Small Area Health Research Unit

A National Deprivation Index

for

Health and Health Service Research

Department of Community Health & General Practice

Trinity College Dublin

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I: A National Index

1. Introduction and background to deprivation indices

Deprivation is a concept that has taken a variety of forms and has had many different meanings that have evolved over time. It is generally recognised as a composite concept, in that there is no single variable that can be said to measure it but rather a number of variables must be combined in some way. While poverty, as measured by household income, is usually recognised as an important component of deprivation it is only one of many variables affecting quality of life. Moreover the measurement of poverty remains controversial, governments tend to dislike the political implications and the poor dislike the stigma of being labelled poor.

Deprivation has been defined as a state of "*observable and demonstrable disadvantage relative to the local community to which an individual belongs*".[2] The idea has come to be applied to conditions (i.e. physical and social circumstances) rather than resources or income and can therefore be distinguished from the concept of poverty, though the two are closely related. This conceptualisation can explain why people can experience deprivation but do not necessarily live in poverty.

The measurement of deprivation has been pursued energetically in the UK since the early 1980s and a number of deprivation indices have been put forward.[3-9] Some of these indices have been defined specifically in relation to health while others, designed in a different context, have been appropriated into the health field. Early attempts at deriving suitable deprivation indices exhibited many methodological differences and the number of indicators included were large, typically ranging from 8 - 12 items.[3-7] One criticism leveled at these early indices was the tendency to include socio-demographic sub-groups of the population, like elderly living alone, population aged under five, one-parent families, or ethnic minorities, as part of the definition of deprivation.[8] While many people in these sub-groups may be deprived, some are not, and the point is to find out how many are deprived rather than operate as if all were in that condition. Socio-demographic indicators reflect groups which "may be at risk" of deprivation rather than those "presently experiencing" deprivation. It should be stressed at this point that socio-demographic indicators are still very much of interest to public health planners, and this interest is best addressed in a separate 'at-risk' deprivation index.[a]

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[a] Currently under development as Technical Report No. 3

One recent approach to measuring deprivation attempts to locate areas (and the populations in them) on a dimension which reflects the access people have to goods, services, resources, amenities and physical environment, which are customary, or at least widely aspired to in society.[8,9] This approach has lead to the compilation of "material" deprivation indices which have gained considerable credence in the UK, not least for their sound conceptual basis. Two material deprivation indices have been developed in the UK, one for the North of England[8] and the other for Scotland.[9]

The North of England index, developed by Townsend *et al.*,[8] is a composite of four census based indicators which are widely believed to represent or be a determinant of material disadvantage, namely:

Unemployment – Proportion of the economically active who are unemployed

No car – Proportion of private households which do not possess a car

Home ownership – Proportion of private households which are not owner occupied

Overcrowding – Proportion of private households with more than one person per room

These four indicators were combined into a single deprivation score for each local authority ward by means of the Z score technique.

Using a similar methodology Carstairs and Morris [9] developed a Scottish deprivation index which contained the following four census based indicators:

Male unemployment – Proportion of economically active males who are seeking work

Low social class – Proportion of all persons in private households with a head of household in social class 4 or 5

No car – Proportion of all persons in private households with no car

Overcrowding – Persons in private households living at a density of >1 person per room as a proportion of all persons in private households

A number of differences exist between these two material deprivation indices. Townsend *et al.* did not include social class in their material deprivation index on the basis that being in a low social class (i.e. in semi-skilled or unskilled occupations) did not necessarily mean being deprived. They maintained, as with socio-demographic variables, that this was a category within the population that were especially prone to forms of

deprivation. However, Carstairs and Morris argued the case for including low social class in the their deprivation index on the basis that it indicated earnings at the lower end of the income scale. Reduced income, like unemployment, has important implications with regard to access to material resources and the ability to make choices in life.

Housing tenure did not feature in the Scottish material deprivation index on the grounds that a higher proportion of the country's housing stock was in the public sector and lesser variation existed between areas compared to the North of England. Another difference between the Townsend and Carstairs indices is that in the Carstairs index all four variables were calculated on the basis of individuals not households. While this was considered preferable for the purpose of the analysis of events which related to individuals it was felt that in practice any differences from using the two approaches were likely to the small.

Irish Deprivation Indices

Two previous attempts have been made to develop a deprivation index for Ireland. Howell *et al*. developed a deprivation index for each county of Ireland using eight equally weighted variables. [10]   Four of the variables were similar to those used by Townsend *et al*., namely: the proportion of the labour force who were unemployed, the proportion of households not owning a car, the proportion of people living in overcrowded conditions, and the proportion of households not owner occupied. The remaining four variables were: the proportion of the population in either social class 5 or 6, the proportion of those completing formal education before 15 years of age, the proportion of those holding a medical card, and the proportion of families in receipt of Family Income Support. The latter two variables were non-census variables and not available at a small area level and so this approach is not suited as a basis for developing a national index.

Jackson and Haase reported a small area deprivation index for Ireland comprising 13 census based indicators. [11]   The diverse range of indicators included both socio-demographic variables (age dependency rate and lone parents) as well as traditional material deprivation indicators (unemployment, overcrowding, car ownership, housing tenure). It has already been argued that it is wrong in principle to include socio-demographic sub-groups of the population in a definition of deprivation. The Jackson and Haase deprivation index also mixes indicators of potential affluence (households with two or more cars, third level education, higher and professional classes) with indicators of deprivation, and includes a number of variables which are simply opposite

ends of the same spectrum, for example local authority rented households and owner occupied households.

Combining indicators of material deprivation with socio-demographic indicators of potential risk is not only conceptually flawed, but may also be seriously misleading in practice. Negative correlations exist between selected indicators *within* the set of demographic indicators and *between* this group and the material deprivation group. Although a technical solution exists to mitigate this problem [b] it is still not clear how one interprets a high deprivation score in terms of the underlying indicators in this situation - a required condition for any practical index.

Thus, difficulties with the current Irish indices require a fresh approach that avoids both the conceptual and empirical problems identified. Below we discuss the components of the proposed index designed to avoid these difficulties.

1.1 Indicators considered for the national deprivation index

Relevant questions concerning health status, population needs, care delivery and uptake, are sensitive to both scale and location. High levels of aggregation (community care area or county) mask significant geographic variation in population characteristics of concern to public health. Analysis on a sub-county level must provide a more sensitive basis for the identification of need and delivery of care.

The Republic of Ireland is divided into 3,440 District Electoral Divisions (or Wards in County Boroughs) for census purposes. These are the smallest administrative area for which population statistics are published by the Central Statistics Office (CSO). For convenience the terms District Electoral Division and Ward will henceforth be abbreviated to DED. Small Area Population Statistics (SAPS) from the 1991 census for each DED in the Republic of Ireland were obtained from the Central Statistics Office (CSO). SAPS only contain detailed classifications of the census variables; data pertaining to the individual within the household are not available.

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[b] But this solution brings its own difficulties as will be noted in Section 2. It is intended to deal with the issues surrounding the development of a suitable demographic risk index in the Technical Report No.3.

A total of five census based indicators, widely believed to represent or be a determinant of material disadvantage, were considered for possible inclusion in the SAHRU Deprivation Index. These were:

> Unemployment
> Low social class
> No car
> Rented accommodation
> Overcrowding

The rationale for choosing each indicator is given below.

Unemployment

Unemployment reflects lack of access to earned income and the facilities of employment. Moreover it may impose other pressures on individuals through loss of self-esteem, and on families through problems and tensions generated.

One of two 'unemployment' indicators were considered for possible inclusion in the deprivation index:

> Proportion of the economically active population (15-64 year olds) unemployed or seeking a first time job,
>
> **or**
>
> Proportion of the economically active males (15-64 year olds) unemployed or seeking a first time job.

Low social class.

The Irish Social Class Scale is an ordinal scale from 1 (higher professional) to 6 (unskilled manual). It is based on the concept of groups whose members possess capacities for the generation of income through their occupations, not the status/prestige associated with particular occupations. A social class code of seven is assigned to people who can not be assigned to any of the other six groups. Being in a low social class — i.e. Class 5: semi-skilled manual occupations (including farmers farming less than 30 acres) and Class 6: unskilled manual occupations — reflects earnings at the lower end of the income scale. Low income limits access to material resources and the ability to make choices in life.

One of two 'low social class' indicators were considered for possible inclusion in the deprivation index:

> Proportion of the population in social class 5 or 6,
> **or**
> Proportion of the population (social classes 1 to 6 only) in social class 5 or 6.

This later indicator was proposed because of the relatively high proportion of the population in social class 7 (range: 0% to 74%, median 10%). This category includes many who are unemployed and its inclusion in the denominator of an indicator of 'low social class' will lead to an underestimate of the its impact, particularly in areas of high unemployment.

No car

Car ownership has been suggested as a surrogate for current disposable income. Apart from the cost of purchasing a car there are the necessary licensing, insurance, maintenance and repair costs, as well as day-to-day running expenses. Car ownership also confers benefits in terms of access to other resources. It might be argued that in city areas, with good access to public transport services, owning a car is not a necessity. Nevertheless despite the availability of public transport ownership of a car appears to be something that many households do wish to achieve. This may be a reflection of the inconvenience and/or limited scope of public transport as well as the prestige associated with owning a car. In rural areas car ownership is more of a necessity and its value as a discriminator between affluent and deprived areas may be diminished. However in rural Ireland there is considerable variability in car ownership between areas (range: 0% to 92%, median 23%) but the range is similar to that in urban areas (range: 0% to 96%, median 43%).

The following 'no car' indicator was considered for possible inclusion in the deprivation index:

> Proportion of permanent private households with no car.

Rented accommodation

Non-owner occupation has been suggested as a surrogate for income in the long term. Taken together with car ownership these two indicators are likely to provide a fairly good reflection of income levels in different areas.

One of three 'rented accommodation' indicators were considered for possible inclusion in the deprivation index:

> Proportion of permanent private households rented from a local authority
>
> **or**
>
> Proportion of permanent private households rented privately or from a local authority.
>
> **or**
>
> Proportion of permanent private households rented privately or from a local authority, or in the process of being acquired from a local authority

While acquiring a house from a local authority is not renting *per se* it was nevertheless included as part of this third potential indicator as it represents people likely to be less well off than many of those renting privately.

Overcrowding

Overcrowded accommodation reflects living circumstances and housing conditions. It may also reflect wealth as people in overcrowded circumstances are likely to wish to improve their circumstances provided financial resources are available.

The following 'overcrowding' indicator was considered for possible inclusion in the deprivation index:

> The average number of persons per room in permanent private housing units

The nature of this last indicator reflects one of the short-comings of the routinely available SAPS data. The present format of the SAPS data only allows the extraction of an overcrowding indicator which is based on a rate rather than the more conventional proportion. Thus it is not presently possible to identify, for example, the proportion of private households with more than one person per room.

2. Development of a material deprivation index

2.1 General methodology

<u>Task</u> The selection of a coherent and parsimonious set of indicators, reflecting how deprivation is conceived and how best that conception can be related to the available SAPS data.

The number of indicators

The history of index development (not confined to the field of health research) has seen a tendency to 'trawl' for possible measures without enough regard being paid to the rationale for variable selection. This has given rise to the 'bigger is better' philosophy of index construction - an index based on 10 indicators must be preferred to one based on 5! This is likely to result in serious error. It not only reflects poor problem definition but is also more likely to result in an index that is too highly specified to be stable - a common fault in statistical modelling and forecasting. With a large number of indicators, there will be strong inter-dependencies implying a significant degree of redundancy - additional indicators do not contribute new information (capture a further *dimension* of the problem), they merely duplicate the information already present. Townsend et al. warned against this practice. [8] Multicollinearity (highly correlated variables) will lead to problems during statistical model building and subsequent application. Avoidance of this by employing the principle of *parsimony* during index development is a critical feature of good statistical practice. [12,13]

Parsimony might argue for an index based upon a single indicator (e.g. unemployment) rather than a composite index, with the added attraction of simplicity of interpretation. However, this is too limiting in that there are many dimensions to the concept and measurement of deprivation and several indicators reflecting the multi-dimensionality of the problem, combined in a suitable manner, offer a proven better solution - one that is more sensitive and a better discriminator.[c]

Section 1 listed the potential indicators for consideration in the construction of the index. The final choice of indicators was determined empirically by the 'best' principal components model (see Technical Notes below).

The final selection included (with common name in brackets):

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[c] Confirmed by our own experience and elsewhere, for example, Davey-Smith (14).

Proportion of the economically active population (15-64 year olds) unemployed or seeking a 1st time job - (**Unemployed**)

Proportion of the population (social classes 1 to 6 only) in social class 5 or 6 - (**Low social class**)

Proportion of permanent private households with no car - (**No car**)

Proportion of permanent private households rented privately or from a local authority, or in the process of being acquired from a local authority - (**Rented accommodation**)

The average number of persons per room in permanent private housing units - (**Overcrowding**)

Correlations between constituent indicators

The pairwise correlations between these indicators is shown in Table 1. All pairwise correlations are positive and highly significant at $p<0.001$ - although given the sample size (3,444 DEDs), the latter is unsurprising. The highest correlation is between 'Rented accommodation' and 'No car', followed by 'Unemployment' and 'No car', and 'Unemployment' and 'Low social class'. The lowest correlation is between 'Overcrowding' and 'No car'.

Table 1 - All pairwise correlations between indicators

Indicator 1	Indicator 2	Correlation
Low social class	Unemployment	0.63
Rented accommodation	Unemployment	0.57
Rented accommodation	Low social class	0.34
No Car	Unemployment	0.64
No Car	Low social class	0.51
No Car	Rented accommodation	0.71
Overcrowding	Unemployment	0.33
Overcrowding	Low social class	0.43
Overcrowding	Rented accommodation	0.11
Overcrowding	No Car	0.07

2.2 Steps in index construction

Given the 5 indicators measured on 3,444 DEDs, the task is to reduce the *dimensionality* of these data whilst preserving as much of the original information content as possible. For example, if the original 5 indicators can be combined into a single *index* then this would constitute a more manageable model, provided the reduction in dimensionality is not at the expense of excessive information loss as we discuss below.

Step 1: Indicator standardisation. Some indicators (y_1 ...... y_5) are expressed in different units, e.g. *proportion* of unemployed and the *number* of persons per room, and so linear combinations of these variables will make little sense. It is therefore important that each indicator be standardised to have a common scale [d] - conventionally, with a mean of 0 and a variance of 1:

$$z_i = \frac{(y_i - \overline{y_i})}{s_{y_i}} \tag{1}$$

the transformed variables are designated as z_1...... z_5

Step 2: Indicator weighting. To weight or not to weight? The simple additive index -

$$index = \sum_i z_i \tag{2}$$

is the sum of the scores for each standardised variable.

Its advantages are that it is simple to construct, and thus easy to understand - this is the format employed originally by Townsend and also by Carstairs. A serious disadvantage is that this index assumes that, for example, car ownership is of equal importance to unemployment rate. A well recognised alternative exists, i.e. a general weighted index[15]

$$index = \sum_i w_i z_i \tag{3}$$

with the choice of weights determined by an objective multivariate technique such as Principal Components analysis (PCA). [12,13]

Step 3: Principal components analysis. PCA is a widely used method of data reduction in multivariate analysis where the goal is to produce a small number of derived variables

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[d] 'Normalisation' by means of a complex transformation, prior to standardisation, as suggested by Gilthorpe (15) was examined, but was not found to be useful or improve upon the final model for these data.

in lieu of a larger number of original variables.[e] (see Technical Notes: Box 1 for a brief overview of principal components.) We start with a matrix of 3,444 rows (the DEDs) by 5 columns (indicators) and hope to finish with single new vector uniquely scaling the individual DEDs. Initially, there are as many new principal components (PCs) as there were original variables (5 in this case), however, the 1st PC will serve as the new summary measure if this component complies with certain guidelines. [12,17]   PCA generates a self weighting index with weights derived directly from the data and the 1st PC constitutes the index:

$$PC_1 = \sum_i w_i z_i \qquad\qquad (4)$$

The 1st PC was computed as follows (with original indicators standardised):

$$PC_1 = 0.50 \text{ (Unemployment)} + 0.45 \text{ (Low social class)} + 0.44 \text{ (Rented accommodation)} + 0.46 \text{ (No car)} + 0.34 \text{ (Overcrowding)} \qquad (5)$$

The weights range from 0.50 for Unemployment to 0.34 for Overcrowding and are all positive. This 1st PC uses roughly equal amounts of the indicators (with less emphasis on overcrowding) and can be interpreted as a weighted average. For these data the first PC meets set guidelines (see Technical Notes: Box 2 for a discussion of the number of components to be retained) and so satisfies the requirements for an index of deprivation.

Step 4: Scaling for mapping purposes. The PCA generates a continuous variable (the *deprivation score*) which is then standardised (mean 0, standard deviation 1) for convenient expression and without loss of information. Finally, for mapping purposes, this score is converted to an ordinal scale or *deprivation level* of 1 (least deprived) to 5 (most deprived). [f] The choice of cut-off points in the conversion is designed specifically to retain the shape of the distribution of the original score (see Technical Notes, Box 3).

Step 5: Colour coding. The choice of colours in representing the levels of deprivation is important. [18] These were selected to provide a clear discrimination between levels, but additional and importantly, to allow for black-and-white photocopying without visual misrepresentation.

2.3 Technical Notes

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[e] Factor analysis (FA) is an alternative technique to principal components. FA postulates a formal model relating the observed indicators to a set of unobserved factors. As noted by Everitt (ref 17), FA is commonly employed in the bahavioural sciences but not so often with the medical sciences "perhaps because the assumed model is often not considered realistic". FA is implemented in either of 2 modes: i) with orthogonal rotation of the factors - this yields essentially the same information as PCA; and ii) with oblique rotation - this mode is subjective and is viewed by statisticians as problematic and is not recommended, though this latter method has been used recently in one Irish index (11).

Box 1: Brief description of Principal Components

Principal components analysis attempts to explain as much of the total variation or information in the data as possible with as few components as possible. The first principal component (PC_1) is defined as that linear combination of the original variables that accounts for the maximun amount of the total variation of the original data, or

$$PC_1 = w_{11} Z_1 + w_{12} Z_2 + w_{13} Z_3 + w_{14} Z_4 + w_{15} Z_5 \qquad (6)$$

where Z_i (i=1 to 5) represents the standardised indicators, and w_{11} ... w_{15} are the weights chosen automatically from the data subject to the necessary restriction that the sum of the squared weights equals 1. An additional consideration is the need for individual observations (on DEDs) to be population weighted as is standard practice when analysing aggregated data.

PC_2 is computed with a different set of weights so as to be uncorrelated with PC_1 but accounting for the maximun proportion of the remaining total variation not captured by PC_1:

$$PC_2 = w_{21} Z_1 + w_{22} Z_2 + w_{23} Z_3 + w_{24} Z_4 + w_{25} Z_5 \qquad (7)$$

Etc, etc. As there are 5 variables in this analysis, there will be a maximum of 5 PCs. However, in general most of the total variation will be accounted for by the first one or two PC s (see Box 2).

The weights associated with PC_1 are:

Indicator	Weights	Correlation between PC_1 and individual indicators
Unemployment	0.50	0.88
Low social class	0.45	0.80
Rented accommodation	0.44	0.73
No car	0.46	0.80
Overcrowding	0.34	0.49

The 1st PC may be written (with the original indicators standardised) as:

$$PC_1 = 0.50 \text{ (Unemployment)} + 0.45 \text{ (Low social class)} +$$
$$0.44 \text{ (Rented accommodation)} + 0.46 \text{ (No car)} + 0.34 \text{ (Overcrowding)} \qquad (8)$$

This component is a weighted average of the 5 indicators with weights ranging from 0.5 to 0.34, and may be considered as an overall measure of their information content. The correlation between the 1st component and the individual indicators is also shown. While the weights have no simple intuitive interpretation, note that the degree of correlation of this component is roughly related to the size of the corresponding weight, i.e. the larger the weight, the higher the correlation. The index based on this component is evidently highly correlated with the first 4 indicators, but to a lesser degree with over crowding.

[f] It is important to emphasise that the deprivation score is used for all formal analyses (e.g. for external validation in Part II) while the grouping of this score into 5 levels serves the important purpose of deprivation mapping and summarisation.

Box 2: How many components must be retained?

Statisticians have devised some guidelines to assist in determining the number of components that must be retained to adequately capture the information content of the original variables:

- Include just enough components to explain at least 70% of the total variance;
- Exclude components with eigenvalues less than 1;
- Plot the eigenvalues for i=1...p, and look for a sharp drop or 'elbow' in a so-called *scree plot..*

These guidelines might demand that more than one component be retained, and this would not therefore meet the specific requirement for a single index. However, should we find that the 1st PC meets the above requirements, then a highly parsimonious summary of the data would have been achieved. The eigenvalues below give the variances of the PCs - and the sum is the total variance of the original variables, which, if we have standardised is simply the number of variables (i.e. 5 in this case).

Results of the principal components analysis of the 5 indicators:

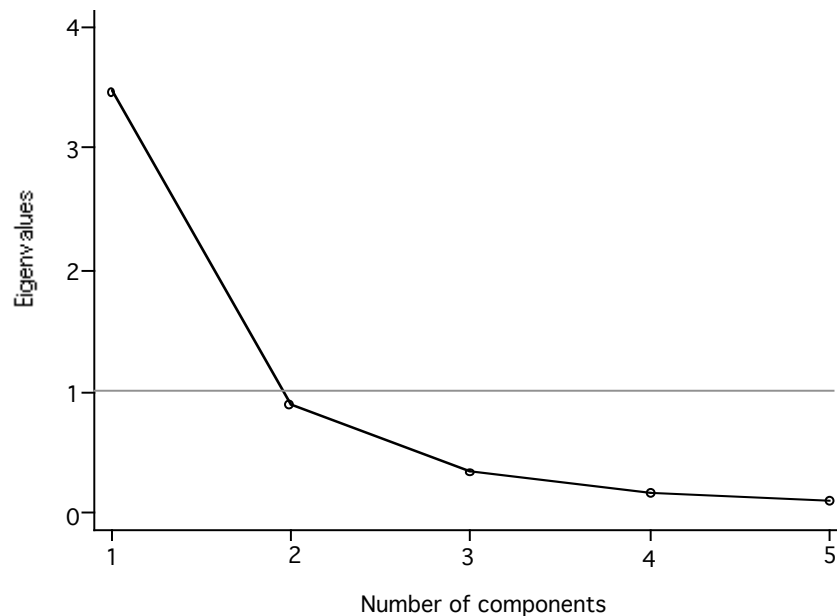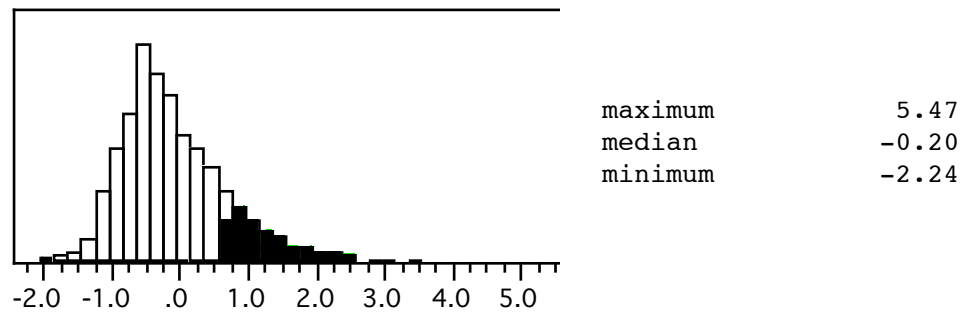| Component	Eigenvalue	Difference	Proportion	Cumulative
1	3.47214	2.56894	0.70	0.70
2	0.90320	0.56324	0.18	0.88
3	0.33996	0.16723	0.06	0.94
4	0.17273	0.06075	0.03	0.97
5	0.11198		0.02	1.00

Figure 1 - Scree plot of eigenvalues against the number of principal components

Note the following: the 1st PC accounts for 70% of the total variance; the 2nd PC has an eigenvalue less than 1 and the scree plot (Figure 1) clearly separates the 1st from the subsequent PC s.
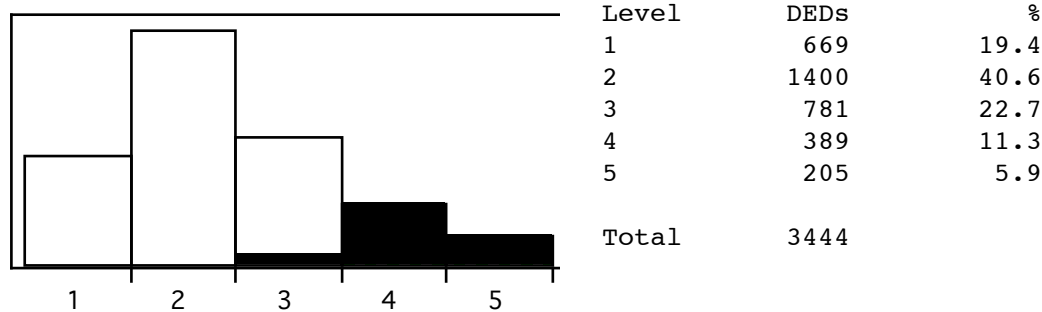
Box 3: Choosing cut-off points

Starting with a deprivation score on a continuous scale, we wish to assign DEDs to 5 ordered categories - the choice of cut-off points for these categories is important. On occasion, this conversion is based on simple quintiles with each category containing 20% of the DEDs. This simplistic approach can be highly misleading as can be easily demonstrated. For approximately uniform distributions it would be reasonable to divide the distribution into 5 equal parts (quintiles), however, this approach would make little sense with highly skewed data (Figure 2, top). (Carstairs and Morris [9] also sought to retain the characteristics of the sample distribution by carefully selecting cut-off points.) The bottom plot in Figure 2 represents quintiles of the score distribution; the final category is selected and the corresponding values (DEDs) are highlighted in the middle and upper plots. The upper plot is the empirical score distribution for all 3,444 DEDs and the middle plot is the chosen categorisation. Note that the upper quintile incorporates scores as low as 0.7. This would clearly not serve the purpose of correctly identifying the most deprived DEDs nationally.

Histogram of Deprivation score

maximum	5.47
median	−0.20
minimum	−2.24

Deprivation Level (preferred scaling)

Level	DEDs	%
1	669	19.4
2	1400	40.6
3	781	22.7
4	389	11.3
5	205	5.9
Total	3444	

Deprivation Level (quintiles)

Level	DEDs	%
1	688	20.0
2	689	20.0
3	689	20.0
4	689	20.0
5	689	20.0
Total	3444	
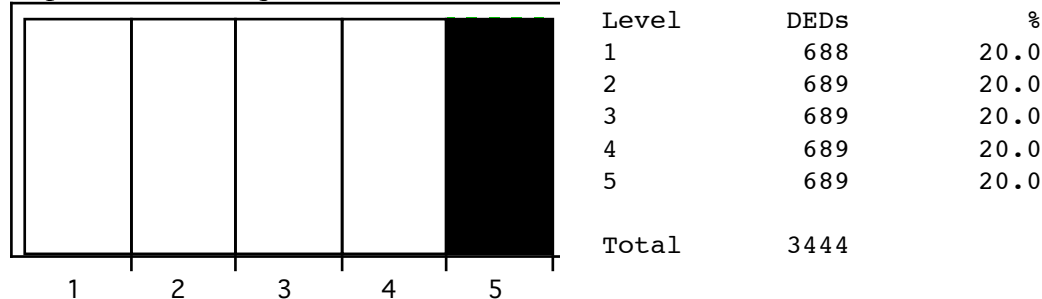
Figure 2 - Effect of the choice of cut-off point in deriving a scale

Top: Original score; middle: preferred scaling; bottom: possible alternative (quintile) scaling. (Highest quintile selected and corresponding areas shown in black on each plot.)

3. Results

3.1 Overview

The distribution of the deprivation score is presented in Figure 3. The distribution is scaled to have a mean of 0 and a standard deviation of 1, however as the distribution is positively skewed (evident from both the histogram and the superimposed box plot) the median (-0.21) represents the central tendency more effectively than the mean. It will be noted that there are a substantial number of outliers - all observations identified from just below 2.0 to the maximum value of 5.4, accounting for nearly 6% of DEDs. The minimum value of the score is -2.2.
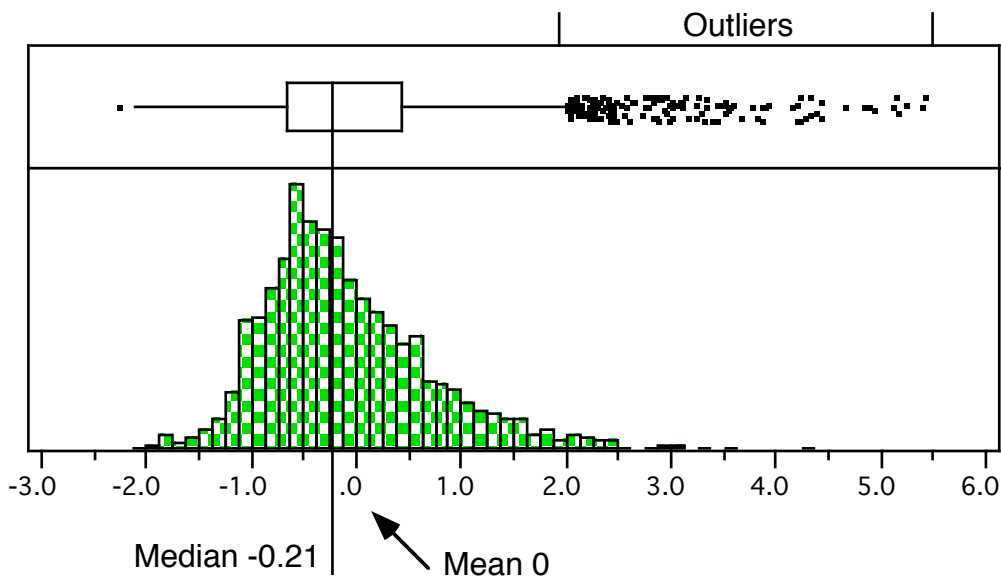
Figure 3 - Distribution of the deprivation score (high scores are worse)

As noted in Step 4 above, the deprivation score is categorised into 5 levels (for convenience of mapping) in a manner so as to preserve the characteristics of the original distribution (Figure 4). For example, the outliers in Figure 3 are assigned the highest deprivation level of 5. The details are summarised in Table 2 below.
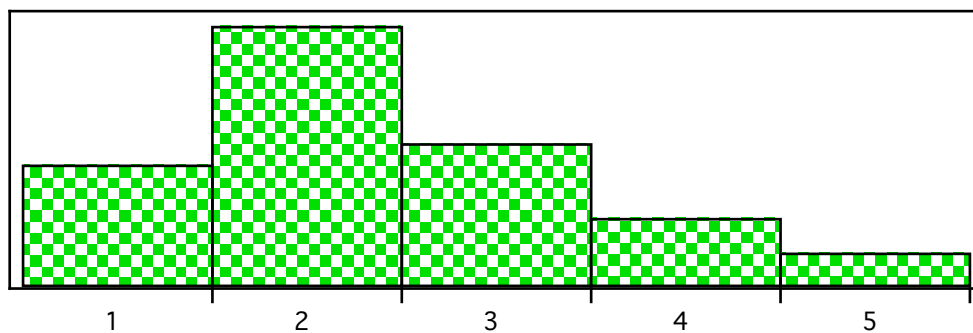
Figure 4 - Distribution of deprivation levels nationally (3,444 DEDs)
(Deprivation score categorised into 5 levels: 1 = least deprived and 5 = most deprived.)

Table 2 - Summary of distribution of deprivation levels nationally (3,444 DEDs)

Deprivation Level	No of DEDs	%
1	669	19.4
2	1400	40.6
3	781	22.7
4	389	11.3
5	205	5.9

Note that 19% of DEDs are designated as level 1 (least deprived) and just under 6% are designated as level 5 (most deprived). A majority (40.6%) of DEDs are assigned a depreviation level of 2.

3.2 Regional variation

Regional differences in Deprivation Score

The distribution of the deprivation <u>score</u> is shown within each health board by means of a series of juxtaposed box plots (see Figure 5); the details are in Table 3. The overall median score across all DEDs is -0.21 (range -2.24 to +5.47). For those HBs on the right hand side of figure 5 it will be seen that their respective medians are coincident with the overall median - although range and degree of skewness differ markedly. For the HBs on the left of the figure, the individual median scores are either higher (marginally so for the EHB, but significantly so for the NWHB), or marginally lower for the MWHB and SHB. The EHB has the greatest range followed closely by the MWHB (Table 3). The MHB and NEHB regions display the smallest ranges.

Figure 5 - Box plots of the deprivation score within each health board. (Overall median score is -0.21)

Table 3- Quantiles of deprivation score by Health Board and for Ireland overall.

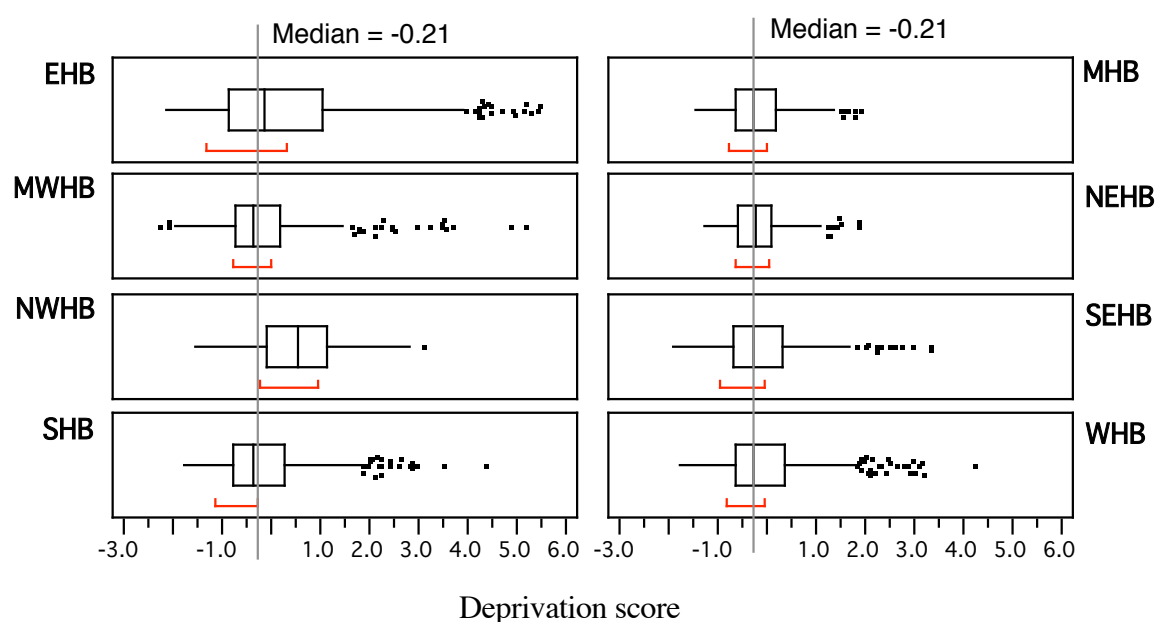| Health Board	Minimum	25.0%	Median	75.0%	Maximum	Range
EHB	-2.10	-0.85	-0.11	1.07	5.47	7.57
MHB	-1.41	-0.61	-0.24	0.22	1.93	3.04
MWHB	-2.24	-0.69	-0.33	0.20	5.18	7.42
NEHB	-1.26	-0.55	-0.22	0.13	1.88	3.14
NWHB	-1.51	-0.08	0.56	1.15	3.10	4.61
SEHB	-1.88	-0.65	-0.24	0.34	3.36	5.24
SHB	-1.76	-0.75	-0.32	0.27	4.37	6.13
WHB	-1.74	-0.61	-0.25	0.36	4.27	6.01
Ireland	-2.24	-0.63	-0.20	0.43	5.47	7.71

Regional differences in Deprivation Level

Focusing on the most deprived DEDs (i.e. levels 4 + 5) Table 4 provides an overview by health board region. For a detailed breakdown by deprivation level within each health board see Appendix 2.

Table 4 - Overview of most deprived DEDs (levels 4 + 5; n=594) by Health Board

Health Board	No of DEDs	No of DEDs with levels 4+5	% nationally (n=594)	% per HB	Popn in DEDs with levels 4+5	% nationally (n=996840)	% per HB
EHB	495	148	25	30	414995	42	33
NWHB	309	127	21	41	93800	9	45
WHB	504	81	14	16	65816	7	19
SEHB	518	73	12	14	116686	12	30
SHB	566	68	11	12	116000	12	22
MWHB	412	50	8	12	68365	7	22
MHB	347	28	5	8	48562	5	24
NEHB	293	19	3	6	72616	7	24

As an example of the interpretation of this table, note from the 1st row that 25% of DEDs classified as deprived (i.e. levels 4+5, amounting to some 594 DEDs out of 3,444 nationally) are located in the EHB, and 42% of all those living in deprived DEDs are in this area. [g] The EHB has the highest percentage of deprived DEDs (and population living in deprived DEDs) nationally. Alternatively, in view of the unequal distribution of DEDs and population per health board, the results can be usefully re-expressed as a percentage per health board - representing the burden in relative terms. The NWHB now has the highest percentage of deprived DEDs (and population living in deprived DEDs)

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[g] NB: this exercise can not determine the actual <u>numbers of deprived individuals</u>, nationally or by health board. As stated in Section 1, not everyone living in a deprived DED is necessarily deprived, and *vice*

relative to its size, followed by the EHB. There is less variation across the remaining health boards than before. Both views of the distribution are valid and depend upon the reader's perspective: national or inter-regional.

From Figure 6, it will be seen that the EHB and NWHB are clearly different from the others. The former shows the least variation across the 5 levels for any region, while the latter is shifted to the right (more deprived). The shapes displayed by the balance of the health boards are broadly similar with level 2 dominating and level 5 representing the smallest proportion (at only 1% of DEDs for the MHB and NEHB). The results are mapped in Maps 3 to 10 (all health board maps are drawn to the same scale). The national map (Map 1) appears as the frontispiece.
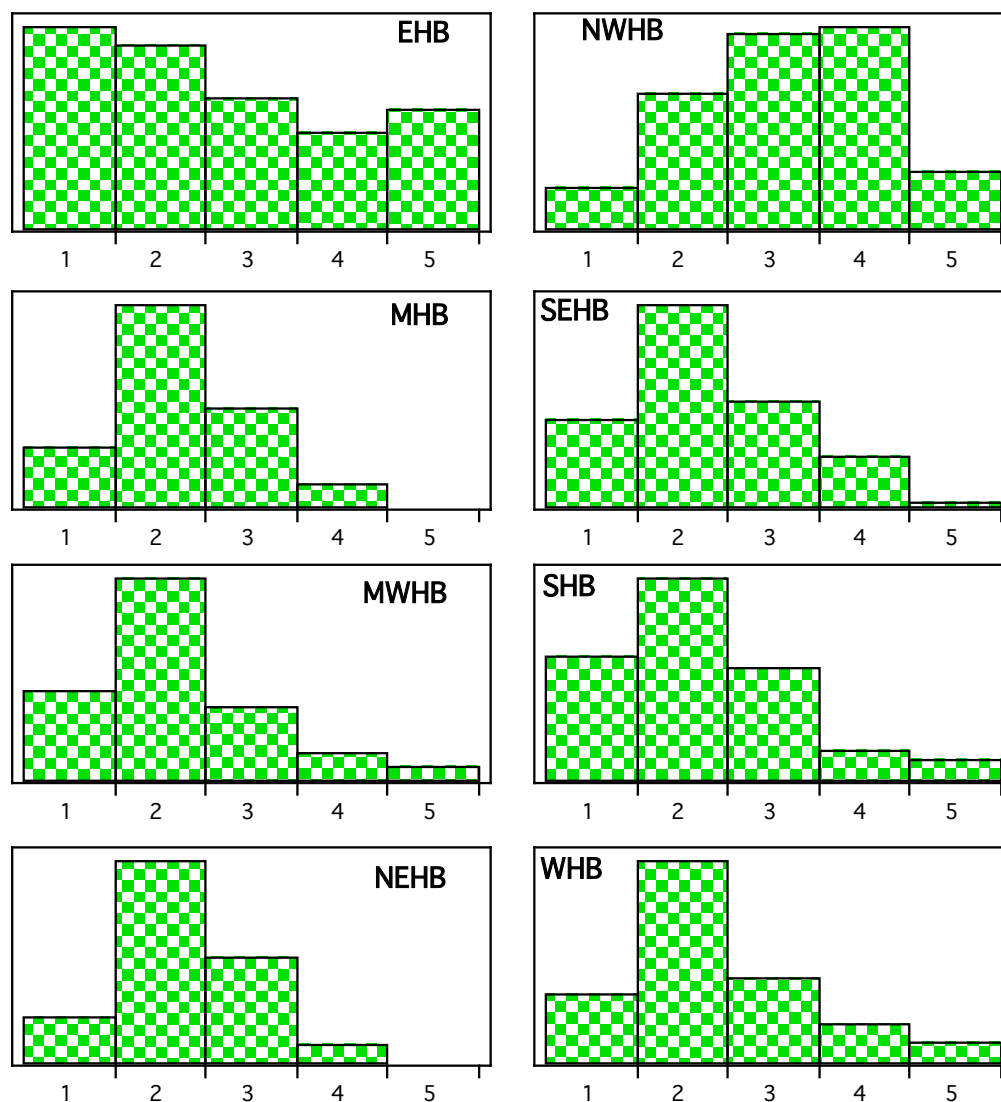

Figure 6 - Distribution in deprivation level (1 to 5; 5 is most deprived) within each health board.

VARIOUS MAPS APPEARED HERE AND FOLLOWING PAGES
THESE ARE NO LONGER AVAILABLE

3.3 Variation in component indicators by deprivation level

As discussed in Section 1, the deprivation index is a weighted combination of five indicators. It is of interest to consider how these typically vary by deprivation level (see Table 5 and Figure 7). Note that all means consistently increase with increasing deprivation level - this would be a prerequisite for a sensible index. The degree of increase between deprivation levels 1 to 5 is as follows:

Unemployment	4-fold increase;
Low social class	3-fold increase;
Rented accommodation	6-fold increase;
Car ownership	nearly 4-fold increase;
Overcrowding	less than 1.5 fold increase.

The indicator of overcrowding (persons/room) differs from the other indicators because the others are expressed as proportions whereas overcrowding is a ratio measure with the smallest coefficient of variation (CV i.e. standard deviation/mean) at a value of 11 across all DEDs; by contrast, the corresponding CV for unemployment is 53 and that for rented accommodation is 94. Reference to equation (8) will confirm that overcrowding has the smallest principal component weight of the 5 indicators.

Table 5 - Means and standard deviations for the 5 indicators by deprivation level

Level	No of DEDs	Unemployment		Low social class		Rented accommodation		No Car		Overcrowding	
		Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
1	669	0.05	0.02	0.17	0.06	0.08	0.05	0.17	0.07	0.60	0.07
2	1400	0.08	0.02	0.26	0.06	0.10	0.07	0.23	0.07	0.65	0.06
3	781	0.11	0.03	0.34	0.07	0.17	0.10	0.31	0.09	0.67	0.07
4	389	0.15	0.03	0.40	0.08	0.27	0.14	0.41	0.13	0.69	0.08
5	205	0.22	0.06	0.50	0.11	0.49	0.26	0.63	0.17	0.74	0.10

3.4 Analysis of the most deprived areas

The distribution by Health Board of the 205 most deprived DEDs (i.e. those assigned a deprivation level 5) is shown in Table 6 (and listed by DED in Appendix 1). The EHB contains the bulk of the most deprived DEDs (40%) equivalent to nearly 63% of the nearly 390,000 individuals living in these DEDs. The national rate is 205/3,444 or 5.95%, from which we can compute the expected numbers of DEDs with a deprivation level of 5 if distributed at the same rate across health boards (see column headed 'Expected No. DEDs'in total). The departure from expected is highly significant
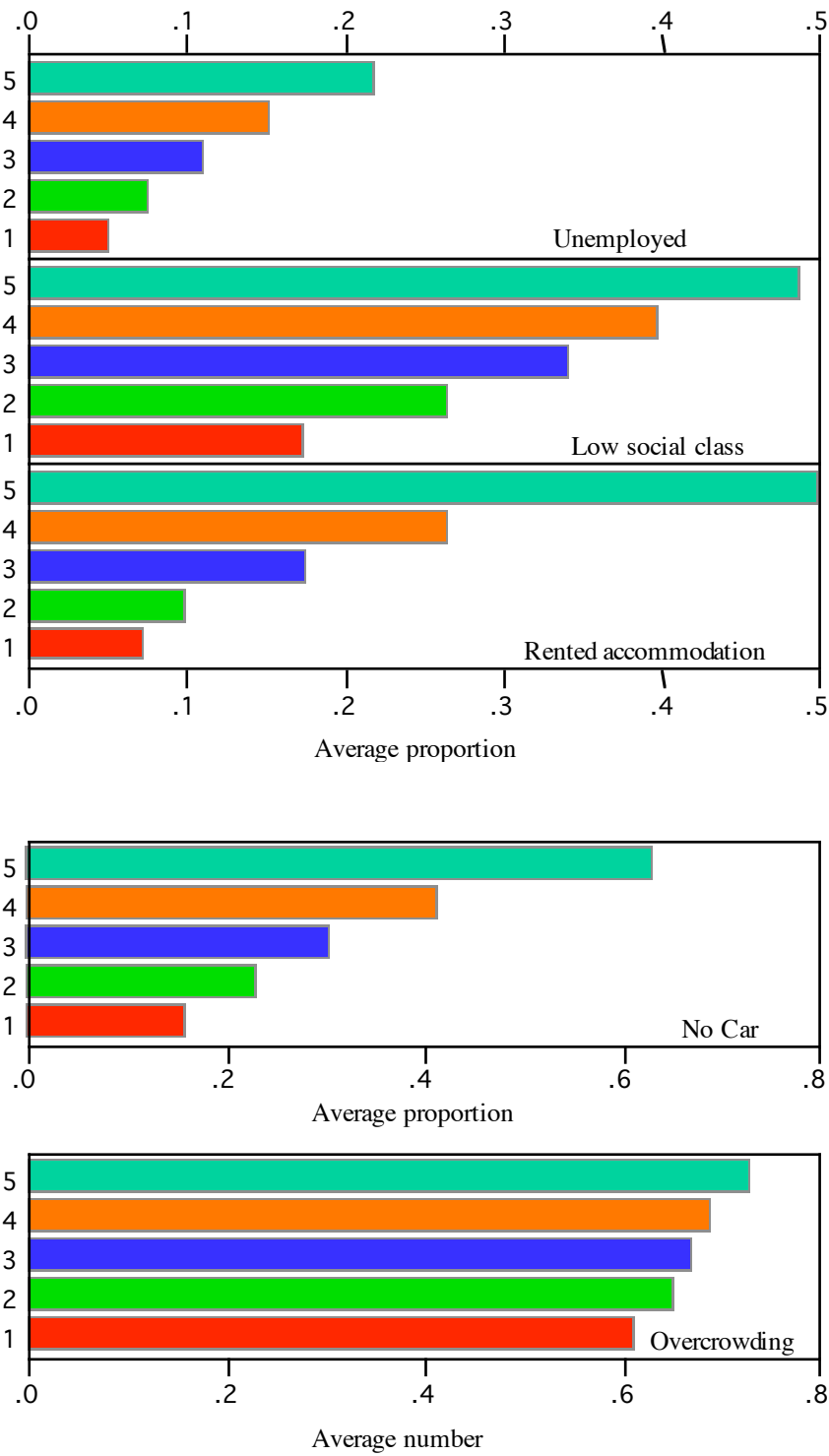
Figure 7 - Variation in means of component indicators by deprivation level (1-5)

p<0.001) with the difference between the observed and expected (O-E) shown in the last column. Clearly, both the EHB and NWHB carry a disproportionate number of most deprived DEDs. In population terms some 11% of the national population live in the 205 most deprived DEDs. Using this rate, the discrepancy between the expected numbers of persons and the observed per health board may be determined. Only the EHB has a substantial excess of its population living in the most deprived DEDs (not shown here).[h]

One hundred and thirty seven of the 205 DEDs (66%) are urban, and 68 rural (34%). This represents a two to one majority of urban over rural, yet nationally there are nearly 5 rural DEDs to every 1 urban DED.

Table 6- Distribution of the most deprived (level = 5) DEDs by Health Board

Health Board	No of DEDs	% (n=205)	Popn	% (popn.= 389107)	Expected No. DEDs	O-E
EHB	82	40.0	244441	62.8	29	+53
NWHB	30	14.6	22554	5.8	18	+12
WHB	29	14.1	19809	5.1	30	−1
SHB	28	13.7	45745	11.7	34	−6
MWHB	19	9.3	26247	6.7	25	−6
SEHB	12	5.9	20229	5.2	31	−19
MHB	3	1.5	6644	1.7	21	−18
NEHB	2	1.0	3438	0.9	17	−15
Total	205	100.0	389107	100.0	205	0

4. Cross validation

Given that the preponderance of the most deprived DEDs were found to be urban, it is reasonable to enquire if the derivation of the index by population weighted principal components might have introduced an *urban bias*. This has been checked by the following cross-validation procedure. Two separate principal component analyses were conducted, the first employing only the rural DEDs (n=2,865) and the 2nd only the urban DEDs (n=579). Two sets of indicator weights (derived from the 1st PC in both instances - as before) were obtained. These separate weights were applied to all DEDs to construct two indices. Using common cut-off points all DEDs were assigned a deprivation level of 1 to 5 (see Table 7). It will be seen that the differences are slight in terms of proportions of DEDs assigned to each level. Moreover, when all DEDs are

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[h] As already noted in footnote f, it is important to recall the statement made in Section 1 that not all persons living in deprived DEDs are themselves deprived, and conversely, a relatively affluent DED will still have numbers of deprived individuals.

cross-classified by both methods the level of agreement is excellent (Kappa = 0.914, p<0.001) Table 7. We conclude that there is no evidence for an urban-rural bias.

Table 7 - Cross-validation results

Deprivation Level	No (%) of DEDs using Rural weights	No (%) of DEDs using Urban weights
1	657 (19.1)	668 (19.4)
2	1421 (41.3)	1375 (39.9)
3	786 (22.8)	803 (23.3)
4	376 (10.9)	398 (11.6)
5	204 (5.9)	200 (5.8)
Total	3444 (100)	3444 (100)

Table 8 - Cross classification of all DEDs by both methods

		No of DEDS by deprivation level using Urban weights					Total
		1	2	3	4	5	
No of	1	637	20	0	0	0	657
DEDs	2	31	1328	62	0	0	1421
using	3	0	27	726	33	0	786
Rural	4	0	0	15	350	11	376
weights	5	0	0	0	15	189	204
	Total	668	1375	803	398	200	3444

Kappa = 0.914 (Std Err = 0.005); p<0.001.

The distributions of the individual indicators by urban and rural DEDs are to be found in Appendix 3.

Part II: A Health Board specific index

5. Introduction and rationale

The national deprivation index provides a unique ranking of the nearly three and a half thousand DEDs in Ireland. This ranking serves to identify areas that are extreme in terms of variation in the 5 indicators nationally. The index is thus optimal in this sense. However, this index is not optimal for the requirements of individual health boards where the need is to identify the degree of *relative deprivation within the region*. The importance, i.e. principal component weight appropriate to each indicator may vary from region to region, in a manner that is locally optimal and best discriminates between the sub-set of DEDs, and for this purpose separate indices have been computed for each health board.[i] The methodology is the same as that discussed above for the national index except of course that the census data used relate to individual health board areas. The process is illustrated by reference to the 495 DEDs comprising the Eastern Health Board region.

5.1 Deprivation in the EHB

The equation of the 1st principal component is given below. The eigenvalue associated with this component accounts for 80% of the total variation in the 5 indicators.

$$PC_1 = 0.48 \text{ (Unemployment)} + 0.45 \text{ (Low social class)} + 0.44 \text{ (Rented accommodation)} + 0.45 \text{ (No car)} + 0.38 \text{ (Overcrowding)} \qquad (9)$$

The frequency distribution of DEDs by deprivation level follows (Table 9 and Figure 8).

Table 9 - Distribution of DEDs by Deprivation Level (495 DEDs)

Deprivation Level	No of DEDs	%
1	112	22.6
2	191	38.6
3	96	19.4
4	59	11.9
5	37	7.5

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[i] These had been formally requested by 6 of the 8 boards Departments of Public Health.
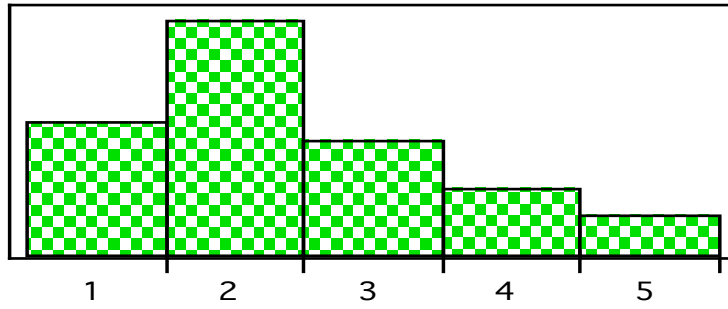
Figure 8 - Frequency distribution of deprivation levels

The contribution by each Community Care Area (CCA) to overall deprivation in the EHB is shown in the Table 10. As before, for ease of reporting we have grouped deprivation levels 4 and 5 (n=96) and labelled these *deprived*.

Table 10 - Overview of most deprived DEDs (levels 4 + 5) by Community Care Area (CCA) in the EHB

CCA	No of DEDs	No of DEDs with levels 4+5	% EHB (n=96)	(% per CCA)	Popn. in DEDs with levels 4+5	(%) (popn=286956)
CCA 6	41	19	(20)	(46)	57131	(20)
CCA 7	40	14	(15)	(35)	41677	(15)
CCA 5	28	13	(14)	(46)	50778	(18)
CCA 4	40	13	(14)	(33)	48943	(17)
CCA 3	34	9	(9)	(26)	17972	(6)
CCA 2	41	8	(8)	(20)	20136	(7)
CCA 9 (Kildare)	90	8	(8)	(9)	18422	(6)
CCA 8	52	7	(7)	(13)	22010	(8)
CCA 10 (Wicklow)	83	3	(3)	(4)	4358	(2)
CCA 1	46	2	(2)	(4)	5529	(2)

As an example of the interpretation of this table, note from the 1st row that 20% of DEDs classified as deprived (i.e. deprivation levels 4+5, n=96) are located in CCA 6, and 20% of all those living in deprived DEDs in the EHB (popn.=286,956) are in CCA 6. CCA 6 has the highest proportion of deprived DEDs in the regional and also the highest proportion of the population living in deprived DEDs; CCAs 10 (Wicklow) and 1 have the fewest deprived DEDs in the EHB region. Alternatively, in view of the unequal distribution of DEDs per CCA, the results can be usefully re-expressed as a percentage per CCA - representing the burden of deprivation in relative terms. In these terms, CCAs 6 and 5 have the highest relative proportion of deprived DEDs (19/41 and 13/28, respectively), followed by CCA 7 (35%) and CCA 4 (33%).

5.2 Other health boards in brief

The indicator weights for the 1st principal component for the individual models for each health board are listed in Table 11. [j] It will be noted that the weights associated with unemployment and social class are consistently among the highest in each health board, but the remaining indicators are more variable, especially that for overcrowding. The connection between the size of the weights and the correlation between the principal component and the corresponding indicators was noted in Box 1 of the Technical Notes relatively large weights attached to indicators equates with large correlation between the principal component and the corresponding indicator. Conversely, in Table 11, the small weights associated with - for example - 'rented accommodation' in the NWHB and 'overcrowding' in the NEHB and MHB, indicate that their respective 1st principal component is relatively unassociated with these variables in these regions. The rank order of weights is seen to change from region to region. This underlies the distinction between the development of the national index on the one hand, and the need for separate health board-specific indices which are internally optimal and designed for within-region comparisons. The indicator means plus standard deviations by health board appear in Table 12.

Table 11 - Weights associated with the 1st principal component in the separate principal components analyses for each health board

Health Board	Unemployment	Low social class	Rented accommodation	No car	Overcrowding
EHB	0.48	0.45	0.44	0.45	0.38
NWHB	0.56	0.56	0.18	0.38	0.42
WHB	0.54	0.51	0.31	0.53	0.23
SHB	0.50	0.48	0.47	0.47	0.22
MWHB	0.48	0.47	0.45	0.47	0.31
SEHB	0.49	0.47	0.49	0.48	0.22
MHB	0.48	0.46	0.51	0.52	0.06
NEHB	0.51	0.44	0.50	0.53	0.01

Table 12 - Means (standard deviation) by indicator for each health board

Health Board	Unemployment	Low social class	Rented accommodation	No car	Overcrowding
EHB	0.11 (0.07)	0.27 (0.13)	0.27 (0.23)	0.35 (0.23)	0.64 (0.11)
NWHB	0.13 (0.06)	0.37 (0.11)	0.13 (0.08)	0.34 (0.09)	0.69 (0.08)
WHB	0.09 (0.06)	0.31 (0.13)	0.10 (0.08)	0.30 (0.11)	0.67 (0.07)
SHB	0.09 (0.04)	0.28 (0.09)	0.15 (0.13)	0.27 (0.14)	0.64 (0.08)
MWHB	0.09 (0.05)	0.26 (0.09)	0.14 (0.15)	0.27 (0.15)	0.66 (0.06)
SEHB	0.10 (0.04)	0.29 (0.09)	0.17 (0.12)	0.23 (0.12)	0.65 (0.06)
MHB	0.09 (0.04)	0.29 (0.09)	0.12 (0.09)	0.23 (0.09)	0.67 (0.06)
NEHB	0.09 (0.04)	0.30 (0.07)	0.11 (0.09)	0.25 (0.09)	0.66 (0.05)

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[j] Strictly speaking it makes little sense to compare the weight *values* cross-regionally as these are estimated on non comparable data sets. However, the rank order of weights in one region as compared to the rank order in another region will give a sense of the relative importance of individual indicators in constructing the particular index.

6. External Validation

At present, small area data on mortality (or relevant health service indicators) are only routinely coded for 322 DEDs in Dublin County & County Borough within the Eastern Health Board region. This allows us to validate the deprivation index in this region. The following Table 13 shows the correlation between the deprivation score and selected mortality and other indicators expressed as standardised mortality (or incidence) ratios. Is deprivation predictive of relevant health outcomes? Overall, the correlation between the deprivation score and Bayesian adjusted SMRs [k] for all cause (<65 years) mortality between 1986 and 1989 is 88% and for all cause all ages it is 81%. In addition, the correlation between the score and area mortality for lung cancer in men is 66%, while that for prevalence of low birth weight is 65%. The correlation with percent GMS population within each DED is 93%.

Table 13 - Correlation with selected outcomes

Outcome	Correlation (FB-SMR)	p-value
All Cause SMR (< 65 years)	0.88	<0.0001
All Cause SMR (all ages)	0.81	<0.0001
Lung Cancer (adult men)	0.66	<0.0001
Low Birth Weight	0.65	<0.0001

Two separate studies in progress provide additional useful support for the index. In the first of these the distribution of all general practitioners' surgeries in Dublin County and County Borough were geocoded and assigned to a DED. The DEDs with no GP surgery present are cross-tabulated by level of deprivation in Table 14. The reported Kruskal-Wallis statistic (a test to determine the presence of trend across deprivation level) is very significant - confirming the negative association between GP surgery presence and deprivation level. [24]

Table 14 - Presence of any GP surgery by deprivation level

No. of DEDs	Level 1	Level 2	Level 3	Level 4	Level 5	Total
No GP present	18 (20%)	24 (25%)	15 (30%)	20 (41%)	17 (47%)	94 (29%)
GP present	73 (80%)	72 (75%)	35 (70%)	29 (59%)	19 (53%)	228 (71%)
Total	91	96	50	49	36	322

Kruskal-Wallis Test $z = -3.64$ $P < 0.01$

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[k] This methodology is discussed in detail in the SAHRU Technical Report No. 1 (May 1997).

Analysis (in progress) of a major survey of households in the Tallaght district (situated to the south west of Dublin city) clearly confirms the relationship between demand for various health service facilities (GP visits, use of public health nurse, use of social worker, absence of family health cover, casualty visits, household smoking, use of tranquillizers, and smear testing, etc.) and area deprivation level. In this study information was also available - at the household level - in relation to the constituent indicators of the deprivation index, allowing a check on the congruence between the census-based DED level assignment of deprivation and that determined on a household-by-household basis.

7. Conclusion

The importance of small area statistics in monitoring change in population health is discussed in the first issue of the Journal of Health Gain. [19] Mapping variation in disease rates is a natural means of enabling spatial patterns and neighbouring clusters to be discerned and provides a method for identifying inequalities in health between areas.[20] A deprivation index is an invaluable aid to understanding and, in part, explaining these observed inequalities. [20 - 24]

Summary of key points

- An extensive review of the published literature on deprivation in Ireland and the United Kingdom indicated certain problems with existing Irish indices.
- A suitable index of deprivation must be based - in the first instance - on an appreciation of the functional role of the index. This requires that a distinction be made between an index of material deprivation and other potential *at risk* indices. A firm conceptual basis allows for the selection of the relevant individual indicators (subject to their availability in SAPS).

In view of these points, it was decided that the SAHRU index would be similar in design to the widely regarded Carstairs and Townsend indices, with certain modifications in view of differences in definition and scope between census variables in the UK and Ireland.

- Principal components analysis was employed to construct a weighted combination of indicators of unemployment, social class, type of housing, car ownership and overcrowding. PCA objectively determines the weights (hence the influence) of individual indicators in the index.
- A careful distinction was made between the role of a national index (as discussed in Part I) and the need for separate health board specific indices (as illustrated in Part II). The national index provides for a country-wide overview by DED as well as

inter-regional comparisons. Cross-validation on an urban/rural divide ruled out any bias in the index.

Map 1 (frontispiece) points to selected coastal areas, particularly in the north west and west of the country, as experiencing high levels of deprivation. Additionally, many urban centres are also highly deprived.

- While the national index is appropriate for inter-regional comparisons, it is not ideally suited for intra-regional comparisons. Analysis conducted on data pertaining specifically to one HB area allows for the construction of a more sensitive index - with better discrimination across the DEDs comprising that region. This exercise was completed for the 8 health boards and illustrated for the Eastern HB. An exercise in external validation (with mortality and other health outcome data) was possible for the Dublin County & County Borough area. This confirmed the ability of the index to perform as anticipated.

- In summary: It is estimated that some 17% of DEDs (n=594) are deprived (DI 4 or 5) with nearly 6% (n=205) of the 3444 DEDs in Ireland being highly deprived (DI of 5).

  Comparisons between health board regions indicates that the bulk of deprived DEDs are located in the Eastern and North Western health board areas. In terms of numbers of individuals living in deprived DEDs, the Eastern HB dominates nationally due to its population density. When adjusted for the unequal distribution of DEDs and population between health boards, the North Western HB is seen as the most problematic. Maps 3 through 10 present the national index for each HB separately.

References

1. Kelly A, Sinclair H. Deprivation and health: identifying the black spots. Journal of Health Gain 1997; 1(2): 13-14.

2. Townsend P. Deprivation. Journal of Social Policy 1987; 16: 125-46.

3. Department of the Environment. Urban deprivation. Information Note No. 2. London: DOE, 1983.

4. Duguid G, Grant R. Areas of special need in Scotland. Edinburgh: Scottish Development Department, Central Research Unit, 1983.

5. Jarman B. Identification of underprivileged areas. British Medical Journal 1983; 286: 1705-1709.

6. Jarman B. Underprivileged areas: validation and distribution of scores. British Medical Journal 1984; 289: 1587-1592.

7. Scott-Samuel A. Need for primary health care: an objective indicator. British Medical Journal 1984; 288: 457-458.

8. Townsend P, Phillimore P, Beattie A. Health and deprivation: inequality and the North. London; Croom Helm, 1988.

9. Carstairs V, Morris R. Deprivation and health in Scotland. Aberdeen: Aberdeen University Press, 1991.

10. Howell F, O'Mahony M, Devlin J, O'Reilly O, Buttanshaw C. A geographical distribution of mortality and deprivation. Irish Medical Journal 1993; 86: 96-9.

11. Jackson JA, Haase T. Demography and the distribution of deprivation in rural Ireland. In: Poverty in rural Ireland. Curtin C, Haase T, Tovey H. (eds). Dublin: Combat Poverty Agency, 1996.

12. Kleinbaum DG, Kupper LL, Muller KE. Applied regression analysis and other multivariate methods. 2nd edition. Boston: PWS-Kent, 1988: 610.

13. Folwell K. Single measures of deprivation. Journal of Epidemiology & Community Health 1995; 48(Suppl 2): S51-S56.

14. Davey Smith G, Bartley M, Blane D. The Black report on socioeconomic inequalities in health 10 years on. British Medical Journal 1989; 301: 373-377.

15. Gilthorpe MS. The importance of normalisation in the construction of deprivation indices. Journal of Epidemiology & Community Health 1995; 48(Suppl 2): S45-S50.

16. Gordon D. Census based deprivation indices: their weighting and validation. Journal of Epidemiology & Community Health 1995; 48(Suppl 2): S39-S44.

17. Everitt BS. Statistical methods for medical investigations. 2nd edition. London: Edward Arnold, 1994.

18. Olsen SJ, Martuzzi M, Elliot P. Cluster analysis and disease mapping - why, when, and how? A step by step guide. British Medical Journal 1996; 313: 863-866.

19. Johnson Z, O'Reilly O. The importance of small area statistics to monitor population health. Journal of Health Gain 1997; 1(1): 12-13.

20. Small area analysis in health & health service research: principles & application, SAHRU Technical Report No. 1, Department of Community Health & General Practice, Trinity College Dublin, May 1997.

21. Ben-Shlomo Y, Davey Smith G. Inequalities in health: reasons and possible solutions. Journal of Health Gain 1997; 1(2): 4-8.

22. Carstairs V. Deprivation indices: their interpretation and use in relation to health. Journal of Epidemiology & Community Health 1995; 48(Suppl 2): S3-S8.

23. Use of deprivation indices in small area studies of environment and health - general discussion. Journal of Epidemiology & Community Health 1995; 48(Suppl 2): S80-S87.

24. Sinclair H, Bradley F, Murphy AW, Kelly A. The inverse care law: a Rubicon yet to be crossed? Paper presented at the Association of University Departments of General Practice, 26th Annual Scientific Meeting, Trinity College Dublin, 16-18 July 1997.

Appendix 1

Table A1 DEDs ranked most deprived on the National Deprivation Index by Health Board and County (ranked by Deprivation Score).

(NB: for the EHB the Community Care Area (CCA) within Dublin County & County Borough is indicated)

HB	County/CCA	Popn	DED Name (Urban)	DED Name (Rural)
EHB	CCA 3	1124	Merchants Quay A	
EHB	CCA 7	2983	Mountjoy A	
EHB	CCA 7	2324	North Dock C	
EHB	CCA 8	3646	Priorswood C	
MWHB	Limerick CB	1524	John's A	
EHB	CCA 8	3554	Priorswcod B	
EHB	CCA 3	565	Ushers B	
EHB	CCA 5	4274	Cherry Orchard C	
MWHB	Limerick CB	2748	Galvone B	
EHB	CCA 6	1323	Blanchardstown-Mulhuddart	
EHB	CCA 2	1949	Wood Quay A	
EHB	CCA 6	896	Rotunda B	
EHB	CCA 4	5103	Tallaght-Killinardan	
SHB	Cork CB	5218	Knocknaheeny	
EHB	CCA 7	1950	Ballymun A	
EHB	CCA 6	1160	Blanchardstown-Tyrrelstown	
EHB	CCA 7	3536	Ballymun D	
WHB	Galway County	181		Inishbofin
EHB	CCA 7	1837	Rotunda A	
EHB	CCA 7	1657	Mountjoy B	
EHB	CCA 7	4605	Ballymun B	
EHB	CCA 4	5334	Tallaght Fettercairn	
EHB	CCA 4	6349	Tallaght-Jobstown	
EHB	CCA 2	1183	Royal Exchange B	
EHB	CCA 6	921	Arran Quay C	
EHB	CCA 3	2610	Ushers C	
EHB	CCA 5	5577	Clondalkin-Rowlagh	
EHB	Wicklow	2633	Rathmichael (Bray)	
MWHB	Limerick CB	4630	Ballynanty	
EHB	CCA 7	6954	Ballymun C	
EHB	CCA 3	2012	Merchants Quay C	
EHB	CCA 5	1283	Cherry Orchard A	
MWHB	Limerick CB	1497	Killeely A	
EHB	CCA 6	1698	Inns Quay C	
SHB	Cork CB	1772	Churchfield	
MWHB	Limerick CB	2548	Rathbane	
MWHB	Limerick CB	749	Glentworth C	
MWHB	Limerick CB	1164	Prospect B	
EHB	CCA 6	3824	Finglas South C	
EHB	CCA 7	819	North City	
EHB	CCA 8	3772	Kilmore B	
EHB	CCA 7	3581	Ballybough A	

Table A1 continued from page 41

HB	County/CCA	Popn	DED Name (Urban)	DED Name (Rural)
SEHB	Waterford CB	4077	Ballybeg North	
EHB	CCA 2	1140	Royal Exchange A	
SEHB	Waterford CB	1519	Larchville	
EHB	CCA 8	3437	Priorswood D	
EHB	CCA 5	3212	Kylemore	
MWHB	Limerick CB	317	Custom House	
WHB	Galway County	602		Skannive
EHB	CCA 6	3613	Finglas South B	
EHB	CCA 5	3630	Decies	
WHB	Galway County	575		Turlough
WHB	Mayo	281		Glenamoy
NWHB	Donegal	1107		Carthage
EHB	CCA 5	3308	Cherry Orchard B	
EHB	CCA 8	2107	Kilmore C	
EHB	CCA 3	2414	Merchants Quay F	
EHB	CCA 2	3011	Mansion House A	
WHB	Galway County	1334		Gorumna
EHB	CCA 4	2212	Tallaght-Avonbeg	
EHB	CCA 5	4417	Drumfinn	
SHB	Cork CB	3702	Mayfield	
EHB	CCA 6	4189	Finglas North A	
SEHB	Waterford CB	1057	Roanmore	
WHB	Mayo	136		Bunaveela
MWHB	Limerick CB	1066	Prospect A	
WHB	Mayo	500		Knockadaff
EHB	CCA 5	2519	Kilmainham A	
EHB	CCA 6	2995	Finglas South 0	
SHB	Cork CB	1232	Farranferris B	
SHB	Cork CB	2768	The Glen A	
WHB	Galway County	324		Owengowla
EHB	CCA 2	4427	Pembroke East A	
SHB	Cork CB	1172	Gurranebraher C	
EHB	CCA 6	2912	Cabra West B	
NWHB	Donegal	661		Dunaff
EHB	CCA 3	1946	Ushers E	
WHB	Mayo	861		Knocknalower
EHB	CCA 6	3196	Arran Quay D	
SEHB	Waterford CB	420	Morrison's Avenue West	
SHB	Cork CB	908	Gurranebraher A	
WHB	Galway County	820		Lettermore
NWHB	Donegal	1326		Meenaclady
SHB	Cork CB	833	Blackpool A	
EHB	CCA 4	2374	Kimmage A	
SEHB	Waterford CB	780	Morrison's Road	
WHB	Mayo	278		Muings
SEHB	Tipperary S.R.	4128	Carrick-On-Suir Urban	
MWHB	Limerick CB	1037	Killeely B	
MWHB	Limerick CB	1143	John's B	

Table A1 continued from page 42

HB	County/CCA	Popn	DED Name (Urban)	DED Name (Rural)
NWHB	Donegal	436		Kilgoly
MWHB	Limerick CB	1770	Singland A	
EHB	CCA 3	1875	Ushers D	
EHB	Kildare	633		Kilberry
EHB	CCA 7	2528	Inns Quay B	
WHB	Mayo	235		Beldergmore
NWHB	Donegal	596		Aran
EHB	CCA 4	4375	Kimmage B	
EHB	CCA 4	3147	Crumlin E	
EHB	CCA 6	3080	Finglas South A	
WHB	Mayo	380		Muingnabo
SHB	Cork CB	1195	Gurranebraher D	
SHB	Cork CB	1314	Gurranebraher E	
NWHB	Donegal	1709		Gortahork
EHB	CCA 7	2934	Clontarf West B	
EHB	CCA 5	8761	Clondalkin-Dunawley	
WHB	Galway County	418		Camus
SEHB	Carlow	626		Rathvilly
EHB	CCA 3	1621	Merchants Quay B	
EHB	CCA 6	8032	Blanchardstown-Coolmine	
EHB	CCA 6	3395	Finglas North B	
EHB	Kildare	2260	Athy West Urban	
NWHB	Donegal	1147		St. Johnstown
EHB	CCA 5	6213	Clondalkin-Moorfield	
WHB	Galway County	501		Sillerna
MWHB	Limerick CB	397	John's C	
SEHB	Waterford CB	343	Shortcourse	
NWHB	Donegal	436		Malinbeg
SHB	Cork CB	681	Gurranebraher B	
SHB	Cork CB	1245	Fair Hill B	
SEHB	Waterford CB	1852	Lisduggan	
SHB	Cork	34		Whiddy
MWHB	Limerick CB	614	Shannon B	
SHB	Cork CB	816	Centre B	
EHB	CCA 6	1872	Cabra West A	
EHB	CCA 5	2097	Inchicore B	
SHB	Cork CB	1857	Farranferris A	
EHB	CCA 2	2589	South Dock	
NWHB	Donegal	267		Corkermore
WHB	Galway County	437		Bunowen
WHB	Mayo	382		Ballycroy North
SHB	CorkCB	950	Fair Hill A	
NWHB	Leitrim	37		Arigna
EHB	CCA 2	3047	St Kevin's	
NWHB	Donegal	266		Church Hill
NWHB	Donegal	229		Glen
NWHB	Donegal	2261		Cross Roads

Table A1 continued from page 43

HB	County/CCA	Popn	DED Name (Urban)	DED Name (Rural)
NWHB	Donegal	867		Carrickart
NWHB	Donegal	937		Burt
WHB	Galway County	65		Loughatorick
WHB	Galway County	1322		Inishmore
MWHB	Limerick CB	632	Glentworth A	
MWHB	Limerick CB	1917	Abbey D	
EHB	Kildare	2569		Ballysax East
SHB	Cork CB	2216	Pouladuff B	
NWHB	Donegal	803		Manorcunningham
SHB	Cork CB	4425	Fair Hill C	
EHB	CCA 1	2063	Dun Laoghaire-Mount Town	
NWHB	Donegal	823		Castleforward
WHB	Mayo	215		Clare Island
NWHB	Donegal	193		Crovehy
NWHB	Donegal	726		Lettermacaward
EHB	CCA 6	5112	Blanchardstown-Cord uff	
SEHB	Waterford CB	874	Mount Sion	
NWHB	Donegal	695		Ardmalin
SHB	Cork CB	4004	Mahon B	
EHB	CCA 7	2466	Ballybough B	
EHB	Wicklow	190		Knockrath
WHB	Mayo	476		Glencastle
SHB	Cork CB	2932	Togher A	
SEHB	Tipperary S.R.	2993	Tipperary East Urban	
SHB	Kerry	128		Lickeen
WHB	Galway County	498		Roundstone
EHB	CCA 6	3322	Cabra West C	
NWHB	Donegal	212		Glenleheen
WHB	Galway County	272		Errislannan
MHB	Westmeath	3405	Athlone West Urban	
NWHB	Donegal	1107		Straid
WHB	Mayo	1053		An Geata Mor Theas
EHB	Kildare	973		Ballysax West
NWHB	Donegal	645		Desertegny
WHB	Galway County	67		Derrycunlagh
NWHB	Donegal	684		Dunlewy
NEHB	Cavan	3332	Cavan Urban	
SHB	Cork CB	657	Shandon B	
SHB	Kerry	348		Portmagee
NWHB	Donegal	684		Glentogher
MWHB	Limerick CB	1868	Galvone A	
NEHB	Cavan	106		Killinagh
EHB	CCA 4	3594	Crumlin B	
SEHB	Carlow	1560	Graigue Urban	

Table A1 continued from page 44

HB	County/CCA	Popn	DED Name (Urban)	DED Name (Rural)
WHB	Roscommon	91		Altagowlan
NWHB	Donegal	79		Doocharry
NWHB	Donegal	666		Cranford
EHB	CCA 4	2519	Crumlin C	
WHB	Galway CB	4229	Ballybaan	
SHB	CorkCB	1294	Blackpool B	
NWHB	Donegal	394		Inch Island
NWHB	Donegal	1471		Raphoe
MHB	Longford	2887	Longford No. 1 Urban	
MHB	Longford	352		Foxhall
SHB	Cork CB	1059	Ballyphehane B	
EHB	CCA 5	1818	Clondalkin-Cappaghmore	
MWHB	Limerick CB	535	Dock A	
SHB	Kerry	699		Ardagh
SHB	Cork CB	1542	Greenmount	
WHB	Galway CB	3086	Newcastle	
EHB	CCA 5	3669	Kilmainham C	
MWHB	Limerick CB	91	Shannon A	
NWHB	Donegal	1090		Killea
EHB	CCA 7	3503	North Dock B	
EHB	CCA 4	4042	Crumlin A	
EHB	CCA 8	2047	Kilmore A	
WHB	Mayo	190		Goolamore
SHB	Cork CB	744	Sundays Well B	

Appendix 2 - Regional variation in the National Deprivation Index

Table A2 - EHB

Deprivation level	No DEDs	(%)	Popn	(%)
1	135	(27)	385890	(31)
2	123	(25)	284502	(23)
3	89	(18)	159838	(13)
4	66	(13)	170554	(14)
5	82	(17)	244441	(20)
Total	495	100	1245225	100

Table A3 - MHB

Deprivation level	No DEDs	(%)	Popn	(%)
1	56	(16)	16955	(8)
2	175	(50)	73131	(36)
3	88	(25)	64336	(32)
4	25	(7)	41918	(21)
5	3	(1)	6644	(3)
Total	347	100	202984	100

Table A4 - MWHB

Deprivation level	No DEDs	(%)	Popn	(%)
1	90	(22)	64461	(21)
2	197	(48)	95679	(31)
3	75	(18)	82223	(26)
4	31	(8)	42118	(14)
5	19	(5)	26247	(8)
Total	412	100	310728	100

Table A5 - NEHB

Deprivation level	No DEDs	(%)	Popn	(%)
1	38	(13)	40985	(14)
2	153	(52)	105332	(35)
3	83	(28)	81250	(27)
4	17	(6)	69178	(23)
5	2	(1)	3438	(1)
Total	293	100	300183	100

Table A6 - NWHB

Deprivation level	No DEDs	(%)	Popn	(%)
1	22	(7)	14652	(7)
2	66	(21)	23077	(11)
3	94	(30)	76645	(37)
4	97	(31)	71246	(34)
5	30	(10)	22554	(11)
Total	309	100	208174	100

Table A7 - SEHB

Deprivation level	No DEDs	(%)	Popn	(%)
1	101	(19)	49424	(13)
2	224	(43)	119906	(31)
3	120	(23)	97172	(25)
4	61	(12)	96457	(25)
5	12	(2)	20229	(5)
Total	518	100	383188	100

Table A8 - SHB

Deprivation level	No DEDs	(%)	Popn	(%)
1	142	(25)	118402	(22)
2	227	(40)	171835	(32)
3	129	(23)	126026	(24)
4	40	(7)	70255	(13)
5	28	(5)	45745	(9)
Total	566	100	532263	100

Table A9 - WHB

Deprivation level	No DEDs	(%)	Popn	(%)
1	85	(17)	50569	(15)
2	235	(47)	135740	(40)
3	103	(20)	90849	(26)
4	52	(10)	46007	(13)
5	29	(6)	19809	(6)
Total	504	100	51293	100

Appendix 3 - Fig. A1 Distribution of indicators by urban/rural DEDs

Unemployment

Low social class

Rented accommodation

No car

r = Rural DEDs

u = Urban DEDs

Overcrowding
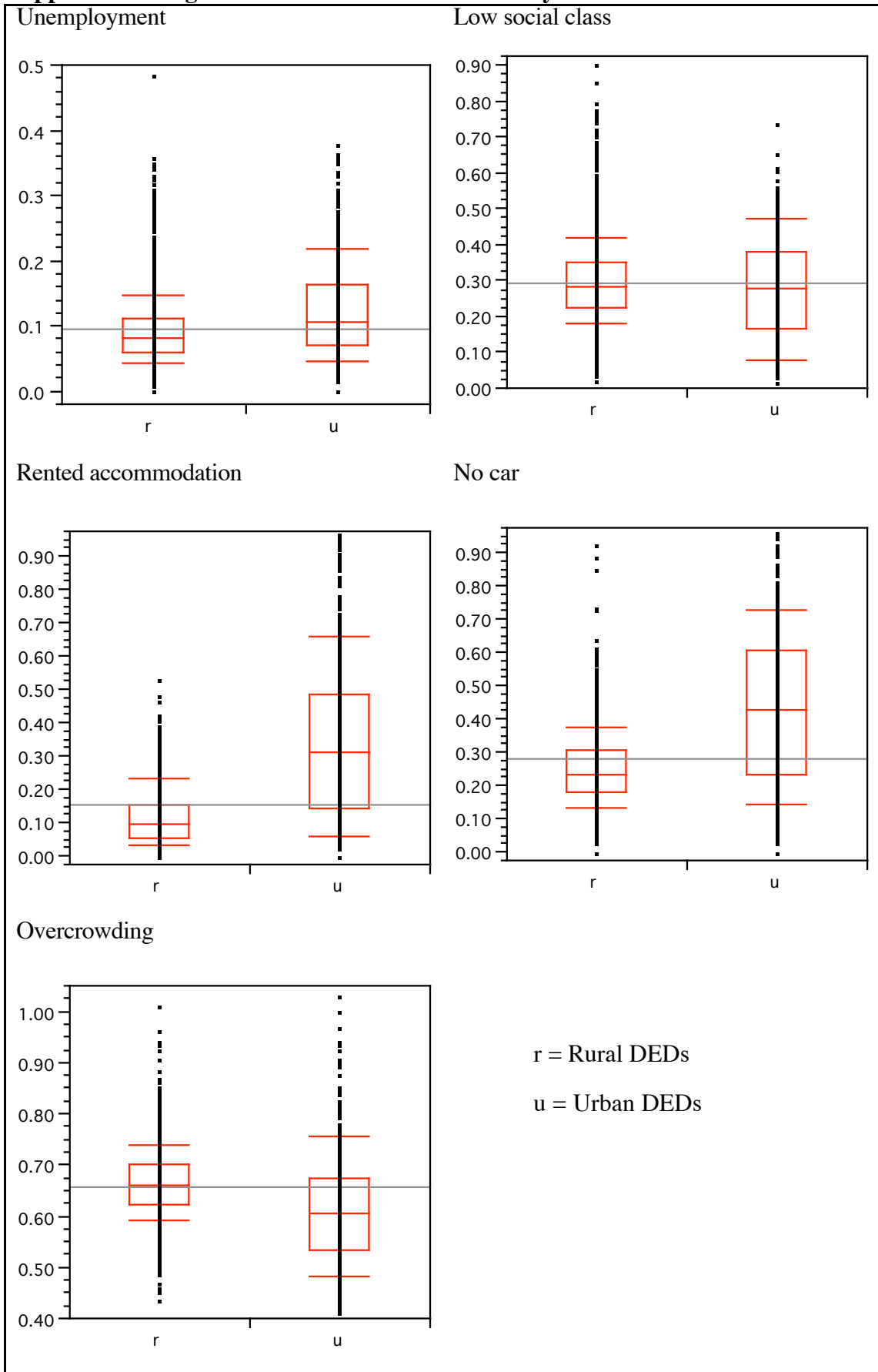
Table A10 - Quantiles for the individual indicators by urban / rural DEDs

Unemployment

	min	10.0%	25.0%	median	75.0%	90.0%	max
rural	0	0.044	0.060	0.082	0.112	0.148	0.484
urban	0	0.046	0.070	0.106	0.163	0.219	0.378

Low social class

	min	10.0%	25.0%	median	75.0%	90.0%	max
rural	0.021	0.183	0.227	0.284	0.350	0.421	0.903
urban	0.015	0.082	0.166	0.278	0.383	0.475	0.736

Rented accommodation

	min	10.0%	25.0%	median	75.0%	90.0%	max
rural	0	0.033	0.058	0.099	0.155	0.233	0.532
urban	0	0.061	0.143	0.315	0.487	0.664	0.969

No car

	min	10.0%	25.0%	median	75.0%	90.0%	max
rural	0	0.136	0.180	0.236	0.309	0.377	0.923
urban	0	0.147	0.237	0.432	0.610	0.728	0.960

Overcrowding

	min	10.0%	25.0%	median	75.0%	90.0%	max
rural	0.436	0.593	0.625	0.662	0.701	0.740	1.010
urban	0.413	0.483	0.534	0.606	0.675	0.757	1.030

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