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Reference: Drakou, Ismini (2017). Measurement methods of inequalities in health services. In: MIBES transactions 11 (1), S. 1 - 13.

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Measurement Methods of inequalities in health services access

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Abstract

Aim: *To present specific methods that measure inequalities in using / accessing health care services, as well as the method of decompositing of the contribution of need (health status)and non-need (socioeconomic) variables to overall inequality in health care.*

Scope: *After making an overview of the methodological measures/indicators in the field of inequalities in health and health care to focus on two specific measures: The regression models method and the Concentration Index (CI) - ECuity method for measuring and decomposing inequalities in health care.*

Methodology for analysis: *The most common summary methods of measuring inequalities in health range in three categories: Absolute (simple), relative (simple regression-based) and Individual Mean differences (more advanced) measures. The most appropriate methods of measuring inequalities in health services access are analytically presented: (a) The regression models approach - based on the behavioral model of health service use that measures the likelihood of contact with health services, the volume of health services used or the expenditures incurred - and (b) the Concentration Index (CI) - ECuity method - based on the Lorenz curve and Gini index of inequality that estimates and quantifies the level of horizontal inequity (HI index) by comparing the cumulative distribution of utilization with the cumulative distribution of needs-adjusted utilization ranking each individual according to their income level.*

Results: *The value of the HI index ranges from -1 ("pro-poor") to +1 ("pro-rich") inequity. A zero inequity index implies that, after controlling for differences in need across income groups, all individuals have equal probability of using health services, regardless of income. Moreover CI permits identifying the contribution of each socio-economic factor related to income on the overall inequity - via the decomposition method based on the regression approach. The advantages and criticism of the specific method are presented as developed in the literature.*

Keywords: measurement methods, inequalities, horizontal – inequity, health services access

JEL Classication Codes: I14 Health and Inequality, D63, C21

Introduction - Review of Measurement methods of inequalities in health

We identify a long lasting debate on the most appropriate method of measuring inequalities in health (mortality and morbidity) as applied in most EU studies, that range from very "straightforward" and "simple" absolute measures, such as the statistical measure of the

"range", to more complex relative measures such as the Gini coefficient, the Index of dissimilarity, the Slope index of inequality and the Concentration index (Coolins & Klein, 1980; Le Grand, 1978; Mackenbach & Kunst (1997). Some are related to statistical visualized techniques such as logistic regression in the case of the Odds Ratios (OR) or simple regression analysis in the case of the Slope Index of Inequality (SII), and the Relative Index of Inequality (RII). Statistical models offer more possibilities in terms of interpretation of health inequality. They are used to straightforward build and test a relation of the measured health inequality with several factors (usually social factors, SES variables). On the other hand, they appear rather complex to those researchers who are not familiar with statistics. Finally, there are some indices that are more known to the researchers involved in measuring inequalities in general, such as the Gini coefficient, and the Concentration index (CI). These offer some advantages in the visualization of inequality level, through the Lorenz and the Concentration curve (CC). In general, the distribution of health care can be described with various types of statistical measures, such as dispersion measures, inequality measures, relative measures such as the coefficients that arise from statistical models (see e.g. Regidor E., 2004) as reviewed and classified on Spinakis A. et al (2011) for inequalities in health care use for EC – DG Health and Consumers and displayed in Table 1 of selected summary measures/indicators including their advantages/disadvantage as following:

(i) **Simple measures** that are easily interpreted and include: The Range ratio; Index of Dissimilarity; Inter-deciles or quintiles ratio (p_i/p_j)

(ii) **Regression based measures** that include: The slope index of inequality (SII); the Relative Index of Inequality (RII); and Odds Ratio (OR)

(iii) **More advanced measures** that take into account the whole distribution of health and usually satisfy many more of certain desirable properties. They include: Coefficient of variation (CV); Standard Deviation of the logs (S_{log}); Gini Coefficient of inequality (G); Concentration index (CI); Theil's Entropy; and Atkinson index. Different measures can give information and interpretation about different aspects of health inequalities, depending on the measure used and tje objective(s) of the analysis. Usually, in order to have a fuller understanding of the health inequalities, it is better to use more than one measure and combine their outcomes.

Table 1: Selected summary measures / indicators of inequalities in health - Adapted from Spinakis A, Anastasiou G, Panousis V, Spiliopoulos K, Palaiologou S, Yfantopoulos J. (2011)

Measures/Indicators	Advantages	Disadvantages
Absolute Measures		
Range	*Simple measure:* • easy to understand and calculate • It compares health indicators between top and bottom groups in a classification of individuals according to a given socio-economic variable.	• Uses two extreme values of the distribution and fails to consider what happens in intermediate socioeconomic groups • It comes short to account for differences in the relative size of the groups and it ignores changes in their size. • Difficult for making international comparisons
Inter- deciles or quintiles ratio (p_i/p_j)	*Simple measure:* • easy to understand and calculate • scale independent • widely used by the EC • Reliable tool for studying trends.	• Uses only two extreme values of the distribution • Unreliable with greatly variable data
Odds Ratios (OR)	*Regression based measure:* • Very known to the health inequality literature • link to logistic regression offers flexible physical interpretation and measurement of statistical significance • Reliable for a trend analysis	• Less simple in concept, • Unable to compare all social categories at once
Coefficient of variation (CV)	*Dispersion measure:* • easy to understand and calculate • scale independent • extensively known statistical dispersion measure • standardized measure • useful for group comparisons like countries • it uses the whole health distribution • reliable tool for studying trends	• It fails to capture inequality present due to a socioeconomic factor, e.g., income • As a variability measure it works satisfactory with aggregate data like mortality
Standard Deviation of the logs (S_{log})	*Dispersion measure:* • easy to understand and calculate • scale independent • extensively known statistical dispersion measure	• It fails to capture inequality present due to a socioeconomic factor, e.g., income • As a variability measure it works satisfactory with aggregate data like mortality

	• standardized measure • useful for group comparisons like countries • it uses the whole health distribution • reliable tool for studying trends	
Theil's Entropy	• Theoretically sound tools for the measurement of health inequalities • Easiness of interpretation • Symmetrical measures • Satisfies the transfer principle • Use the whole distribution • Scale invariant (especially with SES variables) • Atkinson's variant offers sensitivity to various parts of the distribution • The last is linked to welfare economics and societal preferences	• First impression is characterized as complex. Not very comprehensive as the simple statistical measures, e.g inter-deciles ratio • Not very know to the health inequality literature. Lack of simplicity to the researchers in the field of health inequalities
Atkinson index	• Easiness in interpretation Scale independent • uses the whole health distribution, • Link to statistical information theory enables the possible use of entropy variants. • Reliable for a trend analysis	• Complex in a sense • not very much known to health inequality literature
Relative measures		
Slope Index of inequality (SII)	*Simple regression-based measure:* • It reflects the experience in health of all the population not only extreme groups; • It is sensitive to the distribution of population in socioeconomic groups; and • It reflects the socioeconomic dimension of health within the measurement of inequalities • It is sensitive to changes in mean health status	• The applied modeling technique (regression) needs to insert a quantitative variable in order to estimate health inequality. This is not a natural approach in the case of SES characteristics.
Relative Index of Inequality (RII)	*Simple regression-based measure:* • It reflects the experience in health of all the population not only extreme groups; • It is sensitive to the distribution of population in socioeconomic groups; and • It reflects the socioeconomic dimension of	• The applied modeling technique (regression) needs to insert a quantitative variable in order to estimate health inequality. This is not a natural approach in the case of SES characteristics.

	health within the measurement of inequalities • It is sensitive to changes in mean health status	
Concentration index (CI)	• Extensively used for measurement of health inequalities • Take account of changes in the underlying • Population distribution in the social groups over the time and use information across the entire range of social groups • Satisfies the transfer principle • Uses the whole distribution • Scale invariant • Relation to concentration offers flexibility in interpretation	• Sensitive to the direction of the social gradient in health. Could lead to biased results • Decomposability is restricted • Range restricted for binary health data
Individual-Mean differences formula measures		
Index of Dissimilarity	• Conceptually simple • It tries to measure differences between groups shares of population and groups shares of health	• It fails to capture inequality present due to a socioeconomic factor, e.g., income
Gini Coefficient of inequality (G)	• Extensively used, familiar to most users • Scale invariant • Satisfies the transfer principle • Uses the whole distribution • Offers graphical interpretation of the analyzed phenomenon through the Lorenz curve	• Lacks sensitivity at the extremes of the distribution • Decomposability is practical restricted • Not sensitive to health gradients e.g. a social variable

Source: Adapted from Spinakis A, Anastasiou G, Panousis V, Spiliopoulos K, Palaiologou S, Yfantopoulos J. (2011) Expert review and proposals for measurement of health inequalities in the European Union – Full Report. European Commission Directorate General for Health and Consumers. Luxembourg. ISBN 978-92-79-18528-1

Review of measuring inequity of access to health care

The debate for the most appropriate method of measuring inequalities in health services access (most often approximated by utilization) came out through comparisons of health-care use and health-care need by Coolins & Klein (1980); by Le Grand (1978) and presented in more detail by Mackenbach & Kunst (1997). Since then, they have followed two directions, summarized by Allin S. et al (2009) and Mackenbach & Kunst (1997) and displayed in Table 2 below.

(a) Regression models method (mainly odds – ratios)
(b) The Concentration Index – Ecuity method

Table 2: Summary measures of socio-economic inequalities in access to health care

Index	Interpretation
Correlation and regression	
Product-moment correlation	Correlation between health care utilization rate and socio-economic status (SES)
Regression on SES	Increase in utilization rate per one unit increase in SES
Regression on cumulative percentiles (relative index of inequality; Slope index of inequality)	Utilization rate ratio (RI/I) or differences (SII) between the least and most advantaged person
Regression on z-values	Utilization rate difference between group with lower and higher than average morbidity rates (x 0.5)
Gini-type coefficients	
Pseudo-Gini coefficient	0 = no utilization differences between groups; 1 = all utilization in hands of one person
Concentration index	0 = no utilization differences associated with SES; -1/+1 = all utilization in hands of least/most advantaged person
Horizontal inequity index	0 = no utilization differences associated with SES after need standardization; -1/+1 = all need standardized utilization in hands of least/most advantaged person
Generalized concentration index	Based on CI, but includes also mean distribution of health care

Source: Allin S. et al (2009) adapted from Mackenbach & Kunst (1997)

The regression models method

According to this method, we measure the independent effect of socioeconomic measures (need and non need variables) on health care use indicators that include: the likelihood of contact with health services, the volume of health services used or the expenditures incurred. This approach is based on the behavioral model of health service use developed by Andersen R. since 1960s and Andersen R. (1995). The behavioral model suggests that health-care service use is a function of need factors as well as of individual predisposition and ability to use health-care services, which facilitate or impede use, as following:

(i) an individual's predisposition to use services (social structure, health beliefs);
(ii) individual characteristics (income and education);
(iii) community level (availability of services); and
(iv) the level of need for care

Therefore, following the standard approach in the empirical literature, the regression models method regresses medical care use (y_i) on a vector of k medical need indicator variables (x_k), and a set of p non-need variables (z_p) using the equation, assuming a linear model:

(2) $$y_i = \alpha + \sum_k \gamma_\kappa x_{k,i} + \sum_p \delta_p z_{p,j} + \varepsilon_\iota$$

Where y_i are health care use variables (the probability of use; or the volume of health services used or the expenditures incurred), (x_k) need indicators are proxied by demographics (age, gender); health status (SAH, number of chronic medical conditions etc); and health limitations (i.e. long term illness etc) and the non-need z_p indicators – variables (income, higher educational level, marital status, social health insurance fund, region of residence etc). In addition, sample weights were used in all computations in order to make the results more representative of the country's population, as well as robust standard errors. According to the behavioral model of health service use, inequity arises when the non - need factors strongly affect the use of health care. This approach uses a comprehensive model of utilization with explanatory variables convenient for policy-making. However, the results of the regression method cannot quantify the extent of inequity.

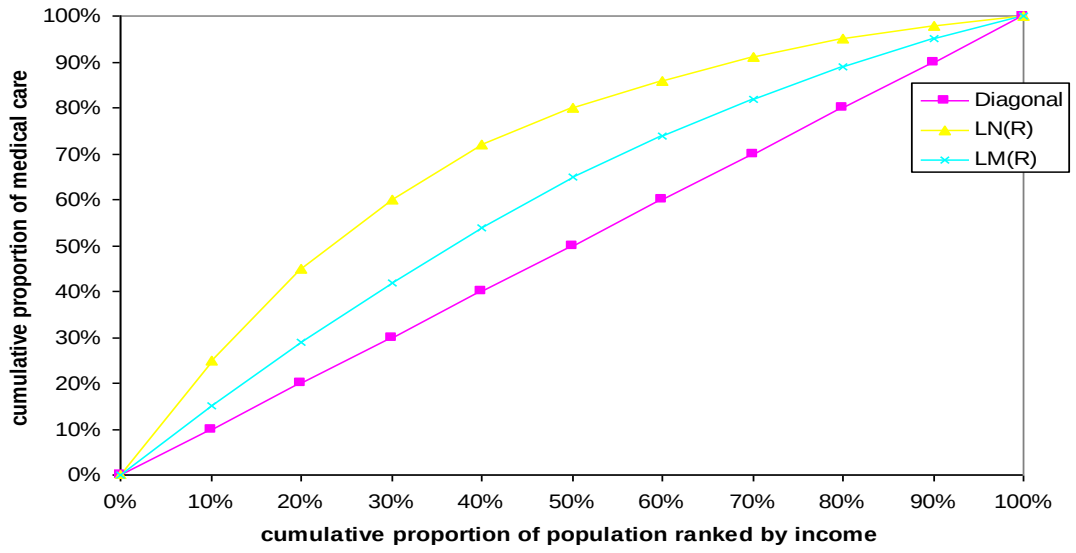
The Concentration Index (CI) - ECuity method

This method comes from the literature on income inequality based on the Lorenz curve and Gini index of inequality. Similar to the Lorenz curve that describes the distribution of income in a population, the concentration curve (CC) for utilization compares the cumulative distribution of healthcare use with the cumulative distribution of the population rank-ordered by income (Allin S. et al, 2009; O'Donnell et al., 2008; Wagstaff and van Doorslaer, 2000; Kakwani et al., 1997; Wagstaff et al., 1991). Similarly with the Gini index that provides a measure of income inequality, the concentration index (CI) is a measure of income-related inequality in health care use. The CI is a measure of income-related inequality in access to health care, to estimate and quantify the level of horizontal inequity (HI index) defined as the difference between the degree of income-related inequality in actual health care use ($CI_{unadjusted}$) and the income-related inequality in need-adjusted use ($CI_{adjusted}$) and calculated from a regression approach developed by Wagstaff and Van Doorslaer in the ECuity project since the 1990s (O'Donnell et al., 2008).

Figure 1 below quantifies the level of horizontal inequity in health care use based on concentration curve that calculates inequity (Horizontal Inequity - HI index) by comparing the cumulative distribution of utilization (*LM*) with the cumulative distribution of needs-adjusted utilization (*LN*), ranking each individual according to their income level. We consider need-adjusted utilisation as the predicted use interpreted as "socio-economic inequality in utilization not justified by socio-economic inequalities in need" (Allin S. et al, 2007). If both the cumulative proportion of health care and the cumulative proportion of needs-adjusted utilization are equally distributed across income, the two curves would coincide with the diagonal (line of equality) that represents the horizontal inequity index, meaning that utilization of health care services is proportional to need. The farther the *(LN)* curve is from the *(LM)* and from the diagonal, the greater the degree of inequality. The value of the horizontal inequity index ranges from −1 to +1. After adjusting for need, when the needs-adjusted utilization concentration curve *(LN)* lies above the health care utilization concentration curve *(LM)*, there is horizontal inequity favoring the rich, and the measure (HI) has a positive value. This is described as "pro-rich inequity" and actual health care utilization is more concentrated among the better-off, on the lower end of the income distribution. This implies that individuals on higher income are more likely to visit a physician than one would expect on the basis of their reported need. On the contrary, if the need concentration curve lies below the medical care concentration curve, there is horizontal inequity favoring the worse-off, so the measure has a negative value and this is described as "pro-poor" inequity. According to Wagstaff & van Doorslaer (2000), "such pro-poor inequity is interpreted as an "over-utilization" among the poorer groups, or it could be interpreted as an appropriately higher utilization due to the inability to accurately measure the greater health needs among these groups with the data available". A zero inequity index implies that, after controlling for differences in need across income groups, all individuals have equal probability of using health services, regardless of income.

$$HI = CI_{unadjusted} - CI_{adjusted}$$

Figure 1: Concentration curves for utilization (LM) and need (LN) compared to the line of equality



Source: Allin S. et al (2009) p. 187

Moreover CI permits identifying the importance of each variable and calculating the contribution of each variable on the overall inequity as a separate component via the decomposition method based on the regression approach as developed by (Kakwani, Wagstaff et al. 1997; O'Donell et al, 2008; Van Doorslaeer & Masseria C., 2004). The important advantages and relevant criticism of CI method are presented below.

Given that in most empirical studies – similar to our study - the levels of inequity are small in magnitude, making difficult to interpret the cumulative proportions and the relevant inequity distributions as depicted in the concentration curve figure, Kakwani and colleagues have shown that it is possible to compute the index using a convenient" regression approach based on an initial health-care demand model for quantifying the above CIs, the horizontal inequity index and perform decomposition analysis in five successive steps (Kakwani, Wagstaff et al. 1997).

Overall, the estimation method of calculating the CIs and the index of horizontal equity involves the following five successive steps as developed and presented by Kakwani et al. (1997); Wagstaff et al. (1991); Wagstaff and van Doorslaer (2000); O'Donnell et al. (2008):

(i) Calculation of the CI actual (CI unadjusted) for unadjusted utilization (LM);

(ii) Estimation of a model of the determinants of health care using the set of need and non-need related variables;

[1] $y_i = \alpha + \beta \ln inc_i + \sum_k \gamma_\kappa x_{k,i} + \sum_p \delta_p z_{p,j} + \varepsilon_\iota$

where y_i denotes the dependent variable (medical care use of individual *i* in a given period): ie probability of inpatient admission for the last 12 months etc. We also distinguish between three types of explanatory variables: the (logarithm of) the household income of individual i($\ln inc_i$),a set of k need indicator variables (x_k) including demographic and morbidity variables, and p other, non-need variables(z_p) (ie income, education, marital status, household composition, housing tenure, SHIF coverage etc) where α, β, γ_κ and δ_p are parameters and ε_i is an error term.

(iii) Obtain the "need - standardized" or "predicted" need adjusted utilization for each individual in the sample by setting the value of all non-need variables at their sample mean in order to calculate the CIneed-adjusted by employing standard OLS models (VanDoorslaer et al., 2004; García and López, 2007).
The predicted of "need-standardized" values of use indicate "the amount of medical care the individual would have received if s/he had been treated the same as others with the same need characteristics" (Van Doorsaler et Masseria, 2004). The need standardization is vital in order to measure inequity, if we accept that income is strongly connected to health care need. What's more, the need standardization is what one expects from a policy making, since it interprets inequity as the inequality remaining from non-need factors (O'Donnell et al, 2008). According to Van Doorslaer et al.(2004) and García and López (2007) we can obtain the "need- standardized" or "predicted"

utilization [2] $\hat{y}_i^X$ by employing standard OLS models (VanDoorslaer et al., 2004; García and López, 2007), as:

[2] $\hat{y}_i^x = \hat{a} + \hat{\beta}\ln \text{inc}^{\text{m}} + \sum_k \hat{\gamma}_{\text{k}} x_{k,i} + \sum_p \hat{\delta}_{\text{p}} z_p^m$

with actual values of the $\sum_k \hat{\gamma}_{\text{k}} x_{k,i}$ variables and sample mean values of the ln inc and z_p variables.

(iv) Calculation of the concentration index (CIadjusted) of need-adjusted utilization for the distribution of need-adjusted utilization (LN);

(v) Calculation of the income related inequity or horizontal inequity (HI) as the difference between the concentration indices of unadjusted (LM) and needs-adjusted utilization (LN).

[3] $HI = CI_{unadjusted} - CI_{adjusted}$

It is important to note that according to the existing literature, for the calculations of $CI_{unadjusted}$ and $CI_{adjusted}$ in the above steps (i) and (iii) and calculation of equation of inequity index [3] they use either OLS techniques by convenient (weighted least squares) regression that "it would involve a re-linearization by using either the marginal or average effects of each independent variable treated as fixed parameters and evaluated at the mean (or some other parameter)", or non linear models. Moreover, the OLS regression is usually used instead of non-linear regression to standardize the health care variables and decompose the CIs.

Sample weights are used in all computations in order to make the results more representative of the country's population. In addition, test for statistical significance, confidence intervals and robust estimates for CI and its standard errors are used by running the convenient (weighted least squares) regression and the Huber/White/sandwich estimator. The Newey-West variance covariance matrix to correct for autocorrelation, as well as heteroscedasticity are used (Newey, Whitney K & West, Kenneth D, 1987; Greene W.H., 2000), as well.

Decomposition of the contribution of need and non-need measures/ variables

Following, as aforementioned, the concentration index approach enables the decomposition of the contribution of need (i.e. SAH, health status variables) and non-need (socioeconomic) variables to overall inequality in health care (O, Donell et al, 2008). The decomposition method is used to measure whether socio-economic factors related to income, such as education, residence, employment status and complementary insurance coverage contribute to the overall level of income-related inequity (Wagstaff et al. 2003). According to Allin S. et al (2009), "The contribution of each variable to inequity is a product of its impact on demand and its correlation with the income distribution" (p.206). For example, a positive contribution of education to dentist pro-rich inequity indicates that higher education is associated with both higher income and utilization.

For calculating the contribution of the variables by the decomposition method the total concentration index can then be written as:

[8] $C = \eta_r C_{\ln inc} + \sum_k \eta_{\text{k}} C_{x,k} + \sum_{\text{p}} \eta_{\text{p}} C_{z,p} + GC_{\varepsilon}$ k p

where the first term denotes the partial contribution of income inequality, the second the (partial) contribution of the need

variables, and the third the (partial) contribution of the other variables. The last term is the generalized concentration index of the error term ε. It is also important to test for statistical significance, confidence intervals and robust estimates for standard errors by running the convenient (weighted least squares) regression and using the Huber/White/ sandwich estimator.

Advantages and criticism

Concentration Index method has many advantages empirically presented in the literature (O, Donell, van Doorslaer, Wagstaff et al, 2008; Wagstaff, Paci and van Doorslaer,1991):

(a) "seizes" the socioeconomic dimension of health care (and health) inequalities;
(b) It uses information from the whole income distribution rather than just the extremes;
(c) It permits visualizing inequalities in use via the concentration curves and identifying their extent;
(d) It permits decomposing the contribution of the various need and non-need components (socioeconomic variables) as determinants of inequity and their relative importance that drives inequity.

On the other hand, criticism has been developed for the method of measuring equity, summarized as following:

(a) Inefficiency in the linear models of utilization (OLS) used on the estimation methods for the CIs and decomposition analysis due to the count nature of some utilization variables (i.e. conditional number of inpatient admissions) (Jones, Rice, Bago d'Uva et al.,2007).
(b) Possible endogeneity derived from the causal impact of health service use on need – health care status.

For the critical problem (a) in order to restore the mechanics of the decomposition, what has been suggested is to turn actual use into propensity to use, as an approximate. However, there is strong evidence that horizontal inequity measures (HIs) calculated by standard OLS techniques - to standardize the health care variables and decompose the CIs - do not differ to those obtained by non linear methods (Van Doorslaer et al., 2000; Van Doorslaer & Masseria C., 2004; Hernandez Quevedo & Jimenez R, 2009; AllinS. & Hurley, 2009; Jones, Rice, Bago d'Uva et al.,2007). Therefore, in our study- similar to others- we use the OLS regression instead of non-linear regression

For the critical problem (b) of possible endogeneity among health service use and need-health status, there is strong empirical evidence that this effect is minimal, provided that nearly all empirical studies of HI in health care utilization, when measuring need, use a combination of demographic and health status indicators such as SAH status, the presence of chronic conditions and activity limitations, and not limited need information that may be affected by the causal impact of health service use (Bado D'Uva, Jones & Van Doorslaer, 2009 and O'Donnell et al, 2008).

Acknowledgements

This paper constitutes part of Ismini Drakou's PhD thesis in Social Policy, LSE, under the supervision of Professor Elias Mossialos.

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