

GLOSSARY

Measures of health inequalities: part 1

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This is the first part of a two part glossary on measures of health inequalities.

as in most public health disciplines it is implicitly assumed that the term “health inequality” denotes socioeconomic inequality in health.

Despite ample empirical evidence of socioeconomic differences in health since the mid-19th century, concern about the problem of measurement of health inequalities did not appear until 1991. In that year, Wagstaff *et al* cautioned that the conclusions reached by different authors about trends in health inequalities may vary depending on the type of measure used; these authors also proposed the measures that they considered most appropriate to evaluate trends and cross country differences in health inequalities.¹ Subsequently, Kunst and Mackenbach published an overview of measures available to determine the magnitude of socioeconomic inequalities in health, in which they incorporated several measures not proposed by the former authors, and noted that the measurement of health inequalities depends on the objective to be pursued.²

Some authors, supporters of the second kind of measures, have shown that countries will be ranked differently, in accordance with the magnitude of their health inequality, depending on which type of measure is used.^{9–10} They have also criticised ranking based on univariate measures, because these measures do not truly reflect socioeconomic inequality in health. However, such comparisons and criticisms have little basis because they are two conceptually different matters. It is as if we were to compare how countries are ranked based on the coefficient of variation of the distribution of body mass index—a measure of inequality of a distribution—with their ranking based on the relation between physical activity and body mass index.

At the beginning of this decade, however, a debate emerged in this area of knowledge when Murray *et al* suggested that these measures do not reflect health inequalities across individuals in the population.^{3–4} The debate is between those who support measuring the inequality in the distribution of a health measure and those who support measuring the differences in a health measure among different values of another variable.^{5–10}

The debate is further complicated by the fact that some authors have introduced the idea that the first type of measure evaluates health inequality among individuals, while the second type of measure evaluates health inequality among groups. Many of these discussions confuse the unit of observation with the definition of the socioeconomic variable. When we obtain information about the level of health of each person in a particular population, a measure of health inequality at the individual level can be estimated: for example, the coefficient of variation of height. But if we also obtain information about educational level, we can estimate the relation between education and health at the individual level: for example, that the mean height of people with primary level education is 4 cm less than that of those who are university educated.

This paper has two objectives: firstly, to help clarify this debate, given that similar terms often mask differences in concepts and methods, and, secondly, to incorporate these different concepts and methods in a glossary of measures of the magnitude of health inequalities that can be used to monitor changes over time and to carry out comparative studies among different areas.

Let us suppose, however, that neighbourhood is selected as the unit of observation. In each neighbourhood, we obtain information on life expectancy and on the percentage of unemployment. We could then calculate the inequality in the distribution of life expectancy among neighbourhoods in a city: this estimation would be an example of the first type of measure mentioned. But we could also determine the relation between the unemployment rate and life expectancy in the neighbourhoods: this estimate would be an example of the second type of measure mentioned. In both cases, these are group level estimates. The second type of measure can also be used to measure differences among groups by means of multilevel analysis, where the unit of observation is the person but groups variables are included.¹¹ The discussion concerning each measure in this article refers to individual observations, but it is equally valid for group observations.

DEBATE OVER MEASURING HEALTH INEQUALITIES

The distribution of a health variable can be described in terms of various statistical measures: its central tendency, dispersion, inequality, etc. These are univariate measures. Frequently, the term “health inequality” is used incorrectly from a statistical point of view, as the objective is to quantify the relation between a variable—gender, race, a socioeconomic characteristic, etc—and health and/or to determine the impact of the distribution of this variable on the health of the population. These, therefore, are bivariate measures. The discussion in this article regarding the second type of measure refers to the relation between health and any socioeconomic variable,

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Inequality and inequity in health

Authors who prefer measures of inequality in the distribution of a health variable criticise measures that evaluate health differences between different categories or values of a socioeconomic characteristic because they involve a moral judgement.³ In their opinion, it is implicitly assumed that these differences or inequalities in health are inequities in health. Although some authors use the term “social inequalities in health” to refer to inequities in health,¹² it is difficult to classify social differences or inequalities in health as inequities in health.^{2 13 14} Gaps in our knowledge are frequently an obstacle to determining causality. In addition, the consideration of health inequity is not a scientific matter, but rather is conditioned by ethical criteria and political priorities. This article describes measures used to evaluate health inequality and another series of measures commonly known as socioeconomic inequality in health, but the discussion will not consider causality or moral judgments regarding inequality.

CLASSIFICATION OF MEASURES OF HEALTH INEQUALITY

Four large groups of measures will be presented: measures of inequality in health in the strict sense, and three measures of socioeconomic inequality in health: measures of association, measures of potential impact, and measures based on the ranking of the socioeconomic variable. In this way, the classification incorporates the distinction among measures that reflect inequality in the distribution of a health variable and measures that quantify differences in health among various values of a socioeconomic variable. This distinction was not taken into account in the two overviews published previously.^{1 2} This paper also includes a clarification from a statistical point of view of some measures, as well as a discussion of how measures of socioeconomic inequality in health have in some cases been used inappropriately.

MEASURES OF INEQUALITY IN HEALTH IN THE STRICT SENSE

These are univariate measures that aim to provide an index of the degree of distribution of a health variable. Measures based on individual mean differences and measures based on inter-individual differences have been proposed.⁴ However,

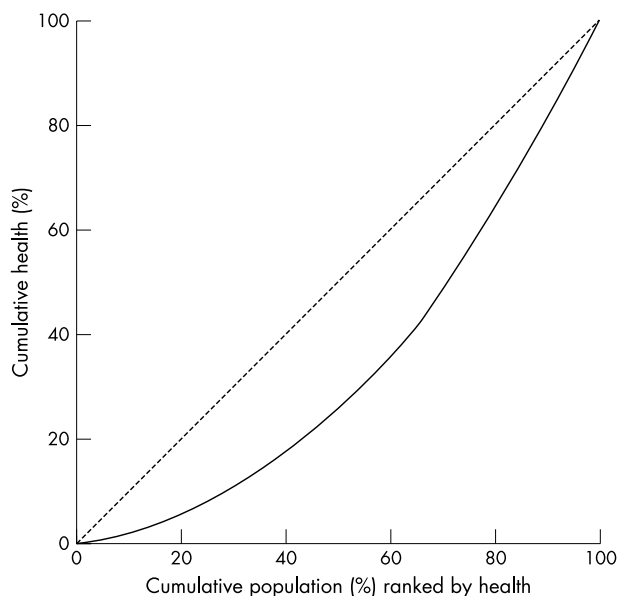


Figure 1 Lorenz health curve.

there is little empirical evidence on the measurement of health inequality based on these kinds of measures, therefore, this paper will mention only those indices that have been used for this purpose: the Gini index and the index of dissimilarity.

Gini index

This index is based on the Lorenz curve, where the x axis represents the cumulative proportion of individuals by level of health, ranked in increasing order—that is, beginning with the sickest persons and ending with those who are healthiest—while the y axis represents the cumulative total proportion of health of these individuals (fig 1). If health is equally distributed among individuals, the Lorenz curve is a diagonal line. The more it deviates from the diagonal, the larger the degree of health inequality. The magnitude of the index ranges from 0—when the curve coincides with the diagonal—to 1—when all the health of the population is concentrated in a single person. It is obtained by means of the formula:

$$G = \frac{\sum_{i=1}^{n-1} |p_i - q_i|}{\sum_{i=1}^{n-1} p_i}$$

where p_i and q_i represent, respectively, the proportion of individuals by health level and the cumulative total proportion of health of these individuals.

The Gini index requires that the health variable be measured on an interval scale. Some variables proposed are years of healthy life—health expectancy—or ratings on health related quality of life instruments.⁴ An alternative way to study binary health variables—alive/dead, healthy/sick—is the use of other characteristics of the observations to define the health variable. Thus, one of the first estimates of health inequality using the Gini index was made by Le Grand and Rabin to estimate what these authors called “inequality in age of death” in England and Wales between 1933 and 1983.¹⁵ In reality, the values of this variable were the expected years of life calculated based on the mortality risks by age.

Subsequently, Leclerc *et al* used this index to compare health inequality among England and Wales, Finland, and France.¹⁶ Although these authors at no time explicitly defined the health variable used, what they measured was inequality in socioeconomic level at death. The values of this variable were the risks of death in each socioeconomic category. In this way they ranked the population to graphically represent the Lorenz curve and to estimate the Gini index. Wagstaff *et al* incorrectly referred to this curve as a pseudo-Lorenz curve because,¹ in their opinion, the authors used group data instead of individual data as used by Le Grand and Rabin. In both cases, however, individual level data were used, but whereas in the first case the authors distributed individuals by age to obtain the values of the variable, in the second case the values of the variable were obtained after distributing individuals by socioeconomic level.

In any case, the estimates made by Le Grand and Rabin and by Leclerc *et al* showed that it was possible to design and assign values to a health variable based on another dimension such as age or socioeconomic level. Nevertheless, because the Gini index requires that individuals be ranked in accordance with the values of the health variable, its ability to measure the size of socioeconomic inequality in health is limited in an important way, as it is not possible to distinguish between a situation in which the sickest individuals belong to the lowest socioeconomic level and

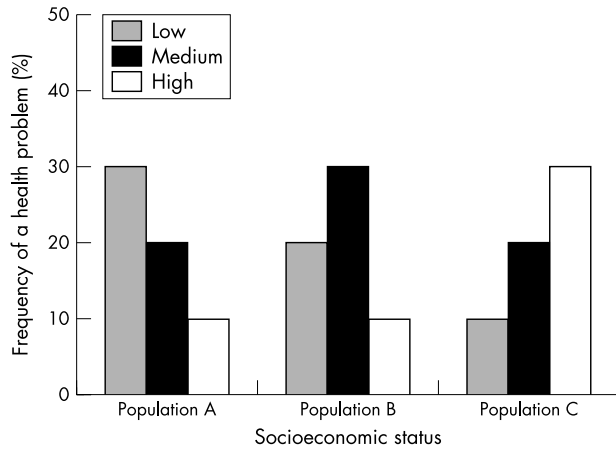


Figure 2 Relation between socioeconomic status and health in three populations.

that in which the sickest individuals belong to the highest socioeconomic level. Furthermore, similar values can be obtained on the Gini index in various situations, even though the health gradient in relation with socioeconomic level is radically different. Thus, for example, the Lorenz curve and the Gini index are identical in the three populations shown in figure 2.

The index of dissimilarity

This index represents the proportion of total health that would need to be transferred from individuals whose health is above average to those whose health is below average, to achieve a situation of total equality. It is obtained by means of the formula:

$$ID = \frac{\sum_{i=1}^n |p_{ip} - p_{ih}|}{2}$$

where p_{ip} represents the proportion of the population representing those individuals whose health value is i , and p_{ih} is the proportion of population health for individuals whose health value is i .

The same as with the Gini index, the index of dissimilarity (ID) has been used with health variables in which the value assigned to each person is the risk of mortality or the frequency of disease in the socioeconomic category to which the person belongs.¹⁷ In this case, the ID can be interpreted as the percentage of all cases—whether deceased or ill—that would have to be redistributed to obtain the same risk of mortality and of disease in all individuals in the population. The larger the percentage of persons who belong to the

categories with the highest or lowest risk, the higher the ID and the larger the degree of health inequality. As with the Gini index, its disadvantage is that similar values can be obtained in situations in which the health gradient with relation to socioeconomic level is radically different (table 1)

MEASURES OF ASSOCIATION

These measures compare the level of health or the frequency of the health event for different values or categories of the socioeconomic variable to be studied, using relative differences—ratios—and absolute differences. The main limitation of these measures is that they do not take into account how individuals are distributed in each category: the percentage of individuals included in each category may vary in populations A and B, therefore similar estimates in the two populations could mean something different when evaluating socioeconomic inequality in health.

Frequency ratio with polytomous socioeconomic variables

This measure shows how much greater (or smaller) the frequency of the health event is in each category of the socioeconomic variable with respect to the reference category, which is usually the uppermost or lowermost category. The dependent variable that reflects the health event must be binary. It is calculated using contingency tables or log-linear regression models after logarithmic transformation of the dependent variable.

Because the measure gives an estimate for each category of the socioeconomic variable, it is not always easy to show in which population the relation between the socioeconomic variable and the health event is strongest or weakest. In population A, the frequency ratio for the low and middle social class with respect to the high social class may be 1.60 and 2.10, while that of population B may be 1.40 and 2.30. An advantage of this measure is that it shows the pattern of the relation between the socioeconomic variable and the health event for the whole range of values of the socioeconomic variable. This makes it possible to assess whether or not it is appropriate to estimate a summary measure of socioeconomic inequality in health.

Frequency ratio between the uppermost and lowermost categories of polytomous socioeconomic variables

This measure shows how much greater (or smaller) the frequency of the health event is in the uppermost or lowermost category of the socioeconomic variable with respect to the opposite category that serves as the reference. The use of a single number makes it easier to compare the magnitude of socioeconomic inequality in health across populations or over time. But it reflects only what happens in individuals in the two extreme categories, ignoring what happens in the intermediate categories. Nevertheless, some

| Frequency of disease (per 1000 people)* | Number of people | Number of cases observed | Population share (1) | Cases share (2) | Absolute differences (1-2) |
|--|------------------|--------------------------|----------------------|-----------------|----------------------------|
| 7.50 | 8000 | 60 | 0.08 | 0.04 | 0.04 |
| 9.00 | 15000 | 135 | 0.15 | 0.09 | 0.06 |
| 12.00 | 20000 | 240 | 0.20 | 0.17 | 0.03 |
| 13.50 | 35000 | 473 | 0.35 | 0.33 | 0.02 |
| 24.75 | 22000 | 545 | 0.22 | 0.38 | 0.16 |
| | 100000 | 1452 | | | 0.31 |
| Index of dissimilarity = 0.31/2 = 0.155 (or 15%) | | | | | |

*Frequencies of disease in each socioeconomic category. The index of dissimilarity is the same regardless of the socioeconomic category to which these values belong.

authors have shown that it can be useful to report the frequency ratio between the uppermost and lowermost categories if clear evidence of a linear trend has previously been observed.¹⁸

Frequency ratio with dichotomous socioeconomic variables

The socioeconomic variable is grouped into two categories, and the frequency of the health event in each category is compared. A typical example is the frequency ratio for manual social class compared with non-manual social class. As in the previously discussed measures, it is calculated using contingency tables or log-linear regression models. It permits great flexibility in the selection of the two categories in which individuals are grouped, making it possible to have a very similar distribution of individuals in each category in different populations, thereby avoiding the main limitation of measures of association. This may be why it is one of the most commonly used measures for comparisons.¹⁹ However, the disadvantage of using two large groups is that it is not possible to know the pattern of the relation between the socioeconomic variable and the health event in each population.

Frequency ratio with continuous socioeconomic variables

The dependent variable that represents the health event must be binary, but the socioeconomic variable is measured on an interval scale. Sometimes a transformed variable like the standard deviation is used, so that each unit of increase (or decrease) corresponds to one standard deviation of the variable. Some variables like social class cannot normally be used with this measure. However, social class is often defined as an ordinal variable and analysed in this way; such an analysis assumes that the difference between each social class category is equal in magnitude. Log-linear regression models are normally used for this type of calculation, after the logarithmic transformation of the dependent variable. The estimated measure is the frequency ratio associated with one unit of increase in the socioeconomic variable: for example, the mortality risk ratio associated with one additional year of education is 0.96. Sometimes this ratio is expressed as a percentage by subtracting 1 from it and multiplying the result by 100.²⁰ In the previous example, the mortality risk decreases by 4% for each additional year of education.

This statistic is a summary measure of socioeconomic inequality in health, which includes the entire range of values of the socioeconomic variable in its calculation, but it has a disadvantage: when measuring the independent variable on the interval scale there is a high probability that adjustment of the regression function based on the observed data can show deviations from linearity, in which case it is not appropriate to calculate the frequency ratio.

Odds ratio

The odds ratio is often used instead of the aforementioned frequency ratios. All the frequency ratios discussed have a

correlate form of the odds ratio. The odds of a health event represent the frequency of this event divided by its complement. When the frequency of the event is very low, the odds ratio is an excellent approximation of the frequency ratio. It is calculated using contingency tables or logistic regression models after the logit transformation of the dependent variable. It has the same advantages and disadvantages as the frequency ratio, together with one additional limitation: the odds ratio overestimates the size of the relation between two variables when the frequency of the dependent variable—the health event in this case—is higher than 0.20.²¹

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