

<table>
<thead>
<tr>
<th>Domain</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income deprivation</td>
<td>30%</td>
</tr>
<tr>
<td>Employment deprivation</td>
<td>30%</td>
</tr>
<tr>
<td>Health deprivation and disability</td>
<td>15%</td>
</tr>
<tr>
<td>Education, skills and training deprivation</td>
<td>15%</td>
</tr>
<tr>
<td>Geographical access to services</td>
<td>10%</td>
</tr>
</tbody>
</table>
Each domain score is ranked and exponentially transformed, to standardise the distribution. The five transformed domain scores for each ward are then summed, using the weights in the table above. Thus, a ward’s overall score is:

\[(0.3 \times \text{Income}) + (0.3 \times \text{Employment}) + (0.15 \times \text{Education}) + (0.15 \times \text{Health}) + (0.1 \times \text{Access})\]
Chapter 4: Presenting the Results

Results have been released at ward level for each of the Domain Indices and the overall SIMD as well as local authority level summaries of the ward level SIMD.

Ward level presentations

At the ward level there are six Indices for each ward in Scotland: five Domain Indices (which are combined to make the overall SIMD) and an overall SIMD. The Deprivation Indices are each assigned a rank. There are 1222 wards in Scotland. The most deprived ward for each Index is given a rank of 1, and the least deprived ward is given a rank of 1222. The ranks show how a ward compares to all the other wards in Scotland and are easily interpretable.

Maps have been produced to show the spatial distribution of the Domain Indices and the overall SIMD at ward level. The wards have been deciled (divided into ten equal groups) according to the deprivation scores in each domain or on the SIMD. Each decile contains 122 or 123 wards.

The five Domain Indices and their Ranks

Each Domain Index consists of the combined indicators in that domain. These are then ranked. These Domain Indices can be used to describe each type of deprivation in an area. This is important as it allows users of the Indicies of Deprivation to focus on particular types of deprivation, and to compare this across wards. There may be great variation within a local authority, and the ward level Domain Indices allow for a sophisticated analysis of deprivation information.

The scores for the Income and Employment Deprivation Indices are rates. So for example if a ward scores 30.1 in the Income Domain, this means that 30.1% of the ward’s population are Income deprived. The same applies to the Employment Domain. The scores for the remaining three domains are not rates. Within a domain, the higher the score, the more deprived the ward. However, the scores should not be compared between domains as they have different minimum and maximum values, and ranges. To compare between domains, the ranks should be used.

The overall Scottish Index of Multiple Deprivation at ward level

The overall SIMD describes the ward by combining information from all five domains: Income, Employment, Health, Education, and Access. These were combined in two stages; first each domain was ranked and then transformed to a standard distribution – the exponential distribution described above. Then the domains were combined using the explicit domain weights chosen. The overall ward level SIMD is ranked in the same way as the Domain Indices.

The SIMD score is the combined sum of the weighted, exponentially transformed domain rank of the domain score. Again, the bigger the SIMD score, the more deprived the ward. However, because of the exponential distribution, it is not possible to say, for example, that a ward with a score of 40 is twice as deprived as a ward with a score of 20.

The most deprived ward according to the SIMD is assigned a rank of 1, and the least deprived ward, a rank of 1222.
The ward level geography of deprivation in Scotland

Ward Level Domains of Deprivation

Each domain of deprivation has been mapped at ward level. In addition a chart has been produced for each domain measure showing the most deprived rank, least deprived rank, and population weighted mean rank for each local authority in Scotland (Map 1 shows the location of local authorities in Scotland).

The geographical distribution of income deprivation has a highly deprived belt from Fife and East Lothian to North and East Ayrshire, coupled with deprived areas in the Northern Highlands, the Western Isles and Aberdeen. Of the 10% most income deprived wards in Scotland, 35% (43 of 122 wards) are located in Glasgow. At the other end of the income deprivation scale Aberdeenshire and Edinburgh have large percentages of less deprived wards.

Chart 4.1

The Income Deprivation Domain: Range of Ranks by Local Authority

Chart 4.1 shows that most Scottish local authorities contain wards at both ends of the income deprivation spectrum. Local authorities that are relatively deprived generally contain some less deprived wards and vice versa. For instance, Glasgow which has an average rank of 239 on the Income Deprivation Measure (making it the most income-deprived council in Scotland) contains the Jordan Hill ward which has a rank of 1108 (where the least deprived rank is 1222). Conversely, a relatively less deprived council such as East Dunbartonshire which has a population weighted average rank of 930 contains the Hillhead And Broomhill Ward, which is ranked as the 101st most income deprived ward in Scotland.
Employment deprivation is located in largely the same areas as shown by the SIMD and income deprivation measures. As with income deprivation, there are some concentrated areas of employment deprivation in Scotland. Of the 10% most employment deprived wards in Scotland, 32% are in Glasgow and a further 12% are in Dundee City. As Chart 4.2 illustrates the pattern for the employment deprivation domain is similar to that for the income deprivation domain.
The health deprivation domain shows more evidence of the clustering of deprivation than the other domains. Health deprivation is focused more in the deprived ‘belt’ with the Highland and Western Isles wards not in the most deprived deciles on this measure (although again Aberdeen has a concentration of health deprived wards). 43% of the most health deprived 10% of wards in Scotland are located in Glasgow. At the other end of the scale, 28% and 17% of the least health deprived decile are in Aberdeenshire and Edinburgh respectively.
The pattern of educational deprivation is similar to that for the employment and income deprivation. Most local authorities contain wards with different levels of deprivation. Aberdeen City for instance has wards across the spectrum – Queens Cross ward ranks 1172 of 1222 (i.e. it is one of the least education deprived wards in Scotland) and Auchmill Ward is ranked at 21 (i.e. one of the most education deprived wards).
As is immediately apparent from Map 6 the pattern of deprivation on the geographical access to services measure is very different to that for the other domains. The Geographical Access to Services measure appears to be a near inversion of the other deprivation. As mentioned in the discussion of the SIMD, those wards that are deprived on the other measures of deprivation tend to be considerably less deprived in terms of geographical access to services. This does not imply that having geographical isolation from services is not a deprivation, merely that it is distributed very differently to the other dimensions of deprivation. This difference is shown by the fact that Glasgow’s wards feature prominently in the least deprived decile of wards on the Geographical Access to Services domain whereas they are prominent in the most deprived decile of wards on the other domains.
**The Scottish Index of Multiple Deprivation**

The 100 most deprived wards on the Scottish Index of Multiple Deprivation are shown in Appendix 6.

Map 7 shows the distribution of multiple deprivation at ward level in Scotland. The most deprived wards (coloured dark blue) are strongly concentrated in a strip from Fife and East Lothian in the East, to North and East Ayrshire in the West. The inserts of the cities of Glasgow and Dundee also show that Scotland contains some concentrations of deprivation in urban areas. There are also highly multiply deprived areas in the North of the country, particularly in the Western Isles and the Northern parts of the Highlands. In addition, there is an isolated pocket of deprived wards in Aberdeen City.

There are 122 wards in the most deprived 10% of wards in Scotland and these are located in 20 (of 32) local authorities. Glasgow has the highest number of wards in the most deprived decile (44) and Dundee the second highest (15), no other council has more than 7 wards in the most deprived decile. Glasgow (with 44 out of 79 wards, 55.7%) and Dundee (with 15 out of 29 wards, 51.7%) also have the highest proportions of wards in the most deprived 10% of wards in Scotland. Other local authorities with high proportions of their wards in the most deprived decile include: Clackmannanshire (3 of 18 wards, 16.7%), West Dunbartonshire (7 of 22 wards, 31.8%), Inverclyde (6 of 20, 30%) and East Ayrshire (7 of 32, 21.9%).

Most local authorities contain wards which have deprivation scores spanning a number of deciles. Even those councils that are relatively homogenous, such as Glasgow (at the deprived end of the spectrum) and East Dunbarton (at the less deprived end) still contain wards at the opposite end of the deprivation scale. There seems to be little link between the range of ward ranks in a local authority and the percentage of its wards which fall into the most deprived decile of all wards in Scotland.

30 of the 32 local authorities in Scotland contain wards in the 20% least deprived in the country. Of the 20% least deprived wards, 14% are in Aberdeenshire and 10% in Edinburgh. Those councils most characterised by wards in the two least deprived deciles are: East Dunbartonshire with 75% of its wards in the 20% least deprived in the country, East Renfrewshire with 70%, and Aberdeenshire with 52%.

Chart 4.6 shows the most deprived rank, least deprived rank and population weighted mean rank for each local authority in Scotland of the SIMD. For example, Aberdeen City’s most deprived ward has a rank of 97 (where 1 is the most deprived), and its least deprived ward has a rank of 1222 (where 1222 is the least deprived). Its population weighted mean rank, illustrated by a diamond, is 750.

Of the 122 wards which fall within the most multiply deprived 10% of all wards in Scotland, the following can be said:

73% (i.e. 89 wards) fall within the most deprived 10% on 3 or more of the 5 domains.
46% (i.e. 56 wards) fall within the most deprived 10% on four or more of the 5 domains.
No wards fall in the most deprived 10% in all of the domains. This is largely because none of the 10% most multiply deprived wards are in the 10% most deprived wards on the access domain.

A little over 698,737 people live in the most multiply deprived 10% of wards in Scotland, amounting to 13.7% of the Scotland’s population. At the other end of the spectrum just over 598,993 people live in the least deprived 10% of wards in Scotland, constituting 11.7% of Scotland’s population.
Chart 4.6
The Scottish Index of Multiple Deprivation: Range of Ranks by Local Authority
Local authority level presentations of the ward level Scottish Index of Multiple Deprivation

The SIMD produced is at ward level. However, six measures at local authority level have been devised to summarise the ward information.

Local authorities are complex to describe as a whole or to compare for several reasons. First, local authorities can vary in population size. Further, some local authorities may have a less homogenous population, containing more variation in deprivation and in some places deprivation may be concentrated in severe pockets rather than being evenly spread. This makes an ‘overall picture’ more difficult to establish. All areas experiencing high levels of deprivation will be identified by one or more of these six measures, as they are designed to capture deprivation in areas of different sizes with different levels of heterogeneity.

The six measures have been devised to take account of these issues. They all describe the local authorities in different ways: looking at the most deprived populations, the most deprived wards, as well as the average of the wards, to get six meaningful descriptions of deprivation at local authority level. Given the different patterns of deprivation within local authorities, it is important to have a number of measures to capture this variation. All of the summary measures need to be considered together to give a full description of an area’s deprivation. More subtle descriptions of deprivation across a local authority can be established by a close analysis of the wards within that local authority, as the ward level SIMD contains the most detailed account of local deprivation. At the ward level much more information is retained than in the local authority level summaries.

There are 32 local authorities in Scotland. For each measure each local authority is given a rank and score (with the exception of Extent, as explained below). For presentation, a rank of 1 indicates that the local authority is the most deprived according to the measure, and 32 is the least deprived. The meaning of the scores for each of the measures is detailed below.

The measures are population weighted by the ward populations for the local authority (except for the two Scale measures which are in the form of a simple count).

Local Concentration

The population weighted average of the ranks of a local authority’s most ‘multiply’ deprived wards that contain exactly 10% of the local authority’s population.

Local Concentration is an important way of identifying local authorities’ ‘hot spots’ of deprivation. It highlights the most deprived wards in a local authority. These need not be contiguous but may comprise pockets of deprivation which can be seen from the ranks of the ward level SIMD.

The Local Concentration measure defines the ‘hot spots’ by reference to a percentage of the local authority’s population. The average of the population weighted ranks of a local authority’s most deprived wards that capture exactly 10% of the local authority’s population was selected. In many cases this was not always a whole number of wards. The population weights were calculated by determining the proportion that each of these selected wards contributed to the 10% (of the local authority’s total population). For the purpose of calculating this score the wards are ranked such that the most deprived ward is given the rank of 1222.
**Worked example**

An example might be a local authority containing 8,000 people. Ten percent of this population is 800 people. The Local Concentration measure would calculate the score of the most deprived wards containing exactly 800 people. Having sorted the wards in descending order of deprivation, the most deprived ward contains 700 people and has a rank of 900 (out of 1222, where 1222 is the most deprived ward for this calculation). The next most deprived ward contains 400 people and has a rank of 600. 100 people from the second ward are required to reach the total of 800 people (which is 10% of the local authority’s population). The Local Concentration score for this local authority would be:

$$((700/800) \times 900) + ((100/800) \times 600)$$

$$= (0.875 \times 900) + (0.125 \times 600)$$

$$= 862.5.$$  

The larger the Local Concentration score, the more deprived the local authority, on this measure. The most deprived local authority on this measure is given a rank of 1, for presentation.

**Extent**

Proportion of a local authority’s population living in wards which rank within the most ‘multiply’ deprived 10% of wards in Scotland.

The aim of this measure is to portray how widespread high levels of deprivation are in a local authority. It only includes local authorities which contain wards which fall within the top ten percent of the most deprived wards in Scotland. Therefore some local authorities will not have an overall score for this measure and will be given an equal ‘least deprived’ rank. The Extent measure is the proportion of a local authority’s population living in the wards which rank within the most deprived 10% of wards on the SIMD in Scotland.

**Worked example**

An example might be a local authority with 10 wards. Five of the wards are within the most deprived 10% of wards in Scotland on the SIMD. The populations of the five highly deprived wards are aggregated and divided by the local authority’s total population and presented as a percentage. So, the populations of these highly deprived five wards are 500, 800, 1,000, 1,500, and 2,000 and the total local authority population is 12,000.

$$\text{Extent} = \frac{(500 + 800 + 1,000 + 1,500 + 2,000)}{12,000} \times 100 = 48.3\%$$

The local authority scores are ranked in descending order, so the local authority with the highest percentage is given a rank of 1.

**Scale (two measures)**

*Income Scale is the number of people who are income deprived; Employment Scale is the number of people who are employment deprived*

These two measures show the sheer numbers of people experiencing income deprivation and employment deprivation at local authority level.
Income Scale is a count of the number of people in each local authority who are included in the Income Domain i.e. the sum of the ward level numerators. This captures all people reliant on IS, JSA-IB, together with those from ‘low income’ WFTC/DTC families.

Employment Scale is a count of the number of people in each local authority who are included in the Employment Domain i.e. the sum of the ward level numerators. This captures the unemployment claimants, IB or SDA recipients aged 16-59 and certain New Deal participants as specified in Chapter 2.

The SIMD itself has been created in such a way as to be independent of population size. However, the two scale measures will inevitably identify local authorities with large numbers of people experiencing these deprivations. It is important to note that the scale measures do not pick up all large populations, but only large deprived populations. If two local authorities have the same percentage of income deprived people, the larger local authority will be ranked as more deprived in the Income Scale measure because more people are experiencing the deprivation.

Worked example

Local authority X has five wards. The number of people in low income families in each ward (i.e. the numerator in the Income Domain) are 1765, 3832, 941, 440 and 279.
The Income Scale score is therefore = 1765 + 3832 + 941 + 440 + 279
= 7257

The Employment Scale score is generated in the same way, using the numerator of the Employment Domain.

In both cases, the local authority scores are ranked in descending order, so the local authorities with the largest number of Income or Employment deprived people are ranked ‘1’.

Average of ward ranks

Population weighted average of the combined SIMD ranks for the wards in a local authority

This measures the local authority as a whole, including both deprived and less deprived wards. All the wards in a local authority need to be included to obtain an average, as each ward contributes to the character of that local authority. In this measure, the deprived and less deprived ward ranks will ‘average out’. For the purpose of calculating this score the wards are ranked such that the most deprived ward is given the rank of 1. The ward ranks are population weighted within a local authority to take account of the fact that ward size can vary significantly within local authorities.

Worked example

A local authority has five wards, with populations of 500, 1,000, 1,500, 2,500, and 2,700. These wards rank 110, 290, 550, 589 and 19 respectively (for the purposes of the calculation the ranks are such that 1=most deprived). The total local authority population is 8,200. In order to calculate the score, each ward rank is multiplied by the proportion of the local authority’s population that falls in that ward. These are summed to make the local authority score. Thus, the average ward rank for this local authority is:

\[ ((500/8,200) \times 110) + ((1,000/8,200) \times 290) + ((1,500/8,200) \times 550) + (2,500/8,200) \times 589) + ((2,700/8,200) \times 19) \]

\[ = 328.5 \]
The local authority scores are ranked in ascending order, and the most deprived local authority (which has the smallest score) is given a rank of ‘1’ for presentation.

**Average of ward scores**

**Population weighted average of the combined SIMD scores for the wards in a local authority**

This measure also describes the local authority as a whole, taking into account the full range of ward scores across a local authority. The advantage of the Average of Ward Score measure is that it describes the wards by retaining the fact that the more deprived wards may have more ‘extreme’ scores, which are not revealed to the same extent if the ranks are used. This means that the more deprived ward scores will not be moderated to the same extent by the less deprived ward scores as they are for the Average of Ward Ranks measure. This measure is calculated by averaging the ward scores in each local authority after they have been population weighted. This measure, and the Average of Ward Ranks, are equally valid ways of presenting the average deprivation of a local authority’s wards.

**Worked example**

This is calculated in exactly the same way as the Average of Ward Ranks, except that the SIMD ward score is used instead of the ward rank.
<table>
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<tr>
<th>Local Authority Name</th>
<th>SIMD Average Score</th>
<th>Rank of SIMD Average Score</th>
<th>SIMD Average Rank</th>
<th>Rank of SIMD Average Rank</th>
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<th>Rank of number of employment deprived</th>
<th>Number of income deprived</th>
<th>Rank of number of income deprived</th>
<th>Extent score</th>
<th>Rank of Extent</th>
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Appendix 1: The ‘Shrinkage’ Technique

The ‘shrunken’ estimate of a ward-level proportion (or ratio) is a weighted average of the two ‘raw’ proportions for the ward and for the corresponding local authority. The weights used are determined by the relative magnitudes of within-ward and between-ward variability.

If the rate for a particular indicator in ward \( j \) is \( r_j \) events out of a population of \( n_j \), the empirical logit for each ward is:

\[
m_j = \log \left( \frac{(r_j + 0.5)}{(n_j - r_j + 0.5)} \right)
\]

whose estimated standard error \( (s_j) \) is the square root of:

\[
s_j^2 = \frac{(n_j + 1)(n_j + 2)}{n_j(r_j + 1)(n_j - r_j + 1)}
\]

The corresponding counts \( r \) out of \( n \) at local authority level give the local authority-level logit:

\[
M = \log \left( \frac{(r + 0.5)}{(n - r + 0.5)} \right)
\]

The ‘shrunken’ ward-level logit is then the weighted average:

\[
m_j^* = w_j m_j + (1 - w_j) m
\]

where \( w_j \) is the weight given to the ‘raw’ ward-\( j \) data and \((1-w_j)\) the weight given to the overall rate for the local authority. The formula used to determine \( w_j \) is:

\[
w_j = \frac{1/s_j^2}{1/s_j^2 + 1/t^2}
\]

where \( t^2 \) is the inter-ward variance for the \( k \) wards in the local authority, calculated as:

\[
t^2 = \frac{1}{k-1} \sum_{j=1}^{k} (m_j - m)^2
\]

\[9\] Where appropriate the weighted average is calculated on the logit scale, for technical reasons, principally because the logit of a proportion is more nearly normally distributed than the proportion itself.
Thus large wards, where precision $1/s^2_j$ is relatively large, have weight $w_j$ close to 1 and so shrinkage has little effect. The shrinkage effect is greatest for small wards in relatively homogeneous local authorities.

The final step is to back-transform the shrunken logit $z_j^*$ using the ‘anti-logit’, to obtain the shrunken ward level proportion:

$$m_j^* = \frac{\exp(m_j^*)}{1 + \exp(m_j^*)}$$  \[7\]

for each ward.
Appendix 2: Factor Analysis

In the domains where individuals can be identified as being deprived or not in terms of the domain definition, the number of deprived people can simply be summed and divided by a suitable denominator to create an area rate. In other domains, deprivations tend to exist in different spatial and temporal forms so, for example, an area will be education deprived if the adults in the area have no qualifications or if the children do not obtain any qualifications. These two situations co-exist in an area but relate to different individuals at any given point in time. It is hypothesised that an underlying factor exists at an ecological level that makes these different states likely to exist together in a local area. This underlying factor cannot be measured directly but can be identified through its effect on individuals (e.g. failure to obtain qualifications and failure to enter higher education). These variables need to be combined at an ecological level to create an area score. Fundamentally this score should measure, as accurately as possible, the underlying factor.

There are a number of problems in achieving this goal. The variables: [1] are measured on different scales, [2] have different levels of statistical accuracy, [3] have different distributions, [4] may or may not apply to the same individual and [5] measure, to different degrees, the underlying factor imperfectly. Maximum Likelihood (ML) factor analysis was used with a view to overcoming these problems. Other methods, such as applying a linear-scaling model (i.e. adding a large number of items that purport to measure the same construct together to increase the reliability of a scale – assuming error elements to be non-additive and random), deal with only some. Alternative statistical methods, such as Principal Components Analysis (PCA), do not address all these problems. PCA, for example, ignores measurement error (error variance) or the variables’ imperfect measurement of the underlying construct (specific variance). This is because it does not attempt to separate common variance (i.e. variance shared between three or more variables) from specific variance and error variance. The appropriate technique, where specific and error variance are suspected (i.e. problems 2 and 5), is a form of common factor analysis of which ML factor analysis is a type.

The premise behind a simple one-common-factor model is that the underlying factor is imperfectly measured by each of the variables in the dataset but that the variables that are most highly correlated with the underlying factor will also be highly correlated with the other variables. By analysing the correlation between variables it is therefore possible to make inferences about the common factor and indeed to estimate a factor score for each case (i.e. ward). This, of course, assumes that the variables themselves are all related to the underlying factor to some extent and are in most cases fairly strongly related to it.

It is not the aim of this analysis to reduce a large number of variables into a number of theoretically significant factors as is usual in much social science use of factor analysis (i.e. exploratory factor analysis). The variables will be chosen because they are believed to measure a single area deprivation factor. The analysis therefore involves testing a one-common factor model against the possibility of there being more than one factor. If a meaningful second common factor is found it would suggest the need for a new domain or the removal of variables. Decisions over
whether a meaningful second common factor exist are aided by standard tests and criteria.

Once a satisfactory solution is achieved a factor score can be estimated for each ward. That is, the combined indicators, using weights generated by the factor analysis process, are then used as the domain score. Thomson’s method for estimating factor scores was used.
Appendix 3: Constructing the Comparative Mortality Factor

Indirect standardisation has frequently been used to study area differences in mortality rates. However there are problems with its use in this context. These are outlined below and a case is made for using direct standardisation instead, to produce a Comparative Mortality Factor.

If \( m_{ij} \) is the age/sex specific mortality rate in study area \( j \), then the SMR for that area is:

\[
SMR_j = \frac{d_j}{\sum p_j m_i} = \frac{\sum d_j p_j m_{ij}}{\sum p_j m_i}
\]

[1]

\( d_j \) = deaths in study area \( j \).

\( m_{ij} \) = the death rate in age/sex group \( i \) in the study area \( j \).

\( m_i \) = the death rate in age/sex group \( i \) in the standard population.

\( p_j \) = the population in age/sex group \( i \) in the study area \( j \).

From the third term in equation [1] it is clear that variation in the SMR results from both the difference in the demographic composition of the ward as well as in the age/sex specific death rates. The population structure weights the proportional difference between the expected age/sex specific death rate and the observed, so that the SMR can range theoretically from the highest proportional difference recorded in any one age/sex group, to the lowest. Unless the proportional difference between the standard population age/sex specific death rate and that of a study area is constant across age groups, or all wards have an identical demographic composition, then the SMR will not measure the relative health status of an area. As neither of these conditions are likely to be true of all wards in Scotland, the SMR cannot measure relative health status.

To visually illustrate the ‘weighting’ impact of the population structure on the SMR, a simple but slightly extreme situation is taken where the population is divided into two age groups (the young and old) and ward [A] has an age specific death rate of 10% amongst the young, and 25% amongst the old, compared to ward [B] which has rates of 9% and 24%, respectively. The first ward is clearly relatively less healthy than the second. If the SMRs are calculated for these two areas (the death rate in the standard population is 5% and 22%) and the proportion of the population that is ‘young’ is varied from 0 to 1 (i.e. 1 indicating all the population are young), two SMR lines can be plotted (Figure A8.1). In the case where ward [A] has the same ratio of young to old as ward [B], ward [A] correctly has a higher SMR than [B]. However, this is not necessarily true if the population ratios are different. For example if ward [B] is made up of 80% young people and ward [A] has any proportion less than 70%, then ward [B] will have a higher SMR than [A]. Similarly the age specific death rate is constant for the two wards, and yet their SMRs vary considerably as the population structure is altered.
The Comparative Mortality Factor, equation [2], is not influenced by variation in the population structure between wards.

\[
CMF_j = \frac{\text{Expected deaths (in standard population)}}{\text{Observed deaths (in standard population)}} = \frac{\sum_i p_i m_{ij}}{\sum_i p_i m_i} = \frac{\sum_j p_j m_{ij}}{D} = \frac{\sum_j p_j m_{ij}}{\sum_i p_i m_i}
\]  

[2]

\( p_i \) = the population in age/sex group \( i \) in the standard population.
\( D \) = total deaths in the standard population.

Unlike the SMR, the CMF does not down-weight the proportional difference between the age/sex specific observed and expected rates if they relate to a small proportion of the study population. The CMF weights the proportional difference by a standard population structure (\( p_i \)) that is constant across study areas. This does make the CMF in some senses more vulnerable to small number error in \( m_{ij} \) than the SMR. If for example an age/sex rate is based on a relatively small age/sex population (compared to other groups in the study population), then that rate will be down-weighted in the SMR. However the SMR will still be vulnerable to small number error if the overall ward population is small, so this alone does not seem sufficient justification for using the SMR over the CMF. Instead it would seem sensible to deal with the small number problem separately and then to use the CMF. This can be achieved by applying the ‘shrinkage’ method to the crude age/sex rates. The calculation of the ‘shrunk’ crude age/sex rates are shown below, and this results in \( m_{ij} \) being replaced by \( m_{ij}^* \), its ‘shrunk’ estimate. The CMF is therefore:
\[ CMF_j = \frac{\sum_i p_i m_{ij}^*}{\sum_i p_i m_i} \]
Appendix 4: Hospital episodes related to alcohol use: full list of case indicators

<table>
<thead>
<tr>
<th>Acute and psychiatric discharges excluding transfers (ICD-10 codes)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>E52 Niacin deficiency [pellagra] T510 Toxic effect of ethanol</td>
<td></td>
</tr>
<tr>
<td>F10 Mental and behavioural disorders due to use of alcohol T519 Toxic effect of alcohol, unspecified</td>
<td></td>
</tr>
<tr>
<td>G312 Degeneration of nervous system due to alcohol X65 Intentional self-poisoning by and exposure to alcohol</td>
<td></td>
</tr>
<tr>
<td>G621 Alcoholic polyneuropathy Y15 Poisoning by and exposure to alcohol undetermined intent</td>
<td></td>
</tr>
<tr>
<td>G721 Alcoholic myopathy Y573 Alcohol deterrents</td>
<td></td>
</tr>
<tr>
<td>I426 Alcoholic cardiomyopathy Y90 Evidence of alcohol involuntary determined by blood alcohol level</td>
<td></td>
</tr>
<tr>
<td>K292 Alcoholic gastritis Y91 Evidence of alcohol involvement determined by level intoxication</td>
<td></td>
</tr>
<tr>
<td>K70 Alcoholic liver disease Z133 Special screening exam for mental and behavioural disorders</td>
<td></td>
</tr>
<tr>
<td>K860 Alcohol-induced chronic pancreatitis Z502 Alcohol rehabilitation</td>
<td></td>
</tr>
<tr>
<td>O354 Maternal care for (suspected) damage to foetus from alcohol Z637 Other stressful life events affecting family and household</td>
<td></td>
</tr>
<tr>
<td>P043 Foetus and newborn affected by maternal use of alcohol Z714 Alcohol abuse counselling and surveillance</td>
<td></td>
</tr>
<tr>
<td>Q860 Foetal alcohol syndrome (dysmorphic) Z721 Alcohol use</td>
<td></td>
</tr>
<tr>
<td>R780 Finding of alcohol in blood Z811 Family history of alcohol abuse</td>
<td></td>
</tr>
<tr>
<td>T506 Antidotes and chelating agents, not elsewhere classified Z864 Personal history of psychoactive substance abuse</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 5: Exponential Transformation of the Domain Indices

The precise transformation proposed is as follows. For any ward, denote its rank on the domain, scaled to the range \([0,1]\), by \(R\) (with \(R=1/N\) for the least deprived, and \(R=N/N\), i.e. \(R=1\), for the most deprived, where \(N=1222\) which is the number of wards in Scotland).

The transformed domain, \(X\) say, is

\[
X = -23 \log \{1 - R \times [1 - \exp(-100/23)]\}
\]

where \(\log\) denotes natural logarithm and \(\exp\) the exponential or antilog transformation, and \(*\) denotes multiplication. This formula may at first sight seem complicated, but it is very straightforwardly calculated and is in fact simpler than the commonly-used transformation to a normal curve which necessitates the use of a look-up table.

Each transformed domain has a range of 0 to 100, with a score of 100 for the most deprived ward. The chosen exponential distribution is one of an infinite number of possible such distributions. The constant (23) determines that ten percent of wards have a score higher than 50. When transformed scores from different domains are combined by averaging them, the skewness of the distribution reduces the extent to which deprivation on one domain can be cancelled by lack of deprivation on another. For example, if the transformed scores on two domains are simply averaged, with equal weights, a (hypothetical) ward that scored 100 on one domain and 0 on the other would have a combined score of 50 and would thus be ranked at the 90th percentile. (Averaging the untransformed ranks, or after transformation to a normal distribution, would result in such a ward being ranked instead at the 50th percentile: the high deprivation in one domain would have been fully cancelled by the low deprivation in the other.) Thus the extent to which deprivation in some domains can be cancelled by lack of deprivation in others is, by design, reduced.
## Appendix 6: The 100 most deprived wards in Scotland on the SIMD 2003

<table>
<thead>
<tr>
<th>Local Authority</th>
<th>Ward code</th>
<th>Ward</th>
<th>SIMD score</th>
<th>Rank of SIMD</th>
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<tbody>
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Appendix 7: Data Sources

Department for Work and Pensions
Income Support (Income)
Income Based Job Seekers Allowance (Income)
Working Families Tax Credit households below a low income threshold (Income)
Disability Tax Credit households below a low income threshold (Income)
Attendance Allowance (Health)
Disability Living Allowance (Health)
Incapacity Benefit (Employment and Health)
Severe Disablement Allowance (Employment and Health)
Compulsory New Deal participants - New Deal for the under 25s and New Deal for 25 + not included in the unemployment claimant count (Employment)
Child Benefit (Education)

Essex Data Archive
Working age adults with no qualifications (Labour Force Survey) (Education)

Information and Statistics Division (ISD)
Mortality Figures (Health).
Hospital episodes related to alcohol use (Health)
Hospital episodes related to drug use (Health)
Emergency admissions to hospital (Health)
Proportion of population being prescribed drugs for anxiety or depression or psychosis (Health)
Proportion of live singleton births of low birth weight (<2,500g) (Health)
Location of a GP surgery or health centre (Geographical Access to Services)

Market Scan
Location of a general stores or supermarket (Geographical Access to Services)

Office of National Statistics
Unemployment claimant count (Employment)

Retail Locations
Location of a petrol station (Geographical Access to Services)
Location of a bank or building society (Geographical Access to Services)

Scottish Executive
Location of a primary school (Geographical Access to Services)
Location of community internet facilities (Geographical Access to Services)
Location of ports and ferry routes (Geographical Access to Services)
Secondary Level Absences (Education)

Scottish Qualifications Agency
Pupil performance on SQA at Stage 4 (Education)

Universities and Colleges Admissions Service
Applications to higher education (Education)
Glossary of Abbreviations

The following abbreviations have been used in the report.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AA</td>
<td>Attendance Allowance</td>
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<tr>
<td>CIF</td>
<td>Comparative Illness Factor</td>
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<td>CMF</td>
<td>Comparative Mortality Factor</td>
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<td>CTB</td>
<td>Council Tax Benefit</td>
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<td>DLA</td>
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<td>Department of Work and Pensions</td>
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<td>FC</td>
<td>Family Credit</td>
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<td>FE</td>
<td>Further Education</td>
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<td>GP</td>
<td>General Practitioner</td>
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<td>General Register Office for Scotland</td>
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<td>HB</td>
<td>Housing Benefit</td>
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<td>HBAI</td>
<td>Households Below Average Income</td>
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<td>Hospital Episode Statistics</td>
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<td>Incapacity Benefit</td>
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<td>ILO</td>
<td>International Labour Organisation</td>
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<td>IS</td>
<td>Income Support</td>
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<td>ISD</td>
<td>Information and Statistics Division</td>
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<td>JSA(IB)</td>
<td>Job Seeker’s Allowance (Income Based)</td>
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<td>LBW</td>
<td>Low birth weight</td>
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<td>LFSLA</td>
<td>Labour Force Survey Local Authority</td>
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<td>NDLP</td>
<td>New Deal for Lone Parents</td>
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<td>NIM</td>
<td>National Intelligence Model</td>
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<td>OA</td>
<td>Output Area</td>
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<td>Office for National Statistics</td>
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<td>PCA</td>
<td>Principal Component Analysis</td>
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<td>Scottish Criminal Records Office</td>
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<td>SIMD</td>
<td>Scottish Index of Multiple Deprivation</td>
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<td>SMR</td>
<td>Standardised Mortality Ratio</td>
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<td>SQA</td>
<td>Scottish Qualification Agency</td>
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<td>WFTC</td>
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