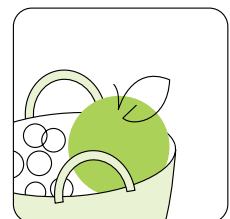
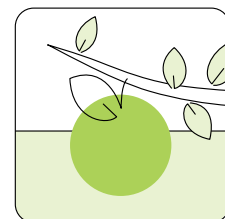
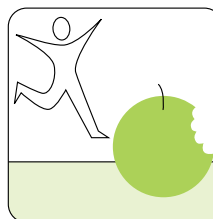


# Expert Review and Proposals for Measurement of Health Inequalities in the European Union

## Summary Report



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European Commission



# Expert Review and Proposals for Measurement of Health Inequalities in the European Union

Summary Report\*

March 2011

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## Abstract

The search for the best appropriate “summary measure” of health inequality that can be observed individually or in terms of groups of individuals is a task that occupies a lot the researchers involved in the fields of inequality research. Lately in the EU, it has been recognized that a more focused effort is required. It is more natural to suggest and construct methodologies or indices that will be suitable for assessing trends in terms of mortality, morbidity and also self-perceived health.

This report is an addition to the above investigation. It summarizes the most important findings of the project “*Expert review and proposals for monitoring trends in health inequalities in the EU*”, Contract n° SANCO/2008/C4/04 – Lot 1 (SI2.530184) which was funded & supervised by the European Commission and the Directorate-General of Health & Consumers (DG SANCO).

Focus is made on readily applicable solutions that are based on data already collected or published by Eurostat. The basic aim was to make proposals and/or recommendations that will facilitate the monitoring of health inequalities and their trends within the EU area as a whole, as well as the EU regions, cities, social groups, etc.

Under the framework of this analysis an extensive review of the administrative data (e.g. mortality data) with respect to countries/regions of the EU and the data on morbidity and self-reported health with respect to social groups of the individual's was conducted. Health data suitability for measuring health inequalities was based on appropriate criteria.

At the end, the most suitable indicators based on the above mentioned and also future data were proposed. Inequality indicators such as the famous in the literature Gini coefficient, the Concentration index, the Odds Ratios and also simple measures like the Life Expectancy gap gather the most desirable properties for performing such a work.

As suggested in much literature (e.g. Wagstaff et. al., 1991) the conclusions reached by the various authors in issues about trends in health inequalities vary depending on the type of the measure used. A comment in Masseria, C (2009) is indicative: “*the measurement and monitoring of inequalities in health over time and across countries is not straightforward since the choice of the measure will influence the results*”. Therefore, the choice of the appropriate indicators for health inequality measurement is a crucial matter, not only for the accurate estimation of the magnitude of inequality, but also for the proper monitoring of its variation through time. This work focused on the search for the best appropriate measure and also one or two equivalent measures that may serve just as well as health inequality indicator. Significant correlations exist between most of the proposed indicators verifying that they coincide in the measurement of health inequalities.

# 1. Measurement of Health & Health inequalities in the EU

Monitoring of inequalities in health is an important public health task. Interest in health inequalities among EU countries and their regions as well as among the various social clusters in the EU population is growing. This is driven by the fact that European and national epidemiological studies highlight a widening gap between North and southern Countries and regions of the EU as well as within countries and regions and between socio-economic groups. (see Mackenbach *et al.*, 1997, Dalstra *et al.*, 2002). So, a more focused effort is required to the search for the best appropriate summary measure(s) of health inequality.

## 1.1. Health Data

Statistics in health are collected by various sources and surveys. E.g., Eurostat and DG-Health & Consumers (DG SANCO) have jointly developed a system of health surveys in order to bring together different surveys modules, namely the European Health Surveys System (EHSS).

It is important for the purposes of an analysis of health inequalities, the existed health data & indicators to be able to provide the means for monitoring of variations in terms of mortality, morbidity and self-perceived health. A basic criterion for inclusion among the data sources to be considered is the degree of harmonization, in order for international comparisons to be valid. Data sources falling within the European Statistical System (see Figure 1) meet this requirement. As O'Donnell, O (2009) comments, survey data over mortality data allow to study health differences in relation to various socioeconomic dimensions. The last is a much needed task within the EU with regard to health inequalities.

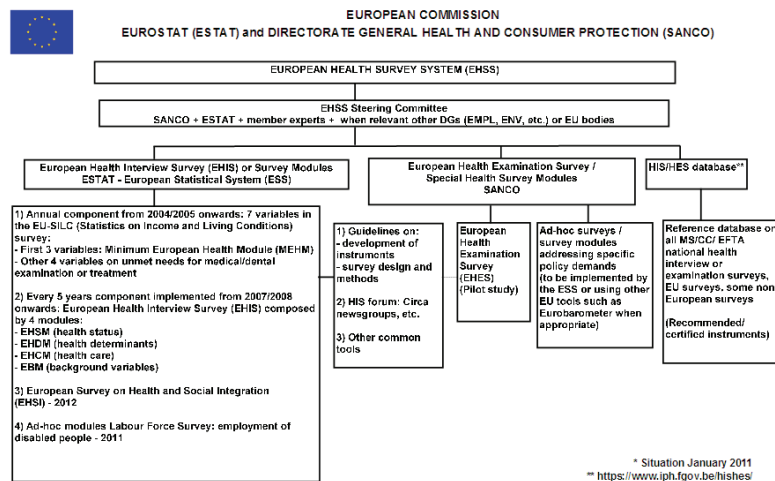
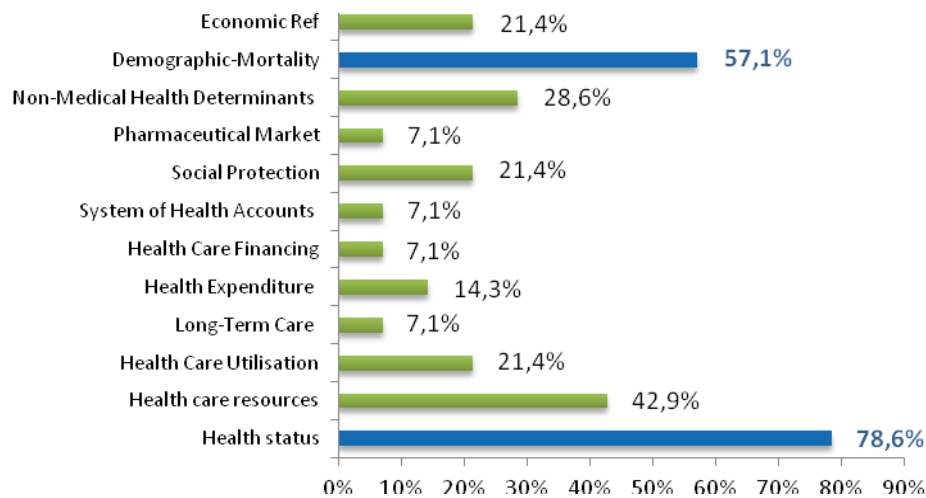


Figure 1: Schematic representation of the European Health Survey System (EHSS)

The suitability of the reviewed data sources was initially evaluated in terms of a qualitative and a quantitative analysis. This analysis resulted to an exhaustive evaluation which showed which are currently the most suitable data sources in the EU, for the purposes of this project and similar uses. Such data sources deal mostly with quantitative information (57,1% in total e.g., indicators for various dimensions of health, such as mortality indicators). The existence of mostly quantitative information reveals the size of the effort undertaken by the various EU

agencies to collect and harmonize data that can be used for the monitoring of health and also health inequalities in the EU area.



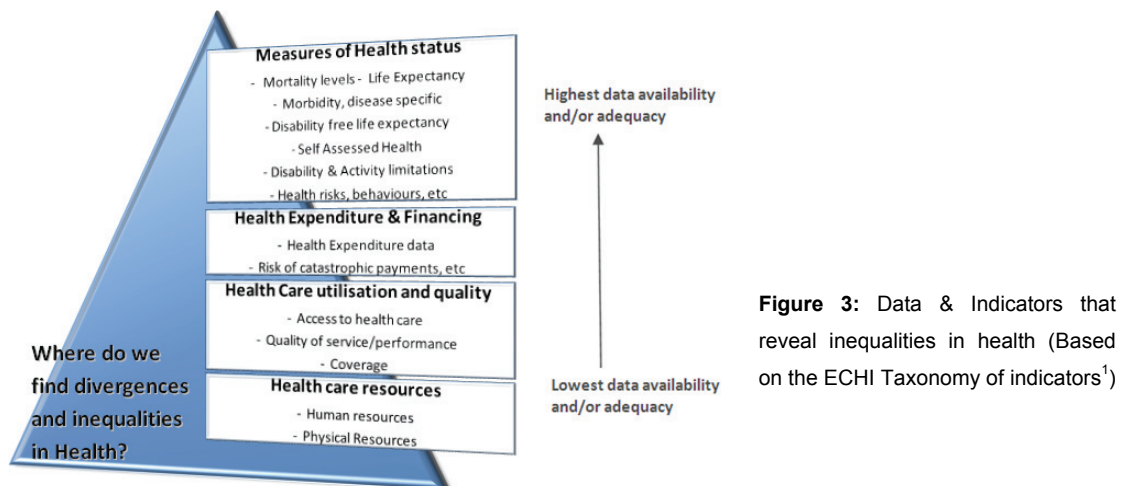
**Figure 2:** % of data sources covering health indicators by subject (Source: "Review and Analysis of EU Data Sources, SANCO2008C404Lot 1\_Sl2.530184")

Some of the existing data sources cover the statistics needed for research in Health Inequalities to a great extent (e.g. the EUROSTAT Statistics Database, OECD health data) providing extensive analysis in all health topics. Others provide more specialised information (for instance, with a focus on the issue of mortality (WHO Mortality database) or Life expectancy (EHEMU database). Mortality data are commonly met (57,1% of the EU data sources, see Figure 2). Data on mortality usually appear in at least 3 data sources. Even more commonly found are data on Health status, such as Self Perceived Health, Chronic illness and Disability, in almost 80% of the EU data sources (see also Figure 2).

This report focuses on the one hand on the study of **Mortality and Life expectancy** variations within the EU countries and regions. Analysis of inequalities for smaller groups of populations, such as among cities of the EU and in immigrants or ethnic minorities is also of interest. For the latter issue, the possibilities for exploration are very much limited, due to low data availability. The data availability issues also affect the analysis of mortality differences with respect to wealth, education (see Corsini, V. 2010) and other socioeconomic characteristics of the EU population. Of equal interest is the study of variations on **Self Perceived Health and Disability** within the various SES groups that exist in the EU area. Comparison in these cases mostly concludes to a contrast of the extreme SES groups (e.g. Lowest vs Highest Income, Lowest vs Highest education). It is of much interest to include in this analysis the inequalities in terms of Health Expenditure and Health care data (e.g. unmet need for health care). Several researchers have started using such data recently (see, van Doorslaer E and van Ourti, T., 2009, or Van Doorslaer, E and O'Donnell, O., 2009). The presentation is however constrained by the limited availability of such data, which does not allow an adequate analysis of inequalities.

Figure 3 presents some of the most indicative types of data for studying health inequalities in the EU. Health data categories are presented in a ranked form based on their availability and adequacy at the time of this study.





**Figure 3:** Data & Indicators that reveal inequalities in health (Based on the ECHI Taxonomy of indicators<sup>1</sup>)

To summarize, we can say that, variations in health can be measured with respect to various health-related topics. The “Health Status” and “Mortality” indicators appear to be the most useful, since they are based on more data available. This data availability is observed both with respect to groups of interest for the analysis in this report, and also with respect to time (allowing therefore trend analysis).

## 1.2. What is Health Inequality? Definitions & Measurement

Usually health inequality is related to observed divergences in health status between groups of individuals of a population (here, the EU population). Differences that are related “indirectly” with the health status of a population are also observed in various deterministic measures e.g., mortality rates or survival rates. Such measures reflect to a large degree the effect of differences in the daily life of individuals (life habits, e.g. smoking, nutrition, etc) to morbidity. Significant differences may be observed between various populations groups, such as the regions of the EU Member States (e.g. NUTS II level), cities, ethnic minorities etc.

All these must be measured and interpreted. Interpretation is mostly related to the effort of linking the observed differences to the various groups of Socioeconomic status (SES groups) that are formed in the EU or to some other dimension of differentiation (e.g. regional differences).

Kunst and Mackenbach (1995) adopted an epidemiological or public health view to provide a workable definition of health inequalities:

*“Differences in the prevalence or incidence of health problems between individual people of higher and lower socio-economic status”*

Gakidou et. al. (2000) on the other hand defined health inequality as *“the variations in health status across individuals in a population”*. A key argument in their work is that, in an analysis of measurement methodologies, such as the one at hand, it is critical first to define in detail the quantity to measure and then proceed to its measurement (the selection of the

<sup>1</sup> [http://www.healthindicators.org/ICHI/general/ECHI\\_Hierarchy.htm](http://www.healthindicators.org/ICHI/general/ECHI_Hierarchy.htm)

appropriate methodology). The following analysis attempts to clear this debate by making specific and justifiable proposals for monitoring (also with respect to time) inequalities in terms of mortality and morbidity in the EU area.

The family of measurement methods applied in the field of health inequalities is very wide. Measurement methods that appear in the literature usually arise from the disciplines of Statistics and Economics. These can be very “straightforward” and “simple” such as the very well known to researchers in many fields measure of “range”. Some are related to statistical modelling techniques such as logistic regression in the case of the Odds Ratios (henceforth: OR) or simple regression analysis in the case of the Slope Index of Inequality (henceforth: SII), and the Relative Index of Inequality (henceforth: 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. These offer some advantages in the visualisation of inequality level, through the Lorenz and the Concentration curve.

Different measures can give information about different aspects of health inequalities. Some measures concentrate on the extremes, others study inequalities across the whole span of a distribution. A main distinction is between Absolute and Relative measures, see for example Houweling et.al. 2007. The authors in this work examine many aspects of these two approaches and give recommendations for monitoring health inequalities on the basis of empirical data. The interpretation of health inequality can also be quite different, depending on the measure used. The same applies for the analysis of trends in health inequalities (see Wagstaff et.al.1991). 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. In general, the distribution of health 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).

The approach followed in this report, concluded to the following taxonomy of indicators (based on pre-selected criteria):

- i) **Simple measures** that are easily interpreted
- ii) **Regression based measures**
- iii) **More advanced measures** that take into account the whole distribution of health and usually satisfy many more of certain desirable properties.

This taxonomy was the result of the preliminary evaluation of the various measurement techniques but it was not the only one taken into account in the analysis of the proposed indicators. Apart from some basic filtering criteria, some additional criteria were used for a more advanced evaluation, e.g. indicator’s closeness to widely accepted practices, applicability for a gradient approach (i.e. instead of focusing only on extreme segments of a

population), use of theoretically sound measures (e.g. Concentration Index, Relative Index of Inequality) etc.

Both relative and absolute measures are useful for the evaluation of health inequalities. Sometimes the relative position of two indicators may remain unchanged, yet the absolute gap indicates narrowing trends between the worse and the better off. Many of the simple indicators are not unique to the study of health inequalities but are well known epidemiological indicators. Kunst and Mackenbach (1995) presented a battery of several health inequality measures of this type (such as the Rate ratio, the Rate difference and the Odds Ratios), along with simple numerical examples for illustration. The aim was to combine the desirable features of indicators from various approaches into a feasible (with the given data landscape) calculation base. This report also focuses on such classifications by describing the various approaches and proposing the best solutions based on the indicators characteristics and the availability of data in the EU at the specific time frame. It takes into account evaluation criteria that are considered critical by the literature on inequalities (e.g., Harper S, Lynch J. 2006).

## **2. Most suitable summary measures for monitoring health inequalities in the EU**

In the health literature *the first comprehensive approach* to measure health inequalities was published by Wagstaff A., Paci, P. & van Doorslaer, E. in 1991. These researchers critically assessed the various measures used to evaluate trends and cross country differences in socio-economic inequalities in health. Their focus was on six inequality measures ranging from 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. Subsequently, Mackenbach and Kunst (1997) presented a more detailed analysis of health inequality measures by building on the previous work of Wagstaff et al. (1991), and by presenting some indicative examples using European data. In 2000, Gakidou E., Murray C.J.L. and Frenk J. from the WHO suggested that emphasis should be given to individual data and not to aggregate analysis. We should comment here that the selection of the proper approach really depends on the objective(s) of the analysis.

The following Sections describe the evaluation and selection of the most suitable solutions of summary measures for monitoring health inequalities in the EU. Experimentation was done with several indicators in order to examine and demonstrate the potential applicability of various indices in measuring in the best possible way the magnitude of health differences in the EU. The indicators that were reviewed within the project<sup>2</sup> were evaluated in terms of properties that must be satisfied by an “inequality indicator” in general, and also properties that must be satisfied, more specifically, by a “health inequality indicator”. Properties such as “invariance in scale or time”, and “decomposability” are needed and are important for any

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<sup>2</sup> “Review and Analysis of Existing Measurement Approaches, SANCO2008C404Lot 1\_Sl2.530184”

selection of indicator. Inequality indicators such as the very well known in the literature Gini coefficient or the Concentration index gather some or all of these desirable characteristics.

## **2.1. Indicators for assessing inequalities in mortality across the EU area, regions and time**

If the interest posed by the study is on mortality differences across the EU countries and their regions, then the choice of a simple absolute measure such as the inter-quintiles ratio maybe an interesting solution, especially for a trend analysis. However, this simple measure can easily fail to retrieve certain characteristics of health inequalities. A more sophisticated solution may be more adequate.

In this context, one of the main objectives was the evaluation of inequalities at the national as well as at the regional level. Although not all the EU Member States provide regional data on mortality, several of them present an adequate analysis at the level of NUTS II regions. Others provide data only at the NUTS I level. Such complications were more evident in the evaluation of mortality differences across regions through time (trend analysis). The selection of appropriate indicators needed therefore careful considerations to compensate for these data problems. More specifically the outcomes of this analysis concluded to the use of the following inequality indicators:

### **The absolute/relative Life Expectancy gap**

Life Expectancy is a widely used and accepted measure for monitoring the evolution of mortality within a population such as the EU. It can facilitate comparisons between demographic groups that exist within a population, such as between genders or groups of countries of the EU.

Based on the above, it is very common in the health inequality literature to calculate the difference in life expectancy between two categories (usually the extremes) of a demographic or social group of a population.

This index is known as the Life Expectancy Gap (henceforth: LE gap) and is very simple in its application and interpretation (details are given in previous reports of the project<sup>3</sup> and also in Annex V in this report). As Harper S, Lynch J. (2006) propose, it is very convenient to apply an indicator that also has an easy understood graphical representation. This facilitates communicating health disparity indices to the researchers and policy makers.

The index has two forms:

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<sup>3</sup> "Review and Analysis of Existing Measurement Approaches, SANCO2008C404Lot 1\_Sl2.530184"

**Absolute Life expectancy gap:**

$$LE_i - LE_j ,$$

where  $i, j$  represent two groups being compared, e.g. males and females.

**Relative Life expectancy gap:**

$$\frac{LE_i}{LE_j} ,$$

where  $i, j$  represent two groups being compared.

This index can be used for social group comparisons, for example to compare “rich” vs. “poor”.

As a simple solution it is very handy and easily understood especially to policy people involved in the field of health inequalities, but it is restricted in terms of its applicability since it requires Life Expectancy data.

*It is however very useful for the description of the evolution of the health gap in the EU. As Schneider, M.C., et.al. (2005) mention, it is very important to have a descriptive analysis of the differences presented in mortality and health in general. The LE gap can facilitate this descriptive analysis and can also be used to verify the existence of inequalities captured by another indicator.*

**The Inter-quintiles ratio**

Any general statistical measure used to express the variability of a set of values is also potentially a measure of what, in this project, we have been terming inequality. For example, the healthy life years at age of 65, the infant mortality rates or the standardized death rates in the EU constitute a set of 27 data points with a variability that can be summarized by any of more familiar statistical measures such as the standard deviation or the range. Since these measures are not related in any way with the particularities of the study of inequality, but can be applied with any set of data, they can be characterised as simple measures. Emphasis is given on the “simplicity” and “easiness in understanding and interpretation”. On the other hand, important restrictions on the usefulness of this indicator arise in cases of demanding data (very much variability), where what is first and foremost needed is to evaluate the whole distribution of the data and estimate the inequality level observed. Because of the simplicity of calculation and the applicability with any health variable, the inter-quintiles ratio is also a very promising *trend monitoring tool*. This was also verified by the data analysis presented in this report. Furthermore, the inter-quintiles ratios have been used extensively in the academic literature (see, Zartaloudis, S., 2007), on income and health inequality and also in the European Commission literature<sup>4</sup>, to highlight health inequalities across Member States.

**The Coefficient of Variation (CV) & The Standard Deviation of the logs ( $S_{log}$ )**

Because of the weaknesses presented by the inter-quintiles ratio, the Coefficient of Variation and the Standard deviation of the log values of a health variable under consideration are proposed to always accompany its application. The property of “standardization” and “use of the whole health distribution” that are introduced by these two solutions can only improve to a

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<sup>4</sup> Social Situation Report of 2009, European Commission

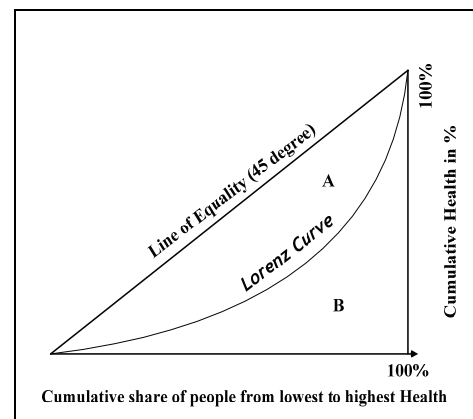
significant extent the measurement of inequality when mortality data present extreme fluctuations.

The Coefficient of Variation (CV) as well as the Squared Coefficient of Variation ( $CV^2$ ) have been used extensively in the literature of economic (see, Atkinson A.B., 1970, Cowel, et.al., 1982, Chakravarty SR., 2001) and health inequality. It is a normalized measure of dispersion and it is defined as the ratio of the square root of variance (standard deviation) to the average value of the distribution. The *Standard Deviation of the logs* (henceforth:  $S_{log}$ ) is another normalized measure that arises from the family of statistical dispersion measures. This indicator measures the standard deviation of the log values of the health distribution. The log transformation of the health variable offers more **standardization** and the opportunity to reveal some additional variations regarding the existing health inequality level. These two solutions apply better with aggregate data and are very handy for comparing clusters of individuals like Countries or Regions.

### The Gini Coefficient of inequality (G)

The Gini coefficient is very extensively used for the measurement of inequality, especially in the field of economics and income inequality measurement (see, Kawachi and Kennedy, 1997). This is one good reason for investigating its applicability for the present purposes. But mostly, the Gini coefficient is an informative measure, examining all parts of the distribution at once. It also facilitates direct comparisons with any quantitative variable which describes two or more populations, regardless of their sizes.

It can therefore be used easily for the comparison of inequality between groups, countries or regions. It has a geometric interpretation: it can be defined as the ratio of two areas defined by a 45 degree line and a Lorenz curve in a unit box. It can also be expressed as a function of Gini's mean difference, or as the covariance between specific variables and their ranks, or in a special matrix form. All these interpretations and expressions favour its widespread use, because every formulation has its own appeal in some specific context (see, Xu, Kuan 2004). Selected values of these parameters lead to some of the previous proposed indicators. This indicates the *significant correlation between Gini and the latter in the field of mortality inequality measurement*. E.g., for  $\alpha=2$ ,  $\beta=1$ ,  $G_1$  is the Coefficient of Variation (CV).



**Figure 4:** Example of a Lorenz Curve (Source: Review and Analysis of Existing Measurement Approaches, SANCO2008C404Lot 1\_SI2.530184)

The Following Table (Table 1) summarizes the proposed indicators along with their properties, advantages and disadvantages.

Indicator	Mathematic Expression	Notations	Advantages	Disadvantages
<b>Inter-deciles or quintiles ratio</b> ( $p_i/p_j$ )	An absolute/simple measure $\frac{P_i}{P_j}, i \neq j$	$P_i, P_j$ : two selected quintiles of the distribution	<ul style="list-style-type: none"> <li>easy to understand and calculate</li> <li>scale independent</li> <li>widely used by the EC</li> <li>Reliable tool for studying trends.</li> </ul>	<ul style="list-style-type: none"> <li>Uses only two extreme values of the distribution</li> <li>Unreliable with greatly variable data</li> </ul>
<b>Coefficient of Variation (CV)</b>	An absolute/dispersion measure $CV = \frac{\sigma}{\mu} = \frac{\sqrt{\frac{\sum_{i=1}^n (X_i - \mu)^2}{n}}}{\mu}$	$\sigma$ : standard deviation of the distribution $\mu$ : average health level.	<ul style="list-style-type: none"> <li>easy to understand and calculate</li> <li>scale independent</li> <li>extensively known statistical dispersion measure</li> <li>standardized measure</li> <li>useful for group comparisons like countries</li> <li>it uses the whole health distribution</li> <li>reliable tool for studying trends</li> </ul>	<ul style="list-style-type: none"> <li>It fails to capture inequality present due to a socioeconomic factor, e.g., income</li> <li>As a variability measure it works satisfactory with aggregate data like mortality</li> </ul>
<b>Standard Deviation of the logs (<math>S_{log}</math>)</b>	An absolute/dispersion measure $S_{log} = \sqrt{\frac{\sum_{i=1}^n (nX_i - In\mu)^2}{n}}$	$X_i$ : health of the i-th individual (individual based data) or country/region (aggregate data) $\mu$ : average health level.	<ul style="list-style-type: none"> <li>easy to understand and calculate</li> <li>scale independent</li> <li>extensively known statistical dispersion measure</li> <li>standardized measure</li> <li>useful for group comparisons like countries</li> <li>it uses the whole health distribution</li> <li>reliable tool for studying trends</li> </ul>	<ul style="list-style-type: none"> <li>It fails to capture inequality present due to a socioeconomic factor, e.g., income</li> <li>As a variability measure it works satisfactory with aggregate data like mortality</li> </ul>
<b>Gini Coefficient of inequality (G)</b>	Individual-Mean differences formula $G_1 = \frac{\sum_{i=1}^n  Y_i - \mu ^\alpha}{n\mu^\beta}$ Inter-individual absolute differences formula $G_2 = \frac{\sum_{i=1}^n \sum_{j=1}^n  Y_i - Y_j ^\alpha}{2n^2\mu^\beta}$	$Y_i$ : health of individual i $\mu$ : average health level of the population. $\alpha, \beta$ : parameters that range between 0 and 1	<ul style="list-style-type: none"> <li>easy to understand and calculate</li> <li>scale independent,</li> <li>standardized measure</li> <li>it uses the whole health distribution</li> <li>Offers graphical interpretation of inequality through the Lorenz curve</li> </ul>	<ul style="list-style-type: none"> <li>Not strongly recommended for socioeconomic health inequalities</li> <li>Reliable when data are very sparse only after a specific standardization</li> </ul>

Table 1: Summary of selected & proposed health inequality indicators for mortality data

A short correlation analysis of the results with the proposed indicators, with EU mortality data verified the covariance of their performance. Table 2 presents the correlation of the applied indicators on the HLYs data of the EU males aged over 65 years. Most of the proposed

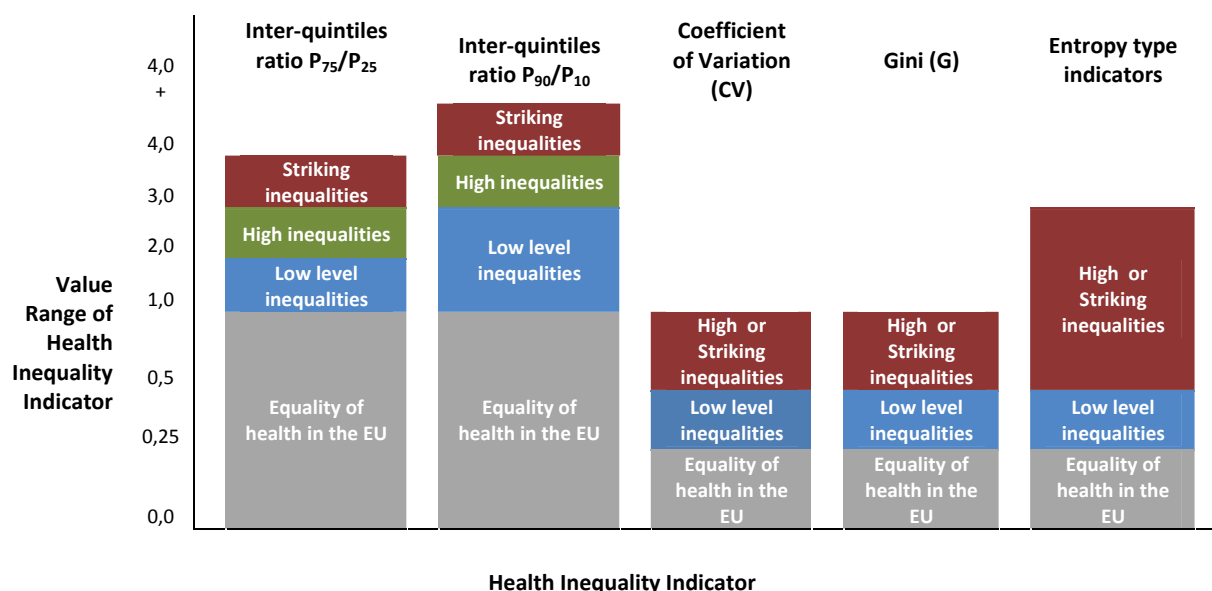
indices present almost “perfect” positive correlation (values of Pearson correlation are close to 0,9), meaning that in the case of the HLYs data, these indicators perform almost identically in the measurement of inequality. The same conclusions are drawn when applying a correlation analysis on the results of the same selected indicators on Infant mortality and Standardized mortality rates.

Indicator	P <sub>90</sub> /P <sub>10</sub>	P <sub>75</sub> /P <sub>25</sub>	Rel. Mean Dev.	CV	Slogs	Gini	Theil0	Theil1	Atk0.5	Atk1	Atk2
P <sub>90</sub> /P <sub>10</sub>	1										
P <sub>75</sub> /P <sub>25</sub>	,616*	1									
Rel. Mean Dev.	,829**	,681*	1								
CV	,839**	,628*	,977**	1							
Slogs	,771**	,543	,936**	,985**	1						
Gini	,854**	,634*	,987**	,995**	,968**	1					
Theil0	,843**	,635*	,959**	,995**	,984**	,984**	1				
Theil1	,802**	,589	,947**	,992**	,994**	,979**	,995**	1			
Atk0.5	,852**	,607*	,950**	,992**	,987**	,979**	,996**	,992**	1		
Atk1	,806**	,582	,940**	,990**	,994**	,976**	,995**	,998**	,993**	1	
Atk2	,768**	,539	,921**	,980**	,997**	,959**	,985**	,994**	,987**	,996**	1

\* Correlation is significant at the 0.05 level  
 \*\* Correlation is significant at the 0.01 level

**Table 2:** Pearson Correlations of health inequality indicators for Healthy Life Years (age of 65, males) in the EU

It is important to make the interpretation of the above indicators as obvious as possible by describing their cut-off points. This will make communicating health inequality indices to the various users easier.



**Figure 5:** Indicative values and range of values for selected health inequality indicators in the field of Mortality.

Figure 5 is an illustrative presentation of the ranges of values of the applied inequality indicators with EU Mortality data. In general, *large values of an indicator* suggest a case of *inequality*. But each indicator has a different structure. The inter-quintiles ratios usually range



from 0 to 4, but larger values may occur, suggesting unusual inequalities. On the other hand the CV and the Gini coefficient have an upper value of 1. Values of these indices that approach unity, indicate very high inequalities of health. For means of comparison and verification, these indicators are also presented together with other solutions that have recently attracted the interest of the researchers involved in this field (see Schoen, R., Nau, C., 2008), and arise from the Entropy family of indicators (e.g. Theil's entropy).

Summarizing, we can confidently say that the selection of only one indicator for health inequality measurement may not be the appropriate solution to the problem. Different choices may lead, in some cases, to different conclusions. So, it is always more preferable to accompany the estimations produced by the best indicator with another indicator that usually works as well as the best one.

For example, the use of the Life Expectancy gap indicator can lead to a descriptive analysis of the inequality exhibited in the EU (also across time). Such results can verify the results of monitoring solutions, such as the Gini coefficient.

Based on the evaluation that was carried out, we concluded that:

- The Gini coefficient is the most appropriate solution for measuring health inequalities in the EU when the data at hand refer to mortality, life expectancy and health expectancy rates. Gini is expected to say more on the existence of inequality than the other solutions, especially when the data are very demanding (very much variability).
- It is however recommended to apply one of the other proposed simple solutions (such as the life expectancy gap or the inter quintiles ratio) in order to verify Gini's estimations.

### **2.1.1. Analysis of Trends**

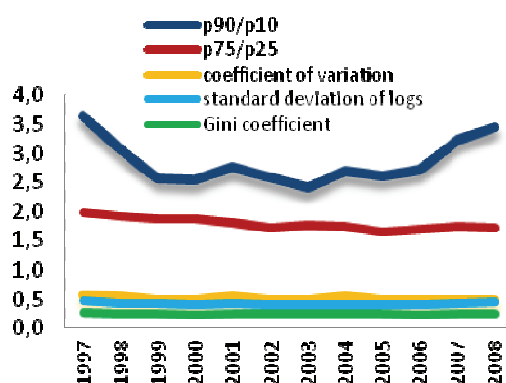
The proposed indicators were applied with the available EU data on Mortality rates and Life expectancies. The results demonstrated their capabilities and performance and also led to some comments on the evolution of health inequalities in the EU. All the analysis was based on mortality data extracted from the Eurostat Statistics Database for the period 1997-2008. There is no complete data availability for all the countries in the EU and for all the mortality indicators used. In particular the regional analysis of inequalities was restricted to some extent, because for many EU Member States there were no NUTS II level regional mortality data.

The analysis of Infant Mortality (IMRs) and Mortality levels at the later ages (SDRs for age<65,) revealed "low" but "statistically significant" variations among the EU Member States. In that sense, the inequality in health as it is summarized by the indicators tested is small but considered very likely to be a real one, and not a result of random variations. The application of  $P_{75}/P_{25}$ <sup>5</sup> to the Infant mortality rates (IMRs) revealed a low downward trend during the study period. The CV, Standard deviation of logs and the Gini coefficient reveal the same "low level" inequality, along with a light downward trend during 1997 – 2008. The analysis of the

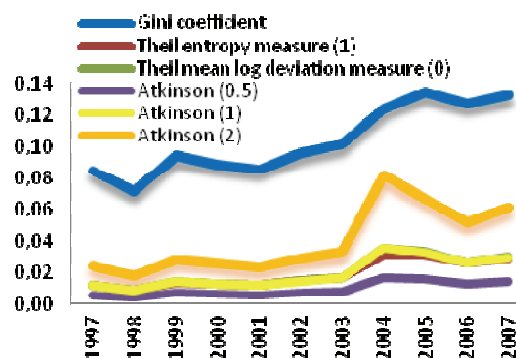
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<sup>5</sup> It is worth to remind that this indicator take account of a small group of countries - the ones more close to the average infant mortality level)

Standardized mortality rates (SDRs) shows the same levels of inequality but in all cases the existing trend reveals a steady but very slight increase during the study period 1997 - 2008. All the applied indices of inequalities reveal the same slightly increasing pattern, without any significant variations between the indicators (even with the inter-quantiles index of  $P_{90}/P_{10}$  which is more sensitive to extreme values). All these are summarized in the following Figures (Figures 6, 7).



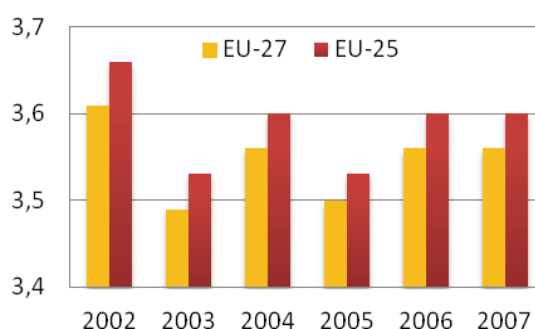
**Figure 6:** Health Inequalities trends via selected inequality indicators in terms of Infant Mortality Rates. EU27, 1997-2008



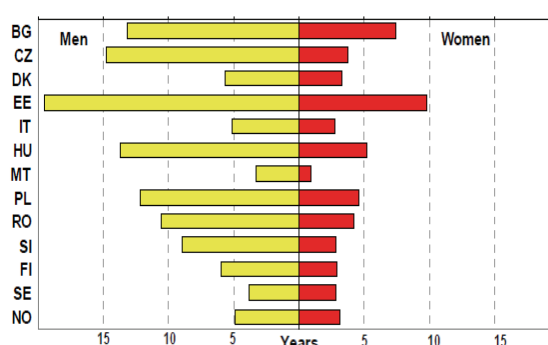
**Figure 7:** Health Inequalities trends via the Gini index and selected entropy type indicators in terms of HLYs (at age of 65) for the female population of the EU. EU15, 1997-2007

Source: Eurostat

The analysis of the Life Expectancy rates showed the differences in life expectancy between different groups of European countries and also the differences when taking into account demographic characteristics such as gender. With regard to the difference in absolute life expectancy (at the age of 65) between males and females in the EU population (see Figure 8) it is shown that, during the period 2004 – 2007, this is consistently at almost 3 years more for the female population, in both the EU 25 and EU 27 countries.



**Figure 8:** Life Expectancy (absolute) gap of the EU population's Males & Females at age of 65 (Source: EUROSTAT)

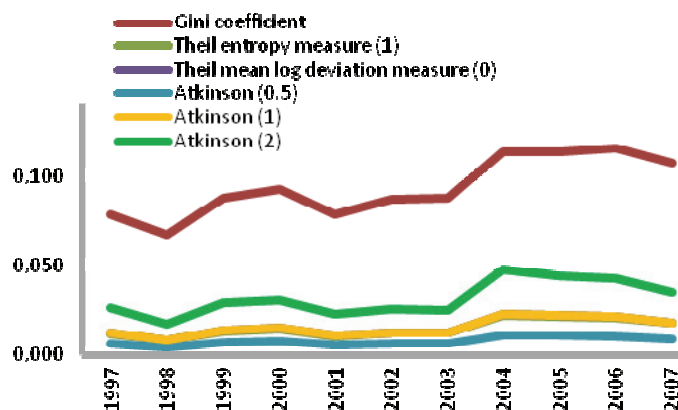


**Figure 9:** Life expectancy gaps between high and low educational attainment at age 30, women and men, 2007 (Source, Corsini, V. 2010)

Recently, much interest has been drawn in the study of mortality differences by selected social groups. Life expectancy by educational attainment is a very important indicator of socio-economic inequalities in health (see Corsini V., 2010). Based on the available data (some EU Member States and Norway), a systematic relationship between educational

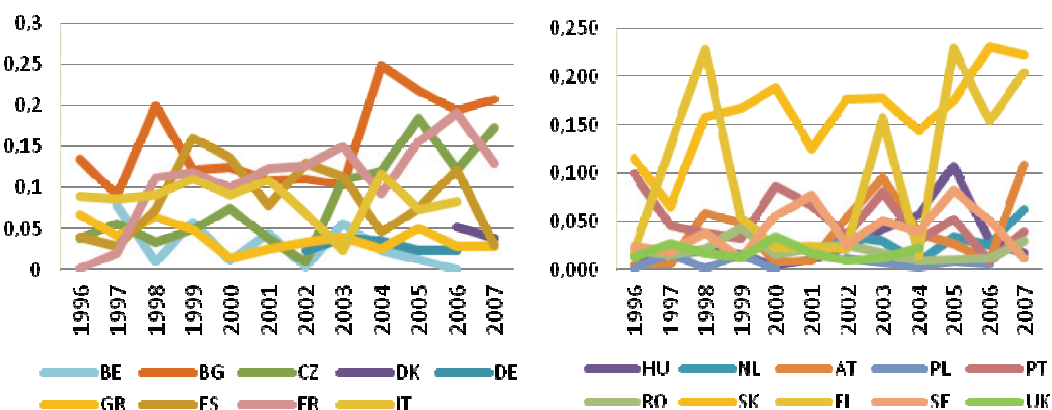
attainment and mortality can be observed. Life expectancy is lower among persons with the lowest educational attainment and increases with educational level. Moreover, these differences are more pronounced for men than for women.

The Gini coefficient can always offer more on the interpretation of health inequality. The selection of the Gini coefficient contributes much more to the interpretation of the health inequalities, also due to the graphical representation with the Lorenz inequality curve. Its performance was additionally evaluated through a comparison with selected indicators from the Entropy family. Previous research (e.g., Schoen R. 2008) has revealed that when analyzing mortality data, especially with respect to monitoring of trends, the Gini coefficient and selected entropy indicators (e.g. Entropy  $H$ , or Theil,  $T$ , see Annex I and Table A1) estimate similar and reliable trend patterns. (see Figure 10).



**Figure 10:** Trends of Health Inequalities based on HLYs at age of 65 of male population for the period of 1997-2007 and 15 EU countries based on Gini index and selected entropy type indicators (Source: Eurostat)

Due to the great data variability presented by regional level data (NUTS II), an indicator that combines inequality measurement with data standardization like the Gini index is most preferred.



**Figure 11:** Health inequalities measured by the Gini coefficient on the Infant Mortality Rates (IMRs) for the NUTS II regions of 19 EU members and the period 1996-2007 (Source: Eurostat)

Summarizing, we can say that the most common outcome of the application of the selected indicators is the increasing trend of health inequalities during 1997 and 2008. This applies for all mortality data used (IMRs, SDRs and Life expectancy) and also for the HLYs data. No significant differences are observed between the two genders.

However, it must be emphasized that this increasing trend does not also imply high inequalities. The trend pattern is far from reaching those high levels of inequality measured in terms of mortality in the EU, an observation that must be taken into account by policy makers in the area.

## **2.2. Indicators for assessing inequalities on Self Perceived Health, Chronic illness, and Disability by Social groups.**

Health inequalities are most frequently investigated in association with socio-economic classes. It is therefore very important and also very interesting to investigate the effects on health of socioeconomic characteristics of individuals in the EU. This part of the analysis focused in the study of Self Reported Health and Morbidity (self reported), with respect to the various socioeconomic groups that are formed in the EU society.

The investigation of inequalities in morbidity and self-perceived health requires a different approach than the one for the comparison of mortality across the EU area and its regions. A major reason for this differentiation is that, whereas data on mortality are naturally given as aggregates, data on morbidity and self-perceived health are available at the individual level through the various surveys such as the EU SILC and the ESS. This change in the data leads to a change in the range of indicators that are available for consideration. Based on the results of this research, we conclude to the use of the following inequality indicators.

### **Odds Ratios (OR)**

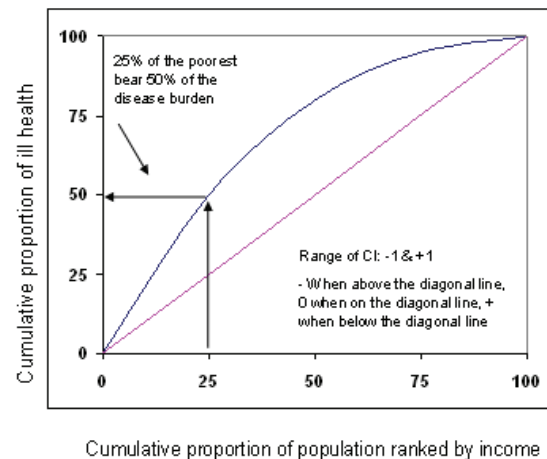
The **Odds Ratio (OR)** is considered as one of the main contenders for adoption as an indicator of inequality. It occupies a very prominent place in the statistical analysis of data in the health sciences and is well-known as an applied research tool in the social sciences in general (see Mackenbach and Kunst, 1997). It is likely to be the only indicator among those that have been employed in this analysis that most users of health statistics are familiar with. Its relation to the statistical modelling technique of logistic regression offers the ability to measure its statistical accuracy (calculation of confidence intervals) and also test its statistical significance. For that it is strongly recommended.

### **The Concentration Index (CI)**

The same grounds for proposing the examination of the Gini coefficient also lead to the proposal of the Concentration Index. The **Concentration Index (CI)** measures the degree of inequality between socioeconomic groups with respect to a given health status variable, for example the self perceived health status (Kakwani, Wagstaff, and van Doorslaer 1997).

In the field of health economics, it has been used for the measurement and comparison of degrees of socioeconomic-related inequality (see O'Donnell, et.al. 2008). Its applications are numerous, and vary depending on the specific mortality and morbidity issues addressed.

The CI has direct extensions to decomposition analysis which are quite promising and very useful because they provide a more clear understanding of how several factors affect inequality (see Speybroeck et al, 2010).



**Figure 12:** Example of a Concentration Curve of ill health vs income level

(Source: Review and Analysis of Existing Measurement Approaches, SANCO2008C404Lot 1\_S12.530184)

A much interesting note for policy oriented monitoring comes from Koolman and van Doorslaer (2004) who suggest that multiplying the value of the concentration index by 75 gives an estimation about the percentage of the health variable (including health care) that may be redistributed from the richer half to the poorer half of the population in order to approach distributions of perfect equity. It is also interesting to note that Wagstaff et al. (1991) claimed that the *CI* and the Relative Index of Inequality (*RII*) are the only methods likely to present an accurate picture of socioeconomic inequalities in health.

It is important to note that the Concentration Index depends only on the relationship between the health variable and the rank of the living standards variable (for example, income) and not on the variation in the living standards variable itself. Essentially, this means that a change in the income distribution and inequality possibly will not affect the *CI* measure of the underlying health inequality.

### Entropy type indicators (Theil's "T", Atkinson's "A" variants)

These are based on the concept "entropy". According to information theory "maximum entropy" occurs in a society when all resources are equally distributed among its members. In the case that we live in an ideal world where everything is equal, (perfect equality), such indices would take values close to zero. However, resources are unequally distributed among the citizens of a society and some groups of people, like the rich, tend to differentiate themselves in terms of income or health, from the rest of the people. The more distinguishable the rich become the lower is the actual entropy in the society.

Application of selected indicators from the *Entropy type family of indicators* appears very promising. An increasing number of researchers apply this kind of indicators in the place of more traditional ones. **Atkinson (A)** alternative to the CI, **Theil's (T)** variation of the entropy are introduced in this analysis both for the measurement of inequality and the monitoring of trends.

The following Table (Table 3) summarizes the proposed solutions along with their characteristic properties, advantages and disadvantages.

Indicator	Mathematic Expression	Notations	Advantages	Disadvantages
<b>Odds Ratios (OR)</b>	<p>An absolute/ regression based measure</p> $OR = \frac{\frac{p_i}{(1-p_i)}}{\frac{p_j}{(1-p_j)}}$	<p><math>p_i</math>: percent of individuals belonging to the i-th social group (e.g. lowest income quintile)</p> <p><math>p_j</math>: percent of individuals belonging to the j-th social group (e.g. highest income quintile).</p>	<ul style="list-style-type: none"> <li>• Very known to the health inequality literature</li> <li>• link to logistic regression offers flexible physical interpretation and measurement of statistical significance</li> <li>• Reliable for a trend analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Less simple in concept,</li> <li>• Unable to compare all social categories at once</li> </ul>
<b>The Concentration Index (CI)</b>	<p>A relative measure</p> <p>Formula for individual based data,</p> $CI = \frac{2Cov\left(\frac{H_i}{R_i}\right)}{\mu}$ <p>Formula for aggregated data,</p> $CI = (p_1L_2 - p_2L_1) + \dots + (p_{T-1}L_T - p_TL_{T-1})$ <p>Relative measure</p>	<p><u>Formula for individual based data:</u></p> <p><math>H_i</math>: health situation of the i-th individual</p> <p><math>R_i</math>: Living standards distribution, with <math>i=1</math> for the poorest and <math>i=N</math> for the richest <math>\mu</math>: average health level.</p> <p><u>Formula for aggregated data:</u></p> <p><math>P</math>: cumulative percent of the people ranked by economic status</p> <p><math>L_i</math>: concentration curve ordinate</p> <p><math>T</math>: number of SES groups.</p>	<ul style="list-style-type: none"> <li>• Scale independent,</li> <li>• It uses the whole health distribution,</li> <li>• offers graphical interpretation of inequality through the Concentration curve</li> <li>• Reliable for a trend analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Sensitive to the direction of the social gradient in health-possible misinterpretation</li> <li>• Non decomposable measure</li> <li>• It works better with binary health indicators</li> </ul>
<b>Theil's Entropy (T)</b>	<p>An absolute measure</p> $T = \frac{1}{n\mu} \sum x_i \log\left(\frac{x_i}{\mu}\right)$	<p><math>n</math>: number of social groups</p> <p><math>\mu</math>: overall average health</p> <p><math>x_i</math>: average health in each social group.</p>	<ul style="list-style-type: none"> <li>• Easiness in interpretation, Scale independent</li> <li>• uses the whole health distribution</li> <li>• Link to statistical information theory enables the possible use of entropy variants.</li> <li>• Reliable for a trend analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Complex in a sense</li> <li>• not very much known to health inequality literature</li> </ul>

Atkinson's index (A)	<p>An absolute measure</p> $A = 1 - \frac{1}{\mu} \left( \frac{\sum_{i=1}^N X_i^{1-\varepsilon}}{N} \right)^{\frac{1}{1-\varepsilon}}$ <p><math>0 \leq \varepsilon &lt; 1</math></p> $A = 1 - \frac{1}{\mu} \left( \frac{\prod_{i=1}^N X_i}{N} \right)^{\frac{1}{N}}$ <p><math>\varepsilon = 1</math></p>	<p><math>N</math> : number of social groups</p> <p><math>\mu</math> : overall average health</p> <p><math>X_i</math> : average health in each social group.</p>	<ul style="list-style-type: none"> <li>Easiness in interpretation, Scale independent</li> <li>uses the whole health distribution,</li> <li>Link to statistical information theory enables the possible use of entropy variants.</li> <li>Reliable for a trend analysis</li> </ul>	<ul style="list-style-type: none"> <li>Complex in a sense</li> <li>not very much known to health inequality literature</li> </ul>
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**Table 3:** Summary of selected & proposed health inequality indicators for Self-Reported Health & Disability data

The following Figure is an illustrative presentation of the value range of some of the selected potential inequality indicators, with data on SPH and other Self Reported Morbidity data. The interpretation of the results of the analysis that follows is based on this classification of values. In general, *large values indicate high levels of inequalities*. This applies for most of the indices proposed in this report.

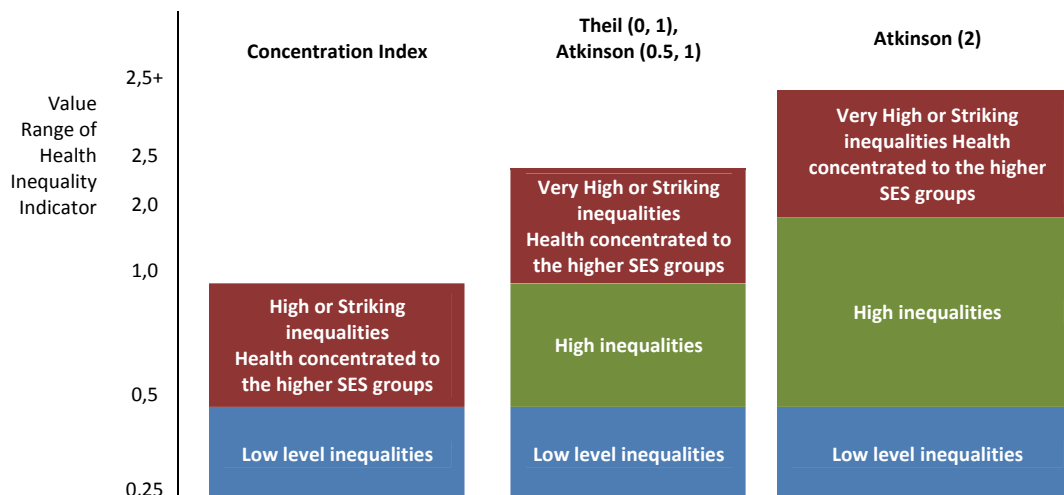
The Odds Ratios (OR) differ much in the interpretation and are not presented in this figure. Since they commonly represent the odds of being in the lowest status group divided by the odds of being in the highest status one, the usual interpretation is as follows:

- Values below 1 ( $OR < 1$ ) indicate significant inequalities in favour of the higher status group (this was a very common case in our analysis).
- Values over 1 ( $OR > 1$ ) indicate significant inequalities in favour of the lower status group.
- Values equal to 1 ( $OR = 1$ ) or close to 1 ( $OR \rightarrow 1$ ) indicate equal distribution of health among all the individuals.

Apart from the Odds Ratios, the other indicators follow the rule:

*“larger values indicate larger differences in health and associated larger inequalities”.*

The following Figure (Figure 13) illustrates the value ranges of the rest of the proposed indicators, except from the Odds Ratios.





**Figure 13:** Indicative values and range of values for selected inequality indicators in the field of Perceived Health & Disability

To summarize, we conclude that the Odds Ratios present the most adequate solution to the problem of measuring inequalities with respect to social categories. The reasoning for this selection lies mostly with the easiness in carrying out all possible paired-comparisons between social groups. An additional reason is their relation to statistical modelling techniques (e.g. logistic regression) that can provide more detailed interpretation of inequalities in terms of specific factors and covariates. More specifically, the logistic regression model attempts primarily to estimate the effects of categorical variables (which can be SES categories) on a categorical outcome (which can be the self assessed health status), optionally controlling for effects of other covariates.

The well known in the literature Relative index of inequality (RII) and Slope index of inequality (SII) are similar solutions, that are also related to statistical modelling techniques (linear regression). However, their application poses certain restrictions, notably the applied modeling technique needs to insert a quantitative variable in order to estimate health inequality. This is not a natural approach in the case of SES characteristics.

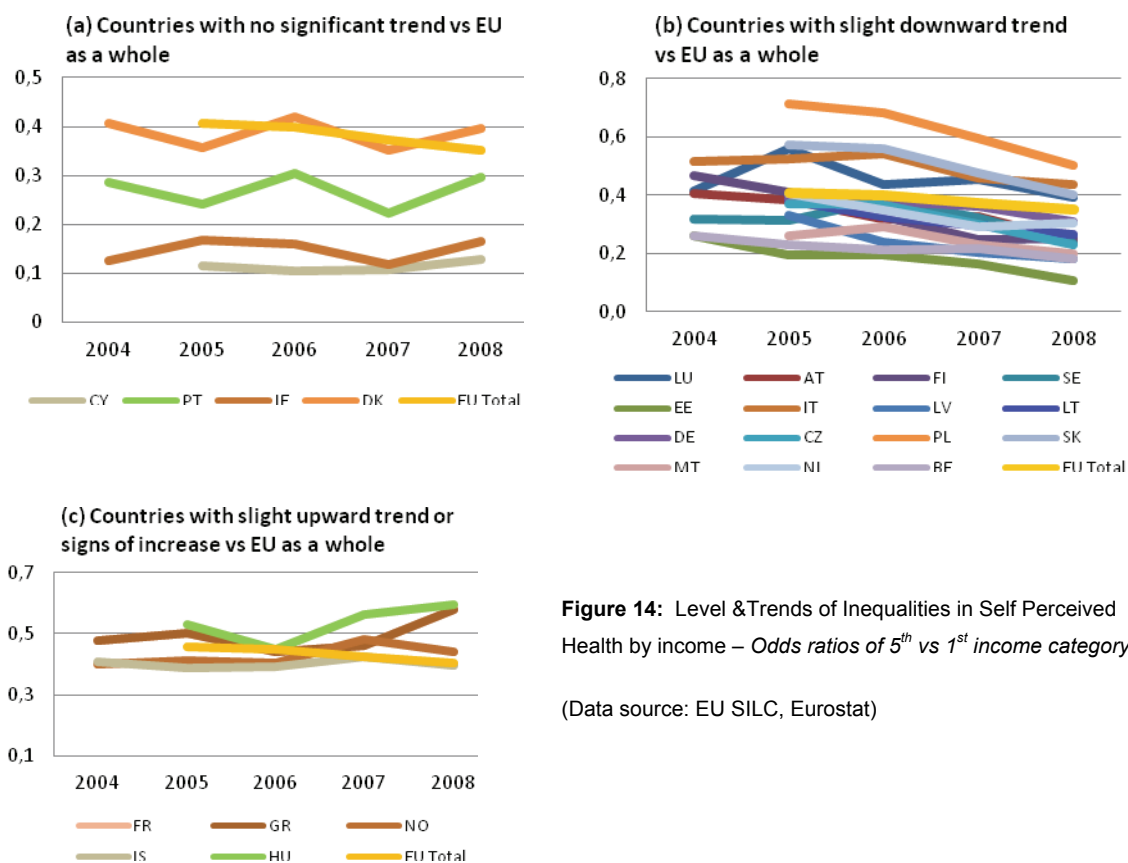
The reasoning for selecting more than one indicator solution that was applied in this study for mortality inequalities, applies also in the analysis socioeconomic inequalities in health. Therefore, it was considered important to suggest an additional measure that could verify the performance of the Odds Ratios and also offer additional insights in the study of health inequalities. As already commented, the measurement of inequalities in Self-Perceived health and Morbidity requires a different approach. It is of the same importance to be able to compare two distinct social groups (e.g., poor vs. non poor) and to measure variations within the whole range of categories of a social variable. As it was verified by the evaluation and the analysis based on EU data the existence of inequality is captured also in the same way by the Concentration index and the Entropy type indices. The latter are not widely known to researchers, and appear somewhat complex. On the other hand, the Concentration Index is a very familiar tool in the study of the socio-economic aspects of health inequalities. The CI performs adequately, as also verified by the evaluation and analysis presented in this report. The CI has also a graphical interpretation which is appealing and in some cases appears to be the most important aspect in monitoring for policy-making. However, the entropy type indices (especially the Theil's index) although relatively complex, can also perform adequately and in many cases even better, with all kinds of existing EU data on self-perceived health, morbidity and disability. For these reasons, and given the increasing familiarity of researchers with Entropy type indicators, it is proposed to always accompany the application of the Odds Ratios with Entropy type indicators.



### 2.2.1. Analysis of Trends

The social variables most commonly used in the empirical literature include the educational level, the occupational class and the income category. For example, Wilkinson, R., and Pickett, K. (2010), find strong evidence of a relationship between income inequality and the health levels of a population. Also previous research makes evident that people belonging in low socioeconomic groups usually underreport their health status in a self-health evaluation (see, e.g. O'Donnell, O., Proper, C., 1991). However, it should be emphasised that the choice of the social grouping can affect the results. The most valuable source for the examination of the socioeconomic characteristics in the EU is the collection of instruments of the EHSS, especially the ones using the MEHM (see Figure 1), such as the EU SILC. This study focused on the use of the latter, as well as, the ESS and SHARE. Additionally a short analysis was carried out with disability data collected by the 2002 LFS ad-hoc module. Based on this analysis the following results are presented.

A significant relation between health and income level is observed for the EU as a whole and in Member States, for the period 2004 - 2008. Subsequently, significant inequalities are observed between the people that belong to the high income categories (5<sup>th</sup> income quintile, upper income) and the ones belonging to the lowest income categories (1<sup>st</sup> income quintile, lower income). Figure 14 presents a clustering of selected EU Member States based on the similarity of their pattern across time.



**Figure 14:** Level & Trends of Inequalities in Self Perceived Health by income – Odds ratios of 5<sup>th</sup> vs 1<sup>st</sup> income category

(Data source: EU SILC, Eurostat)

Group (a) clusters together the countries of Portugal, Denmark and others that present no trend between 2004 and 2008 and no significant fluctuations in the values of OR which range between 0,1 and 0,5. Group (b) gathers the cases of Luxembourg, Austria and many others which exhibit a slight downward trend through the study period. In this last group (Group c), only in the case of Hungary and Greece we find a slightly increasing trend.

*The EU as a whole is affected by all the previous and presents a clear “downward” trend which in terms of inequalities indicates significant increasing inequalities in SPH with respect to income.*

The values of OR for the EU as a whole range from a value of 0,424 in 2005 to 0,420 in 2006, 0,392 in 2007 and 0,357 in 2008 (see Table 4). It is evident that there is a decrease in the ORs and equivalently an increase (of almost 7% to 8%) in health inequalities over time.

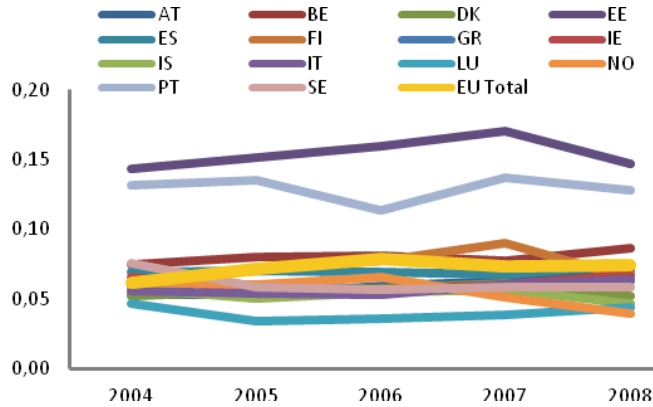
Year	2005	2006	2007	2008
<b>EU as a whole</b>	<b>0,424</b>	<b>0,420</b>	<b>0,392</b>	<b>0,357</b>
<b>% of ORs decrease over time</b>	-	<b>-0,9%</b>	<b>-6,7%</b>	<b>-8,9%</b>
<b>% of Health inequalities increase over time</b>	-	<b>0,9%</b>	<b>6,7%</b>	<b>8,9%</b>

- EU total was not calculated for the year 2004 because of the small participation of countries

**Table 4:** Variation of Self Perceived Health inequalities with respect to income quintiles in the EU as a whole. Odds Ratios estimations (Source: EUROSTAT, EU SILC)

Although SHARE survey deals only with two periods (2004-2005 & 2006-2007), and measures differently the Self Perceived Health variable, it coincides to the above results. This comes with an agreement to the recent analysis of Börsch-Supan, A. and F. Mariuzzo, (2005) who judge that SHARE produces a very similar distribution of health status to the one measured by EUSILC and ESS.

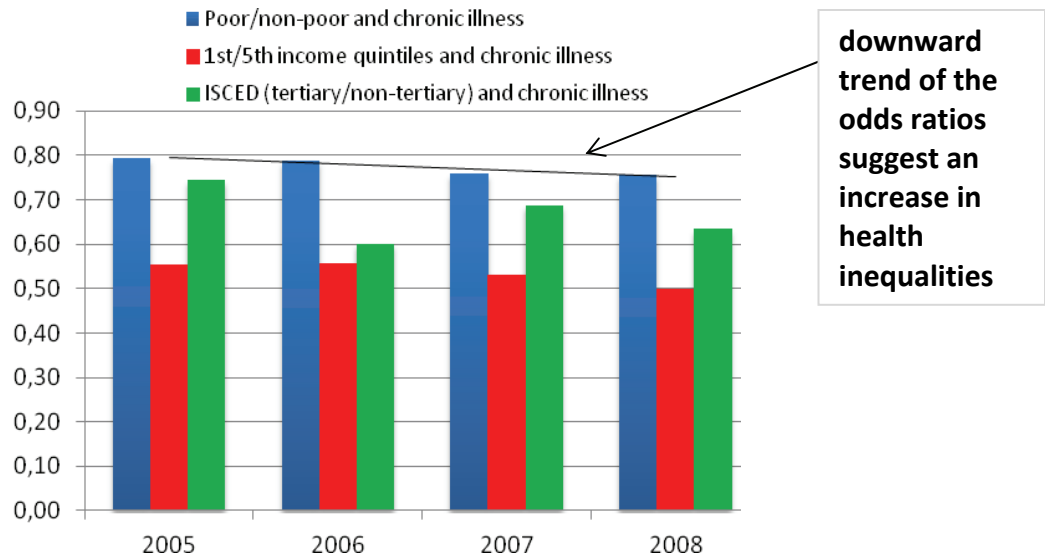
Income related inequalities were also estimated through the use of the Concentration Index (CI). A slight increase is observed in most of the EU 27 members during the period of 2004-2008. This increase suggests that more health is concentrated to persons that belong to the upper income levels of the population. It is worth mentioning that an index such as the CI uses the whole distribution of the data, and, in that sense, describes the differences among all social categories (e.g. income quintiles) at once. Therefore, the results are not expected to coincide with the ones produced with the ORs. The results with the CI are on the contrary expected to be similar with the ones obtained with the Entropy family of indices which also make use of the whole distribution.



**Figure 15:** Concentration Indices for Self-perceived health and Income level for selected European member states, period 2005-2008 (Data Source: EUROSTAT, EU-SILC)

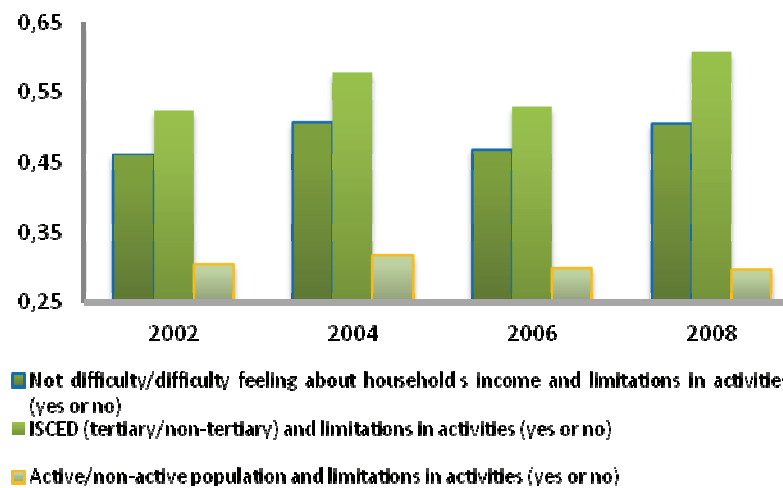
In order to quantify the contribution of other social differences in Self Perceived Health inequalities, the analysis continued by examining variables such as the Education and Activity status. Significant inequalities exist between the people that have a tertiary level education and those that have not. The former tend to judge their health as good or very good more often than the latter. Previous studies (see Raalte, V.A., Kunst, A., Mackenbach, J., 2009, Mackenbach, J., et.al., 2008) have also revealed that self-reported health is poorer in the lowest educational group as compared to the highest educational one.

Socioeconomic inequalities in terms of other health indicators such as the existence of a chronic illness, limitations in activities (AL) due to health problems do not change the picture shown in all these results. For example, low level inequalities exist in cases of chronic illness with respect to the education or income of the individual. An increase in these inequalities is again evident from 2004 to 2008 (see Figure 16). In other words, people with a low education (non tertiary level), or a low income report more often the existence of a chronic illness



**Figure 16:** Inequalities in case of chronic illness statements by selected SES variables– Odds ratios of 5<sup>th</sup> vs 1<sup>st</sup> income category (Data source: EU SILC, Eurostat)

High inequalities between the various social groups in terms of self-assessed health are also verified using the ESS data. With regard to the activity limitations, it is verified by the results that people belonging to the non active population tend to judge their health below the average levels and also are more likely to report severe activity limitations. Odds Ratios show a slight downward trend when comparing the active and the non-active population. This indicates a small increase in the estimated inequalities during the period of analysis, 2002 to 2008 (see Figure 17).

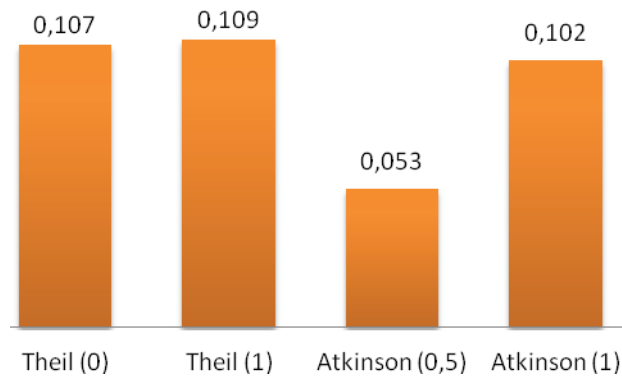


**Figure 17:** Trends of Inequalities based on Activity Limitations (AL) vs SES groups calculated by the Odds Ratios (Data Source: ESS 2002-2008)

Olsen, K., Dahl, SA (2007) agree that education has a positive effect on health. This report adds to this finding, by concluding that this positive effect remains stable (i.e. without any significant trend) in the EU through the years. Also based on previous work, it is now evident, from all the years of analysis of the ESS data, that Economic satisfaction (as this is translated by the level of feeling difficulties with the household's income) is strongly related to health. People that feel good with the income of their household and in general are economically satisfied, are more likely to report better health and this association remains stable with respect to time.

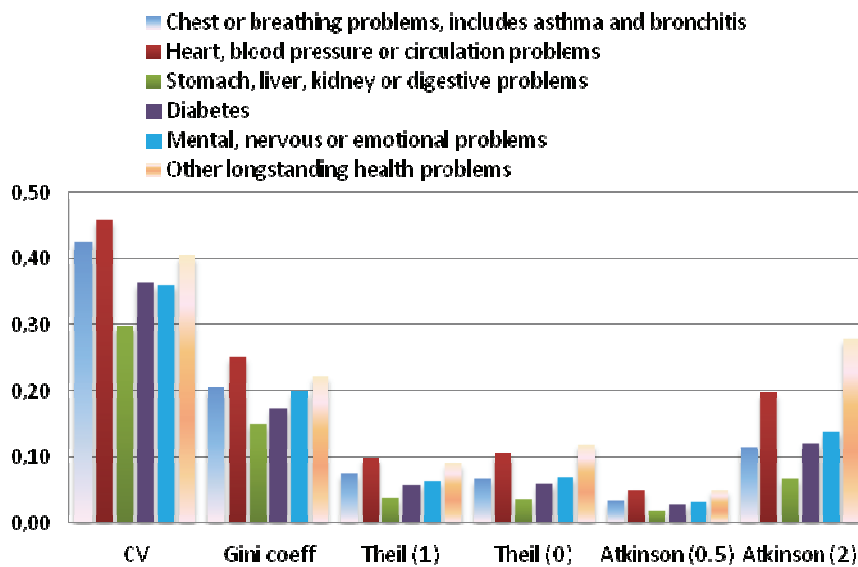
The data on "disability" collected by the 2002 European Labour Force Survey" (EU LFS) ad-hoc module on health conditions offered the opportunity to study inequalities in terms of disabilities and restrictions in daily living.

Inequality within the distribution of disability among individuals is better revealed by indicators such as the ones of the entropy type. All entropy type indices result to values close to 0 (e.g. Theil(1)=0,109) when applied to the disability distribution of 2002. This suggests equality or near equality in most of the cases in the EU.



**Figure 18:** Percentage of disability in 23 EU countries of 2002 and the level of health inequality in terms of entropy type indices. (Source: EUROSTAT, EU LFS 2002 core and ad hoc module data)

Based on the Perceptual distribution of the different types of disability there do not appear any significant inequalities, as is evident from Figure 19. Only the cases of “Heart, blood pressure, circulation problem”, or “Chest or Breathing problem” or “Other longstanding health problem” present some interesting differences but these are not large enough to be interpreted as inequalities. E.g. the Theil index (1) equals almost 0,1 for “Heart, blood pressure, circulation problems”, almost 0,07 for “Chest or Breathing problem”, and almost 0,08 for “Other longstanding health problem”.



**Figure 19:** Selected inequality indices for Percentual distribution of types of disability, EU27, EU-LFS 2002 (Data Source: EUROSTAT, LFS ad hoc 2002)

### 3. Conclusions

In this report, inequalities in health with respect to mortality, morbidity, self perceived health, and disabilities in the EU are measured, based on proposals for the most suitable indicators. One of the main objectives of the European Commission is to “develop headline indicators to monitor health inequalities, that can also show ways to developing in further the collection of data by age, gender, socio-economic status and various geographic dimensions of the EU population”. The study was conducted in three stages:

**First**, a detailed evaluation of measurement methods and health inequality indicators was carried out. This evaluation was conducted in the context of inequality measurement and with respect to health data collected (or planned to be collected).

**Second**, an analysis of the level of inequality in health in the EU with respect to several variable breakdowns (e.g. social variables) was conducted:

- Mortality differences that revealed inequalities in the EU, accompanied by analysis at the regional and population groups level (NUTS II regions, cities and also smaller groups of population (e.g., migrants-non migrants).
- Inequalities in Self assessed health, as measured by the main survey instruments that cover many or all of the EU Member States: the EU SILC, the ESS, and the SHARE.
- Inequalities in terms of activity limitations, mobility restrictions and also more specific health issues such as depression.
- Differences in disability with respect to the employment status, as measured in the 2002 LFS ad-hoc module.

The main objective was to analyze in detail patterns of mortality and/or health in relation to socioeconomic features of individuals, based on the proposed indicators. This also served as an additional step in the evaluation of performance of these indicators. For example, both the EU SILC and the LFS can be used to construct a large variety of socioeconomic indicators. It should be noted that the SHARE data collection is a special case: It can lead to a much detailed analysis of health indicators, but its country and time coverage is limited. *All these tools however contribute to the measurement of socioeconomic health inequalities, each one from its own perspective and under its own limitations.*

**Finally**, the aim was to offer insights for the health inequalities in the EU as a whole and in its Member States. The intent was to investigate both the most recent picture and also trends across time. In this analysis we focused on:

- Inequalities in mortality in the EU, within the EU Member States and through time, and
- Socioeconomic inequalities in health through time.

Several researchers tried in the past to assess the patterns and trends in health inequalities, mostly the ones due to socioeconomic factors (see, Khang, Y.H. et.al. 2008, Mackenbach, J.P., et.al. 1997, Houweling, T.A., 2007). Researchers involved in the field of socioeconomic inequalities faced many difficulties with the comparability issues regarding the survey tools used (e.g. EU SILC, SHARE, etc). but were also much concerned with the ways of measuring the observed differences in health. As various researchers have suggested in the past (e.g. Wagstaff et. al., 1991) the conclusions reached by the various authors studying trends in health inequalities may vary depending on the type of the measure used. As Masseria, C (2009) also comments: *“the measurement and monitoring of inequalities in health over time and across countries is not straightforward since the choice of the measure will influence the results”*. Therefore, the choice of the appropriate indicator for health inequality measurement is a fundamental issue, not only for the accurate estimation of the magnitude of inequalities, but also for the investigation of their variation through time.

With regard to the measurement of inequalities in terms of mortality the proposed measures range from “simple measures” such as the Life Expectancy gap or the inter-quintiles ratio, to more complex measures such as the Coefficient of Variance and the Standard deviation of log values, and finally to strict “inequality” measures such as the Gini coefficient. Theil and Atkinson indices were also selected from the Entropy family of indicators, as additional ways of measurement, and also as “reference points” for the performance of the other indicators.

Some *key outcomes* of this analysis were that:

- the selection of only one indicator for the health inequality measurement may not be the appropriate solution to the problem.
- The *Gini coefficient* is the most appropriate solution for measuring health inequalities in the EU when the data at hand refer to mortality, life expectancy and health expectancy rates.
- It is however recommended that a life expectancy gap analysis or the inter quintiles ratio is always applied, to verify Gini’s estimations.

All the analysis was based on mortality data extracted from the Eurostat Statistics Database for the period 1997-2008. The results of our analysis are in agreement with previous research (e.g., Schoen R. 2008) which has shown that, when analyzing mortality data, especially with respect to the monitoring of trends, the Gini coefficient and entropy type indicators estimate similar and reliable patterns. The analysis concluded led to the following general observations:

Inequalities in terms of mortality show a consistent increase over time (1996 or 1997 to 2008) but their level is not yet a “large level of inequality”. All applied indicators coincide to the finding that with all used mortality data (IMRs, SDRs and Life expectancy) and also with HLYs data, no significant differences are observed between the two genders. An increasing trend is present but not indicating high inequalities. Based on the analysis of the NUTS II regional data, it appears that in almost all EU Member States, the inequality levels are similar as for the EU in total. Some countries present an increasing and/or very fluctuating pattern. Finally, the measurement of mortality differences in relation to economic status, educational level, and other social characteristics is an issue of recent activity by researchers working in the field of health inequalities (see Corsini, V. 2010). The study of such issues is restricted by the limited data availability in the EU. It can however be the subject of further work, with the proposed indicators (especially the Gini coefficient which can incorporate such socioeconomic dimensions), in the near future, when more data become available.

With regard to the measurement of Socioeconomic Health Inequalities the main objective of this analysis was the comparison of differences in health with respect to various socioeconomic factors. Based on the evaluation and the application of the proposed indicators, we concluded that,

- The Odds Ratios present the most adequate solution to the problem of measuring inequalities with respect to social categories. The reasoning for this selection lies mostly with the easiness in carrying out all possible paired-comparisons between social groups.

An additional reason is their use in statistical modelling techniques (e.g. logistic regression) that can provide more detailed interpretation of inequalities in terms of specific factors and covariates.

- The same levels of inequality are estimated by the Concentration index and the Entropy type indices. The Concentration Index is a very familiar tool in the study of the socio-economic aspects of health inequalities and performs adequately, as also verified by the evaluation and analysis presented in this report. It also has a graphical interpretation which is appealing and in some cases appears to be the most important aspect in monitoring for policy-making. The adequacy of this indicator is also verified by the recent interest of the researchers such as Quevedo-Hernandez, C. et.al. (2009), and Koolman, X. (2009) in measuring inequalities in “unmet need for health care” based on the EU-SILC. The entropy type indices although relatively complex, can also perform adequately and in many cases even better, with all kinds of existing EU data on self-perceived health, morbidity and disability. It is proposed to always accompany the application of the Odds Ratios with one of these solutions.

Significant inequalities were estimated in this part of the analysis, with respect to income level, activity status, educational level, etc. In general, “more health” is concentrated in the higher-level socioeconomic groups, characterized e.g. by higher (tertiary) education, or higher income, etc. In other words, for numerous EU members and the EU as a whole, health inequality is present and is in favour of individuals with higher socioeconomic status.

Further improvements in the measurement of health and extensions in the existing harmonized survey instruments (e.g. EU SILC) can only improve the measurement of health inequalities based on the tools suggested in this report.

With regard to disability rates as measured in the 2002 LFS ad hoc module, it appears that the distribution of disability presents equality or near equality in most of the cases in the EU (the analysis was mostly based on entropy type indices). The disability differences present a different pattern when associated with SES categories. For example, people with non tertiary education are more likely to report disabilities with respect to their occupation status. It is also evident that there exist significant inequalities when comparing people that exhibit “light or no disabilities” to those having “severe disabilities”. Caution is needed here however, because there is bias in the measurement of disability in the EU Member States, which poses restrictions in the interpretation of these and similar results. The situation will be partly improved with the 2<sup>nd</sup> run of the LFS ad hoc module which is estimated by Eurostat to be run in 2011. A second run will offer the possibility of comparisons and the measurement of variations through time.

Finally, the European Commission is very much interested in the possibilities of analyzing the differences that are observed between typical and vulnerable groups of the EU population, such as the migrants or ethnic minorities. Such differences can be studied in terms of the mortality rates in these groups, and also in terms of health inequalities related to



socioeconomic characteristics. This part of the analysis is very much restricted due to the so far limited data availability in the EU.

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