Health Inequality Indicators for Local Authorities and Primary Care Organisations

Guide to Interpretation

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December 2011

Definition of the health inequality indicators

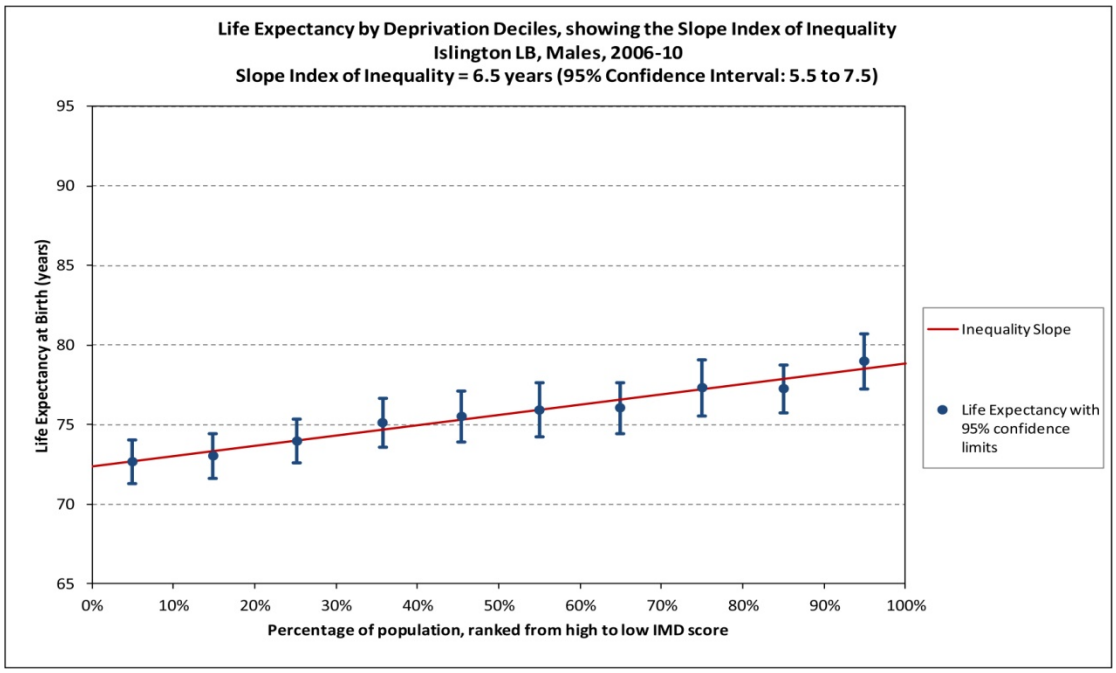
The London Health Observatory and East Midlands Public Health Observatory (on behalf of the Public Health Observatories of England) have published health inequality indicators for each local authority and primary care organisation (PCO) in England using the slope index of inequality (SII) for life expectancy at birth. These figures were calculated by grouping lower layer super output areas (LSOAs) within each local authority or PCO into deciles[i] based on the Index of Multiple Deprivation 2010 (IMD 2010) score for each LSOA. The life expectancy for each decile is based on mortality data for a five year period, with latest available figures based on data for 2006-10, and the earliest figures based on data for 2001-05. The SII is a single score which represents the gap in years of life expectancy between the best-off and worst-off within the local authority, based on a statistical analysis of the relationship between life expectancy and deprivation scores across the whole authority. Detailed technical information on the IMD, population and mortality data used are provided in Appendix 1. The calculation of deciles, life expectancy and the SII are explained in Appendix 2.

Trends in the SII indicators, which were formerly based on the Index of Multiple Deprivation 2007, have been revised in December 2011 to be consistent with the latest figures for 2006-10. All figures, from 2001-05 onwards, are therefore all now based on IMD 2010.

Interpretation of the indicator

The SII is most easily understood with reference to a graph. The graph for male life expectancy in the London Borough of Islington is shown below. The local authority's population is divided into ten deciles, by grouping LSOAs according to their IMD score. Life expectancy at birth has been calculated for each of the deciles and is plotted on the graph in blue, with 95% confidence limits. Hence the blue dot towards the left of the graph shows that for men in the most deprived 10% of LSOAs in Islington, life expectancy is 72.7 years (95% confidence interval 71.3 to 74.1 years). In contrast, the equivalent figures for the least deprived 10% of LSOAs in the same local authority are 79.0 years (77.3 to 80.7 years).

[i] Deciles each contain approximately a tenth of the LSOAs in the local authority or PCO.



While the deciles have roughly one-tenth of the population in each, they are not precisely equal because they are aggregated up from LSOAs. The x-axis represents the whole male population of the local authority, so if Decile 1 includes exactly 10% of the population, the blue dot is positioned at 5%, the mid-point of the range of population covered by that decile. If the second decile includes 11% of the population, this would cover the range from 10% to 21%, so the mid-point is 15.5%, and that is where the point would be located on the x-axis. The 0% and 100% points on the x-axis nominally represent the most and least deprived individuals in the local authority. The red line on the graph is a linear regression line of best fit for the data, calculated by the usual least squares method. The SII is simply the gradient of that line, or the difference between the top of the line (at 100% on the x-axis) and the bottom (zero). In the case of male life expectancy in Islington, the fitted line goes from 72.4 to 78.9. This gives an SII of 6.5 years (with a 95% confidence interval of 5.5 to 7.5 years). This can be interpreted as a difference in life expectancy of 6.5 years, between the most and least deprived individuals within the local authority.

The SII gives a description of the extent of inequality in each local authority or PCO, and is broadly comparable between areas. Clearly, some areas have more diverse populations than others, in terms of deprivation. Because life expectancy and deprivation are so strongly correlated, local authorities or PCOs with a wider range of deprivation will tend to have greater ranges of life expectancy and therefore a large SII. It is important to note that while the SII is broadly comparable between areas, the deprivation deciles are defined separately for each

area based on the local range of deprivation in the area. The 10% most deprived population in a local authority such as Islington might not be comparable to the 10% most deprived population in a more affluent area such as Guildford. The 0% and 100% values on the chart can be used to compare the best and worst life expectancies between local authorities and will aid in the interpretation of the data. For example, Hackney in London has a very flat SII (3.0 years for males in 2005-09), and the range in life expectancy across the slope goes from 74.7 to only 77.7 years. The best life expectancy in Hackney is still worse than the worst life expectancy in areas such as Kensington and Chelsea. The SII and the associated charts can be used to compare areas in this way.

Geographies

AII figures have been calculated for both upper and lower tier local authorities in England, including county councils and their county districts, and unitary authorities including metropolitan county districts and London boroughs. The City of London and Isles of Scilly have been excluded from the results because of the small populations in these areas. Figures have also been calculated for all primary care trusts and care trusts in England.

England values

Within each set of SII results, the median of all local authorities or PCOs in England is provided as a comparator, to place the individual area SII figures in context. This figure should not be regarded as the SII value for England.

While the overall SII can be calculated for England, it is not a valid comparator for individual areas within it: the SII is essentially a range measure, and the range within England will tend to be larger than the range within individual parts of the country.

Within the results for local authorities, two median figures are presented:

1) The figure for Upper Tier Local Authorities is the median value of the results for 150 upper or single tier administrative areas in England (counties, unitary authorities, London boroughs and metropolitan county districts).

2) The figure for Lower Tier Local Authorities is the median value of the results for 324 lower or single tier administrative areas in England (county districts, unitary authorities, London boroughs and metropolitan county districts).

The median indicates the value of the SII that is in the middle of the distribution of SII results for all local authorities: the mid-point of the distribution is different when looking at counties rather than county districts (which are smaller and therefore more homogeneous). The median PCO value is also reported. This will also differ from the median values for local authorities because the mid-point of the distribution will again be influenced by the number and size of the areas included.

The median values have been calculated using unrounded SII results. Confidence intervals around the median figures are not available.

Confidence intervals

95% confidence intervals are given for the SII figures and life expectancy decile data. These intervals describe the degree of uncertainty around the calculated values. For the SII, the uncertainty reflects how well the slope line fits the decile life expectancy figures. There will always be variation in the life expectancy figures resulting from random fluctuation in the numbers of deaths occurring in any period of time, in any area, but there is also variation in the degree to which the linear relationship between deprivation deciles and life expectancy is appropriate. The width of the confidence interval depends on the closeness of the decile life expectancy figures to the slope line. The width of the confidence interval for the life expectancy deciles themselves depends on the size of the population of the area and the underlying variability in death rates. A 95% confidence interval implies that 95 times out of 100, the interval will include the true underlying life expectancy or slope score.

Interpretation of life expectancy

Life expectancy at birth for an area in a given time period is an estimate of the average number of years a new-born baby would survive if he or she experienced a particular area's age-specific mortality rates for that time period throughout his or her life. The figure reflects mortality among those living in the area in each time period, rather than mortality among those born in each area. It is not therefore the number of years a baby born in the area could actually expect to live, both because the death rates of the area are likely to change in the future and because many of those born in the area will live elsewhere for at least some part of their lives.

Questions and Answers

Why have slope index of inequality figures been calculated?

Proposals for a public health outcomes framework, published by the Department of Health on 20 December 2010, proposed the slope index of inequality in life expectancy within every local authority as one of the public health outcomes indicators for assessing health inequalities.[1] The proposal reflects the fact that the SII has been widely researched and there is a body of literature to underpin its validity. The indicator statistic is easy to understand, as it is the gap in years of life expectancy between the best-off and worst-off within the local authority or PCO, based on a robust statistical model of the life expectancy and deprivation scores across the whole area. Inequalities have most commonly been analysed by presenting the 'gap' between a deprived subgroup of the population and the rest (or the average). Using a gradient indicator that represents the whole distribution across the local authority/PCO increases the power of the analysis and avoids arbitrary cut-offs, where areas are defined only as either 'deprived' or 'not deprived.'.

Why has IMD been used?

The IMD score is the Government's official measure of multiple deprivation at small area level in England. The IMD is generally accepted as the current standard measure of deprivation, it is widely used and familiar to a large audience.

Why have previous published results from 2001-05 to 2005-09 been revised?

Results for these time periods were previously based on IMD 2007. The release of IMD 2010 in March 2011, allowed figures for 2006-10 to be calculated using the most recently available deprivation scores. Figures for previously published trend data have also been revised using IMD 2010, so that each deprivation decile represents the same LSOAs in each time period.

IMD 2010 includes a health component. Does this cause a problem?

The IMD 2010 is constructed from 38 indicators grouped into 7 domains. The weight accorded to the four indicators of the Health Deprivation and Disability Domain is only 13.5% of the total IMD score. The IMD however contains only one direct measure of mortality amongst its 38 indicators (years of potential life lost – an age and sex standardised measure of premature death). Although it would be possible to use a single IMD domain (such as Income) as an alternative, the IMD score itself has the considerable advantage of measuring people's experience of deprivation across a wide range of dimensions. The extent to which any correlation between life expectancy and IMD will be exaggerated by the presence of the years of life lost indicator is small, and the advantages are felt to outweigh this disadvantage.

Why have LSOAs been used?

The data have been analysed using LSOAs as they are the smallest areas for which population data and deprivation scores are consistently available. Using data at the smallest level possible is desirable, as populations will tend to be more homogeneous in small areas, and thus be subject to similar levels of deprivation. Larger areas, such as middle layer SOAs, will tend to have more diverse populations and would therefore be much less discriminating, giving less likelihood of detecting significant differences between local authorities or PCOs.

Why have deciles been used?

LSOA deciles have been shown through experimentation to be large enough (in terms of population size) to give robust estimates of life expectancy and the SII. They are more discriminating than quintiles, but pairs of deciles correspond exactly to quintiles. As the deciles in the SII results are now based on IMD 2010, they will not however correspond to quintiles in tools which are based on earlier versions of the IMD, such as the Health Inequalities Intervention Tool for All Areas, and the Health Inequalities Gap Measurement Tool.[ii]

Why have five years' data been used?

The period of analysis for comparative analysis should generally be chosen to be the fewest years (giving the most up-to-date data) that provide sufficient numbers to enable robust calculation. Although using five years' data makes the SII less up-to-date and less responsive to changes in the short term, shorter timescales are more subject to random fluctuation and would give very few statistically significant differences between local authorities. Changes in the SII can realistically be expected to be measured if they occur within five to ten years. This is a fair representation of realistic aspirations to make real changes in overall health outcomes, which do not react quickly to even the most dramatic of interventions.

Why does my local authority/PCO have a comparatively high SII?

This indicator describes the extent of overall inequalities in life expectancy within the local authority or PCO population, without ascribing the inequalities to any cause. Areas with a diverse range of communities, from very affluent to very deprived, tend to have wide inequalities in health outcomes as well, and the SII will reflect these underlying differences. Similarly, local authorities or PCOs that have relatively uniform populations will tend to have smaller health inequalities and lower SII scores. These underlying population factors must be taken into account when interpreting the SII: it should not be used as a performance indicator for services.

[ii] The version of the Gap Measurement Tool released in 2011 is based on IMD 2007 but an update is planned to revise all current results using IMD 2010.

A high score in an area may sometimes also result from random variation in the numbers of deaths occurring. The width of the confidence intervals, both around the SII itself, and around the life expectancy results for the deprivation deciles, give an indication of the degree of uncertainty around the calculated values. There may be many other factors which influence the level of inequality in life expectancy within an area, such as how services are accessed by different parts of the population, or particular local lifestyle and behavioural factors.

Do local authorities/PCOs with large populations tend to have higher SII scores?

The SII describes the range of inequalities, so if larger areas contain a broader range of communities they will have higher scores, but if they are large and relatively uniform, they will not.

Why not use the relative index of inequality?

It is possible that there is a statistical tendency for areas with higher overall life expectancy to have slightly higher SII scores, purely as a result of scaling (i.e. there is greater variability in the indicator when its value is higher). In practice, there is no evidence of wider inequalities in areas with higher life expectancy, although this could be the result of a combination of factors. An alternative approach would have been to use the relative index of inequalities (RII), which is calculated by dividing the SII by the average life expectancy for the area. The RII is an abstract statistic, however, and the SII is the life expectancy gap in years, and is hence much easier to understand. For this reason, any statistical advantages of the RII are not, in this case, believed to outweigh the advantages of understanding of the SII.

Why do the life expectancies for each decile in my local authority/PCO appear not to fit the straight line well?

The actual numbers of deaths in an area vary from year to year, so some deciles will experience higher death rates in a given period simply through natural variation. By calculating the SII across the full range of deciles, the effect of any particular decile is reduced, giving a clearer picture of the overall effect of deprivation on life expectancy. The confidence intervals on the graphs for each decile allow identification of significant outliers, i.e. deciles which do not fit the general pattern within the local authority. Charts for each local authority and PCO are available from the APHO website. Where the confidence intervals for any decile do not cross the slope line, it may be because specific factors in some of the LSOAs in that decile are causing higher or lower death rates, and hence lower or higher life expectancy than expected. By fitting a straight line to the decile data, it is possible that the relationship between deprivation and life expectancy is not well described. If the deciles appear to be consistently above or below the line at either end of the scale (i.e. the deprived deciles or the affluent ones) then it is likely that a curve would describe the relationship better for that local authority.

The SII scores for my area in 2005-2009 have increased now that IMD 2010 has been used. Does this indicate that inequalities are widening?

No – you should look at the revised figures across all six periods (2001-05 to 2006-10) to check if inequalities are widening or narrowing.

Appendix 1 – Data used to calculate the indicator

The SII is calculated using life expectancy at birth results for each deprivation decile within a local authority or PCO. Three data sources are therefore required: deprivation scores to allow LSOAs to be grouped into deciles, and mortality and population data for the calculation of the life expectancy figures.

Deprivation scores

The Index of Multiple Deprivation 2010 (IMD 2010) was used to order LSOAs into deprivation deciles. The index is published by the Department for Communities and Local Government and combines a number of indicators, chosen to cover a range of economic, social and housing issues, into a single deprivation score for each LSOA in England. This allows each area to be ranked relative to one another according to their level of deprivation.

A guide to the IMD 2010 scores can be found on the Communities and Local Government (CLG) website.[iii] This includes an analysis of changes between the 2007 and 2010 versions of the IMD. Both versions are based on broadly the same methodology but 34 per cent of LSOAs in 2010 are in different deprivation deciles in England to the ones they were in in 2007. Analysis by CLG has shown that most of this movement occurred in the middle part of the distribution of LSOAs, however, with less movement at either end of the distribution (88% of the most deprived LSOAs and 84% of the least deprived LSOAs being in the same decile in both 2010 and 2007).

Mortality data

Mortality data by sex and age group were extracted from annual files supplied to the public health observatories (PHOs) by the Office for National Statistics (ONS). These were deaths registered in the calendar years 2001-10, aggregated into rolling five-year time periods. Deaths were allocated to the deceased's LSOA of usual residence using the August 2011 version of the Office for National Statistics Postcode Directory.

Population estimates

Experimental mid-year population estimates for super output areas are produced by ONS. Results for LSOAs are published only in broad age groups, but figures by sex and single year of age have been supplied by ONS to the PHOs for internal use only. For the calculation of the life expectancy results, estimates were used from 2001-10, aggregated into rolling five-year time periods.

[iii] http://www.communities.gov.uk/publications/corporate/statistics/indices2010

Appendix 2 – Calculation of the indicator

Geographical areas and deciles

Population estimates and IMD scores were both available for the 32,482 LSOAs in England, and deaths were assigned to these same boundaries. Each LSOA was also assigned to an English local authority (county district, unitary authority, metropolitan county district or London borough). LSOAs in county districts were also allocated separately to their appropriate county so that figures could also be calculated for county councils. Within each local authority, deprivation deciles were created by sorting LSOAs by their IMD score, from most to least deprived. The LSOAs were then aggregated into ten groups within the local authority. Where the number of LSOAs was not exactly divisible by ten, the 'remainder' LSOAs had to be allocated to deciles. This was determined by an algorithm, with the allocation of extra LSOAs weighted towards the most deprived decile, rather than the least. Although LSOAs were designed to have roughly similar populations, their actual size does vary. This diversity, and the fact that the deprivation deciles in most local authorities contain slightly unequal numbers of LSOAs, means that the population size in each deprivation decile is not consistent. The calculation of the SII does however take account of this variation.

The same procedure was followed to assign LSOAs to deprivation deciles within primary care organisations. The allocation of LSOAs to deprivation deciles (and also quintiles and quartiles) within local authorities, counties, PCOs, Government Office Regions and England as a whole, has been published on the APHO website:

http://www.apho.org.uk/resource/item.aspx?RID=110504

Calculation of life expectancy

Using mortality data and population estimates which had been aggregated into deprivation deciles for each local authority and PCO, sex-specific life expectancy results were calculated using the South East Public Health Observatory (SEPHO) life expectancy calculator. The calculation of the confidence intervals within this was made using the method developed by Chiang.[2] The SEPHO calculator however also includes an adjustment to include a term for the variance associated with the final age interval as developed by Silcocks.[3]

Calculation of the slope index of inequality

The SII is calculated using population-weighted linear regression and it represents the hypothetical absolute difference in life expectancy between the extremes of deprivation within a local authority or PCO population.

To allow for differences in population size between deciles, each is given a 'rank score' based on the midpoint of its range in the cumulative distribution of the local authority/PCO population. The deciles are first ordered from most deprived to least deprived. If decile 1 then contains 12% of the population, its rank score 1 would be 12/2=6. If decile 2 includes 10% of the population, its rank score would be 12+(10/2)=17. The life expectancy for each decile is plotted against this rank score and a population-weighted regression line is fitted to the data by the least squares method.[iv]

[iv] Statistical note: a square-root transformation is applied to the population-weights in order to stabilise the variance.

The SII is the gradient of the resulting fitted line, i.e. m in the equation y = mx + c. Confidence intervals are calculated around the gradient of the line in the usual way. The method is fully explained in the paper by Low and Low,[4] and the confidence intervals for the gradient of a regression line are defined by Altman.[5] The SII, along with other methods of measuring inequalities, are explained in a ScotPHO guide.[6]

References

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