RESEARCH PAPER
Department of Economics
Faculty of Social Sciences
University of Ottawa

uOttawa

Decomposition of the Global Socioeconomic Inequalities in Health

Research Supervisor: Professor Paul Makdissi

Student: Olena Melin (5744938)

September, 2011

1. Introduction

Over the last several years global socioeconomic health inequality has emerged as an important health policy concern around the world. Narrowing the global health divide has become a key health policy agenda for multinational institutions including World Health Organization (WHO), World Bank and international community at large (World Health Organization (1993), (1999), (2000), (2005); World Health Assembly (1998); World Bank (1997); Gwatkin (2000); John-wook (2003)). Formulation of a sound global strategy aimed at reducing inequalities in health calls for thorough and reliable knowledge grounded in research. It is especially important to be well informed about the sources of health inequality in order to design health policy initiatives that target specific groups thereby affecting health inequality with the greatest impact. Despite the presence of a large literature studying socioeconomic health determinants and health inequalities within and between industrialized and developing countries, little attention has been given to socioeconomic health inequality in the global context[1]. In particular, to the best of my knowledge, the analysis of the extent to which different components of health and population sub-groups contribute to socioeconomic inequality in health has yet to be carried out on the global scale.

The objectives of this paper are twofold: first is to use aggregate level data for 173 countries to examine global socioeconomic inequality in health using subgroup decomposition analysis. Due to the aggregate level of the available data, only between-country inequality can be estimated. To gain further insight regarding the sources of socioeconomic health differences between countries, I stratify countries into groups according to aggregate income levels and WHO regions and decompose between-country inequality into within and between group inequality plus a residual term. This analysis reveals the extent to which inequality is accentuated within and between subgroups and can provide guidance for creating interventions aimed at lessening socioeconomic health gap between industrialized and developing countries.

The other goal in this study is to evaluate weighted contributions of different disease categories to the world health inequality. Such decomposition provides valuable information about the importance of various diseases in terms of their shares of the overall inequality which

[1] See the literature review for more details.

can prove useful for health policy design and audit. The analysis in this case was limited to 169 countries due to the lack of health data for a few countries.

To carry out these decomposition analyses I use concentration index which has became a widely accepted instrument for assessment of socioeconomic inequality in health. For decomposition of the concentration index I apply decomposition techniques proposed by Clarke, Gerdtham and Connelly (2003) which were originally developed and commonly used in the literature on income inequality. Health variable is measured in terms of Disease Adjusted Life Years (DALY) since comparable data for this measure is available from the World Health Organization for a large number of countries representative of the entire world income distribution. Socioeconomic status is represented by per capita GNI adjusted for purchasing parity obtained from the World Bank online database for the year 2004.

The remainder of this paper is arranged as follows. In the next section, I present a literature review of the related studies. The methodology used to conduct decomposition analyses is discussed in section three, while the health measure and the data are described in sections four and five respectively. Results are provided and analysed in section six. The last section of this paper presents conclusions.

2. *Review of Literature*

Socioeconomic inequalities in health have been the focus of a vast literature. Nevertheless, relatively few studies examined the subject from the global perspective. This paper seeks to answer the following questions: what is the extent of between-country inequality in the global socioeconomic inequality in health, and how is the latter affected by different types of diseases?

At present, there exists a large body of literature exploring health inequalities between socioeconomic groups within countries or compare health inequalities between a few countries at a time. The debate on the subject was initially prompted by the Black Report (Townsend and Davidson, 1982) which draws attention to inequality in death rates between occupational classes in England and Wales and concludes that inequality in mortality has been on the rise since 1930. Using data from the Annual Report of the Registrar General, Pamuk (1985) also estimates health inequality along occupational classes in England and Wales during the period 1921-1972. In contrast to the Black Report, his study shows a decline in mortality gap during thirties and forties with a following inequality rise starting in fifties. While the Black Report uses the ratio of mortality between the lowest and highest occupational classes, Pamuk (1985) introduces the Slope Index of Inequality as a novel measure of health inequality associated with occupational class. This new index overcomes drawbacks of the ratio by taking into account mortality rates and relative sizes of all occupational classes.

In another empirical paper, Lahema and Valkonen (1989) use standardized mortality ratios to investigate socioeconomic differentials in mortality based on occupation and education in Finland. The authors also contrast health inequality in Finland with the data from other Nordic countries as well as England and Wales, and Hungary. The study reports significantly lower mortality rates among the Finnish men with the highest educational attainment relative to those with the least education. Occupational mortality was found to follow a similar pattern.

Of a particular interest is the paper by Wagstaff, van Doorslaer and Paci (1989) in which the authors first propose widely used today concentration index and associated concentration curve as a measure of socioeconomic health inequality. Also, Wagstaff, van Doorslaer and Paci (1991) provide a critical examination of various measures of inequality in health that have been applied in the literature. In this critique, they argue that only the concentration index and the slope index of inequality satisfy three minimal prerequisites of an index measuring socioeconomic health inequality: 1) reflect information on the whole population as opposed to just the extreme categories; 2) account for the population shares of each category; 3) capture socioeconomic aspect of health inequalities. Using the concentration index, the authors compare disparities in mortality between England and Wales and Sweden. Inequalities in morbidity are also examined for Britain, Sweden and Nordic countries.

Among recent studies, Kunst and Mackenbach (1997) investigate trends in occupation-related inequality in mortality in Finland during the late 1970s and 1980s, and education-related disparities in self-reported morbidity in the Netherlands throughout 1980s and 1990s. The results indicate growing relative inequality in mortality in Finland as well as increasing disparities in perceived general health in the Netherlands. Also, Sihvonen, Kunst, Lahelma, Valkonen and Machenbach (1998) examine health inequalities associated with educational achievement in Finland and Norway in 1980s using health expectancy as a summary measure of health status which synthesizes data on mortality and morbidity. Using regression-based method, the authors discovered presence of significant health inequalities that favour better educated groups in both countries. While absolute inequalities in health were found to be the same in both countries, in relative terms, however, disparities in Norway were shown to be higher.

Many studies carry out comparative multiple-country analysis of socioeconomic disparities in health. Most of them focus on socioeconomic inequalities between industrialized countries. In particular, Kunst, Geurts and Van den Berg (1995) examined differences in self-reported health associated with educational attainment among 8 developed countries: The Netherlands, Denmark, Sweden, United Kingdom, Germany, Italy, United States and Canada. Comparison of inequality indices estimated for each country revealed that poor health prevails among groups with lower educational levels. The authors, however, discovered significant cross country fluctuations in the magnitude of these inequalities.

Van Doorslaer et al. (1997) report similar findings on income-related inequalities in self-assessed health for nine countries using data from health and multi-purpose national surveys. Concentration indices are found to be negative for all countries indicating existence of substantial income-related inequalities in health unfavourable to the poor within countries. At the same time, index values fluctuate considerably between countries showing that inequality in some countries is larger than in others.

Also, Cavelaars et al. (1998) used data on self-reported morbidity from national health interview and level of living surveys to compare the extent of health inequalities associated with educational achievement between 11 Western European countries: Finland, Great Britain, France, Italy, Norway, Sweden, Denmark, Spain, Switzerland and Germany. Using the relative index of inequality to measure morbidity differentials between educational groups within each country, the study found that the magnitude of health inequalities varies from one country to another. The largest inequalities were found in Norway, Sweden and Denmark, while far smaller disparities were observed in Spain, Switzerland and Germany.

More recently, Mackenbach, Stirbu, Roskam, Schaap, Menvielle, Leinsalu and Kunst (2008) carried out comparison of inequalities in mortality and self-assessed health among 22 European countries relying on the data from census-based mortality studies and health surveys and measuring socioeconomic status by education, occupation and income. Their findings reinforce the results of previous multi-country studies that indicate the presence of socioeconomic inequalities within countries and a significant differences in the size of these inequalities across countries.

A growing number of publications document socioeconomic disparities in health across developing countries. The research in this area focuses mainly on infants and children as the best data exists for this population group. Of a considerable interest in this regard is the paper by Wagstaff (2000) who compared inequalities in child mortality associated with household consumption across nine developing countries using concentration curves and indices. The study found that infant and under-five mortality is accentuated among the worse-off in all countries. Yet the extent of disparities was shown to fluctuate between countries with the largest inequality found in Brazil. In another relevant study, Wagstaff and Watanabe (2000) discover presence of pro-rich socioeconomic inequality in child malnutrition across 20 developing countries. The degree of inequality is also shown to vary from country to country, with Peru, Nicaragua and Morocco experiencing the largest health disparities. Comparing socioeconomic inequality in child malnutrition across 47 developing countries, Va de Poel, Hosseinpoor, Speybroeck, Van Ourti and Vega (2008) also find evidence of higher malnutrition rates among the poor.

The aforementioned comparative papers rely on individual level data from sample surveys to carry out their analyses. Lack of reliable and comparable individual data for the world hinder research on international health inequality associated with SES. To go around this problem, the present paper uses aggregate data on per capita GNI and a composite measure of health status that incorporates data on morbidity and mortality (Disease Adjusted Life Years) to investigate socioeconomic inequalities in health at the global level.

Whereas much of the existing work in the field focus on health disparities between different socioeconomic groups within countries and investigate socioeconomic inequalities in health between industrialized and developing countries, little attention has been given to global health inequality. Of particular interest in this line of research is the paper by Ruger and Kim (2006) in which authors investigate global socioeconomic disparities in adult and child mortality with the help of cluster analysis dividing countries into three mortality groups: better-off, worse-off and mid-level. The researchers use data from the World Development Indicators database over the period 1960 – 2001 for 207 countries and 94 country indicators including education, health expenditure, income and poverty, environment, energy production and use. Their findings indicate the presence of wide and increasing disparities in adult and child mortality across groups of countries. The study found that, among other things, the worse-off group of countries, on average, experienced smaller average incomes, more severe poverty, less efficient prevention of illnesses and less investment in human and physical capital. While the present paper also examines health inequalities along income dimension from an international prospective, it is quite different from Ruger and Kim (2006) in terms of the methodological approach (concentration index as opposed to cluster analysis), measure of SES (per capita GNI versus 94 country indicators) and the measure of health status used (DALY versus mortality rate).

In another relevant paper, Safaei (2007) uses aggregate data on population health and real per capita GDP for 160 countries to study income-related health inequality with the help of the concentration index. Population health is measured in terms of six mortality rates and four life expectancies. Concentration index estimates are found to be negative for all mortality rates and positive for all life expectancies indicating that richer countries experience better health than the poorer ones. While the present paper also relies on the concentration index to measure socioeconomic inequalities in health and uses aggregate-level data, it differs from Safael (2007) in several important respects. In particular, population health is measured in terms of DALY as opposed to mortality rate and life expectancy. Also, unlike Safaei who follows Wagstaff, van Doorslaer and Watanabe (2001) approach and decomposes total income-related health inequality according to socioeconomic health determinants such as income, education, income inequality and urbanization rate, I disaggregate overall inequality in health according to different causes and also estimate contributions of within- and between- group (of countries) inequalities to the between-country inequality in health.

Using DALY values for the 14 WHO mortality sub-regions and aggregate data on per capita GNP, Reidpath and Allotey (2007) estimate and compare a measure of global health inequality, the Robin Hood index, and a new measure of world health inequity. They argue that prosperous countries have a greater ability to bear ill health by providing better healthcare and social services which tend to mediate negative impact of poor health. The inequality measure, in their view, should weight regional health data with corresponding wealth levels given by per capita GNP. Health disparities across sub-regions were shown to be wider under the new measure of health inequity than under the Robin Hood index. Although Reidpath and Allotey (2007) chose DALY to represent health status and aggregate income data for SES, it must be noted that the authors use the Robin Hood index rather that the concentration index as a measure of health inequality worldwide. At the same time, their primarily focus remains on international health inequity rather than inequality.

Another valuable contribution to the literature on global health inequality is the report prepared for the World Bank by Gwatkin and Guillot (2000) which documents the disease burden for the global poor. The report presents estimates of the burden of disease expressed in terms of Disease Adjusted Life Years (DALY) for the 20% of the global population living in the most disadvantaged countries (named by the author as the global poor) and for the 20% of the world population living in the wealthiest countries (global rich). The study also disaggregates DALY estimates according to 25 distinct ailments and uses this data to examine health inequalities within the global poor group alone as well as to compare the global poor to global rich and to the entire world population. One of the major findings of the report is that communicable diseases are the main cause of mortality and disability in the poorest countries. While the present study also uses DALY as health indicator and examines burden of disease according to different causes, it remains quite distinctive from Gwatkin and Guillot (2000) in that it focuses on burden of disease and socioeconomic health inequality of the entire world population as opposed to the disease burden of global poor.

As for the literature on decomposing inequality in health, a great deal of empirical papers follow regression-based approach from Wagstaff, van Doorslaer and Watanabe (2001) and decompose overall health inequality into contributions from its socioeconomic determinants. Less attention, however, has been paid to decomposition of health inequality into contributions of different diseases or components of health. Research in this field relies on decomposition techniques introduced and extensively used in the analysis of income inequality[2]. In particular, Clarke, Smith and Jenkinson (2002) compare occupation-related health inequality across eight different dimensions of health between England and Australia using data from Short Form (SF-

[2] See Rao (1969) for decomposition of concentration ratio and Duclos and Araar (2006); Also, numerous papers decompose the Gini index into sums of contributions of income sources including Aaberge, Bjorklund, Jantti, Pedersen, Smith, and Wennemo (2000), Achdut (1996), Cancian and Reed (1998), Gustafsson and Shi (2001), Keeney (2000), Leibbrandt and Woolard (2000),Lerman (1999), Lerman and Yitzhaki (1985), Morduch and Sicular (2002), Podder (1993), Podder and Mukhopadhaya (2001), Wodon (1999), Shorrocks (1982), Yao (1999).

36) questionnaire. For this purpose, they estimate concentration indices for each of the SF-36 dimensions. The authors found substantial fluctuation in the values of the estimated indices for different aspects of health in both countries. The physical functioning dimension of SF-36 was found to have the highest level of inequality disadvantageous to the lower occupational classes in England as well as in Australia. Also, while inequalities attributed to mental health component were shown to fluctuate between the countries, no significant variability was observed in inequalities associated with physical health scores. It is important to note that unlike the present paper, Clarke et al. (2002) does not decompose the overall concentration index into weighted contributions of concentration indices for different health dimensions but instead evaluate the values of dimension-specific indices in their own right.

Of a considerable interest is the paper by Clarke et al. (2003) which uses data from Australian SF-36 questionnaire to decompose the overall concentration index for the physical functioning part (PF) of SF-36 into ten components representing different aspects of health. The decomposition analysis represents the overall PF concentration index as a weighted average of the concentration indices of the constituent health dimensions. Although this paper follows the methodology proposed by Clarke et al. (2003), the scope of their empirical analysis is restricted to only one country, while the present study aims at assessing health inequalities worldwide using aggregate income data and a different measure of health status.

Using scores for fifteen health dimensions collected from 15D survey, Lauridsen, Christiansen, Gundgaard, Hakkinen and Sintonen (2007) go even further merging the decomposition by health dimension proposed by Clarke et al. (2003) with the decomposition by socioeconomic characteristics proposed by Wagstaff et al. (2001) so that the overall income-related inequality in health is disaggregated into weighted contributions of socioeconomic determinants to each of the 15 health dimensions. Empirical illustration based on the Finnish Health Care Survey in 1995/1996 reveals substantial variability in the effect of determinants on different health dimensions. In addition, Gundgaard and Lauridsen (2006) employ technique proposed by Lauridsen et al. (2007) to decompose income-related inequality based on the SF-36 summary scores from a Danish health survey. While the present paper is somewhat similar to Lauridsen et al. (2007) and Gundgaard and Lauridsen (2006) in respect to the methodology used, it abstracts from examining contributions of socioeconomic determinants and focuses on decomposing income-related health inequality by disease category, income group and WHO region. Also, while Lauridsen et al. (2007) and Gundgaard and Lauridsen (2006) examine health disparities in Finland and Denmark respectively, the present paper takes a global perspective on inequality in health.

There are also papers that focus on decomposing health inequality according to population subgroups. These publications have mainly drawn on the methods established in the income inequality literature[3].

Particularly interesting in this regard is the study of Clarke et al. (2003). The authors propose two types of decomposition analyses. The decomposition by health dimension was discussed in the earlier part of this literature review. Alternatively, if the population can be grouped by gender, employment status, race or geographic location, the authors suggest disaggregating the overall concentration index into contributions of within- and between-group inequality and a residual term. Stratifying Australian population according to employments status, the study demonstrates subgroup decomposition for the Physical Functioning scores of the SF-36. Between group disparities are found to be the leading source of overall inequality. The present paper applies subgroup method suggested by Clarke et al. (2003) to obtain the decomposed contributions of inequality within and between groups of countries and a residual into the between-country inequality. Also, due to the aggregate level of the data, this study estimates only the between-country inequality component of the country-group decomposition.

Furthermore, measuring health status by standardized heights for children, Pradhan, Sahn and Younger (2003) use Theil entropy index to exactly decompose the worldwide health inequality into within- and between-country inequality. The study showed that within-country inequality is a major contributor to the global health inequality. It must be noted, however, that Pradhan et al. (2003) examines pure international health inequality that did not reflect socioeconomic status.

In addition, Wagstaff and van Doorslaer (2004) examine the relationship between the overall and socioeconomic health inequality by decomposing the Gini coefficient into the concentration indices for inequality between and within socioeconomic groups plus an overlapping residual

[3] Decomposition of the Gini coefficient and rank-dependent inequality indices are explored in Yitzhaki and Lerman (1991), Sastry and Kelkar (1994), Dagum (1997), Tsui (1998), Deutsch and Silber (1999a), Deutsch and Silber (1999b) and Milanovic and Yitzhaki (2002).

term. The empirical illustration based on annual before-tax household income and health utility of Canadian adults demonstrate that while one quarter of the overall health inequality is due to the between-income group inequality, only 11% is represented by the within-income group inequality with the remainder accounted for by the residual term. Interpreting these findings, the authors suggest that socioeconomic inequality may only constitute a minor part of the total health inequality.

Also, Asada (2005) examines health of American population expressed in terms of the Health Related Quality of Life (HRQL) relying on the data from the 1990 and 1995 National Health Interview Survey. He chooses the average Health and Activity Limitation Index (HALex) as a measure of HRQL. Using the Gini coefficient, the study decomposes inequality in the HALex by race (Whites, Blacks and other racial groups) into contributions of within and between group inequalities and a residual overlap Gini coefficient. The results indicate that the between-group inequality explains only 4-5% of the overall health inequality.

Although similar in terms of decomposition technique used, the present paper differs from that of Asada (2005) and Wagstaff and van Doorslaer (2004) in the choice of health indicator (DALY), measure of health inequality (the concentration index) and the subject examined (global income-related inequality).

3. *Methodology*

This section provides a brief discussion of the theory on measurement of inequalities in health and presents the methodological approach followed in this paper.

In the economic literature two streams for analysing inequalities are dominant. The first one is pure health inequality approach which is concerned with the extent of overall inequality in health across population and does not take into account socioeconomic aspect of inequalities. This method does not distinguish between situations when poor health is concentrated among more disadvantaged people and the one when poor health prevails among less deprived individuals. Pure inequalities in health are estimated using standard instruments developed for measuring income inequality such as Gini coefficient and associated Lorenz curve or Atkinson index. Another approach evident in the literature analyzes health inequalities associated with socioeconomic status (SES) which can be represented by income level, occupational category, educational attainment or other criteria. Numerous studies link inequality in health to inequality in other dimensions of well-being such as socioeconomic status or working conditions. For example, in USA the National Longitudinal Mortality Survey shows that the life expectancy at all ages of people in the highest income category in 1980 was around 25 percent longer than the life expectancy of those in the lowest income group (Deaton, 2003). Also, in Scotland the all cause mortality rate of the richest 10 percent of the population was around half of the rate of the poorest 10 percent of the population in 2004 (Public Health Information for Scotland, 2007). It is therefore important to include socioeconomic status in the analysis of health inequalities. In this paper, I will follow the last approach and restrict my attention to socioeconomic-related inequality in health among countries. A key measure of health inequality widely used in the literature that captures socioeconomic dimension is a concentration index and related concentration curve which charts on the vertical axis cumulative proportion of health and on the horizontal axis cumulative proportion of the sample ranked in ascending order according to socioeconomic status. In this study, I use per capita GNI of countries as a measure of SES and Disease Adjusted Life Years (DALY) as a measure of health status. The concentration curve gives a cumulative proportion of health held by $100p\%$ of the poorest countries. The concentration index, which fluctuates between -1 and 1, is defined as twice the area between the concentration curve and the line of equity given by the 45-degree line. In the absence of health inequality associated with SES concentration index will be null and concentration curve will coincide with the line of equity. The index will be negative if the curve is located above the 45-degree line, indicating prevalence of poor health among poorer countries than the richer ones, and positive if the curve stays beneath the line of equity (Wagstaff et al., 1991).

The concentration index has several advantages over the other measures of health inequality proposed in the literature. Unlike the range which only considers the highest and lowest socioeconomic groups and fails to take into account the population shares of each group, the concentration index summarizes information about the entire population and reflects the distribution of the population across groups. Also, by ordering sample according to SES, the concentration index captures socioeconomic dimension to inequalities in health which is overlooked by the Gini index and the index of dissimilarity (Wagstaff et al., 1991).

Following Duclos and Araar (2006), the concentration index denoted by C is computed using the following formula:

$$C = 2\int_0^1 (p - C(p))dp \qquad (1)$$

where p is the cumulative proportion of the sample ordered by SES, $C(p) = \frac{1}{\mu_{DALY}} \int_0^p DALY(p)dp$ is the associated ordinate of the concentration curve. In this study, the data for all countries is weighted by their respective population sizes to account for relative population share of each country.

Clarke et al. (2003) suggested using decomposition techniques developed and applied for the measurement of income inequality to decompose the concentration index by population subgroup and by health component. Applying subgroup decomposition approach to the analysis of global socioeconomic health inequalities, the overall concentration index can be decomposed as a sum of between-country and within-country concentration indices and a residual:

$$C = \sum_{n=1}^{N} w_n p_n C_{wn} + C_B + R \qquad (2)$$

where the first decomposition component captures socioeconomic health inequality within countries and is equal to the weighted sum of concentration indices for individual countries C_{wn} with weights given by health share w_n and population share p_n of group n. The second term C_B represents inequality in health associated with SES between countries, while the last term is a residual which occur due to overlap between subgroup income ranges.

In this paper, due to the absence of comparable individual level data for countries throughout the world I abstract from the within-country inequality and estimate only the socioeconomic differences in health between countries.

To gain greater understanding of inter-country health inequalities, I reapply subgroup decomposition technique to further decompose between-country concentration index C_B. By first dividing countries into groups according to income category and WHO region[4], the between-country concentration index C_B can be represented as a sum of concentration indices for health inequality between and within groups of countries (C_B^G and C_W^G respectively) plus a residual component:

$$C_B = \sum_{j=1}^{J} w_j p_j C_{wj}^G + C_B^G + R^G \qquad (3)$$

where the first term captures intra-group inequality given by the weighted sum of group concentration indices C_{wj}^G with w_j and p_j representing health and population shares of group j respectively. The second component reflects inter-country socioeconomic differences in health and the final term represents overlap inequality. This decomposition allows us to find out how much of the socioeconomic health inequality between countries can be explained by the inequality inside the groups of countries and by inequality between the groups.

To examine contributions of various disease categories to global socioeconomic inequality in health I employ decomposition technique by health component proposed by Clarke et al. (2003) and decompose concentration index for global inequality into weighted sum of concentration indices for different disease categories. Suppose we have $s = 1,2 \dots, S$ disease categories, then global concentration index, C, can be represented as follows:

$$C = \sum_{s=1}^{S} \theta_s C_s \qquad (4)$$

where θ_s gives the average value of health variable for disease category s relative to the average value of health variable for all diseases, $\theta_s = \frac{\mu_s}{\mu}$, and C_s represents concentration index of disease category s.

To gain further insight, I also carry out decomposition analysis by health component for each of the four income groups of countries separately and compare the contribution of different diseases to inequality across all groups. Suppose we have $m = 1, 2 \dots, M$ disease categories in income group $\in \{\mathit{High\ income\ group, Upper\ middle\ income\ group, Lower\ middle\ income\ group, Low\ income\ group}\}$, then concentration index for income group p is given by:

[4] Countries grouped by WHO region and income category are listed in the Appendix A, Tables A1 and A2 respectively. Income categories used in this paper are presented in terms of the World Bank's income group classification.

$$C_p = \sum_{m=1}^{M} \theta_m^p \, C_m^p \quad (5)$$

where θ_m^p gives the average value of health variable for disease category m in group p relative to the average value of health variable for all diseases in group p, $\theta_m = \frac{\mu_m^p}{\mu^p}$, and C_m^p represents concentration index of disease category m in group p.

To explore socioeconomic health inequality in more depth, the same type of decomposition analysis as in (5) is further carried out for each WHO region.

4. Health Measure

As a measure of health status I chose Disability-adjusted life year (DALY) which was jointly created by Harvard University, the World Bank and the WHO in 1993 for the assessment of the world population health. DALY is a health gap measure which estimates the global burden of disease in terms of healthy years of life lost as a result of premature death and morbidity. The formula for calculating DALY is given by:

$$DALY = YLL + YLD \quad (6)$$

where the first component of the summation represents loss of life years as a consequence of premature mortality (YLL), and the last term captures the equivalent years lost as a result of disability (YLD).

The time lost due to premature death (YLL) for a particular cause, age and sex can be estimated by multiplying the number of deaths, N, by the standard expectancy of life for the age at which death took place, E :

$$YLL = N \cdot E \quad (7)$$

Standard life expectancies at different ages were determined on the basis of standard life tables.

Equivalent years lost as a result of disability (YLD) attributed to particular condition and period are calculated by multiplying the number of incident cases for that disablement denoted by C by the average length of the disease, D. Notably, YLD is also adjusted by a disability weight, W, representing the severity of condition:

$$YLD = C \cdot D \cdot W \quad (8)$$

Disability weights range from zero (perfect health) to one (death). Application of these weights makes years of life lost due to disability comparable to years of life lost due to premature death.

DALY estimates used in this paper were adjusted by WHO at a 3% time discounting rate to incorporate value judgement that additional years of a healthy life in the present count for more than those in the future. Future health benefits were discounted using continuous discounting function $e^{-r(x-a)}$ where r represents the discount rate, x is time and a captures the age of onset. Application of time discounting to DALY estimates is based on the number of arguments, particularly: to preserve consistency with cost-effectiveness analyses, to avoid excessive weighting of mortality at younger ages, and to resolve disease research paradox which states that if research has a positive probability of success then without time discounting all present expenditures must be directed toward disease research since this investment will yield infinite future stream of benefits (Murray and Acharya, 1997). DALY estimates were also weighted so that less value is assigned to years of life at childhood and old age (World Health Organization, 2008). Unequal age weights were used to reflect different social roles of individuals at different ages with children and elderly depending on support of the middle age group. Application of non-uniform age weights is also justified on the basis of human capital argument suggesting that years of life of young adults should be assigned more weight as youth is more productive and contributes more to the well-being of society. Yet another rationale for uneven age weighting, according to Murray and Acharya (1997), is given by empirical evidence from several studies including some population surveys identifying a wide social preference for valuing a year of life at youth more than a year of life at old age or childhood.

For this study, I chose age-standardized DALY per 100, 000 people by cause which is defined as a weighted average of age-specific DALY rates for each cause with weights given by the population shares for respective age groups of the WHO world standard population. Age standardization is used to account for fluctuations in population age patterns between countries.

As a standard population WHO uses average age composition of populations of the world (World Health Organization, 2001).

Today DALY is widely used in the field of public health and health impact evaluation to identify target groups for health interventions, assess cost-effectiveness of interventions in different countries and develop guidance for health policy and planning regarding resource distribution aimed at curtailing the disease burden. One of the major reasons for its widespread use is that DALY incorporates data on non-fatal health outcomes along with the data on mortality. Furthermore, WHO analyzed, verified and reconciled a large volume of data on population health that is oftentimes incomplete and varies in reliability and comparability to produce a single number that can be easily compared across causes to analyze the contribution to the burden of disease of each cause by age, gender and geographical area.

The opponents of DALY criticize the index for assumptions and social value judgment choices incorporated in DALY, in particular disability and age weighting and time discounting.

Hadson and Anand (1997) argue that assigning higher weights to middle age population because of their greater productivity amounts to valuing human life in monetary terms, based on ones usefulness to society and is inequitable to children and elderly. They further object that time discounting is unfavourable to future generations. Such adjustment, in their view, can serve as a basis for adoption of policies and programs that generate gains for current generation at the expense of future ones. The authors also note that gender gap in life expectancy incorporated in DALY disfavours women since the advantage in years lost of females over males decline when age weighting and time discounting is applied.

With regards to disability weights, Hadson and Anand (1997) and Reidpath, Allotey, Kouame and Cummins (2003) argue that weights do not reflect the socioeconomic circumstances under which the disablement is occurring such as services and support provided by public and private institutions and the ability of individuals affected by disability to cope with the condition. Thus, a particular disability condition is given the same weight irrespective of the country where person with disability resides failing to account for fluctuations in socioeconomic environment of those affected by the disablement. Consequently, DALY estimates do not reflect the true contributions to the overall burden of disease by wealthy and poor countries (Reidpath et al.

2003). In this paper, I attempt to extend DALY concept and capture the effect of socioeconomic status of countries on the distribution on health among populations and assess the contribution of each disease to socioeconomic health inequality using concentration index and supplementing DALY estimates with the data on per capita GNI.

5. Data

In this paper, total and disease-specific estimates for DALY as well as population data for all countries are taken from "Death and DALY Estimates for 2004 by Cause for WHO Member States" tables (DALY 2004) published on the website of the World Health Organization. The data for per capita GNI adjusted for purchasing parity for all countries was obtained from World Bank online database for the year 2004.

DALY 2004 provides estimates for multi-level disease categories comprising of 136 causes of disease and injury for 192 countries. Due to the lack of data on per capita GNI for 19 countries and islands included in the original dataset, decomposition analysis by income group and WHO region is limited to 173 countries. Also, decomposition of global socioeconomic health inequality by disease category is carried out for 169 countries due to limited health data along some disease categories for another 4 small countries[5]. As population sizes of these countries and islands are for the most part very small, their exclusion from the analyses should not significantly affect the results.

DALY 2004 dataset categorizes causes of disease and injury using the International classification of diseases, 10th version (ICD-10). At the first level of disaggregation, all causes are divided into three major categories: (Group I) communicable, maternal, perinatal and nutritional conditions; (Group II) noncommunicable diseases; (Group III) injuries (World Health Organization, 2008). In this paper, I focus on 3 main disease categories and 21 disease subcategories to examine global socioeconomic disparities in health[6].

WHO used a wide range of methods and sources of data to generate estimates of the number of death by cause which were subsequently used to calculate DALYs. ***Table 1*** presents

---

[5] Appendix A, table A4 provides a list of countries used in the analysis.
[6] List of disease categories and subcategories applied in the decomposition is presented in the Appendix A, table A3.

approaches and data used to estimate cause-specific death rates by WHO region for the year 2004. Estimates of deaths by cause for 78 countries were made using complete (85% or more coverage) and incomplete vital registration data provided by death registration systems. In the cases where the latest year with available data preceded 2004, the cause distribution for 2004 was estimated using data from 1980 to the latest year available. Data on deaths due to HIV, drug use disorders, war and natural disasters were revised on the basis of epidemiological studies and surveys, information from WHO technical programmes, UNAIDS, OFDA/CRED, UNODC. Death estimates for another 34 countries with limited data were obtained using cause of death model (CodMod).

Table 1: Approaches and data used to estimate cause-specific death rates by WHO region for the year 2004

	Number of Member States						
Data/method	Africa	The Americas	Eastern Mediter-ranean	Europe	South-East Asia	Western Pacific	World
Vital registration data with coverage of 85% or more	3	21	2	39	1	12	78
Vital registration data with coverage < 85% use of CodMod*	-	12	7	11	1	3	34
Sample registration system	-	-	-	-	1	1	2
CodMod, regional pattern of causes of death, and cause-specific estimates	43	2	12	2	8	11	78
Total Member States	46	35	21	52	11	27	192

*CodMod, cause-of-death model.

For 78 countries without usable vital registration data, mortality levels were derived using CodMod for each country separately. Proportional cause distributions in major disease categories were obtained using regional death registration data. Cause-specific adjustments were based on epidemiological and verbal autopsy studies, disease surveillance systems and WHO technical programmes.

Information about mortality in China was obtained from the sample vital registration system supervised by the Ministry of Health and the Disease Surveillance Points system controlled by the Chinese Center for Disease Control and Petition. Mortality data for India was taken from the Medical Certificate of Cause of Death Database for urban India and the Annual Survey of Causes of Death for rural India as well as WHO technical programmes and UNAIDS (World Health Organization, 2008).

YLD estimates were based on a variety of data sources among which are disease registers, population surveys, epidemiological studies and health facility data. To ensure consistent estimates WHO used Dismod software tool that helped synthesize information from different sources and of varying quality (Murray et al., 2006). Resident population data for 2004 was provided by the United Nations.

6. Results

The concentration index for the between-country inequality is estimated to be -0.211491 and is statistically significant from zero at 5% level of significance. The associated concentration curve plotted in ***Figure 1*** remains everywhere above the 45-degree line. These findings indicate higher prevalence of poor health among countries with lower per capita GNI.

Figure 1: Concentration curve for the between-country inequality

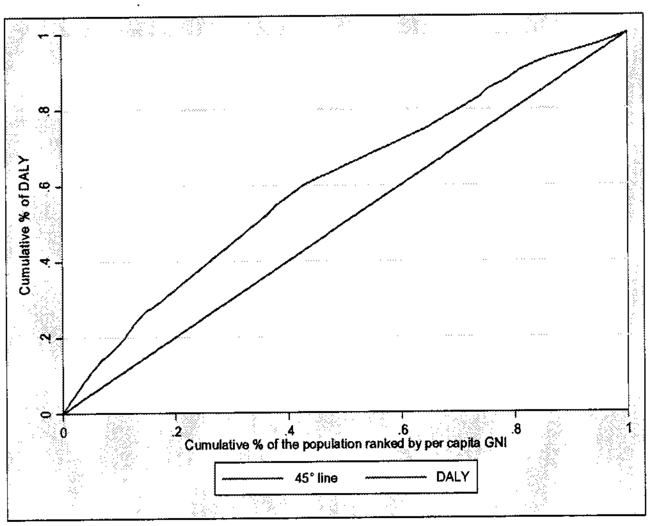


Table 2 reports results of decomposing the between-country inequality by income groups. Notably, the largest contribution to the inequality among countries comes from the inequality between income groups. It is nearly 7 times higher than the contribution of the within-group inequality. The contributions from both sources of inequality are negative reflecting that ill health is more pronounced among the lower income groups as well as poorer countries within all income groups. Exception to that is the high income group in which ill health is concentrated among the richer countries. Low income group is found to be the largest contributor of the within-group inequality accounting for approximately 11% of the overall inequality between countries. These findings have important policy implications suggesting that measures aimed at

reducing between-group inequality will have greater impact on the health inequality among countries than those targeting within-group disparities.

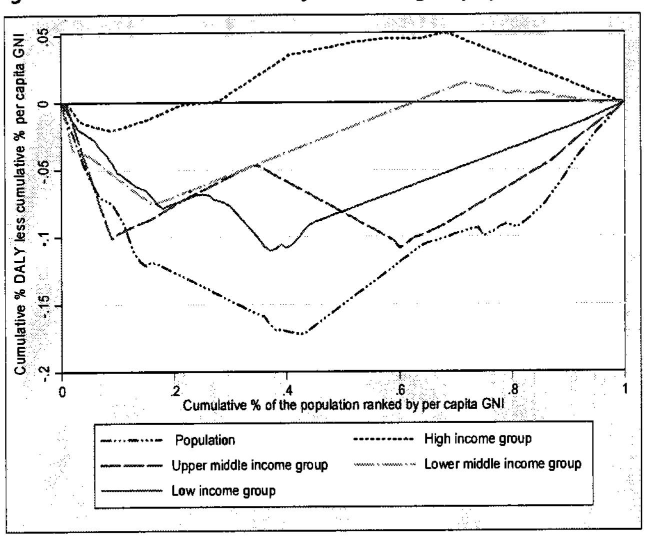
Table 2: Decomposition of the between-country health inequality by income groups

Between-country inequality	**-0.2114910**	
Contribution of the between-group inequality*	**-0.2064630**	**97.6%**
Contribution of the within-group inequality:	**-0.0307500**	**14.5%**
High Income	**0.000414**	**-0.2%**
Upper middle income	**-0.000883**	**0.4%**
Lower middle income	**-0.006476**	**3.1%**
Low income	**-0.023805**	**11.3%**
Residual Term	**0.0257220**	**-12.2%**

***Estimated concentration index for the between-group inequality is statistically significant at 10% level**

It is interesting to examine concentration curves for the income groups charted as gaps from the 45-degree line in ***Figure 2***.

Figure 2: Concentration curves for income groups plotted as gaps from the diagonal



The concentration curves for low and upper middle income groups are located completely below the diagonal suggesting that poor health predominate among the worse-off countries in these groups. The related statistically significant concentration indices are equal to -0.112704 and -0.130918 also manifesting presence of substantial pro-rich health inequality in the groups. The curves for lower middle income group, in turn, intersect the 45-degree line and lie mostly below the diagonal which in combination with associated negative concentration index (-0.047072) suggests that poorer countries experience higher concentration of ill health. The curve for high income group, on the other hand, stays for the most part above the diagonal except for percentiles below 25 which coupled with relatively small, but positive concentration index (0.039187) implies that health inequality favours most deprived countries in the group. These results render support to the preceding findings of the decomposition by income group.

The results of decomposing the between-country inequality by WHO regions are provided in ***Table 3***.

Table 3: Decomposition of the between-country health inequality by WHO regions

Between-country inequality	**-0.2114910**	
Contribution of the between-region inequality*	**-0.1672000**	**79.1%**
Contribution of the within-region inequality:	**-0.0112434**	**6.7%**
African Region	**-0.000694**	**0.4%**
Region of the Americas	**-0.001479**	**0.9%**
Eastern Mediterranean Region	**-0.001084**	**0.6%**
European Region	**-0.001930**	**1.2%**
South-East Asia Region	**-0.001565**	**0.9%**
Western Pacific Region	**-0.004491**	**2.7%**
Residual Term	**-0.0330476**	**15.6%**

***Estimated concentration index for the between-region inequality is statistically significant at 5% level**

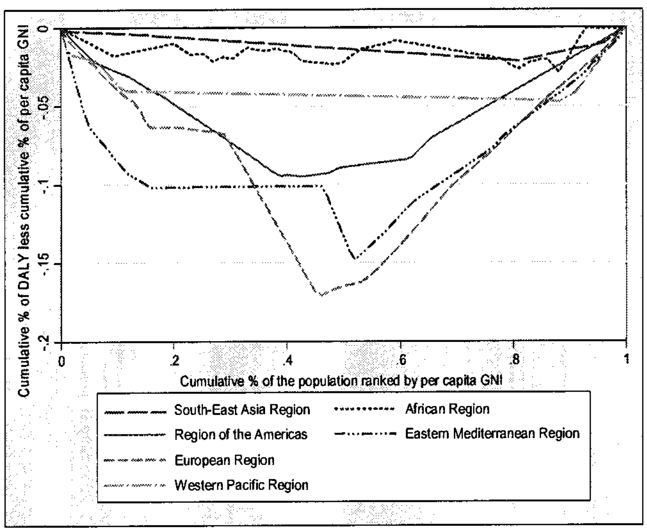
The most striking finding is the difference between contributions of between- and within-region inequality: while inequality among WHO regions accounts for almost 80% of the inequality between countries, only 6.7% is captured by the within-region inequality. Interestingly, all WHO regions contribute negatively to the overall inequality within regions indicating that poor health prevails among worse-off countries [7]. There is, however, significant variation in the magnitude of contributions across WHO regions. Far greater inequality is observed for the Western Pacific Region and European Region contributing 2.7% and 1.2% accordingly. The areas with the lowest inequality contributions are African and Eastern Mediterranean Regions responsible for 0.4% and 0.6% of the health gap respectively. It is important to emphasize the implications of these results for health policy: interventions designed to alleviate between-region inequality will have greater impact on the inequality between countries than those addressing within-region inequality.

To gain further insight, I also examine concentration curves for WHO regions constructed as differences from the diagonal in ***Figure 3***. Remarkably, all the curves stay below the diagonal implying higher concentration of ill health among countries with lower income. This is

[7] Concentration indices were found to be statistically significant at 5% for Region of Americas, Eastern Mediterranean and European Regions.

consistent with the estimated within-region contributions. Graphical analysis, however, distinguishes European and Eastern Mediterranean Regions as the leading contributors of within-region inequality since their concentration curves lie, for the most part, furthest from the 45-degree line and the associated concentration indices (-0.165811 and -0.170101 respectively) are smaller than the indices for all other WHO regions. Such results appear to be somewhat at odds with the findings of the decomposition by WHO regions which identifies Western Pacific Region rather than Eastern Mediterranean Region as one of the two major sources of overall inequality within regions. One must remember, however, that inequality contributions in the decomposition analysis were adjusted by population and health shares which may very well explain such inconsistency in the results.

Figure 3: Concentration curves for WHO regions charted as differences from the 45-degree line



The results of decomposing global socioeconomic health inequality by disease are presented in ***Table 5***. Notably, except for malignant neoplasms and neuropsychiatric conditions, all diseases contribute negatively to the world health inequality attesting that ill health associated with these diseases is concentrated among poorer countries[8]. Yet significant variation is observed in the contributions across diseases. The overall global inequality in health is estimated by aggregating contributions of the major disease categories (or, alternatively, diseases within all major categories) and is equal to –0.230690 indicating existence of substantial heath disparities unfavourable to the poor worldwide.

[8] All concentration indices are statistically significant at 5 % level of significance except those for malignant neoplasms, endocrine disorders, diabetes mellitus, neuropsychiatric conditions and musculoskeletal diseases. Estimated index for oral conditions was found to be statistically significant at 10%.

Table 5: Decomposition of the global income-related health inequality by disease category

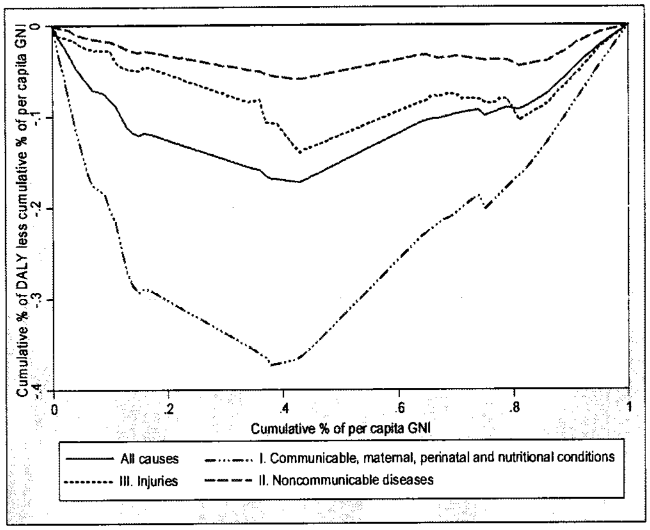
Disease category	CI*	Ws**	WsCIs	% Contribution to the global health inequality
I. Communicable, maternal, perinatal and nutritional conditions	-0.462445	0.389049	-0.179914	78.0%
A. Infectious and parasitic diseases	-0.509673	0.224333	-0.114337	48.8%
B. Respiratory infections	-0.499693	0.056514	-0.028239	12.0%
C. Maternal conditions	-0.507200	0.031821	-0.016140	6.9%
D. Conditions arising during the perinatal period	-0.330467	0.054636	-0.018055	7.7%
E. Nutritional deficiencies	-0.334894	0.021745	-0.007282	3.1%
II. Noncommunicable diseases	-0.069590	0.505000	-0.035143	15.2%
A. Malignant neoplasms	0.026163	0.054240	0.001419	-0.6%
B. Other neoplasms	-0.087151	0.001672	-0.000146	0.1%
C. Diabetes mellitus	-0.030794	0.018087	-0.000557	0.2%
D. Endocrine disorders	-0.073982	0.011414	-0.000844	0.4%
E. Neuropsychiatric conditions	0.025520	0.121957	0.003112	-1.3%
F. Sense organ diseases	-0.170973	0.058013	-0.009919	4.2%
G. Cardiovascular diseases	-0.131813	0.118424	-0.015610	6.7%
H. Respiratory diseases	-0.105452	0.034419	-0.003630	1.5%
I. Digestive diseases	-0.127403	0.030127	-0.003838	1.6%
J. Genitourinary diseases	-0.192839	0.011907	-0.002296	1.0%
K. Skin diseases	-0.229222	0.003556	-0.000815	0.3%
L. Musculoskeletal diseases	-0.004054	0.021028	-0.000085	0.0%
M. Congenital anomalies	-0.095148	0.014428	-0.001373	0.6%
N. Oral conditions	-0.042724	0.005728	-0.000245	0.1%
III. Injuries	-0.147548	0.105951	-0.015633	6.8%
A. Unintentional injuries	-0.153704	0.072257	-0.011106	4.7%
B. Intentional injuries	-0.130757	0.033694	-0.004406	1.9%
Global income-related health inequality (based on the three major disease			-0.230690	

* CI, concentration index; ** Ws, weights

Another remarkable result is that Communicable, maternal, perinatal and nutritional conditions are found to be the major source of health inequality in the word accounting for 78% of the global health disparities. The contribution of the noncommunicable diseases is distinctly smaller capturing 15% of the inequality, while injuries are found to contribute only 6.3%.

Figure 4 plots gaps between the concentration curves for the major disease categories and the diagonal.

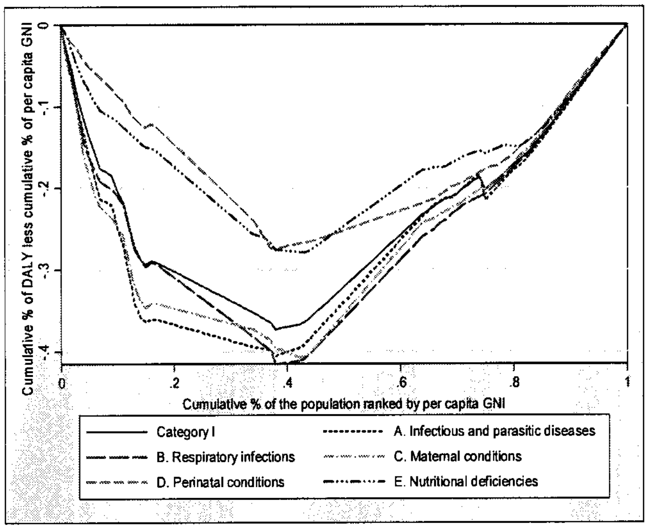
Figure 4: Concentration curves for major disease categories drawn as deviations from the 45-degree line



All curves are charted everywhere below the 45-degree line suggesting that countries with lower per capita GNI experience higher prevalence of ill health. The curve for the communicable, perinatal, maternal, and nutritional conditions stays furthest from the diagonal indicating that the disease category I contributes the most to the world inequality. These visual inequality patterns are consistent with the results of the decomposition by disease category. In contrast to the latter, however, graphical analysis identifies Injuries as the second main source of inequality since its concentration curve runs everywhere below the curve for the noncommunicable diseases. It is important to emphasize, however, that decomposition analysis uses shares of the average DALY for all causes to weight its decomposition components which may well account for the disparities in the results.

It is also interesting to examine in more detail contributions of the diseases that belong to the major categories. Particularly interesting in this regard are the diseases in category I as the latter represents the main source of global inequality. The contributions of all diseases in this category are found to be negative reflecting the fact that ill heath predominates among the most deprived countries. Infectious and parasitic diseases contribute by far the most to health inequality in the world being responsible for approximately 50% of health disparities. The second major contributor are the respiratory conditions which cause 12% of global inequality. These are followed by perinatal and maternal conditions contributing nearly 8% and 7% respectively. Nutritional deficiencies, in turn, account for 3.1% of the inequality. These findings are for the most part consistent with the results of the graphical analysis provided in ***Figure 5***. According to the graph, Infectious and parasitic disease as well as maternal and respiratory conditions are the leading contributors of global inequality in category I unfavourable to the worse-off, while nutritional deficiencies and perinatal conditions are found to contribute considerably less.

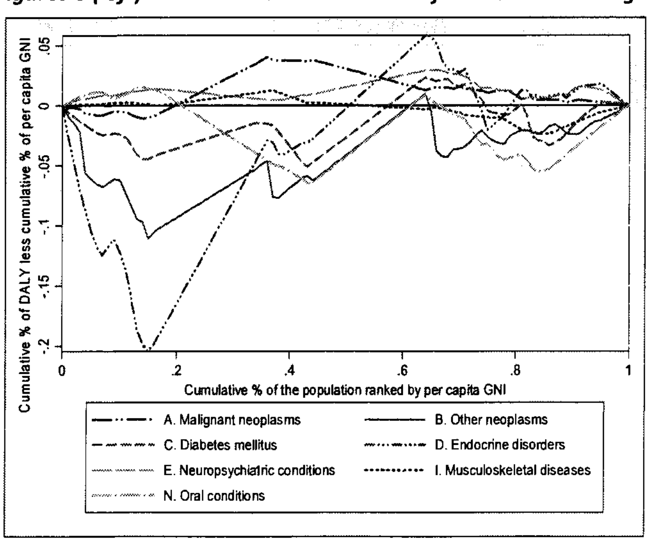
Figure 5: Concentration curves for diseases in category I charted as deviations from the 45-degree line

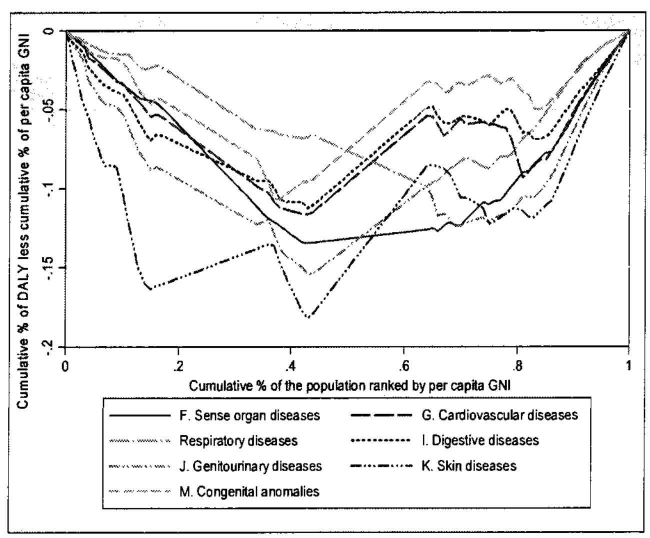


Of a particular interest among noncommunicable diseases are the malignant neoplasms and neuropsychiatric conditions which make small positive contributions to the global inequality in health suggesting that poor health is accentuated among countries with higher per capita GNI. Amongst other illnesses in this category, the largest negative contributions are made by Cardiovascular and Sense organ diseases responsible for 6.7% and 4.2% of the disparities respectively. Digestive, Respiratory and Genitourinary diseases, on the other hand, account for distinctly smaller shares of the world health inequality contributing 1.6%, 1.5% and 1% accordingly, while the negative contributions of the remaining diseases do not exceed 0.6%.

To gain further insight, I also construct concentration curves for noncommunicable diseases drawn as differences from the 45-degree line. In order to facilitate visual interpretation, concentration curves that run completely or largely above the diagonal are charted in ***Figure 6***, while curves that stay entirely or mostly below the 45-degree line are presented in ***Figure*** *7*. Examination of ***Figure 6*** highlights several notable results. In particular, concentration curve for neuropsychiatric conditions is charted entirely above the diagonal suggesting that poor health prevails among richer countries. In addition, the curve for malignant neoplasms mostly lies above the diagonal except for percentiles below 20. The respective concentration indices are found to be relatively small, but positive further attesting presence of inequality disadvantageous to the better-off. These findings confirm prior results of the decomposition analysis. There is also a group of diseases with curves cutting the diagonal and for the most part lying below the 45-degree line. These include Diabetes mellitus, Oral conditions and Other neoplasms. The associated concentration indices are negative which jointly with the information about the concentration curves, suggests that ill health associated with these diseases favours poorer countries. Further comparison of the concentration indices in combination with graphical analysis of the curves reveals that Musculoskeletal diseases (-0.004054), Diabetes mellitus (-0.030794), Oral conditions (-0.042724) contribute the least to the global inequality in terms of negative contributions. In contrast, from ***Figure*** *7* one can see that Skin (-0.229222) and Genitourinary (-0.192839) and Sense organ diseases (-0.170973) are the leading sources of world inequality in category II. Cardiovascular, Respiratory and Digestive diseases, on the other hand, make relatively smaller inequality contributions since their concentration curves lie almost everywhere above those for Skin, Genitourinary and Sense organ diseases. The associated concentration indices (-0.131813, -0.105452 and -0.127403 respectively) further reinforce results of the graphical analysis. Observed graphical patterns for noncommunicable diseases may seem somewhat inconsistent with the findings of decomposition analysis, since the latter found Cardiovascular and Sense organ diseases to be the largest contributors of global income-related inequality in health. As was previously mentioned, however, application of weights to the estimation of inequality contributions may very well be responsible for such dissimilarity in outcomes.

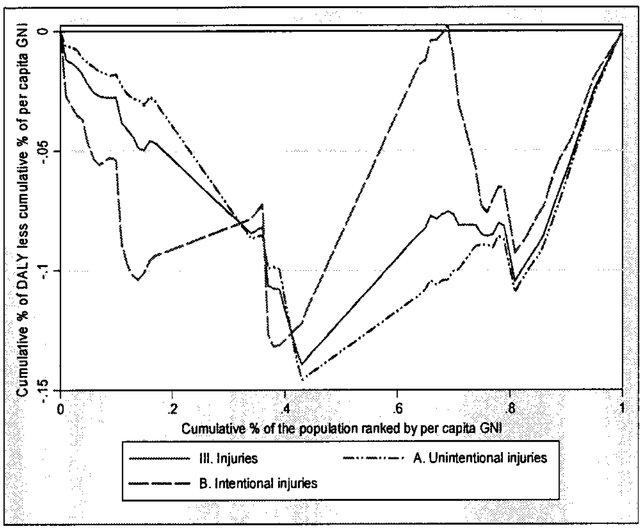
Figures 6 (left) and 7: Concentration curves for diseases in category II drawn as differences from the 45-degree line





In the category III representing Injuries, unintentional injuries contribute the most to global inequality capturing 4.7 % of the disparities in health. However, the findings of graphical analysis presented in ***Figure 8*** are not so clear cut since the curves for intentional and unintentional injuries intersect with each other. Nevertheless, based on this graph one can conclude that both types of injuries contribute negatively to the global inequality in health which is consistent with the results of the decomposition analysis.

Figure 8: Concentration curves for diseases in category III: Injuries drawn as deviations from the 45-degree line



It is also informative to decompose socioeconomic health inequality in each of the four income groups into weighted contributions of different disease categories. Such analysis provides vital insights about significance of different diseases for each income group as well as highlights how disease-specific inequality contributions vary across income groups. The decomposition results are presented in ***Table 6***. From the table one can clearly see that noncommunicable diseases represent the leading cause of inequality in the high income group accounting for a little over 90% of the disparities. For the remaining lower income groups, on the other hand, Noncommunicable diseases are considerably less important capturing less than 15% of inequality in each group. In fact, in the upper and lower middle income group as well as in the low income group, Communicable, maternal, perinatal and nutritional conditions are responsible for most of the socioeconomic disparities in health contributing approximately 80%, 70% and 90% of the overall group inequality respectively.

Table 6: Decomposition of socioeconomic health inequality in each income group by disease category

Disease category/ Overall group inequality	High income group		Upper middle income group		Lower middle income group		Low income group	
	WsCIs*	% Contribution**	WsCIs	% Contribution	WsCIs	% Contribution	WsCIs	% Contribution
I. Communicable, maternal, perinatal and nutritional conditions	0.000611	1.5%	-0.115050	77.6%	-0.037527	69.3%	-0.115271	91.2%
A. Infectious and parasitic diseases	0.000144	0.4%	-0.101511	67.9%	-0.020750	39.4%	-0.089659	64.4%
B. Respiratory infections	-0.000428	-1.2%	-0.004181	2.8%	-0.007548	14.3%	-0.016582	11.9%
C. Maternal conditions	0.000466	1.3%	-0.003508	2.3%	-0.004057	7.7%	-0.012910	9.3%
D. Conditions arising during the perinal period	0.001578	4.3%	-0.004649	3.1%	-0.004684	8.9%	-0.001087	0.8%
E. Nutritional deficiencies	-0.001674	-4.5%	-0.002614	1.7%	-0.002084	4.0%	-0.002492	1.8%
II. Noncommunicable diseases	0.036273	91.2%	-0.020885	14.1%	-0.001472	2.7%	-0.007139	5.6%
A. Malignant neoplasms	0.000534	1.4%	0.000459	-0.3%	-0.000779	1.5%	-0.003044	2.2%
B. Other neoplasms	-0.000139	-0.4%	-0.000247	0.2%	-0.000057	0.1%	-0.000306	0.2%
C. Diabetes mellitus	0.001227	3.3%	0.000467	-0.3%	-0.000387	0.7%	-0.001103	0.8%
D. Endocrine disorders	0.001301	3.5%	-0.001260	0.8%	0.001330	-2.5%	-0.005238	3.8%
E. Neuropsychiatric conditions	0.023002	62.3%	-0.000993	0.7%	0.006668	-12.7%	0.002604	-1.9%
F. Sense organ diseases	-0.003387	-9.2%	-0.004299	2.9%	-0.004166	7.9%	0.000377	-0.3%
G. Cardiovascular diseases	0.003912	10.6%	-0.010529	7.0%	0.000145	-0.3%	-0.001879	1.4%
H. Respiratory diseases	0.006155	16.7%	-0.005087	3.4%	-0.001647	3.1%	0.000017	0.0%
I.Digestive diseases	-0.000003	0.0%	0.001176	-0.8%	-0.000461	0.9%	-0.001555	1.1%
J. Genitourinary diseases	0.000571	1.5%	-0.001064	0.7%	-0.000764	1.5%	-0.000890	0.6%
K. Skin diseases	-0.000164	-0.4%	-0.000517	0.3%	-0.000167	0.3%	-0.000752	0.5%
L. Musculoskeletal diseases	0.000321	0.9%	0.000126	-0.1%	-0.000206	0.4%	-0.000154	0.1%
M. Congenital anomalies	0.001248	3.4%	0.000908	-0.6%	0.000499	-0.9%	0.000202	-0.1%
N. Oral conditions	-0.000273	-0.7%	0.000175	-0.1%	0.000567	-1.1%	0.000277	-0.2%
III. Injuries	0.002884	7.3%	-0.012330	8.3%	-0.015141	28.0%	-0.003965	3.1%
A. Unintentional injuries	0.000673	1.8%	-0.004068	2.7%	-0.012976	24.7%	0.000195	-0.1%
B. Intentional injuries	0.001859	5.0%	-0.008304	5.6%	-0.001079	2.1%	-0.005143	3.7%
Overall group inequality (based on the three major disease categories)	0.039768		-0.148265		-0.054139		-0.126375	

* WsCIs, relative contribution of a disease category to socioeconomic health inequality in a given income group

** % Contribution, percentage contribution of a disease category to socioeconomic health inequality in a given income group

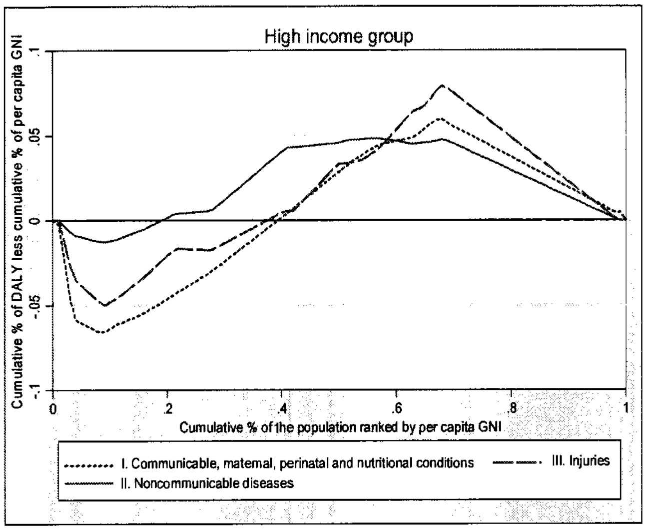
Inequality attributed to Injuries represent only a modest share of health disparities in the low income group (3.1%) and is more pronounced in the lower, upper middle and high income groups capturing approximately 30% , 8% and 7% of inequality accordingly. Notably, these findings are in line with the results obtained by Gwatkin and Guillot (2000) who discovered that communicable diseases are of greater significance for the most disadvantaged countries globally, while noncommunicable diseases are more relevant for most prosperous countries in the world. Interestingly, overall inequality estimate for high income group was found to be positive (0.039768) indicating existence of inequality unfavourable to richest countries. Inequality estimates for all other groups, however, were shown to be negative suggesting that ill health is more pronounced among poorer countries in these groups. Main disease categories display the same inequality patterns across the income groups.

These findings suggest that lower income groups would benefit much more in terms of reduction in health inequality from policy initiatives targeting first and foremost Communicable, maternal, perinatal and nutritional conditions than those directed against Noncommunicable diseases. Also, poorer income groups would experience greater inequality reduction than the high income group from policies addressing Communicable, maternal, perinatal and nutritional conditions.

To augment decomposition analysis, ***Figures 8-11*** plots gaps between the diagonal and the concentration curves representing major disease categories for each income group. In the figure for high income group, the concentration curve for noncommunicable diseases stays mostly above the 45-degree line except for percentiles below 20 which jointly with a relatively high positive concentration index (0.043894) indicates that noncommunicable diseases are prevalent among the most prosperous countries in the group. The curves for Injuries and Communicable, maternal, perinatal and nutritional conditions cross the diagonal at 40^{th} percentile with parts of curves above the diagonal being further from the 45-degree line than those below the diagonal. This information combined with smaller positive concentration indices (0.008418 and 0.028548) implies that inequality associated with these disease categories favours the worse-off countries, yet it is smaller than the inequality attributed to noncommunicable diseases. These observations provide further evidence supporting findings of the the decomposition analysis.

Quite the opposite results are observed for inequality in lower middle and low income groups. All concentration curves depicted in ***Figure 9*** lie everywhere below the diagonal suggesting that health disparities are to the disadvantage of the worse-off countries in the low income group. The curve for Communicable, maternal, perinatal and nutritional conditions stays furthest from the 45-degree line indicating that health disparities associated with this disease category contribute the most to the overall group inequality.

Figure 8 (left) and 9: Concentration curves of the major disease categories drawn as deviations from the diagonal for high and low income groups.



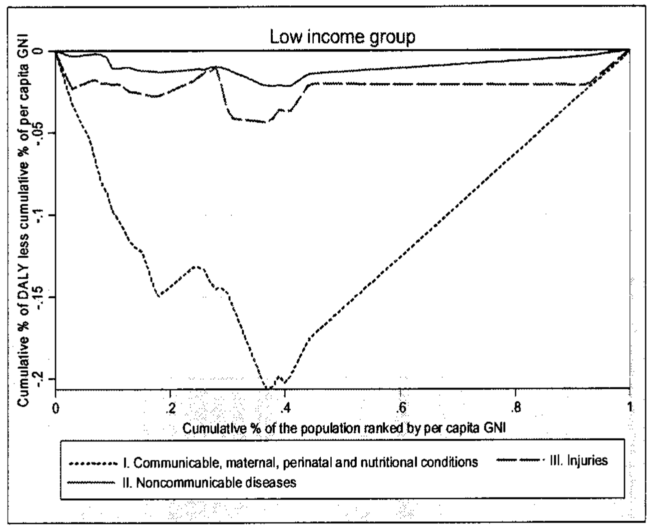
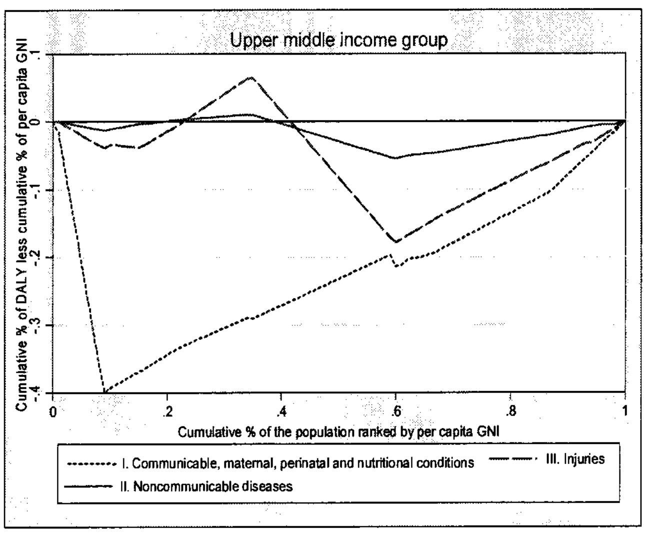
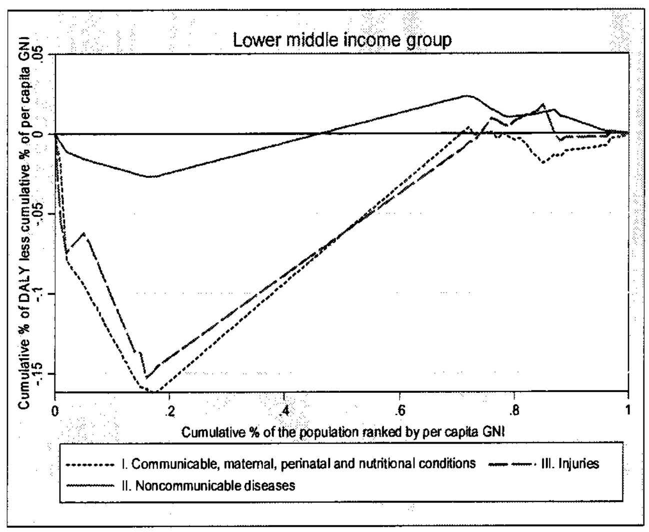


Figure 10 (left) and 11: Concentration curves of the major disease categories drawn as deviations from the diagonal for upper and lower middle income groups.





Concentration curves for the lower middle income group are drawn in ***Figure 11***. All the curves are drawn mainly below the diagonal. For Injuries and Communicable, maternal, perinatal and nutritional conditions, the parts of the curves under the 45-degree line lie distinctly further from the diagonal than those above, which suggests existence of pro-rich inequality between countries in this income group. The curve for Noncommunicable diseases crosses the axis at 45th percentile with segments above and below the diagonal roughly cancelling each other. This observation coupled with a small negative concentration index (-0.001472) implies that poorer countries in the lower middle income group endure higher concentration of ill health caused by noncommunicable ailments. Inequality patterns of diseases in the upper middle income group are presented in ***Figure 10***. The concentration curve for Communicable, maternal, perinatal and nutritional conditions runs everywhere below the 45-degree line providing evidence of inequality unfavourable to the poor. On the other hand, the curves for Injuries and Noncommunicable diseases cross the diagonal twice with segments below lying further from the axis than those above. In addition to negative concentration indices (-0.102703 and -0.034049), these observations suggest that Injuries and Noncommunicable diseases are more prevalent among the poorer countries in the upper middle income group. These results further reinforce findings discovered by the decomposition analysis. However, based on the shapes of the concentration curves and their respective indices, it appears that graphical analysis identifies Injuries rather than Noncommunicable diseases as the second main contributor of global inequality witch contradicts to the results of the decomposition. Yet this disparity in the outcomes may be due to the adjustment of disease contributions by their respective decomposition weights.

It is also interesting to examine socioeconomic health inequality within income groups at the more disaggregated level. In particular, in high income group ill health associated with most conditions is concentrated between the better-off countries as can be seen from positive inequality contributions of most diseases. Specifically, Neuropsychiatric conditions emerge as a leading source of health inequality accounting for over 60% of the disparities. These are followed by Respiratory and Cardiovascular diseases responsible for approximately 17% and 11% respectively. Significant negative inequality contribution of 9% comes from Sense organ diseases. Notably, all of the primary sources of inequality in high income group belong to Noncommunicable diseases.

In the low income group, on the other hand, most of the inequality unfavourable to the poor arises from infectious and parasitic diseases, respiratory infections and maternal conditions responsible for 65%, 12% and 9% of the health gap accordingly.

Similar findings emerge for lower middle income group with Perinatal conditions also observed among the top inequality contributors accounting for nearly 9% of the disparities. Among Noncommunicable diseases, Neuropsychiatric conditions are particularly interesting capturing almost 13% of the inequality with DALY loss concentrated among the better-off countries in the group. In addition, Sense organ diseases are found to make significant negative inequality contributions representing approximately 6% of the health gap. Interestingly, Injuries contribute overwhelming 28% of the disparities in this group with the health burden accentuated among the least advantaged countries.

In the upper middle group, nearly 70% of the inequality arises due to Infectious and parasitic diseases. Cardiovascular diseases and Intentional Injuries are found to contribute considerably smaller inequality shares equal to 7% and 5.6% respectively. Health loss attributed to these diseases prevails among the worse-off countries in the group. The contributions of all remaining diseases in this income group does not exceed 4%.

To further explore socioeconomic health disparities across WHO regions, I also estimate inequality contributions from various diseases for each WHO region. ***Table 7*** presents summary of the decomposition results. Aggregating inequality contributions across the three major disease categories for each region yields estimates of the region-specific overall inequality. As ***Table 7*** reveals, all the estimates are found to be negative implying that burden of disease is accentuated among the least advantaged countries in all regions. However, inequality estimates differ across the regions. Eastern Mediterranean, European Regions and Region of the Americas endure the most severe health disparities with inequality estimates equal to -0.161450, -0.166396 and -0.122306 accordingly. The contributions of major disease categories also vary from region to region. In Eastern Mediterranean, European, Western Pacific Regions and Region of the Americas the burden of ill health attributed to all major disease categories is predominant among the poorer countries as can be seen from negative inequality contributions across all major categories. In African Region, on the other hand, DALY loss caused by Noncommunicable diseases is more severe in richer countries, while ill health associated with Injuries and Communicable, maternal, perinatal and nutritional conditions is more prevalent among poorer countries in the area. Also, in South-East Asia Region inequality arising due to Injuries is unfavourable to the better-off countries, while disparities emerging due to the remaining main disease categories are disadvantageous to the worse-off countries in the region. The magnitude of inequality contributions of major disease categories is also of a considerable interest. Communicable maternal, perinatal and nutritional conditions arise as a leading source of overall health inequality in all the regions except for European Region.

Table 7: Decomposition of socioeconomic health inequality in each WHO region by disease category

Disease category/ Overall regional inequality	African Region		Region of the Americas		Eastern Mediterranean Region		European Region		South-East Asia Region		Western Pacific Region	
	WsCIs*	%*	WsCIs	%	WsCIs	%	WsCIs	%	WsCIs	%	WsCIs	%
I. Communicable, maternal, perinatal and nutritional conditions	-0.028159	93.9%	-0.066811	54.6%	-0.106553	66.0%	-0.054361	32.7%	-0.023794	118.7%	-0.053888	60.3%
A. Infectious and parasitic diseases	-0.006008	20.3%	-0.031617	25.2%	-0.052672	32.6%	-0.018143	11.1%	-0.009401	53.4%	-0.032519	33.0%
B. Respiratory infections	-0.010052	34.0%	-0.010129	8.1%	-0.023770	14.7%	-0.012015	7.4%	-0.003749	21.3%	-0.009793	9.9%
C. Maternal conditions	-0.005270	17.8%	-0.007128	5.7%	-0.014051	8.7%	-0.002484	1.5%	-0.001914	10.9%	-0.007325	7.4%
D. Conditions arising during the perinatal period	-0.003968	13.4%	-0.011018	8.8%	-0.013045	8.1%	-0.016392	10.0%	-0.006149	34.9%	-0.005436	5.5%
E. Nutritional deficiencies	-0.002519	8.5%	-0.007307	5.8%	-0.004534	2.8%	-0.005513	3.4%	-0.001869	10.6%	-0.004865	4.9%
II. Noncommunicable diseases	0.001008	-3.4%	-0.029908	24.5%	-0.035036	21.7%	-0.085135	51.2%	-0.006670	33.3%	-0.031578	35.3%
A. Malignant neoplasms	0.000084	-0.3%	-0.000043	0.03%	-0.004372	2.7%	-0.000606	0.4%	0.001864	-10.58%	0.000023	-0.02%
B. Other neoplasms	0.000008	0.0%	-0.000007	0.01%	-0.000449	0.3%	0.000176	-0.1%	-0.000031	0.17%	0.000060	-0.1%
C. Diabetes mellitus	0.000534	-1.8%	-0.001494	1.2%	0.000945	-0.6%	-0.001449	0.9%	0.001733	-9.8%	-0.001056	1.1%
D. Endocrine disorders	-0.000190	0.6%	-0.001128	0.9%	-0.000585	0.4%	0.000036	0.0%	0.000744	-4.2%	-0.000344	0.3%
E. Neuropsychiatric conditions	0.001063	-3.6%	-0.001115	0.9%	-0.002435	1.5%	-0.001275	0.8%	-0.001923	10.9%	-0.003281	3.3%
F. Sense organ diseases	-0.000178	0.6%	-0.003943	3.1%	-0.003610	2.2%	-0.002549	1.6%	-0.001021	5.8%	-0.005584	5.7%
G. Cardiovascular diseases	-0.000403	1.4%	-0.010281	8.2%	-0.012366	7.6%	-0.057161	35.0%	-0.005618	31.9%	-0.014485	14.7%
H. Respiratory diseases	0.000130	-0.4%	-0.001370	1.1%	-0.003310	2.0%	-0.000196	0.1%	-0.000582	3.3%	-0.002188	2.2%
I. Digestive diseases	-0.000191	0.6%	-0.005559	4.4%	-0.004695	2.9%	-0.007380	4.5%	-0.000828	4.7%	-0.002725	2.8%
J. Genitourinary diseases	0.000000	0.0%	-0.003177	2.5%	-0.001344	0.8%	-0.002415	1.5%	0.000235	-1.3%	-0.002483	2.5%
K. Skin diseases	-0.000019	0.1%	-0.001281	1.0%	-0.000423	0.3%	-0.000562	0.3%	0.000378	-2.1%	-0.000853	0.9%
L. Musculoskeletal diseases	0.000071	-0.2%	-0.001029	0.8%	-0.000354	0.2%	-0.003616	2.2%	0.000808	-4.6%	-0.001083	1.1%
M. Congenital anomalies	0.000122	-0.4%	-0.000131	0.1%	-0.001914	1.2%	-0.003910	2.4%	-0.000651	3.7%	-0.000408	0.4%
N. Oral conditions	0.000000	0.0%	-0.002415	1.9%	0.000659	-0.4%	-0.000852	0.5%	-0.000030	0.2%	-0.000410	0.4%
III. Injuries	-0.002826	9.4%	-0.025587	20.9%	-0.019861	12.3%	-0.026900	16.2%	0.010421	-52.0%	-0.003946	4.4%
A. Unintentional injuries	-0.001721	5.8%	-0.008159	6.5%	-0.006743	4.2%	-0.021051	12.9%	0.011494	-65.3%	-0.003151	3.2%
B. Intentional injuries	-0.001095	3.7%	-0.017206	13.7%	-0.012621	7.8%	-0.005868	3.6%	-0.001098	6.2%	-0.000758	0.8%
Overall regional inequality (based on the three major disease categories)	-0.029976		-0.122306		-0.161450		-0.166396		-0.020043		-0.089411	

WsCIs* , relative contribution of a disease category to socioeconomic health inequality in a given WHO region

%* , percentage contribution of a disease category to socioeconomic health inequality in a given WHO region

Disparities associated with diseases in this category are most pronounced in South-East Asia, African, and Eastern Mediterranean regions contributing approximately 120%, 95% and 66% of inequality respectively. Noncommunicable diseases emerge as a main contributor of regional inequality in the European Region capturing 51% of the disparities, while inequality arising due to these ailments in African Region is found to be very small (3.4%). Notably, in South-East Asia Region health disparities attributed to Injuries account for striking 52% of the regional disparities that are unfavourable to the richer countries. Region of the Americas also experiences relatively high level of inequality associated with Injuries (21%). In the remaining regions, however, Injuries make considerably smaller inequality contributions that do not exceed 16%.

At the more disaggregated level of analysis, cardiovascular, infectious and parasitic diseases, perinatal conditions and respiratory infections are shown to be most relevant for the European Region contributing 35%, 11%, 10%, and 7% of regional inequality unfavourable to the least prosperous countries respectively. Similar inequality patterns are observed for Western Pacific Region with Maternal conditions also identified among leading sources of overall disparities in the area accounting for 7% of the regional health gap. In Region of the Americas and Eastern Mediterranean Region most of the inequality disadvantageous to the poor arises due to Infectious and parasitic diseases, Respiratory infections, Maternal and Perinatal conditions, Cardiovascular diseases and Intentional injuries. For African Region, ailments comprising disease category I are of the greatest importance with Infectious and parasitic diseases as well as Respiratory infections contributing the most of the inequality in the region (20% and 34% accordingly). Particularly interesting are the decomposition results for South-East Asia Region. The largest negative inequality contributions are observed for all ailments in category I as well as Cardiovascular diseases and Neuropsychiatric conditions, while malignant neoplasms and Unintentional injuries make significant positive contributions. Of greatest significance in this region are Unintentional injuries and Infectious and parasitic diseases contributing 65% and 53% of the inequality respectively. Overall, diseases in category I are found to be among the leading sources of region-specific inequality for all the regions.

7. Conclusion

In this paper, global health inequalities associated with socioeconomic status were explored at a disaggregated level. Two types of decomposition analysis were used for this purpose. In the first one, weighted contributions of disease categories to world socioeconomic inequality in health were examined. Decomposition by disease category was also carried out for each income group and WHO region separately. Another type of decomposition investigated the extent to which between-country inequality is cumulated within and between groups of countries stratified by income and WHO region.

The results of the decomposition analysis by disease provide strong evidence supporting existence of income-related world inequality in health unfavourable to poorer countries. Notably, only malignant neoplasms and neuropsychiatric conditions were found to contribute positively to the overall inequality. The magnitude of inequality contributions was shown to fluctuate considerably across diseases. Remarkably, communicable, maternal, perinatal and nutritional conditions were found to contribute the most to global inequality accounting for almost 80% of the overall health disparities. In particular, infectious and parasitic diseases are responsible for almost half of the world health inequality. Among noncommunicable diseases, cardionvascular and sense organ diseases were shown to contribute heavier than other conditions accounting for 6.7% and 4% of inequality respectively.

In addition, noncommunicable diseases were found to be the major source of inequality favouring worse-off countries in the high income group, while communicable, maternal, perinatal and nutritional conditions were shown to be more important for the remaining lower income groups with inequality disadvantageous to the poorer countries.

Also, decomposition analysis by disease carried out for each WHO region discovered evidence of higher concentration of disease burden among poorer countries in all regions. The largest regional inequality was observed in South-East Asia, African and Eastern Mediterranean regions. Communicable, maternal, perinatal and nutritional conditions were identified as the major inequality contributor across all the WHO regions except for the European Region in which most of the inequality arises due to noncommunicable diseases. Inequality associated with Injuries was found to be most prominent in South-East Asia Region and Region of the Americas. Noncommunicable diseases in African region and Injuries in South-East Asia Region were shown to contribute positively toward overall regional inequality implying that richer countries bear higher burden of ill health caused by these ailments than the poorer countries.

Between-country inequality was found to be disadvantageous for most deprived countries. Decomposing it by WHO regions showed that inequality between regions represents the leading source of the between-country inequality capturing approximately 80% of disparities. On the other hand, inequality within regions constitutes only a modest share of the overall disparities between countries contributing 8% of the health gap. Within-region inequality was shown to be more prominent for Western Pacific and European Regions.

Similarly, income group decomposition of the between-country inequality indicates that inequality arising between income groups is about 7 times as high as inequality originated within those groups. The most severe within-group disparities were observed for the low income group. Interestingly, high income group was found to contribute positively to the inequality within groups indicating that ill health is more pronounced among richer countries in the group.

The decomposition analyses conducted in this paper provide valuable insights about the origins of global inequality in health and have important implications for policy initiatives aimed at lessening health inequality worldwide. In particular, the results suggest that inequality arising between WHO regions and income groups should be the main focus of the policy measures designed to curtail inequality. Also, priority targeting of heath disparities attributable to communicable, maternal, perinatal and nutritional conditions should prove most effective at narrowing the global health divide.

The analysis in this paper can be further extended by applying integrated decomposition technique proposed by Lauridsen et al. (2007) to disaggregate global socioeconomic health inequality into relative contributions from income groups and geographic units via each of the disease categories. Also, it would be interesting to examine how different socioeconomic characteristics contribute via each disease category to the world socioeconomic inequality in health.

Appendix A

Table A1: 173 countries arranged by WHO regions

WHO region	Countries included*
African Region	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia,
Region of the Americas	Antigua and Barbuda, Argentina, Belize, Bolivia, Brazil, Canada, United States of America Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Saint Vincent and the Grenadines, Saint Kitts and Nevis, Suriname, Trinidad and Tobago, Uruguay, Venezuela (Bolivarian Republic of)
Eastern Mediterranean Region	Afghanistan, Djibouti, Egypt, Iran (Islamic Republic of), Iraq, Jordan, Lebanon, Libyan Arab Jamahiriya, Morocco, Oman, Pakistan, Sudan, Syrian Arab Republic, Tunisia, Yemen, Bahrain, Kuwait, Saudi Arabia, United Arab Emirates
European Region	Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland, United Kingdom, Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Poland, Romania, Russian Federation, Serbia and Montenegro, Slovakia, Tajikistan, The former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Uzbekistan, Ukraine
South-East Asia Region	Bangladesh, Bhutan, India, Indonesia, Maldives, Nepal, Sri Lanka, Thailand, Timor-Leste
Western Pacific Region	Australia, Brunei Darussalam, Japan, New Zealand, Republic of Korea, Singapore, Cambodia, China, Fiji, Kiribati, Lao People's Democratic Republic, Malaysia, Micronesia (Federated States of), Mongolia, Papua New Guinea, Philippines, Samoa, Solomon Islands, Tonga, Vanuatu, Viet Nam

* For the decompositions by disease Seychelles, Saint Kitts and Nevis, Grenada and Kiribati were excluded from the analysis.

*Table A2: 173 countries arranged by income group**

Income group	Countries included**
High income	Australia, Austria, Bahrain, Belgium, Brunei Darussalam, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Kuwait, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Republic of Korea, Saudi Arabia, Singapore, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States of America
Upper middle income	Antigua and Barbuda, Argentina, Belize, Botswana, Chile, Costa Rica, Croatia, Czech Republic, Dominica, Equatorial Guinea, Estonia, Gabon, Grenada, Hungary, Latvia, Lebanon, Libyan Arab Jamahiriya, Lithuania, Malaysia, Mauritius, Mexico, Oman, Panama, Poland, Russian Federation, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Seychelles, Slovakia, South Africa, Trinidad and Tobago, Turkey, Uruguay, Venezuela (Bolivarian Republic of)
Lower middle income	Albania, Algeria, Angola, Armenia, Azerbaijan, Belarus, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Cape Verde, China, Colombia, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Georgia, Guatemala, Guyana, Honduras, Indonesia, Iran (Islamic Republic of), Iraq, Jamaica, Jordan, Kazakhstan, Kiribati, Maldives, Micronesia (Federated States of), Morocco, Namibia, Paraguay, Peru, Philippines, Romania, Samoa, Serbia and Montenegro, Sri Lanka, Suriname, Swaziland, Syrian Arab Republic, Thailand, The former Yugoslav Republic of Macedonia, Tonga, Tunisia, Turkmenistan, Ukraine, Vanuatu
Low income	Afghanistan, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic People's Republic of Korea, Democratic Republic of the Congo, Eritrea, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Haiti, India, Kenya, Kyrgyzstan, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Moldova, Mongolia, Mozambique, Myanmar, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Papua New Guinea, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, Sudan, Tajikistan, Timor-Leste, Togo, Uganda, United Republic of Tanzania, Uzbekistan, Viet Nam, Yemen, Zambia, Zimbabwe

*Income groups are defined in terms of the World Bank's classification for the year 2004. Countries were assigned to groups based on the 2004 Gross National Income (GNI) per capita.

** For the decompositions by disease Seychelles, Saint Kitts and Nevis, Grenada and Kiribati were excluded from the analysis.

Table A3: Diseases grouped by major categories

Major Category	Sub-category
I. Communicable, maternal, perinatal and nutritional conditions	A. Infectious and parasitic diseases B. Respiratory infections C. Maternal conditions D. Conditions arising during the perinatal period E. Nutritional deficiencies
II. Noncommunicable diseases	A. Malignant neoplasms B. Other neoplasms C. Diabetes mellitus D. Endocrine disorders E. Neuropsychiatric conditions F. Sense organ diseases G. Cardiovascular diseases H. Respiratory diseases I.Digestive diseases J. Genitourinary diseases K. Skin diseases L. Musculoskeletal diseases M. Congenital anomalies N. Oral conditions
III. Injuries	A. Unintentional injuries B. Intentional injuries

Table A4: List of 173 countries used in the analysis

Afghanistan	Georgia	Panama
Albania	Germany	Papua New Guinea
Algeria	Ghana	Paraguay
Angola	Greece	Peru
Antigua and Barbuda	Grenada	Philippines
Argentina	Guatemala	Poland
Armenia	Guinea	Portugal
Australia	Guinea-Bissau	Republic of Korea
Austria	Guyana	Republic of Moldova
Azerbaijan	Honduras	Romania
Bahrain	Hungary	Russian Federation
Bangladesh	Iceland	Rwanda
Belarus	India	Saint Kitts and Nevis
Belgium	Indonesia	Saint Lucia
Belize	Iran (Islamic Republic of)	Saint Vincent and the Grenadines
Benin	Iraq	Samoa
Bhutan	Ireland	Saudi Arabia
Bolivia	Israel	Senegal
Bosnia and Herzegovina	Italy	Serbia and Montenegro
Botswana	Jamaica	Seychelles
Brazil	Japan	Sierra Leone
Brunei Darussalam	Jordan	Singapore
Bulgaria	Kazakhstan	Slovakia
Burkina Faso	Kenya	Slovenia
Burundi	Kiribati	Solomon Islands
Cambodia	Kuwait	South Africa
Cameroon	Kyrgyzstan	Spain
Canada	Lao People's Democratic Republic	Sri Lanka
Cape Verde	Latvia	Sudan
Central African Republic	Lebanon	Suriname
Chad	Lesotho	Swaziland
Chile	Liberia	Sweden
China	Libyan Arab Jamahiriya	Switzerland
Colombia	Lithuania	Syrian Arab Republic
Comoros	Luxembourg	Tajikistan
Congo	Madagascar	Thailand
Costa Rica	Malawi	The former Yugoslav Republic of Macedonia
Croatia	Malaysia	Timor-Leste
Cyprus	Maldives	Togo
Czech Republic	Mali	Tonga
Côte d'Ivoire	Malta	Trinidad and Tobago
Democratic Republic of the Congo	Mauritania	Tunisia
Denmark	Mauritius	Turkey
Djibouti	Mexico	Turkmenistan
Dominica	Micronesia (Federated States of)	Uganda
Dominican Republic	Mongolia	Ukraine
Ecuador	Morocco	United Arab Emirates
Egypt	Mozambique	United Kingdom
El Salvador	Namibia	United Republic of Tanzania
Equatorial Guinea	Nepal	United States of America
Eritrea	Netherlands	Uruguay
Estonia	New Zealand	Uzbekistan
Ethiopia	Nicaragua	Vanuatu
Fiji	Niger	Venezuela (Bolivarian Republic of)
Finland	Nigeria	Viet Nam
France	Norway	Yemen
Gabon	Oman	Zambia
Gambia	Pakistan	

References

1. Aaberge R., Bjorklund A., Jantti M., Pedersen P., Smith N., and Wennemo T. (2000). Unemployment Shocks and Income Distribution: How Did the Nordic Countries Fare during Their Crises? Scandinavian Journal of Economics, 102, 77-99
2. Achdut L. (1996). Income Inequality, Income Composition and Macroeconomic Trends: Israel, 1979-93. Economica,,63, 27.
3. Asada Y. (2005). Assessment of the health of Americans: the average health-related quality of life and its inequality across individuals and groups. Population health metrics, 3:7.
4. Cancian M. and Reed D. (1998). Assessing the Effects of Wives' Earnings on Family Income Inequality. Review of Economics and Statistics, 80, 73-79.
5. Cavelaars A., Kunst A.E., J. Geurts, R. Crialesi, L. Grotvedt, U. Helmert, E. Lahelma, O. Lundberg, J. Matheson, A. Mielck, A. Mizrahi, Arie Mizrahi, N. Kr Rasmussen, E. Regidor, T. Spuhler, J. Machenbach (1998), Differences in self reported morbidity by educational level: A comparison of 11 Western European countries. Journal of epidemiology and community health, 52: 219-227.
6. Clarke P., L. Smith and C. Jenkinson (2002). Comparing health inequalities among men aged 18-65 years in Australia and England using the SF-36. Australian and New Zealand Journal of public health, 26.
7. Clarke P., Ulf-G. Gerdtham and L. Connelly (2003). A note on the decomposition of the health concentration index. Health economics, 12: 511-516.
8. Dagum, C. (1997). A New Approach to the Decomposition of the Gini Income Inequality Ratio. Empirical Economics, 22, 515—31.
9. Deutsch J. and Silber J. (1999a). Inequality Decomposition by Population Subgroups and the Analysis of Interdistributional Inequality. Handbook of income inequality measurement. With a foreword by Amartya Sen, ed. by J. Silber, Boston; Dordrecht and London: Kluwer Academic, Recent Economic Thought, 363-97.
10. Deutsch J. and Silber J. (1999b). On Some Implications of Dagum's Interpretation of the Decomposition of the Gini Index by Population Subgroups. Advances in econometrics, income distribution and scientific methodology: Essays in honor of Camilo Dagum, ed. by D. J. Slottje, Heidelberg: Physica, 269-91.

11. Gustafsson B. and Shi L. (2001). Types of Income and Inequality in China at the End of 1980s. Review of Income and Wealth, 43, 211-26.
12. Gundgaard J. and Lauridsen T. (2006). Decomposition of sources of income-related health inequality applied on SF-36 summary scores: a Danish health survey. Health and quality of life outcomes, 4:53.
13. Gwatkin D.R. (2000). Health inequalities and the health of the poor: what do we know? What can we do? Bull World Health Organization. 78.
14. Gwatkin D. and M. Guillot (2000). The burden of Disease among the global poor: Current situation, future trends, and implications for strategy. The World Bank.
15. Jong-wook L. (2003). Global health improvement and WHO: shaping the future. Lancet , 362.
16. Keeney M. (2000). The Distributional Impact of Direct Payments on Irish Farm Incomes. Journal of Agricultural Economics, 51, 252-65.
17. Kunst A., J. Geurts, J. van den Berg (1995). International variation in socioeconomic inequalities in self reported health. Journal of epidemiology and community health 49, 117-123.
18. Kunst A.and J. Machenbach (1997). Measuring the magnitude of socio-economic inequalities in health: an overview of available measures illustrated with two examples from Europe. Social science and medicine 44,757-771.
19. Lahelma E. and T. Valkonen (1990). Health and social inequalities in Finland and elsewhere. Social Science and Medicine 31, 257-265.
20. Lauridsen J., T. Christiansen, J. Gundgaard, U. Hakkinen and H. Sintonen (2007). Decomposition of health inequality by determinants and dimensions. Health economics, 16: 97-102.
21. Le Grand J. (1987). Inequality in health: Some international comparisons, European Economic Review 31, 182-191.
22. Leibbrandt M., Woolard C. and Woolard I. (2000). The Contribution of Income Components to Income Inequality in the Rural Former Homelands of South Africa: A Decomposable Gini Analysis. Journal of African Economies, 9, 79-99.

23. Lerman R. (1999). How Do Income Sources Affect Income Inequality? in Handbook of income inequality measurement. With a foreword by Amartya Sen, ed. by J. Silber, Boston. Dordrecht and London: Kluwer Academic, Recent Economic Thought, 341-58.
24. Lerman R. and S. Yitzhaki (1985). Income Inequality Effects by Income Source: A New Approach and Applications to the United States," Review of Economics and Statistics, 67, 151-156.
25. Machenbach J., I. Stirbu, A-J. Roskam, M. Schaap, G. Menvielle, M. Leinsalu, A. Kunst (2008). Socioeconomic inequalities in health in 22 European countries. The New England Journal of Medicine, 358:2468-81.
26. Milanovic B. and Yitzhaki S. (2002). Decomposing World Income Distribution: Does the World Have a Middle Class? Review of Income and Wealth, 48, 155-78.
27. Morduch J. and Sicular T. (2002). Rethinking Inequality Decomposition, with Evidence from Rural China. Economic Journal, 112, 93-106.
28. Murray C. J. L. and Acharya A. K. (1997). Understanding DALYs. Journal of Health Economics 16 : 6 703 – 30
29. Murray J.L., Mathers C.D., Lopez A.D., Ezzati M., Jamison D. (2006). Global Burden of Disease and Risk Factors. Chapter 3. The International Bank for Reconstruction and Development/The World Bank Group.
30. Pamuk E. (1985). Social class inequality in mortality from 1921-1972 in England and Wales. Population Studies 39, 17-31.
31. Pradhan M., D. Sahn, S. Younger (2003). Decomposing world health inequality. Journal of health economics, 22: 271-293.
32. Podder N. (1993). The Disaggregation of the Gini Coefficient by Factor Components and Its Applications to Australia. Review of Income and Wealth, 39, 51-61.
33. Podder N. and Mukhopadhaya P. (2001). The Changing Pattern of Sources of Income and Its Impact on Inequality: The Method and Its Application to Australia, 1975-94. Economic Record, 77, 242-51.
34. Reidpath D., Allotey P., Kouame A. and Cummins R. (2003). Measuring health in a vacuum: examining the disability weight of the DALY. Oxford University Press. Health policy and planning, 18(4).

35. Reidpath D. and P. Allotey (2007). Measuring global health inequity. International journal for equity in health, 6:16.
36. Ruger J. and Kim H-J. (2006). Global health inequalities: an international comparison. Journal of epidemiology and community health, 60: 928-936.
37. Safaei J. (2007). Global income-related health inequalities. Social medicine, 2.
38. Sastry D. and Kelkar U. (1994). Note on the Decomposition of Gini Inequality. Review of Economics and Statistics, 76, 584-86.
39. Shorrocks A. (1982). Inequality Decomposition by Factor Components. Econometrica, 50, 193- 211.
40. Sihvonen A., A. Kunst, E. Lahelma, T. Valkonen and J. Machenbach (1998). Socioeconomic inequalities in health expectancy in Finland and Norway in the late 1980s. Social science and medicine 47,303-315.
41. Townsend P. and Davidson N. (1982). Inequalities in Health: The Black Report. Penguin, Harmondsworth.
42. Tsui K. (1998). Trends and Inequalities of Rural Welfare in China: Evidence from Rural Households in Guangdong and Sichuan. Journal of Comparative Economics, 26, 783-804.
43. Van de Poel E., Hosseinpoor A. R., Speybroeck N., Van Ourti T. and Vega J. (2008). Socioeconomic inequality in malnutrition in developing countries. Bulletin of the WHO, 86(4).
44. Van Doorslaer E., A. Wagstaff, H. Bleichrodt, S. Calonge, Ulf-G. Gerdtham, M. Gerfin, J.Geurts, L. Gross, U. Hakkinen, R.E. Leu, O. O'Donnell, C. Propper, F. Puffer, M. Rodriquez, G. Sundberg, O. Winkelhake (1997). Income-related inequalities in health: some international comparisons. Journal of health economics, 16: 93-112.
45. Wagstaff A. (2000). Socioeconomic inequalities in child mortality: comparisons across nine developing countries. Bulletin of the WHO, 78(1).
46. Wagstaff A.,P. Paci, and E. van Doorslaer (1989). Equity in the finance and delivery of health care: Some tentative cross-country comparisons, Oxford Review of Economic Policy 6, 89-112.
47. Wagstaff A.,P. Paci, and E. van Doorslaer (1991). On the measurement of inequalities in health. Social science and medicine 33, 545-557.

48. Wagstaff A. and Watanabe N. (2000). Socioeconomic Inequalities in child malnutrition in the developing world. Policy research working paper 2434. World Bank.
49. Wagstaff A., E. van Doorslaer and N. Watanabe (2001). On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam. The World Bank.
50. Wagstaff A. and E. van Doorslaer (2004). Overall versus socioeconomic health inequality: a measurement framework and two empirical illustrations. Health economics, 13: 297-301.
51. WHO (1993). Health for all targets. The health policy for Europe, September 1991. Copenhagen.
52. World Health Assembly, 1998. Health-for-all policy for the twenty-first century. 51st World Health Assembly.
53. WHO (1999). The health for all policy framework for the WHO European Region. Health 21. Copenhagen.
54. WHO (2000). The World Health Report 2000: health systems: improving performance. Geneva, Switzerland.
55. WHO (2005). WHO Commission on Social Determinant of Health. Social determinants of health: measuring progress and evaluating evidence. Santiago, Chile.
56. Wodon Q. (1999). Between Group Inequality and Targeted Transfers. Review of Income and Wealth, 45, 21-39.
57. World Bank (1997). Health, nutrition and population sector strategy. Washington, DC.
58. Yao S. (1997).Decomposition of Gini Coefficients by Income Factors: A New Approach and Application. Applied Economics Letters, 4, 27-31.
59. Yitzhaki S. and Lerman R. (1991). Income Stratification and Income Inequality. Review of Income and Wealth, 37, 313-29.