Measuring the gap: quantifying and comparing local health inequalities

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Summary
Primary Care Trusts (PCTs) and Local Strategic Partnerships (LSPs) are being asked to assess local health inequalities in order to prioritize local action, to set local targets for reducing levels of health inequality locally and to demonstrate measurable progress. Despite this, little guidance has been provided on how to quantify health inequalities within PCTs and LSPs. This paper advocates the use of a metric, the slope index of inequality, which provides a consistent measure of health inequalities across local populations. The metric can be presented as a relative gap, which is easily understood and enables levels of inequality to be compared between health conditions, lifestyles and rates of service provision at any one time, or across different time periods. The metric is applied to Sunderland Teaching PCT, using routine data sources. Examples of the results and their uses are presented. It is suggested that more widespread use of the metric could enable levels of health inequalities to be compared across PCTs and lead to the development of local health inequality and inequity benchmarks.

Keywords: health inequalities, measurement, relative gaps, equity

Introduction
Since 1997, a commitment to reducing health inequalities by various means has been a central tenet of government policy. The health inequalities that the government is concerned about are differences in health outcomes between groups that are associated with socioeconomic status, such as income, employment, education, ethnicity, social class or residence in a deprived area.1,2 In this paper, the terms health inequalities and health gaps refer to these socioeconomic inequalities in health.

Most of the discussion on local health inequalities has focused on ‘closing the gap’.3 Little attention has been given to ‘measuring the gap’. Local Strategic Partnerships (LSPs) and Primary Care Trusts (PCTs) are expected to set local health inequality targets.3–5 They are also required to demonstrate ‘measurable progress’ in reducing local inequalities over the next 3 years under the Department of Health priorities and planning framework.6 Service planning is to be informed by equity audits, which are to be performance managed by Strategic Health Authorities.7 In this context, measuring levels of health inequality within LSP and PCT areas becomes an essential requirement, for selecting topics for equity audit, for setting local targets against relevant benchmarks and for assessing progress towards reducing inequalities in health.

And yet very little advice has been given on how to measure the level of health inequality locally. The Health Development Agency has provided guidance on how to set local targets to close the health inequalities gap3 and how LSPs and PCTs should conduct health equality audits.8 Both documents suggest that the measurement of levels of health inequality locally represents a significant barrier to progress in these areas.

Two difficulties with quantifying local health inequality gaps have been advanced. The first problem relates to a lack of clarity about which of the many types of measures of inequality should be used.9,10 The second problem relates to the perceived lack of available appropriate local level data.3,8 In this paper, we suggest that both these problems are overstated. We refer to the work of health economists, which has identified the most appropriate type of measure for assessing magnitudes of health inequality.

We show how these measures of inequality can be calculated at the PCT and LSP level, using routine data sources. The results, presented as health gaps, can be used to compare the magnitudes of inequality between health conditions, lifestyles, and service provision at any one time or across different time periods. As such they provide a key measurement tool for equity audit, contributing to both prioritization decisions, as well as the assessment of progress over time. They also have potential use in performance management of health inequalities within PCTs by Strategic Health Authorities, enabling baseline estimates of health inequalities to be established, which can be compared across PCTs and over time.

The slope index of inequality
The Association of Public Health Observatories and the Health Development Agency have developed a basket of 70 local health inequality indicators.11 These include indicators of mortality,
morbidity and lifestyle outcomes, as well as socioeconomic characteristics. However, as Bull and Hamer\(^3\) have pointed out, these indicators will only be useful for assessing and tracking health inequalities if the data are differentiated by area or socioeconomic group and changes in variations across groups are assessed.

There is a need then for a consistent method for summarizing the level of variation in a chosen indicator across socioeconomic groups. A number of reviews of methods for measuring variations in indicators of health across groups have been conducted. Two of these have been published on Public Health Observatory websites.\(^9,10\) These have pointed out the different characteristics of different measures of health inequality such as the range, coefficient of variation, Gini coefficient, Lorenz curve, slope index of inequality (SII) and the concentration index. These reviews suggest different methods of measurement are appropriate under different circumstances and for different audiences. Methods that are simple to understand and calculate, such as the range, lack comprehensiveness, since they only look at the bottom and top ends of the distribution. Also, they do not take account of different sizes of groups. Other measures that are more comprehensive and take account of the whole distribution, such as the Lorenz curve, as applied to health, fail to take into account the socioeconomic dimension. In their review of available inequality measures, Wagstaff \textit{et al.}\(^12\) state that the minimal requirements for a good health inequality measure are that it: (1) reflects the socioeconomic dimension to inequalities in health; (2) reflects the experiences of the entire population; and (3) is sensitive to changes in the distribution of the population across socioeconomic groups. They conclude that only two measures meet these requirements. They are the SII and the concentration index.

In fact the two measures are equivalent. They are mathematically related and can be computed using simple regression analysis.\(^13\) This paper uses the SII because it has a more straightforward interpretation than the concentration index,\(^14\) and it can be presented in terms of the familiar ‘health gap’ used to express national targets,\(^15\) as well as in many of the discussions on local health inequality issues.\(^3\) Figure 1 provides an example of the estimation of the SII across wards in Sunderland in terms of the directly age-standardized myocardial infarction (MI) mortality rate. Wards have been ranked from high to low income deprivation using the income domain scores of the Index of Multiple Deprivation 2000.\(^16\) In this case the SII has a negative sign, indicating a downward slope: wards with high income deprivation having higher MI mortality rates than those with lower income deprivation.

This SII can be interpreted as being the gap in deaths from MI per 100,000 aged 74 years or less associated with income deprivation across all wards in Sunderland.

The SII is given by the regression \((b)\) coefficient in a simple regression of the health (e.g. mortality rate) of a socioeconomic group (e.g. ward) on the ranking of that group according to a deprivation indicator (e.g. income deprivation). The ranking of the group is expressed as a value between 0 and 1. This means that

\[
\text{SII} = b \times (\text{rank} - \text{average rank})
\]

\[
\text{relative rank from high to low income deprivation}
\]

\[
\text{DSR Myocardial Infarction mortality}
\]

Figure 1 The absolute health gap in mortality from Myocardial Infarction (1998-2000) associated with income deprivation across wards in Sunderland.
the \( b \) coefficient, which is the change in the dependent variable (health indicator) for a unit change in the independent variable (rank), provides an estimate of the health gap across all wards from most to least deprived.

**Obtaining the regression variables and estimating the SII**

The dependent variable can be an indicator of health outcome, lifestyle or service provision, which needs to be measured on an interval or ratio scale. Age-specific or directly age-standardized rates for each socioeconomic group are normally used.

The independent variable requires two types of data by socioeconomic group for its calculation: the relevant population size and an indicator of deprivation, which can be on an ordinal scale. These are used together to calculate a relative rank for each group.

The relative rank is calculated by arranging the groups in order from most to least deprived and assigning a cumulative proportion of the total population to each group. For the first group, half its proportion of the total population is taken as its relative rank. For the second group half its proportion of the total population is added to the proportion already taken by the previous group. And so on.

The data used to calculate the SII for MI mortality across wards in Sunderland are given in Table 1. The variables used in the regression are indicated in the first row of the table.

Ordinary least squares regression can be used to obtain an estimate of the SII (\( b \) coefficient). However, because grouped data are used, heteroskedasticity of the error terms exist. To account for this and ensure the assumptions of linear regression are met, the following transformed equation should be used:

\[
Y^* \sqrt{a} = 0 + \sqrt{a} + b \sqrt{a}
\]

In this transformation the square root of the per cent of persons in each ward (\( \sqrt{a} \)) is used as the multiplier to transform the mortality rate variable (\( Y \)) and the relative rank variable (\( b \)), and is also used as an additional independent variable.

This transformed equation can be estimated using the Excel regression function. The column \( Y^* \sqrt{a} \) is entered as the input \( Y \) range. The columns \( \sqrt{a} \) and \( b \sqrt{a} \) are entered as the input \( X \) range.

<table>
<thead>
<tr>
<th>Regression variables Y</th>
<th>a</th>
<th>b</th>
<th>Relative rank (0–1) based on proportion of the 0–74 population in the ward</th>
</tr>
</thead>
<tbody>
<tr>
<td>wards ordered by income deprivation</td>
<td>MI DASMR* per 100 000 &lt;75</td>
<td>Number persons 0–74</td>
<td>% persons 0–74</td>
</tr>
<tr>
<td>Thorney Close</td>
<td>78.47</td>
<td>9921</td>
<td>0.037</td>
</tr>
<tr>
<td>Southwick</td>
<td>87.82</td>
<td>8648</td>
<td>0.032</td>
</tr>
<tr>
<td>South Hylton</td>
<td>71.02</td>
<td>10223</td>
<td>0.038</td>
</tr>
<tr>
<td>Town End Farm</td>
<td>54.09</td>
<td>9212</td>
<td>0.034</td>
</tr>
<tr>
<td>Grindon</td>
<td>42.53</td>
<td>9323</td>
<td>0.034</td>
</tr>
<tr>
<td>Castletown</td>
<td>62.80</td>
<td>10008</td>
<td>0.037</td>
</tr>
<tr>
<td>Hendon</td>
<td>66.31</td>
<td>10503</td>
<td>0.039</td>
</tr>
<tr>
<td>Washington North</td>
<td>87.08</td>
<td>10809</td>
<td>0.040</td>
</tr>
<tr>
<td>Colliery</td>
<td>44.48</td>
<td>8592</td>
<td>0.032</td>
</tr>
<tr>
<td>Central</td>
<td>100.00</td>
<td>12460</td>
<td>0.046</td>
</tr>
<tr>
<td>Houghton</td>
<td>49.01</td>
<td>9692</td>
<td>0.036</td>
</tr>
<tr>
<td>Hetton</td>
<td>55.11</td>
<td>10838</td>
<td>0.040</td>
</tr>
<tr>
<td>Thornholme</td>
<td>65.19</td>
<td>11119</td>
<td>0.041</td>
</tr>
<tr>
<td>Ryhope</td>
<td>53.23</td>
<td>13320</td>
<td>0.049</td>
</tr>
<tr>
<td>Silksworth</td>
<td>63.28</td>
<td>12189</td>
<td>0.045</td>
</tr>
<tr>
<td>Eppleton</td>
<td>58.52</td>
<td>11427</td>
<td>0.042</td>
</tr>
<tr>
<td>Pallion</td>
<td>48.57</td>
<td>10286</td>
<td>0.038</td>
</tr>
<tr>
<td>St Chads</td>
<td>57.99</td>
<td>9441</td>
<td>0.035</td>
</tr>
<tr>
<td>Washington East</td>
<td>26.06</td>
<td>13172</td>
<td>0.049</td>
</tr>
<tr>
<td>Washington West</td>
<td>35.80</td>
<td>10743</td>
<td>0.040</td>
</tr>
<tr>
<td>St Peters</td>
<td>49.13</td>
<td>9741</td>
<td>0.036</td>
</tr>
<tr>
<td>Shiny Row</td>
<td>44.80</td>
<td>12337</td>
<td>0.045</td>
</tr>
<tr>
<td>Washington South</td>
<td>45.43</td>
<td>17618</td>
<td>0.065</td>
</tr>
<tr>
<td>St Michaels</td>
<td>36.86</td>
<td>9964</td>
<td>0.037</td>
</tr>
<tr>
<td>Fulwell</td>
<td>34.27</td>
<td>9684</td>
<td>0.036</td>
</tr>
<tr>
<td>Sunderland</td>
<td>54.67</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*DASMR = directly age standardised mortality rate
and the option of zero constant is selected. With the above data set the output in Table 2 is obtained. The SII is the coefficient of \( Y \) variable 2.

As the relative rank variable is cumulative, autorecorrelation is likely to exist and the standard errors may not be reliable. The normal Durbin-Watson test for autocorrelation is not appropriate as the regression does not have a constant term. Kakwani et al.\(^\text{13}\) demonstrate that for these equations the effect of autocorrelation on the error terms is minimal, as is confirmed in Table 3. For completeness, the results presented in this paper are obtained by applying the Prais-Winsten iterative adjustment procedure available in the autoregression module of SPSS. However this adjustment only results in a small increase in precision of the estimate of the SII.

### Comparing health gaps: the relative principle

The SII provides an estimate of the absolute health gap across all groups. This has limitations for making comparisons between conditions and over time, since the size of the gap will depend on the scale being used to measure a health condition. The requirement for making valid comparisons over time is that the measure stays constant if the health status of all groups changes by the same proportion between two time periods. The requirement for making valid comparisons across conditions is that the measure should be scale neutral and therefore not influenced by the units used to measure any health condition.

Both these requirements can be easily addressed by calculating the relative gap. This merely represents the absolute health gap in terms of a percentage of the average level of health across all groups. Thus, for example, if there are two groups of equal size, with group A having a mortality of 60 and group B having a mortality of 40, then the absolute gap is 20 and the relative gap is 20/50 or 40 per cent. If over time there is a general improvement in health such that mortality falls by 50 per cent for both groups. Then the absolute gap falls to 10 but the relative gap remains constant at 40 per cent (10/25). This is the approach used by the Department of Health in introducing their inequalities targets for life expectancy and infant mortality. The targets are set as 10 per cent reductions in constant relative gaps.\(^\text{15}\)

The absolute gap (SII) in MI mortality across wards in Sunderland is –40.0 per 100 000. The directly age-standardized mortality rate in Sunderland as a whole is 54.7 per 100 000. Thus, the relative gap is –40.0/54.7 = –73 per cent. This says that the negative health gap between the most and least income deprived wards is 73 per cent of the average rate of MI for Sunderland as a whole.

### Comparisons of levels of health inequality

Relative gaps across wards in Sunderland have been estimated, based on the SII.\(^\text{17,18}\) While the approach is not restricted to estimating inequality on a geographic dimension, it is particularly relevant to the estimation of levels of inequality across a number of wards within a PCT or LSP. Many interventions aimed at addressing inequalities are area based.\(^\text{19}\) Of the seven inequality targets set in the Department of Health priorities and planning framework,\(^\text{6}\) five have an area dimension. Thus, tracking changes in inequality across wards will be a common requirement. Moreover the necessary ward level information can be extracted from routine data sources. The sources used for the Sunderland work were the registered resident population from the Exeter system (2000), mortality statistics from the Office for National Statistics (1998–2000), post-coded hospital contract minimum data set (1998–2000) and domains from the Index of Multiple Deprivation 2000.

The value of consistent estimates of health inequality (relative gaps) is that they enable four kinds of useful comparisons to be made. First, health inequalities can be compared across indicators of health status and lifestyles within a PCT. Figure 2 provides examples of these comparisons within Sunderland Teaching PCT.

Teenage pregnancy is included as an example of a lifestyle indicator. The other indicators in Figure 2 reflect health status, in terms of mortality and/or morbidity (hospital admissions). The comparisons of levels of inequality between different health conditions and lifestyles are relevant in informing

### Table 3 Estimates of the SII for MI across wards in Sunderland associated with income deprivation: unadjusted and adjusted for autocorrelation

<table>
<thead>
<tr>
<th>Estimate adjusted</th>
<th>Unadjusted</th>
<th>by Prais-Winsten iteration procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI</td>
<td>–40.0</td>
<td>–39.5</td>
</tr>
<tr>
<td>Standard error</td>
<td>9.8</td>
<td>8.3</td>
</tr>
<tr>
<td>Significance</td>
<td>p = 0.0005</td>
<td>p = 0.0001</td>
</tr>
</tbody>
</table>

### Table 2. Excel regression output from the data in Table 1

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Standard error</th>
<th>t statistic</th>
<th>p-Value</th>
<th>Lower 90.0%</th>
<th>Upper 90.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>X variable 1</td>
<td>76.4</td>
<td>5.7</td>
<td>13.5</td>
<td>0.0000</td>
<td>66.7</td>
</tr>
<tr>
<td>X variable 2</td>
<td>–40.0</td>
<td>9.8</td>
<td>–4.1</td>
<td>0.0005</td>
<td>–66.8</td>
</tr>
</tbody>
</table>

N/A = Not appropriate as the model is specified with the intercept as zero.
discussion on agreeing priorities for PCT/LSP action to reduce health inequalities. For example, in Sunderland relatively low priority may be given to reducing inequality in stroke, hospital admissions of older people and breast cancer relative to teenage pregnancy, mental health and accidents.

Secondly, comparisons can be made for any health condition or lifestyle over time. This is relevant in relation to the government requirement for PCTs and LSPs to demonstrate measurable progress in reducing local health inequalities under the Department of Health priorities and planning framework. Figure 3 suggests that conception rates for 15–17-year-olds may have fallen between 1992–1994 and 1998–1999. This coincides with a reduction in the average rates of conception in Sunderland over these periods from 63.2 to 60.3 per 1000. Neither the fall in inequality levels nor in the average levels are significant at 90 per cent probability. Nevertheless, given local inequality reduction

Figure 2 Comparison of levels of inequality in health outcomes and lifestyles across wards associated with income deprivation (with 90% confidence intervals)
strategies, it is as relevant to set targets and track changes towards them for inequalities in teenage pregnancy as it is for average levels of teenage pregnancy.

Figure 3 also illustrates a third use of estimates of current levels of inequality in a lifestyle or health condition. This is to set realistic and locally relevant targets for reductions in levels of inequality locally. The agreed 10 year target for the conception rate for 15–17-year-olds in Sunderland is 27 per 1000 by 2008/2009. However, this is not strictly a local inequality target. An appropriate local inequality target would be set in terms of a reduction in the magnitude of the relative gap in under 18 conceptions across wards in Sunderland to be achieved by a given year.

The fourth useful comparison of levels of health inequality that may be made is between indicators of inequality in health status and inequality in rates of service provision. This is particularly relevant in relation to stage 2 of the health equity cycle, which requires the identification of equity gaps. When equity implies equal provision for equal need. If it is accepted that mortality rates for MI can be used as a proxy indicator of need for revascularization [mortality rates and acute hospital admission rates (morbidity) for coronary heart disease and MI have been used elsewhere as proxy indicators of need for revascularization22–26], then the need for revascularization is unequally distributed across wards in Sunderland. More deprived wards have a higher need for revascularization and the relative gap is in the region of –73 per cent. However, revascularization provision is evenly distributed across wards. Figure 4 indicates that there is a significant difference, at the 90 per cent confidence level, between the relative gap in the MI mortality rate and the revascularization rate. This suggests that inequity in provision according to need exists across wards in Sunderland in relation to revascularization.

There may be many very good reasons why such inequity exists, including the inadequacy of the mortality data as a valid indicator of need for revascularization. Nevertheless, where equity is a major objective, comparisons of levels of inequality in indicators of need and service provision can identify potential areas for more detailed equity audit. These types of comparisons are commonly presented graphically, but there are obvious advantages in being able to quantify them. (The magnitude of the absolute difference between the relative gaps in indicators of need and provision can be used to quantify levels of service inequity. Magnitudes of service inequity can then be compared between PCTs for a specific service or between services within a PCT.)
Discussion

The most commonly used measure of health gaps is the range between two groups. An example at a national level is the Government’s inequality target for infant mortality, which is based on the relative gap in mortality between manual groups and the population as a whole. In considering the relative merits of the SII versus the range, the first point to note is that the data needed to calculate the SII is the same as those required to calculate the range. Both require estimates of rates of illness or death by group, both require data which allow a ranking of groups by a measure of deprivation and both require population data for each group in order to estimate rates of illness or death. Secondly, the SII has four advantages over the range: (1) it takes account of all groups in the population, not just those at each end; (2) it provides a consistent measure of inequality that does not depend on the arbitrary choice of the groups to represent each end of a range; (3) it accounts for changes in the sizes of the population groups; (4) being based on more than two point estimates, a confidence interval for the estimate can be calculated.

Point 1 above is relevant in the context of government policy on reducing health inequalities, which stresses the importance of not just considering the two extreme ends of the spectrum when examining health inequalities, but the gradient across the whole population.27

A major disadvantage may seem to be the additional computational complexity required to obtain the SII estimate. However, this paper has demonstrated that good estimates of the SII can be obtained by simple transformation of the basic data and the application of ordinary least squares regression. The routines available on spreadsheet programs, such as Excel are adequate for the purpose.

Common to both the range and SII estimates is the issue of the quality of the data available on health outcome, population and deprivation rank by group. The issues related to the quality of health outcome data are not new. Questions about the robustness of deprivation measures relate mainly to the way composite indices are derived. However, it should be pointed out that both the range and SII require only ordinal data on deprivation to enable a ranking of groups and that it will often be appropriate to establish this ranking on the basis of a single domain. Indeed composite indicators, such as the overall Index of Multiple Deprivation 2000, which themselves include a health dimension, are not an appropriate basis for obtaining the independent variable (relative rank).

Apart from the question of how to measure local health gaps, there is a conceptual issue about what constitutes a local health inequality indicator. For example, a statement in the Department of Health equity audit self assessment tool for PCT Boards28 reads:

‘do you know what your health inequalities are, for example, is your life expectancy higher or lower than the national average, and which are the worst affected groups?’

This statement seems to be asking about health inequalities between the PCT and the national average, as well as about health inequalities within the PCT.

This paper has focused on the measurement of the health gap within an area. This ‘within’ area health gap needs to be distinguished from the gap between local and national indicators of health, as described, for example, in terms of standardized mortality ratios (SMRs).

SMRs have long been used as a ‘between’ measure of local health inequality.29 However, these do not tell us anything about the level of inequality within a local area. The same limitation will apply to the basket of local indicators assembled by The Association of Public Health Observatories11 unless they are differentiated by population groups within the area having different socioeconomic characteristics.

This paper has argued that it is possible to generate consistent measures of health inequality within local areas using routinely available data. It is difficult to see how the requirement to set realistic local inequality targets and to demonstrate measurable progress in reducing health inequalities locally can be undertaken without developing consistent and acceptable ways of measuring and comparing local levels of inequality in health outcomes, lifestyles and services.

Quantification can also contribute to decisions on where to focus attention in addressing local health inequalities. Quantification does not, of course, solve the problem of what to do to reduce the identified inequalities. Nevertheless, authorities on health inequalities at the international level have suggested that measuring health inequalities is a prerequisite to developing strategies and programmes to tackle them.30,31 Indeed, it could be argued that the relative dearth of guidance on how to measure health gaps within PCTs and LSPs, compared to guidance on setting local targets to close them, is a case of putting the cart before the horse.

References