

Health Inequality across Populations of Individuals

David E. Sahn
Cornell University

Prepared for the African Economic Research Consortium

Health, Economic Growth and Poverty Reduction in Africa:

Framework Papers Review Workshop

Accra, Ghana

April 20-22, 2009

I. Introduction

Health inequality has many definitions and dimensions. In addition to reviewing them in this paper, I will also discuss the methods employed to measure health inequality, and the related questions of why we should be concerned with health inequality. As a point of departure, it is worth reinforcing that the focus of this paper is inequality, a broad concept that examines the dispersion of the distribution of health. The measurement of inequality is independent of the mean, and it is thus a relative concept. This, of course, distinguishes the concept of inequality from poverty or some other indicator of the absolute level of well-being; in the case of the latter, attention is focused on those households and individuals who fall below some normative threshold.

The fact that inequality is a relative, rather than an absolute indicator, raises a couple of interesting questions that will help motivate this paper. First, assuming we are interested in the idea of relative levels of well-being, why concern ourselves with the distribution of health, and not just the distribution of income, which is the normal metric for examining inequality? Second, why should we worry about “relative” health status, beyond being concerned with the absolute level of health?

In regard to the first question, a number of policy statements and papers have vigorously emphasized the need to reduce the differences in health status between countries and between socioeconomic groups within countries (e.g., WHO 1983, 1986; Whitehead 2000). These calls generally do not address the fundamental question as to why health, as distinct from income, inequality is of interest. I would suggest, however, that a number of considerations motivate this interest. First, Sen (1979, 1985, 1987) argues that the notion of poverty is inadequately captured by money metrics such as income or expenditure. Poverty is the deprivation of basic capabilities, or the failure of certain basic functionings, not just low levels of income. Low incomes are only *instrumentally significant*, while deprivation of capabilities, such as poor health, is *intrinsically important*. Health is thus a more direct measure of capability deprivation, or poverty, than is income or expenditures. And to the extent that measures of health are

appropriate arguments in the social welfare function, there are legitimate reasons to be concerned about health inequality directly.

Health inequality is also more likely to capture the notion of absolute deprivation in the population than is the measurement of income inequality. This reflects the differences in the underlying attributes of the distributions of income and health. In the former case, an increase in inequality is usually caused by a lengthening of the right-hand tail of the distribution – that is, the rich getting richer. In addition, observed increases in income inequality can be relatively easily to offset by increases in mean incomes, implying the potential for greater social welfare despite worsening inequality. For health, unlike incomes, improvements have a biological limit, at least given the present and foreseeable state of medical technology. Therefore, the distribution of health will likely not have a pronounced right-hand tail. Worsening health inequality is thus more likely to be a consequence of dispersion in the left-hand tail of the distribution, which implies that there is a greater likelihood that substantial health inequality is a result of a large dispersion of health in the population, and particularly of concern, people with low levels of healthiness. To the extent that this is the case, health inequality may tend to place more weight on the welfare of those at the lower end of the distribution.

A third reason for being concerned about health inequality relates to the possible health risks associated with disparities in socioeconomic circumstances (Wilkinson 1996, 1997). Wilkinson asserts that there are “neuroendocrine” pathways through which psychosocial risk factors link health to the inequality in a broad range of dimensions, so that implicitly, inequality of health status (as well as other measures of well-being) is a risk factor for poor health. As will be discussed below, the empirical evidence for this is far more limited than other relationships to be explored in this paper, but nonetheless, it is a provocative concept deserving of more careful scrutiny.

Finally, there are pragmatic motivations for examining inequality in health, rather than alternative metrics such as incomes. These derive from the nature of certain health measurements, which I will again discuss in greater detail later in the paper. Health commends itself to inequality measurement by virtue of several factors. First, incomes and expenditures are

generally measured at the level of the household. This contrasts with health which can be measured for individuals. Thus, it is not necessary to make unsupportable assumptions about the intra-household allocation of well-being when using health indicators, in contrast to money metric indicators. There is the additional advantage that health indicators lend themselves to exploring intra-household inequality, an issue I discuss later in the paper.

Second, comparison of incomes and expenditures across time or place is notoriously difficult in developing countries. Challenges include imputing the costs of home production and housing, valuing the rental value of durables, dealing with the problems that arise when own-account enterprises and self-employment make up large shares of consumption, the related difficulties of calculated profits from self-employment, and so forth. Furthermore, deviations in survey design, such as the recall period or the number of commodities in the consumption module, can influence the outcomes of these surveys (e.g., Pradhan 2001; Scott and Amenuvegbe 1990). There is also the challenge of deciding what deflators to employ to create comparable units across time and place. Price deflators suffer from great inaccuracies, especially at high inflation rates (Escobal d'Angelo and del Castillo 1994). Markets are poorly integrated in poor countries, with the result that spatial price variation is often vast; consequently, regional price deflators are required, but almost always are non-existent. Comparing income inequality across countries also requires accurate purchasing power parity indices, which again are in short supply in developing countries.

In contrast, as will be discussed further below, several health indicators are easily comparable across time and location. Additionally, they are not plagued by the problems of survey design, comparability of nominal units, or socioeconomic definitions that affect other welfare measures. So, we are better able to make inter-temporal and inter-country comparisons when focusing on an objective health outcome indicator, rather than trying to define comparable income levels of socioeconomic groups, the latter of which also tend to change in composition over time.

In regard to the second question, why would we concern ourselves with the distribution of health in addition to the levels of health, the answer is perhaps first and foremost to be found

in the relationship between inequality and social justice. It would seem compelling that to the extent that there is legitimate concern for the relationship between social justice in any space, for example, in income or various freedoms, that these concerns over fairness must apply to equity in the dimension; this, by virtue of health's central role as a condition of human existence. Beyond the centrality of health in defining human capabilities, the concern over the distribution of health may find some support in terms of how this dispersion may affect other considerations, such as growth and political stability. Again, these relationships will be discussed in greater detail below.

In the remainder of this paper, I will pull together these various concerns and considerations in the measurement of health inequality and its implications. In doing so, I will discuss concepts and methodology, in keeping with the intent of this framework paper to provide ideas for, and technical and methodological guidance to AERC network members in the Health, Poverty and Economic Growth Collaborative Project. To begin, Section II will focus on defining health indicators that are useful in the measurement of health inequality. In Section III, I will begin by discussing the two major conceptual approaches to health inequality, the univariate and gradient approaches. Section IV continues with a brief discussion of methods for making comparisons of distributions. In Section V, I will introduce the two major methodologies to measuring health inequality: the gradient approach and the univariate approach. I will then discuss issues of measurement of health status, and more specifically, the types of indicators that can be considered in making distributional comparisons in Section VI. Before concluding in the final section of the paper, I will address in Section VII a somewhat tangential, albeit important issue of the link between income inequality and health status.

II. Capabilities, Outcomes, and Access to Services

Motivating an interest in health inequality still leaves us with numerous conceptual challenges, including defining what we mean by inequality of health. Among the many challenges is, first, simply identifying appropriate measures of health – that is, indicators or dimensions over which inequality will be assessed. Health is a multi-dimensional concept. There is no simple or single measure that captures the entirety of a person's health status. More fundamental, however, is the point that derives from Sen's work on defining well-being where he

makes the distinction between equity in health achievements and equity in the capability to achieve good health. Beyond this distinction is a third domain in defining health inequality – that of the equality of access to health services. Indeed, all three concepts are related to social justice, and likewise, equality in all these three areas are expected to affect outcomes such as economic growth and political outcomes.

Ideally, I would give priority to examining inequality in terms of the capability to achieve health, and formulating policy with that objective. The problem is, however, there is no good metric of health capabilities. Doing so requires taking into account factors such as genetic diversity, as well as individual rights and choices that may get in the way of equalizing health outcomes. The obvious example is that of smokers who assert their rights to engage in this detrimental behavior. I expect that few would suggest that it is appropriate to equalize the health status of non-smokers with those who choose to smoke. This is especially the case if such an objective was to be achieved by directing a disproportionate share of public expenditures to smokers by heavily taxing non-smokers or even discriminating against non-smokers in terms of accessing public care. Thus, achieving the objective of equalizing health outcomes is not necessarily paramount in many circumstances. While this amply illustrates the limitations focusing on health outcomes, the challenge is that gathering data on capabilities in the domain of health is difficult, if not impossible to derive. Quite simply, much of what determines health status is unobservable, particularly the underlying genetic diversity in a population. And even the genetic factors that are observable, such as gender, are not easily amenable to change. We are thus left with little choice but to focus on health outcomes and access, despite the limitations in doing so.

In regard to equalizing health outcomes, the main question is how seriously we should take this objective. The answer is in part a function of the extent to which differences in health outcomes is a consequence of differences in individual preferences and genetic susceptibility to disease, or instead differences in the affordability or accessibility of health care. The latter is clearly a matter of concern for public policy. Making choices, for example, about who gets access to anti-retroviral therapies and mosquito nets is clearly a matter of great importance. Reorienting public priorities to ensure that such critical preventative and curative care is

provided is consistent with the objective of equalizing health outcome. Where matters get considerably more complex, however, is when confronting the prospect that achieving health equality is most easily achieved by withdrawing access for one patient and giving it to another, even if the needier and less healthy individual is now the recipient of care. So while the measurement of, and related objective to achieve health inequality focuses on issues of second moments, it is always necessary to keep in mind the means of the distributions as well.

A further qualification regarding the need to consider health inequality in the broader context is discussed by Sen who argues that inequality of health should be analyzed along with other dimensions of social arrangements, and more specifically, the overall allocation of resources to health. As he points out, it is possible to achieve health equality by withdrawing a life saving treatment from a man of means, and instead encouraging him to spend the implied savings on a luxury yacht. It would be difficult to argue that such an arrangement is either Pareto improving, or defensible as a policy to improve equality in health. If, however, the savings are allocated to health spending that raises the mean level of health, such a policy of redistribution would be far more defensible.

As discussed above, beyond measuring the equality of outcomes is the question of equality of access and utilization of health services. In addition to the distribution of health outcomes or differences in the capability to achieve health, access to health services is yet a third dimension of health equality. Further distinction can be made between health care that is private, and that supplied publicly by government. The extent to which the distribution of services, especially by the public sector, will map to health outcomes is interesting and the source of considerable conjecture and controversy. For example, public spending on health care may crowd out private sector spending. Second, there is the distinct possibility that publicly provided care is synonymous with low quality services. And third, it could also be the public sector chooses to provide the wrong services. These considerations suggest that where possible, it is not enough to simply look at the distribution of publicly provided services, but the efficacy of such spending, along with the effect upon, and quality of private sector services as well.

What really makes the analysis of the distribution of health services vexing is that there are inherent conflicts in objectives of public intervention. The tension is between equity and efficiency. There is the distinct possibility that public intervention in the health sector, particularly services such as primary health care, may prove ineffective in improving health for reasons noted above. This might be the case even if they are progressive, in terms of being well targeted. Likewise, many health services might not be appropriate when employing the criteria of having a large public goods component. However, it may equally be true that such health expenditures are progressive, and thus effective in transferring resources to the poor. But if the latter is the major criteria to judge health expenditures, it is equally arguable that the comparison should not be with other health services, but with other types of public spending, such as for education, food subsidies, and so forth. Indeed, there may also be certain types of expenditures, such as communicable disease control that is justified both on equity and efficiency criteria. But the challenge remains that any consideration of the distribution of health care must carefully delineate goals, the metrics of progressivity, and the tensions between equity and efficiency that inevitably arise.

III. Univariate and Gradient Approaches to Health Inequality

Two major approaches to defining health inequality are found in the literature. The first, representing the vast majority of the work in this area, involves examining inequality in health across a variety of dimensions of social and economic stratification. These include income, race, ethnicity, location, and gender. Making comparisons of health across populations with different social and economic characteristics is often referred to in the literature as the so-called “gradient” or “socioeconomic” approach to health inequality. Much of the motivation for examining the gradient approach to health inequality arises out of fundamental concerns over social and economic justice. The roots of the gradient will often arise from various types of discrimination, prejudice, and other legal, social, and economic norms that may contribute to stratification and fragmentation, and subsequently inequality in access to material resources and various correlated welfare outcomes.

The second approach, which has been referred to as the univariate approach to measuring pure health inequality, involves making comparisons of cardinal or scalar indicators of health

inequality and distributions of health, regardless of whether health is correlated with welfare measured along other dimensions. This univariate approach measures pure inequalities in health in a fashion that is similar to what is done for income distribution. Instead of ordering individuals along the x-axis by income (or expenditures) and drawing Lorenz curves using cumulative income, health is used instead to both order individuals from the least to most healthy, and describe the distribution of health.

This can be expressed more formally where we start from an Atkinson (1970) type social welfare function, S , which is defined in terms of the additively separable utilities across persons i . Instead of individual utility being measured in terms of income alone, however, I define the utility function with two arguments, say, income, y , and health, h , where utility is an increasing and concave function of both these arguments, such that:

$$S = \frac{1}{N} \sum_{i=1}^N U(h_i, y_i) \quad (1)$$

The gradient or socioeconomic inequality approach assumes that the two factors, income, y , and health, h , are substitutes in the social welfare function, $U_{hy} < 0$, while the univariate approach implies $U_{hy} = 0$, or $U(h) + U(y) = U(h,y)$. There is an important implication of the perspective that the two factors are substitutes: that a worsening in health status of a population can be compensated in part by poor health being less concentrated among the income poor. This substitutability also implies the social welfare function is greater if poor health is concentrated less among the poor, even if the distribution of pure health inequality worsens. Pure inequality, in contrast, assumes that the two factors are independent.

The preponderance of the literature on health inequality is focused on the gradient, with myriad examples of papers that document the socioeconomic correlates of poor health. It is possible, however, to draw only modest policy conclusions from examining the positive correlation between health and many indicators of socioeconomic status or various measures of social stratification. This derives from the production function literature that admonishes that correlations between health and other social indicators, including income and expenditures do not imply causality, and even the correlations themselves are often quite modest (Appleton and

Song 1999). Instead, a wide variety of social and economic circumstances and behaviors are not captured by the gradients reported in this literature. For example, when we look at the relationship between nutrition and incomes, a range of factors such as the psychological state of the primary care-giver, weaning and other feeding practices, social norms and behaviors that govern sexual transmission of diseases, and the natural occurrence of trace minerals and vitamins available in soils and foods have important influences on nutrition that are not mediated by incomes. Community factors often matter, too. The availability and quality of the health care system and related public health measures such as water and sanitation, vaccination coverage, etc., have all been shown to be of equal or greater importance in determining child nutrition than income (Pitt and Rosenzweig 1986; Thomas, Lavy, and Strauss 1996; Sahn and Alderman 1997; Haughton 1997).

One interesting implication of the low correlations often found between health and socioeconomic status variables, such as incomes, is that reducing the slope of the health:income gradient will not necessarily be an effective way of reducing with pure or univariate inequality in health – that is, inequality of health ordered by the health status of the population. This is especially the case because income distributions have a long right tail, an issue I will come back to in more detail later in this paper.

An additional conceptual weakness of measuring health inequality based on the gradient approach is well illustrated by Deaton (2003), who considers two populations, A and B, with equal levels of average health and equal levels of pure health inequality. Assume that in population A there is a strong correlation between health and income and in B, the correlation between health and income is weak – that is, in the latter case the gradient is quite flat. I would question the view that health inequality in population A is a more serious public policy problem than population B. It is still possible that the univariate distribution of health inequality may be worse in population B than A, despite that the correlation between income, or bivariate health inequality, is greater in the latter. Similarly, I would be reluctant to have to make a strong ethical argument that an improvement in health of a wealthy person is of less than value than a poor person, especially to the extent we were focused on health capabilities. Of course, if we were

unable to measure equality of health capabilities, rather than health outcomes, this becomes a more difficult argument to make.

There is additionally the option of exploring the equality of health services, as alluded to in the introduction. Basically, the focus on the delivery and or use of health care corresponds to the concept of expenditure incidence, which refers to the distribution of benefits, direct and indirect, that individuals receive from public expenditure. This concept and related methods for incidence analysis have been widely discussed in the literature (Sahn and Younger 2000) and will not be repeated in any detail here. Indeed, there are many challenges that need to be addressed, for example, providing an estimate of the value of a public subsidy or service to recipients. If it were possible, we would want a *monetary* estimate, just as we usually want a monetary representation of households' welfare (money metric utility). For some public expenditures, the monetary estimate is straightforward, but not so for health. This particularly applies to health spending with externalities, or the public goods components of health spending where we have no easy way of knowing what quantity each individual consumes or its value to him or her. Thus, we are left relying on estimates of budgetary costs or costs of service delivery, or even bivariate outcomes such as whether or not an individual receives a service, which are generally poor proxies for the utility gains of accessing health care.

Similarly, the descriptive nature of expenditure incidence only provides information on the incidence of existing health services which may in fact diverge markedly from the incidence of marginal spending on health. Conceptually, this problem could be overcome by more careful use of existing data, although in some cases, particularly the introduction of new services or the expansion of existing ones to new beneficiaries, existing descriptive data are insufficient. Similarly, there is tendency to focus the attention of benefit incidence studies on the actions of the public sector. While there is some logic in doing so, it also neglects the fact that household and private providers are likely to adjust their behavior in response to any change in the government provision of health services. Thus, ideally one would engage in econometric estimation to model behavior responses that represents a counter-factual exercise that compares health access under existing and alternative choices in terms of health care delivery policies. Econometric estimates can also begin to address an even more fundamental question of whether

spending on health services are effective in improving health, and if so, what are the distribution of the benefits in terms of health outcomes. This is where the concepts of benefit incidence and health outcomes converge into the broader objective of policy analysis.

IV. Measuring Health: Options for Exploring Inequality

Health status is multidimensional, and there are a vast number of health indicators that are widely used in the biomedical and allied health sciences. They capture a range of physical, mental, and social processes that contribute, along with genetic and phenotypic influences, to various aspects of health status. Some are measures of stocks of health, and others, flows; some indicators capture narrow aspects of health, and some of which are more general in their interpretation. There is also a distinction that can be made between indicators that are appropriate to define health status of individuals, while others are measures for populations. Clearly this distinction is important since it will determine the level of disaggregation possible in terms of exploring inequality across countries, within countries and even within households.

Among the most obvious other candidates for measuring inequality in health are those indicators most often used to define population health status: life expectancy, and mortality and morbidity rates. Variants on life expectancy that take into account “healthiness” of the lifespan also exist.¹ All have the advantage of being broad measures of health status. Data on these outcomes are also universally available, at least at the country level. There are, however, serious limitations of such measures for distributional analysis. First, they are characterized by considerable measurement problems. In the case of life expectancy, the life tables used for these calculations are based on data collected at a time in the (hopefully recent) past, but that time does not correspond to the future experiences of those presently alive (Deaton 1999). Similarly, the use of related indicators such as health risk, which are based on probabilities of death and incidence and remission of non-fatal health outcomes, cannot be measured at the individual

¹ There are methods for measuring healthiness of a lifespan, particularly based on the use of health state weights. Among the obvious problems with such approaches is the arbitrariness of the health state weights themselves that would indicate the degree to which someone is living in a state of less than full health. It is also noteworthy that serious measurement problems exist in terms of collecting and comparing data on non-fatal health outcomes that can be used to arrive at notions such as health expectancy. It would be a monumental challenge to collect such comparable data across countries, and in any event, such data do not exist to realize our objectives of assessing world health inequality.

level. Instead, approximations of health risk, as a function of age, must be made based on tenuous and incomplete information.²

In the case of infant or child mortality, death remains a rare event, even in poor countries, so that reliable studies using infant mortality would require very large samples (Mosley and Chen 1984). Furthermore, one cannot study inequality with a discrete variable, so any use of infant mortality requires estimating each child's probability of death. But econometric mortality models suffer from poor predictive capability, so the variation in predicted mortality will be substantially less than the true variation in mortality probability. Consequently, while the prediction may be useful for measuring levels of mortality, using predicted mortality will under-report inequality.

Beyond the use of population indicators are the potentially more informative indicators of individual health status. As noted above, measures at the level of individuals enable health inequality analysis to go beyond global inter-country distributions. Among the obvious candidates for measuring inter-personal differences in health is morbidity. However, the mis-measurement of self-reported illness is well documented for both specific ailments and general health status (Kroeger 1985; Hill and Mamdani 1989). One prominent manifestation of the bias in self-reported illness is the nearly universal finding from surveys conducted in developing countries that the rich are more likely to report being ill than the poor (Over et al. 1992), and that reported illness is a positive function of one's education (Schultz and Tansel 1997). Factors such as greater health awareness among the rich, and the poor's tendency to disregard illnesses to which they are accustomed, may explain this finding.³ Such bias in reporting is not random, further limiting the usefulness of such indicators to characterize the distribution of health.

A number of other possible indicators of health status, such as questions about general health status (GHS), and specific activities of normal daily living (ADLs) are also discussed in

² See Gakidou, Murray, and Frenk (2000) who estimate individual health risks by age and summarize them in a health survivorship function. A critique of this approach is found in Wolfson and Rowe (2001).

³ Bound (1991) also discusses the prospect of mis-reporting illness to facilitate eligibility in health-related transfer programs.

the literature.⁴ These suffer from various problems for distributional analysis, such as the difficulty of defining the reference for GHS type questions and the difficulty of defining “normal” when relying on ADLs. These problems are particularly acute when contemplating making health comparisons across countries with great economic, social, and cultural differences. Practically, there is also only limited experience with collecting data, particularly from developing countries, relying on these techniques. There are far too few cases where such data exist from representative surveys to contemplate making comparisons of their levels or inequalities across several countries.

There are also a series of bio-markers that can be considered to capture health status of individuals. Many can in principle be used as the basis for distributional analysis. These include options such as hemoglobin and c-reactive protein. However, both tend to measure a relatively narrow aspect of health status, are invasive in terms of collecting a drop of blood, and are relatively expensive, and thus not widely available.

While all the above indicators thus have serious limitations, perhaps the most promise for examining health inequalities lies in the use of anthropometric measures. Most noteworthy is the widely used metric of standardized heights, especially, but exclusively as applied to pre-school age children.⁵ Height of young children has useful properties for examining health inequality; furthermore, using height avoids numerous problems that make other measures of health unsuitable for the particular quantitative exercise that we undertake.

The most important reason to use the height of pre-school age children for our analysis of health inequality is the abundance of medical and public health research showing that children’s height is a good, objective indicator of their general health status (Cole and Parkin 1977; Mata 1978; Tanner 1981; Mosley and Chen 1984; WHO 1995). The principal determinants of the distribution of children’s height in a population are the accumulation of episodes of inadequate nutrient intake, disease, and deprivation that result in stunted growth (Scrimshaw, Taylor, and

⁴ See Strauss et al. 1993, Dow et al. 1997; Newhouse et al. 1993.

⁵ In an interesting recent paper, Jörg Baten (2002) relies on the variation in adult heights of women to explore the relationship between inequality and globalization.

Gordon 1968; Martorell et al. 1975). Thus, a good measure of the extent of children's health deficits is the deviation of the distribution of heights in a population from the distribution for a reference population of healthy children who reach their genetic potential (WHO 1983; WHO 1995). This has led de Onis, Frongillo, and Blossner (2000:122) to suggest that "The best global indicator of children's well-being is growth, because infections and unsatisfactory feeding practices...are the major factors affecting their physical growth and mental development." Similarly, Beaton et al. (1990) argue that stunting in a population, defined as a distribution of heights being different from the World Health Organization reference population,⁶ is explicit evidence of a general public health problem, and that growth failure is "...the best general proxy for constraints to human welfare of the poorest, including dietary inadequacy, infectious diseases and other environmental health risks." They go on to point out that the usefulness of stature is that it captures the "...multiple dimensions of the individual health and development and their socio-economic and environmental determinants (p. 2)." Furthermore, the distribution of healthy children's height is invariant to ethnicity and race (Habicht et al. 1974).

Although measuring heights of children avoids issues of the ethnic and racial composition of the population, this is not the case for adults. Nonetheless, heights still have a valuable place in terms of measuring inequality among adults. The use of attained stature has been particularly widespread among economic historians.⁷ But of greater relevance to this paper, adult heights have been useful in terms of measuring health inequalities (Duclos, LeBlanc, and Sahn 2009).

Beyond the reliance on heights, another physical measure of health is the body mass index (BMI), which is defined as a person's weight in kilograms divided by height in meters squared. BMI has a peculiar property in as far as both low and high levels of BMI imply a health risk. In the case of low BMI, this is a reflection of wasting due to inadequate intake of food and related factors such as infection and disease. There is also a threshold above which too much body fat is bad. Obesity has its own set of health perils. This, of course, makes the use of BMI

⁶ As discussed further below, the WHO (1983) has developed a globally representative reference population for height that is derived from a U.S.-based National Center for Health Statistics survey of the stature of children in the United States.

⁷ See, for example, Steckel and Floud (1997), Komlos (2003), and Fogel (1994).

as a distributional indicator of health quite problematic. That being said, BMI may still be a useful indicator of health inequality in very poor populations in Africa and Asia where there is very little obesity and overweight. Additionally, as discussed in greater detail below, BMI has been employed to capture the inequality in the distribution of resources and adequacy of food consumption relative to needs (which in part are determined by activity levels and health status), even though it may not be a reflection of health inequality per se.

One statistical issue that needs to be addressed when using physical health measures such as height and BMI is that the variance differs by age and gender. Given that the age and gender composition vary by country and over time, and that we wish to give variations in each age group equal importance in the analysis, it is necessary to use a transformed version of heights, BMI and other physical measurements for inequality analysis. The transformed measure can be standardized using a fixed age/sex reference group.

To illustrate in the case of BMI, I arbitrarily designate a 20-year-old female as the basis for our standardization of BMI. The standardized BMI measure is constructed such that an individual's position in the distribution, in terms of percentiles, is the same for actual BMI in the actual age/sex group and the transformed BMI in the reference group WHO distribution. More specifically,

$$BMI = F_{\bar{a}, \bar{g}}^{-1}(F_{a, g}(bmi)) \quad (2)$$

where F is the distribution function of BMI in the WHO reference population for an age/sex group defined by a (age) and g (gender); bmi is the actual BMI; $\bar{a} = 20$ years; $\bar{g} = \text{female}$; and BMI is standardized BMI. My choice of 20-year-old females for the standardization is arbitrary. While not shown, a similar procedure can be used to standardize heights, as discussed in greater detail in Pradhan, Sahn, and Younger (2003).

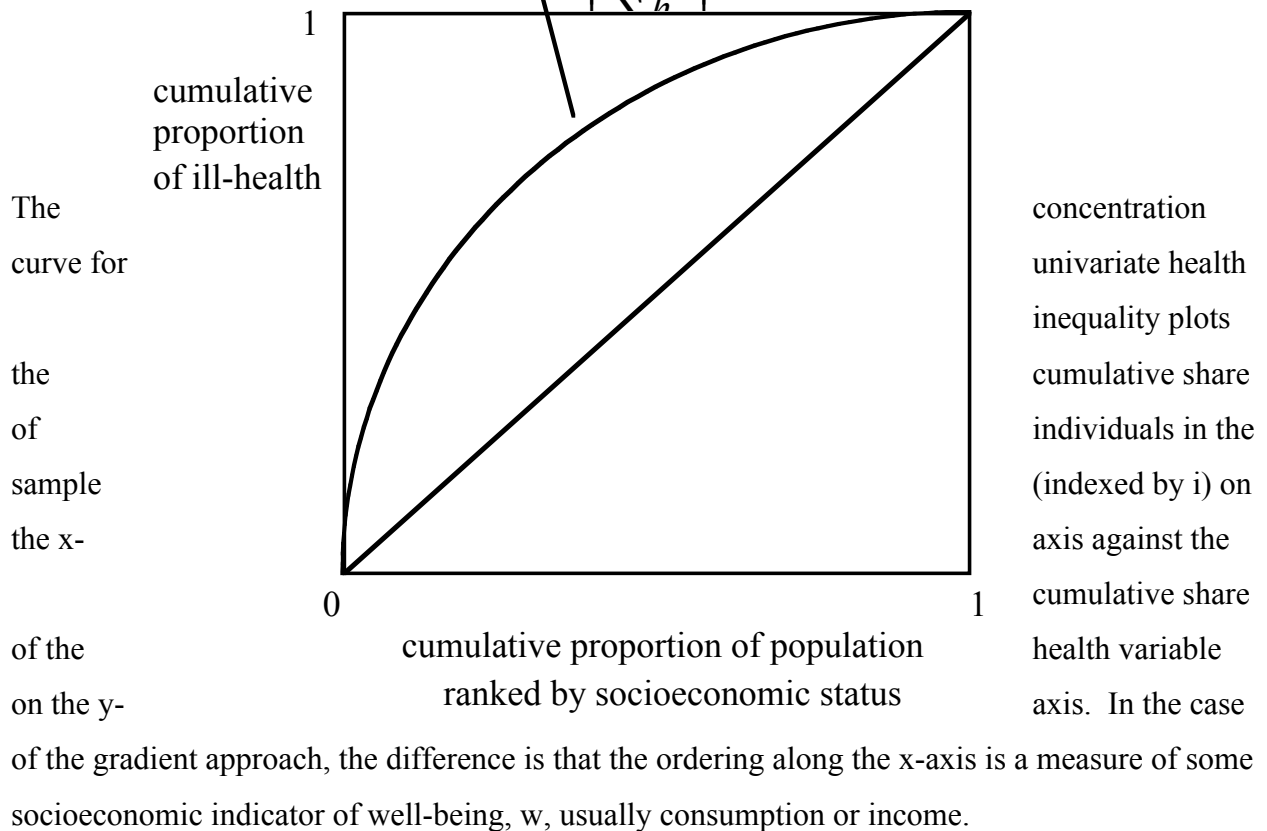
V. Inequality Comparisons

Once we have decided on our measure of health inequality, including the choice of indicator, whether we are using a univariate approach to health inequality or a gradient approach where well-being is ordered by some socioeconomic variable such as income, or even if we are looking at the delivery of services (i.e., expenditure incidence), we will ideally next make

statistical comparison of concentration curves. We can begin doing so by estimating concentration curves. These curves are similar to Lorenz curves in that they plot households or individuals along the x-axis where they are ordered from those with the worst health to best health, or poorest to the wealthiest. Along the horizontal axis we plot the cumulative level of health, or proportion of benefits received, for all individuals.

More specifically, we can estimate a concentration curve for univariate inequality:

$$H(D) \left(\frac{\sum_{k=1}^i h_k}{\sum_{k=1}^n h_k} \right) \quad (3)$$



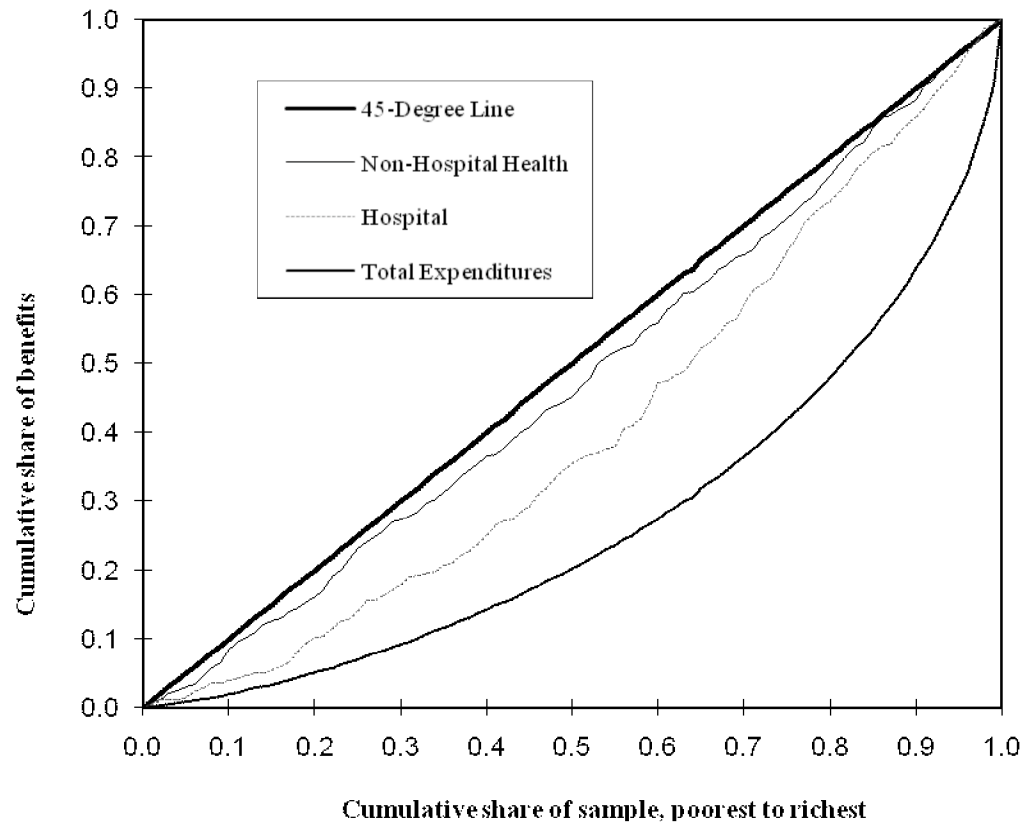
If everyone has the same level of health, the concentration curve will be a 45-degree line that extends from the bottom-left corner to the upper right corner, as shown in Figure 1, where the concentration curve is for the bi-variate approach to assessing health inequality. When the curve is concave, and captures an outcome such as being malnourished or the numbers of infant deaths, it implies that this negative outcome is more concentrated among the poor.

Figure 1: Health Concentration Curve

Alternatively, we can construct a concentration curve for benefits of health spending, as illustrated in Figure 2, which is the same formula as above with the benefit substituted for health. Note that we continue to order the i households from poorest to richest, i.e. based on w , not h . If this concentration curve is everywhere above the 45-degree line, which reflects perfect equity in distribution, we will call such a distribution per capita progressive.

More generally, if a given curve is always above another's, the first distribution can be said to dominate the second. This concept is quite attractive in that it frees the analyst from choosing a particular welfare function: *any* function in the broad class of increasing, anonymous, and equity-preferring social welfare functions will give the same preferences.

Figure 2. Health Benefit Incidence Concentration Curve, Côte d'Ivoire



Much of the literature that applies dominance techniques does not do so statistically. But empirical Lorenz and concentration curves are clearly statistical, i.e. they are estimates of the true distribution and therefore have standard errors. To address the need to test statistically for welfare dominance, an issue discussed in some detail by Yitzhaki and Slemrod (1991), we turn to the discussion of Davidson and Duclos (2000). They show how to estimate the orderings and to perform statistical inference on concentration curves using stochastic dominance tests that can be applied to the entire distributions of a given health indicator.

Consider two distributions of the health indicator with cumulative distribution functions, F_A and F_B . Let

$$D_A^1(x) = F_A(x) = \int_0^x dF_A(y) \tag{4}$$

and

$$D_A^s(x) = \int_0^x D_A^{s-1}(y)dy, \quad (5)$$

for any integer $s \geq 2$. Now distribution A is said to (strictly) dominate distribution B at order s if

$$D_A^s(x) \leq (<) D_B^s(x), \text{ for all } x \in [0, H_{\max}], \text{ where } H_{\max} \text{ is the maximum level } H. \text{ }^8$$

Davidson and Duclos (2000) show that $D^s(x)$ can be equivalently expressed as

$$D^s(x) = \frac{1}{(s-1)!} \int_0^x (x-y)^{s-1} dF(y). \quad (6)$$

Further, if we have a random sample of N independent observations on the welfare variable, y_i , from a population, then a natural estimator of $D^s(x)$ is

$$\hat{D}^s(x) = \frac{1}{(s-1)!} \int_0^x (x-y)^{s-1} d\hat{F}(y) = \frac{1}{N(s-1)!} \sum_{i=1}^N (x-y_i)^{s-1} I(y_i \leq x) \quad (7)$$

where \hat{F} is the empirical cumulative distribution function of the sample, and $I(\cdot)$ is an indicator function as described above. Because we apply this estimator to two independent samples of anthropometric data for each country,

$$\text{var}(\hat{D}_A^s(x) - \hat{D}_B^s(x)) = \text{var}(\hat{D}_A^s(x)) + \text{var}(\hat{D}_B^s(x)), \quad (8)$$

it is easy to estimate since $\hat{D}^s(x)$ is a sum of *iid* random variables. Simple t statistics are constructed to test the null hypothesis,

$$H_0 : \hat{D}_A^s(x) - \hat{D}_B^s(x) = 0, \quad (9)$$

for a series of test points along the distribution. In cases where the null hypothesis is rejected for each test point,⁹ and the signs on all of the t statistics are the same, then dominance of order s is declared.¹⁰ The tests were conducted up to $s = 3$, after which “no dominance” is declared.¹¹

⁸ See Ravallion (1994) for an interpretation of the orders of dominance.

⁹ We employ ten evenly spaced test points based on the lower CDF in the pair-wise comparison.

¹⁰ We note that the data requirements for these tests are no more stringent than for estimating malnutrition rates. Given the two-stage sampling design of the DHS, straightforward application of standard formulas for standard errors can lead to underestimates and thus more Type II errors. We therefore correct for the clustered sample using the *svy* group of commands in Stata 6.0. The programs (*ado* files) used to make these corrections are readily available from the author.

¹¹ Davidson and Duclos (2000) show that eventually one distribution will dominate the other at a higher order. But it is difficult to interpret higher orders of dominance, especially greater than three.

There is an important drawback to making dominance comparisons which is that they may be inconclusive. Lorenz and related concentration curves often cross, preventing the analyst from making a general welfare statement about different distributions. The fallback option is to either accept the absence of a conclusion on the changes in, or comparisons of inequality across time and/or population, or adopting a *specific* welfare function which may or may not have parameters that allow us to vary the weight applied to each household.

The Gini coefficient is by far the most common approach employed in this regard, but there are many others available in the literature. It is easier to conclude that one distribution is better than another with these criteria, but of course, the conclusions are valid only for the specific welfare function, whereas the dominance results are valid for a broad class of welfare functions.

In terms of employing the Gini index to make comparisons across population, its application to health indicators can be defined as:

$$\text{Gini} = 2 \left(\frac{1}{2} - \int_0^1 L(p) dt \right) = \left(\frac{2}{\mu} \right) \text{cov}(H, F(H)) \quad (10)$$

where H measures is the measure of an individuals' (such as heights); $F(H)$ is the cumulative density function of the welfare ordering; and μ is mean of the welfare variable.

One alternative measure to the Gini that is widely used is the Theil entropy measure, especially because it is decomposable into groups, something of considerable use as we will discuss further below. In the case of country level inequality, for a given country k , the Theil index is defined by

$$T(k) = \frac{1}{N} \sum \ln \left(\frac{\mu}{H_i} \right) \quad (11)$$

where N is the sample size in country k , μ is the mean of the health indicator in the sample, and H_i is the value of the health indicator of the i^{th} person in the sample. If we wanted to generate inequality indicators at the household level, $T(k)$ would be replaced by $T(h)$, and N would then be the sample size in household h , μ the mean of the health indicator in the household, and H_i is the value of the health indicator of the i^{th} person in the household.

VI. Decompositions

a. *Within and between group inequalities*

Having examined both levels and pattern of health inequality, whether at the global, country, or household inequality, it is also possible to decompose overall inequality into its two components: between-group and within-group inequality. The Theil entropy measure of global, country, or even household level inequality discussed above can easily be decomposed. To illustrate, I will examine the approach to decomposition global level health inequality. The universe (e.g., in this case, global health inequality) consists of K countries and can now be decomposed according to:

$$I(\text{total}) = \sum_{k=1}^K \frac{N_k}{N} [I(k)] + \frac{1}{N} \sum_{k=1}^K N_k \ln\left(\frac{\mu}{\mu_k}\right) \quad (12)$$

where μ is the average health indicator for the entire sample, μ_k is average health for country k , N is the entire sample size, and N_k is the sample size in country k . The latter term defines between-country inequality as the inequality at country means, while the first term sums all within-country inequality. Countries with no health inequality have $I(k)$ equal to zero and thus do not contribute to within-country health inequality – the first term – but they do affect between-country inequality insofar as their mean health indicator is greater than the mean health indicator for all people in the world. An analogous exercise can be undertaken for decomposing national inequality into within- and between-household inequality.

b. *Decomposition of changes in health into mean and distributional changes*

A large number of empirical studies have addressed the extent to which change in well-being are attributable to the mean improvements and distribution components. The vast majority of this literature has been focused on explaining changes in poverty, and more specifically, the impact of growth, assuming that the income distribution remains the same over time, and the impact of redistribution of income, assuming that the mean level of income remains constant over time. As discussed above, however, if one accepts Sen's argument that poverty is multidimensional, there is also an important question of average improvements and distributional changes in other measures of well-being, specifically, health.

Before considering this question further, however, it is important to raise the possible objection that while it is possible to redistribute income – thus making such decompositions relevant for money metric measures of well-being – it is not possible to redistribute the health of an existing population among its members in the same way that we can redistribute income. Nevertheless, differences in health are related to public policy choices. For example, a government can choose to reduce spending on curative health care for relatively well-off residents and to invest those resources in preventative public health measures. The result of such a policy would tend to compress the health distribution. It is possible that this occurs while leaving the overall mean health unchanged.

The most widely used decomposition method is the one proposed by Datt and Ravallion (1992). The components of the total change in poverty can be captured using a class of poverty measures that are fully characterized by the poverty line (z), the mean of the distribution (μ), and the Lorenz curve (L). For date t the poverty measure can be written as

$$P_t = P(z, \mu_t, L_t). \quad (13)$$

A change in poverty between period t and $t+n$ can then be decomposed as follows:

$$P_{t+n} - P_t = G(t, t+n; r) + D(t, t+n; r) + R(t, t+n; r) \quad (14)$$

growth redistribution residual
component component

The growth component, $G()$, is defined as the change in poverty due to a change in the mean of the distribution, holding the Lorenz curve constant at that of the reference year r :

$$G(t, t+n; r) \equiv P(z, \mu_{t+n}, L_r) - P(z, \mu_t, L_r). \quad (15)$$

Similarly, the redistribution component, $D()$, is defined as the change in the Lorenz curve while keeping the mean of the distribution constant at that of the reference year r :

$$D(t, t+n; r) \equiv P(z, \mu_r, L_{t+n}) - P(z, \mu_r, L_t). \quad (16)$$

As Datt and Ravallion (1992) point out, the residual $R()$ is present whenever a change in the poverty measure due to changes in the mean (distribution) also depends on the precise distribution (mean) (i.e., when the poverty measure is not additively separable in μ and L).

Datt and Ravallion point out that the growth and distribution components will differ depending on which reference period is used, a choice that is arbitrary. Kakwani (1997) has

argued that such arbitrariness is undesirable, and that the only way to avoid it is to make the calculation using, first, one period, then the other, as the reference period, averaging the results. As Datt and Ravallion noted, this procedure also eliminates the residual, which is difficult to interpret. This practice has been adopted widely in the recent literature, and we follow it here (McCulloch, Baulch, and Cherel-Robson 2000; Dhongde 2007; Shorrocks and Kolenikov 2001; Christiaensen, Demery, and Paternostro 2002).

Sahn and Younger (2005) have adapted this methodology to the analyses of children's standardized heights using the -2 z-score cut-off point based on the reference population as the threshold that distinguishes health and malnourished children. This can be thought of as the height (health) poverty line, and we can make a standard probability argument that if a child's height falls below this level, it is probable that he or she suffers from stunting and poor health. Two curves are shown, marked A and B in Figure 3 below. Assuming this stylized example represents a country at two points in time, it can be seen that a substantial share of the population is malnourished in both periods. However, the share of persons malnourished increases from time A to B. In this case, it is due to both changes in the distribution (which is more skewed to the left), and changes in the mean (which has also shifted to the left). It is precisely the contribution of those two changes to the overall increase in the area to the left of the poverty line that we decompose. Sahn and Younger thus show how it possible to decompose the anthropometric measure of health, analogous to the poverty headcount. As shown in Table 1, they find compelling evidence that when the average height of children in a country improves, the heights of stunted children improve as well. This result is similar to existing results for changes in income poverty. But, unlike the literature on income inequality that suggests at best a neutral relationship between the growth and redistribution components, they show that there is a positive association between average improvements in children's heights and the distribution of those heights.

Figure 3. Example of Changes in Mean and Redistribution in Heights

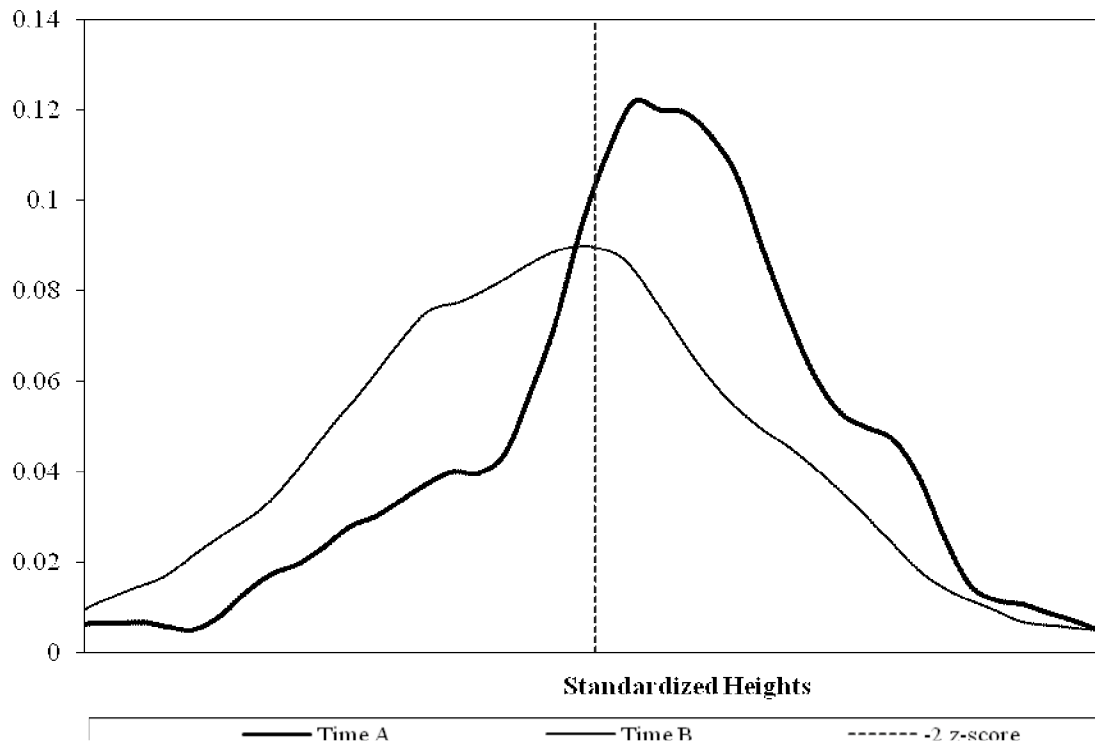


Table 1. Growth and Redistribution Decomposition of Nutrition Headcount Index of Health Status

Country (DHS years)	Nutrition Headcount Index			Ravallion-Datt			Kakwani	
	First Survey	Last Survey	Change	Growth	Redistribution	Residual	Growth	Redistribution
Benin (1996, 2001)	24.979	26.851	-1.872	-1.009	-0.230	-0.633	-1.3255	-0.5465
Bolivia (1989, 1994)	37.691	26.784	10.906	10.034	-0.408	1.280	10.6740	0.2320
Bolivia (1994, 1997)	26.784	24.222	2.563	2.813	0.424	-0.675	2.4755	0.0865
Brazil (1986, 1996)	29.417	10.461	18.956	17.864	1.632	-0.540	17.5940	1.3620
Burkina Faso (1992, 1999)	33.309	36.809	-3.500	-4.053	1.483	-0.930	-4.5180	1.0180
Cameroon (1991, 1998)	22.855	29.292	-6.437	-2.040	-4.462	0.065	-2.0075	-4.4295
Colombia (1986, 1995)	25.473	12.478	12.995	10.375	3.989	-1.369	9.6905	3.3045
Cote d'Ivoire (1994, 1998)	24.442	21.921	2.520	2.747	0.049	-0.275	2.6095	-0.0885
Dominican Republic (1986, 1991)	20.622	16.569	4.053	1.128	3.131	-0.205	1.0255	3.0285
Dominican Republic (1991, 1996)	16.467	10.740	5.727	4.758	1.256	-0.287	4.6145	1.1125
Ghana (1988, 1993)	29.929	25.853	4.077	5.006	-0.486	-0.443	4.7845	-0.7075
Ghana (1993, 1998)	25.853	19.999	5.853	4.292	0.848	0.714	4.6490	1.2050
Guatemala (1987, 1995)	57.680	45.357	12.323	10.851	0.316	1.157	11.4295	0.8945
Guatemala (1995, 1999)	49.737	46.372	3.365	2.493	1.151	-0.279	2.3535	1.0115
India (1993, 1999)	51.826	44.937	6.888	6.201	1.598	-0.911	5.7455	1.1425
Kenya (1993, 1998)	33.259	33.023	0.236	2.964	-3.023	0.296	3.1120	-2.8750
Madagascar (1992, 1997)	54.108	48.341	5.767	6.436	-1.526	0.856	6.8640	-1.0980
Malawi (1992, 2000)	49.220	49.024	0.195	2.009	-1.135	-0.678	1.6700	-1.4740
Mali (1987, 1995)	24.179	30.124	-5.945	-2.561	-3.158	-0.226	-2.6740	-3.2710
Morocco (1987, 1992)	28.579	24.206	4.374	3.641	1.346	-0.613	3.3345	1.0395
Niger (1992, 1997)	35.486	41.069	-5.583	-5.424	0.952	-1.112	-5.9800	0.3960
Nigeria (1990, 1999)	36.167	45.463	-9.296	-3.921	-4.542	-0.833	-4.3375	-4.9585
Peru (1992, 1996)	31.797	25.765	6.032	5.692	0.694	-0.354	5.5150	0.5170
Peru (1996, 2000)	25.765	25.418	0.346	-0.533	1.020	-0.141	-0.6035	0.9495
Senegal (1986, 1992)	22.977	21.724	1.254	5.037	-2.792	-0.992	4.5410	-3.2880
Tanzania (1991, 1996)	43.217	43.430	-0.213	0.289	-0.213	-0.289	0.1445	-0.3575
Tanzania (1996, 1999)	43.430	42.633	0.797	-0.520	1.661	-0.344	-0.6920	1.4890
Togo (1988, 1998)	29.441	21.721	7.720	7.690	0.843	-0.814	7.2830	0.4360
Uganda (1988, 1995)	41.023	35.447	5.576	4.759	1.465	-0.648	4.4350	1.1410
Uganda (1995, 2000)	35.447	35.506	-0.059	0.000	0.242	-0.301	-0.151	0.092
Zambia (1992, 1996)	39.844	42.352	-2.508	-1.410	-0.802	-0.296	-1.5580	-0.9500
Zimbabwe (1988, 1994)	28.853	21.433	7.420	10.593	-1.674	-1.498	9.8440	-2.4230
Zimbabwe (1994, 1999)	21.433	26.455	-5.022	-0.835	-3.989	-0.198	-0.9340	-4.0880

c. Decomposing causes of health sector inequalities

Yet a third type of health decomposition is one which focuses on the gradient approach to measuring health inequalities, and specifically a method for decomposing the causes of health inequalities and changes therein over time. More specifically, the technique initially proposed by Wagstaff, van Doorslaer, and Watanabe (2003), is designed to decompose inequalities in health across the income distribution. The approach that they employ is useful for addressing why there are differences in health inequalities in different populations, and changes therein over time. Additionally, Wagstaff, van Doorslaer, and Watanabe extend their method to address the role of policies and programs in causing or mitigating the growth of health inequalities. Using data from Vietnam, they specifically address the causes of income-related inequalities in child malnutrition, as well as why these inequalities across the income distribution have risen over time.

As their point of departure, they estimate concentration coefficients, similar to those discussed above, to describe the level of inequality in the percent of malnourished children across the cumulative income distribution. These can be used to rank the extent to which there is inequality in health across the income gradient, analogous to what I show above for access to health services. They go on to show how it is possible to decompose changes in these concentration indexes over time. The essence of their approach is built upon a standard reduced form model of health, estimated using linear regression. They too employ standardized child heights as their measure of health, and regress it on a vector of child and household level variables, employing community fixed effects. They use the regression results to examine the extent to which different covariates contribute (e.g., explain) nutritional outcomes, and using models from two years, which covariates are primarily contributing to changes in the malnutrition. They proceed to employ an Oaxaca-type decomposition to determine the extent to which changes in levels of malnutrition over time were attributable to changes in elasticities of nutrition with respect to consumption, rather than changes in inequality in consumption. Furthermore, their approach allows for a determination of the reasons behind the changes in the elasticities: that is, that which is explained by the coefficient on the variable (e.g, consumption) and the mean of the variable itself. So, for example, it is plausible that the elasticity may remain constant, despite the fact that the coefficient may increase. This could be due to a fall in the mean of the variable. Thus, in sum, their approach allows for an examination of the changes in inequality of the health outcome, decomposed into three components: changes in the extent of

inequality in its determinant (e.g., changes in inequality of consumption), changes in the means of the determinant (e.g., changes in mean consumption), and changes in the impact (e.g, changes in the coefficient of how income affects health). Table 2 illustrates the results from the Wagstaff, van Doorslaer, and Watanabe (2003) study from Vietnam. The results, for example in the case of the consumption variable, suggest that changes in the means and inequalities of consumption (the concentration index, or CI), as well as the regression coefficient (or beta-parameter) have all contributed to worsening inequalities in terms of the health outcome, in this case a child's height-for-age z-score.

Table 2:

Total differential decomposition of change in inequality, 1993–98

	β 's	Means of x 's	CI's	GC_{ε}	Total
Child's age (in months)	0.003	0.011	-0.002		0.012
Child's age squared	0.003	-0.010	0.001		-0.006
Child = male	0.001	0.000	0.000		0.001
Household consumption	-0.005	-0.005	-0.002		-0.011
Safe drinking water	-0.002	0.000	0.000		-0.003
Satisfactory sanitation	0.003	-0.002	0.000		0.001
Years schooling household head	0.001	0.000	-0.001		0.000
Years schooling mother	0.005	0.000	-0.001		0.004
Commune fixed effects	0.000	-0.014	-0.010		-0.025
"Residual"				0.005	0.005
Total	0.010	-0.021	-0.016	0.005	-0.021
Column as % total	-47%	98%	74%	-25%	

From A. Wagstaff et al., Journal of Econometrics 112 (2003), p. 218

VII. Health Inequality, Absolute Health, and the Distribution of Income

d. Health inequality, income inequality, and their impact on health status

Does health inequality have a distinct affect on health status? Wilkinson (1996, 1997) initially proposed that inequality in health within a population is a health risk in as far as it contributes to a lack of social cohesion and other disparities in socioeconomic circumstances,

and that such risk goes beyond the correlation between low levels of income and low level of health. Wilkinson's case rests on what he refers to as the "neuroendocrine" pathways through which psychosocial risk factors link health to the inequality in socioeconomic circumstances. That is, psychosocial effects of relative deprivation, as might be measured by inequality of health status, in and of itself, are a risk factor for poor health.

There is little empirical investigation of the relationship between inequality in health status and health status itself. While there may be some possibilities for examining this question across countries or by region within countries, the challenges are great given the need to control for the myriad factors that will contribute to health outcomes, beyond inequality in health indicators. Thus, the potential bias introduced by missing variables, as well as unobserved heterogeneity, make the examination of the relationship discussed by Wilkinson difficult at best.

That being said, the relationship between health inequality and health status is a variant of the larger question addressed by Marmot and Wilkinson (1999) that asks whether inequalities in general, including of income, contribute to poor health. Marmot and Wilkinson (1999) and Bruner and Marmot (1999) have discussed in great detail how relative deprivation contribute to stress, and subsequently, to compromised health status. Indeed, these two links, between relative deprivation and stress, and between stress and health status, are well documented in the psychological and bio-medical literature. In regard to the former, lack of equality can contribute to a loss of dignity, shame, and stigmatization of those at the bottom end of the distribution contributing to increased stress.

Inequalities adversely affect health through a number of mechanisms. First, in populations characterized by large inequality, there is a lower likelihood that social networks and mutual assistance relationships will mitigate the deleterious effects of health shocks that compromise health status directly. Second, inequality is associated with those at the lower end of the income distribution facing greater barriers in terms of access to credit needed both to expand economic opportunities, but to enable high return health investments. And while the talent of the credit constrained poor goes unrewarded, other activities and projects with lower returns proceed as elites capture the benefits of inefficient allocation. Third, it may also be that

inequalities contribute to differences in preferences, and thus reduce political support for investments in public goods. That is, heterogeneity in preferences that derive from various forms of inequalities may make impede the types of political consensus required to promote spending on health-related public goods or services with large externalities, such as vaccinations, water and sanitation, health research, and so forth. Inequality therefore contributes to public institutions that are both inefficient and unequal in terms of protecting and promoting the needs of those in greatest need. Furthermore, there is the prospect that economic inefficiency will result from political tensions contributing to disproportionate shares of budgets and state and private resources being allocated to political repression, internal security, and other spending, rather than promoting the health and well-being of the population. In sum, inequity in all dimensions, both health and income, will thus affect economic efficiency and growth by reducing incomes generating opportunities, health status, and other investments in human capital. The most worrisome aspect of this is the prospect of the emergence of inequality traps, analogous to what we find in the poverty trap literature, where there is persistence in unequal outcomes over the life-course and even across generations.

Of course, there is another relatively straightforward economic explanation for the negative impact of income inequality on health that revolves around the observation that there is a concave functional relationship between health and income. By implication, health will be worse in a population with the same level of average income, but greater with income inequality.

There is a large empirical literature on the relationship between income inequality and health. A comprehensive review of this literature is found in Deaton (2003), who critically reviews both cross-country and within-country studies. His major conclusions are that income inequality is not a major determinant of population health; and that instead of focusing on the role of inequality, more attention should be accorded understanding the role of income levels in determining health outcomes.

e. Health inequality and the distribution of income

Another relationship that is of considerable interest and motivates our concern over health inequality is the possibility that it will affect the levels and distribution of income. The

logic here is quite straightforward: that there is a relationship between health, cognitive skills acquisition, and economic productivity, and as a consequence, the unequal distribution of health is expected to contribute to unequal earnings. The basis for this assertion is to be found in the literature on the impact of health on schooling, cognition, labor supply, and productivity— topics that are reviewed in companion papers prepared for the collaborative project, and are therefore not discussed further here. However, there is an important question regarding whether the nature of inequalities in health in Africa are particularly important in terms of affecting inequalities of health.

There is some empirical evidence, and inferential reasoning to suggest that developing countries have greater inequalities in health that might affect productivity and incomes. When we examine standardized heights as a general measure of child health, there is little inequality in this indicator of well-being among developed countries. However, in countries with lower living standards and overall worse mean health, there is a correlation with greater levels of inequality in health outcomes (Pradhan, Sahn, and Younger 2003). There is also reason to expect that other indicators, such as life expectancy at birth, are characterized by greater inequality in poor countries. In part, this may find explanation in fact such as new health technologies tend to be introduced initially for a small segment of the population, and subsequently are rolled out or made available to the wider population, often at a particularly slow pace in more resource constrained developing countries. The slow rate of transmission of these technologies is expected to give rise to greater inequalities in health and consequently, will likely exacerbate inequalities in income. Similarly, basic health services that are nearly universally available in developed countries, such as access to water and sanitation, are often not accessible to large segments of the population, exacerbating existing inequalities. The same applies to other preventative and treatment options. Again, to illustrate, antibiotics, childhood vaccines, or even anti-retroviral therapies are nearly universally available in the developed world, but not in developing countries. A related issue is that economic and natural shocks that give rise to health inequalities may have more deleterious impacts on outcomes such as schooling and labor market outcomes in developing countries, as mediated by the fact that insurance and credit markets are less accessible and tend to exacerbate *ex-ante* inequalities. One important implication, which merits further research, is the hypothesis that the introduction to basic public health measures,

whether that be dietary supplementation, malaria eradication, or improving water and sanitation facilities will not only improve health, but reduce inequalities in income as well.

VIII. Conclusions and Implications for Future Research

This paper has discussed the many dimensions of health inequality, focusing both on defining the concept of health inequality, and related issues of methods employed to assess its magnitude and characteristics. Perhaps the most important consideration that evolves from this review is that health inequality is a multi-faceted concept which merits attention above and beyond the issues of absolute levels of health. And furthermore, the focus on inequality of health is clearly something that goes beyond an academic exercise, and needs to be considered by policy makers who have a more general interest in issues of social justice and economic efficiency, as well as broader concerns in the domain of the result of policy for overall equality and equity in the population. Of course, when it comes to the role of public policy, it is easiest and most convenient to highlight the issues of equality in the provision of public services. This narrow perspective, however, should be avoided. Instead, policy makers and researchers need to keep their attention focused on issues related to the equality of health outcomes, as well as equality in the dimension of the capability of achieving health.

One issue that is particularly problematic when examining the issue of health inequality is the potential tradeoff between the potential conflict between the competing goals of promoting health equality and improving mean outcomes. I have avoided this subject explicitly, although, it lurks in the background just as it does when it comes to income inequality and poverty reduction. In fact, some of the analytical issues discussed in this paper, such as the decomposition techniques that enable one to determine the extent to which an increase in inequality is associated with increasing inequality in consumption versus increasing in means of consumption, implicitly address this issue. Similarly, the analysis of fiscal incidence inevitably draws attention to the tradeoffs between equity and efficiency in the delivery of health services.

While there is a wide-ranging discussion of conceptual issues in this paper, most of it has been devoted to outlining approaches to empirical analysis of health inequality. The objective has been to provide an introduction to the topic and motivate research in this area as part of the

overall project on health, poverty, and economic growth. While the discussion of the breadth of methods is necessarily limited in order to keep the length of this paper manageable, it does provide a range of possible research ideas and approaches that will hopefully motivate increased research on Africa in the area of health inequality.

References

- Atkinson, A. B. 1970. On the measurement of inequality. *Journal of Economic Theory* 2(3): 244-263.
- Appleton, Simon, and Lina Song. 1999. Income and human development at the household level: Evidence from six countries. Mimeo, Oxford: Centre for the Study of African Economies, Oxford University.
- Baten, Jörg. 2002. Did partial globalization increase inequality? Did inequality stimulate globalization backlash? The case of the Latin American periphery, 1950-80. CESifo Working Paper Series No. 683, Center for Economic Studies and Ifo Institute for Economic Research, Munich.
- Beaton, George, A. Kelly, John Kevany, Reynaldo Martorell, and J. Mason. 1990. *Appropriate Uses of Anthropometric Indices in Children: A Report Based on an ACC/SCN Workshop*. United Nations Administrative Committee on Coordination/Subcommittee on Nutrition ACC/SCN State-of-the-Art Series, Nutrition Policy Discussion Paper No. 7, New York.
- Bound, J. 1991. Self-reported objective measure of health in retirement models. *Journal of Human Resources* 26(1): 106-138.
- Bruner, E., and M. G. Marmot. 1999. Social organization, stress, and health. In M. G. Marmot and R. G. Wilkinson, (eds.), *Social Determinants of Health*. Oxford and New York: Oxford University Press.
- Christiaensen, Luc, Lionel Demery, and Stefano Paternostro. 2002. Growth, distribution, and poverty in Africa: Messages from the 1990s. Policy Research Working Paper #2810, World Bank, Washington, DC.
- Cole, T. J., and J. M. Parkin. 1977. Infection and its effect on growth of young children: A comparison of the Gambia and Uganda. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 71(3): 196-198.
- Datt, Gaurav, and Martin Ravallion. 1992. Growth and redistribution components of changes in poverty measures: A decomposition with applications to Brazil and India in the 1980s. *Journal of Development Economics* 38(2): 275-295.
- Davidson, Russell, and Jean-Yves Duclos. 2000. Statistical inference for stochastic dominance and for the measurement of poverty and inequality. *Econometrica* 68(6): 1435-1465.
- de Onis, M., E. A. Frongillo, and M. Blossner. 2000. Is malnutrition declining? An analysis of changes in level of child malnutrition since 1980. Technical Report, World Health Organization (WHO).
- Deaton, A. 1999. *Inequalities in Income and Inequalities in Health*. NBER Working Paper 7141.
- Deaton, A. 2003. Health, inequality, and economic development. *Journal of Economic Literature* 41(1): 113-158.
- Dhongde, S. 2007. Measuring the impact of growth and income distribution on poverty in India. *Journal of Income Distribution* 16(2): 25-48.
- Dow, W, P. Gertly, R. F. Schoeni, J. Strauss, and D. Thomas. 1997. Health care prices, health and labor outcomes: Experimental evidence. Labor and Population Program Working Series 97-01, RAND (January), Santa Monica, CA.
- Duclos, Jean-Yves, Josée LeBlanc, and David E. Sahn. 2009. Comparing population distributions from bin-aggregated sample data: An application to historical height data from France. Cornell Food and Nutrition Policy Program Working Paper No. 228, Cornell University, Ithaca, NY.
- Escobal d'Angelo, Javier, and del Castillo, Marco Castillo. 1994. Sesgos en la medición de la inflación en contextos inflacionarios: el caso Peruano. Grade: Documento le Trabajo #21.
- Fogel, R. 1994. Economic growth, population theory and physiology: The bearing of long-term processes on the making of economic policy. *American Economic Review* 84(3): 369-395.
- Gakidou, E. E., C. J. L. Murray, and J. Frenk. 2000. Defining and measuring health inequality: An approach based on the distribution of health expectancy. *Bulletin of the World Health Organization* 78 (1): 42-54.

- Habicht, Jean-Pierre, Reynaldo Martorell, Charles Yarbrough, Robert M. Malina, and Robert E. Klein. 1974. Height and weight standards for preschool children. How relevant are ethnic differences in growth potential? *Lancet* 1(7858): 611-614.
- Haughton, J. 1997. Falling fertility in Vietnam. *Population Studies* 51(2): 203-211.
- Hill, A., and M. Mamdani. 1989. Operational guidelines for measuring health through household surveys. Mimeo. Centre for Population Studies, School of Hygiene and Tropical Medicine. University of London.
- Kakwani, Nanek. 1997. On measuring growth and inequality components of changes in poverty with application to Thailand. Mimeo, School of Economics, The University of New South Wales, Sydney, Australia.
- Komlos, J. 2003. An anthropometric history of early modern France. *European Review of Economic History* 7(2): 159-189.
- Kroeger, A. 1985. Response errors and other problems of health interview surveys in developing countries. *World Health Statistics Quarterly* 38(1): 15-37.
- Marmot, Michael, and Richard G. Wilkinson, eds. 1999. *Social Determinants of Health*. New York: Oxford University Press.
- Martorell, R., J.-P. Habicht, C. Yarbrough, A. Lechtig, R. E. Klein, and K. A. Western. 1975. Acute morbidity and physical growth in rural Guatemalan children. *American Journal of Diseases in Childhood* 129(11): 1296-1301.
- Mata, L. 1978. *The Children of Santa Maria Cauque: A Prospective Field Study of Health and Growth*. Cambridge, MA: MIT Press.
- McCulloch, Neil, Bob Baulch, and Milasoia Cherele-Robson. 2000. Poverty, inequality and growth in Zambia during the 1990s. IDS Working Paper No. 114. Institute of Development Studies, University of Sussex, Brighton, UK.
- Mosley, W. H., and L. C. Chen. 1984. An analytical framework for the study of child survival in developing countries. *Population and Development Review* 10(Supplement): 25-45.
- Newhouse, J., and The Insurance Experiment Group. 1993. *Free for all? Lessons from the RAND Health Insurance Experiment*. Cambridge, MA: Harvard University Press.
- Over, Mead, Randall P. Ellis, Joyce H. Huber, and Orville Solon. 1992. The consequences of adult ill-health, in R. G. Feachem, T. Kjellstrom, C. J. L. Murray, M. Over, and M. A. Phillips (eds.), *The Health of Adults in the Developing World*. New York, Toronto, and Melbourne: Oxford University Press for World Bank, pp. 161-207.
- Pitt, M. M., and M. R. Rosenzweig. 1986. Agricultural prices, food consumption and the health and productivity of farmers. In I. J. Singh, L. Squire, and J. Strauss, J. (eds.), *Agricultural and Household Models: Extensions, Applications and Policy*. Washington, DC: World Bank.
- Pradhan, M. 2001. Welfare analysis with a proxy consumption measure: Evidence from a repeated experiment in Indonesia. Cornell Food and Nutrition Policy Program Working Paper No. 126, Cornell University, Ithaca, NY.
- Pradhan, Menno, David E. Sahn, and Stephen D. Younger. 2003. Decomposing world health inequality. *Journal of Health Economics* 22(2): 271-293.
- Ravallion, M. 1994. *Poverty comparisons*. Chur, Switzerland: Harwood Academic.
- Sahn, D. E., and H. Alderman. 1997. On the determinants of nutrition in Mozambique: The importance of age-specific effects. *World Development* 25(4): 577-588.
- Sahn, David E., and Stephen D. Younger. 2005. Improvements in children's health: Does inequality matter? *The Journal of Economic Inequality* 3(2): 125-143.
- Sahn, D. E., and S. Younger. 2000. Expenditure incidence in Africa: Microeconomic evidence. *Fiscal Studies* 21(3): 329-347.
- Schultz, P. T., and A. Tansel. 1997. Wage and labor supply effects of illness in Côte d'Ivoire and Ghana: Instrumental variable estimates for days disabled. *Journal of Development Economics* 53(2): 251-286.

- Scott, C., and B. Amenuvegbe. 1990. Effect of recall duration on reporting of household expenditures: An experimental study in Ghana. Social Dimensions of Adjustment in Sub-Saharan Africa Working Paper 6, Washington DC: World Bank.
- Scrimshaw, N. S., C. E. Taylor, and J. E. Gordon. 1968. Interactions of nutrition and infection. World Health Organization Monograph Series, No. 57, WHO.
- Sen, A. 1979. Personal utilities and public judgment: Or what's wrong with welfare economics? *Economic Journal* 89 (355): 537-558.
- Sen, A. 1985. *Commodities and Capabilities*. Amsterdam: North Holland.
- Sen, A. 1987. The Standard of Living: Lecture II, Lives and capabilities. In: G. Hawthorn (ed.), *The Standard of Living*. Cambridge: Cambridge University Press, pp. 20-38.
- Shorrocks, Anthony F., and Stanislav Kolenikov. 2001. Poverty trends in Russia during the transition. Mimeo, World Institute of Development Research and University of North Carolina, Helsinki.
- Steckel, R. H., and R. Floud. 1997. *Health and welfare during industrialization*. NBER Project Report Series. Chicago and London: University of Chicago Press.
- Strauss, J., Paul J. Gertler, Omar Rahman, and Kristen Fox. 1993. Gender and life-cycle differentials in the patterns and determinants of adult health. *Journal of Human Resources* 28(4): 791-837.
- Tanner, J. M. 1981. *A History of the Study of Human Growth*. New York: Cambridge University Press.
- Thomas, D., V. Lavy, and J. Strauss. 1996. Public policy and anthropometric outcomes in the Côte D'Ivoire. *Journal of Public Economics* 61(2): 155-192.
- Wagstaff, Adam, Eddy van Doorslaer, and Naoko Watanabe. 2003. On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam. *Journal of Econometrics* 112(1): 207-223.
- Whitehead, M. 2000. The concepts and principles of equity and health. Programme on Health Policies discussion paper, World Health Organization Regional Office for Europe, Copenhagen.
- Wilkinson, R. G. 1996. *Unhealthy Societies: The Afflictions of Inequality*. London: Routledge.
- Wilkinson, R. G. 1997. Socioeconomic determinants of health: Health inequalities: Relative or absolute material standards?" *British Medical Journal* 314(7080): 591-595.
- Wolfson, M., and G. Rowe. 2001. On measuring inequalities in health. *Bulletin of the World Health Organization* 79(6): 553-560.
- World Health Organization. 1983. Measuring Change in Nutritional Status: Guidelines for Assessing the Nutritional Impact of Supplementary Feeding Programmes for Vulnerable Groups. WHO, Geneva.
- World Health Organization. 1986. *Social Justice and Equity in Health*. Report on a WHO Meeting (Leeds, United Kingdom, 1985), Regional Office for Europe. (ICP/HSR 804/m02), Copenhagen.
- World Health Organization. 1995. *Physical Status: The Use and Interpretation of Anthropometry*: Report of WHO Expert Committee. WHO, Geneva.
- Yitzhaki, Shlomo, and Joel Slemrod. 1991. Welfare dominance: An application to commodity taxation. *American Economic Review* 81(3): 480-496.