Chapter 36

Determinants of Inequality in Child Survival: Results from 39 Countries

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Introduction

Few would disagree that health policies and programmes ought to be based on valid, timely and relevant information, focused on those aspects of health development that are in greatest need of improvement. For example, vaccination programmes rely heavily on information on cases and deaths to document needs and to monitor progress on childhood illness and mortality. The same strong information basis is necessary for policies on health inequality. The reduction of health inequality is widely accepted as a key goal for societies, but any policy needs reliable research on the extent and causes of health inequality. Given that child deaths still constitute 19% of all deaths globally and 24% of all deaths in developing countries (*1*), reducing inequalities in child survival is a good beginning.

Conceptually, the field of health inequalities can be represented by this simple identity:

$$\text{Total Health Inequality} = \text{Between-Group Inequality} + \text{Within-Group Inequality} \quad [1]$$

The between-group component of total health inequality has been studied extensively by numerous scholars. They have expertly analysed the causes of differences in health status and mortality across population subgroups, defined by income, education, race/ethnicity, country, region, social class, and other group identifiers (*2–9*).

Unfortunately, the within-group component of health inequality was not recognized until recently (*1;10;11*). While no more important than the between-group component, the within-group one may reveal valuable information about policies and interventions to reduce overall inequalities. Indeed, this chapter demonstrates that inequality in child mortality within groups is considerably larger than inequality between groups in low- and middle-income countries, and this finding is only partially accounted for by differences in average mortality. It therefore seems reasonable to suggest that policy-makers need to take into account both these components of inequality, and that measures of total inequality should appear alongside average health and between-group inequality measures in international comparisons. The analysis presented in this chapter takes a first step towards identifying the policy changes necessary to reduce total health inequality in child mortality by examining the effects of two major sources of inequality—income and health services access.

Methods

Data

The data used in this analysis come from 39 countries where a Demographic and Health Survey (DHS) was conducted and comparable data are available on all the determinants of interest, namely child survival, indicators of permanent income, maternal education, and household access to health services (*12*). For each country the latest year of available data was used from a nationally representative DHS, ranging from 1992 to 1997. Table 36.1 displays the countries in this analysis, along with the survey year, sample size, and three-letter acronym used in figures later in the chapter.

The DHS collects complete birth histories for women of reproductive age (usually defined as 15–49 years), as well as health histories for all children born in the last five years, through in-person interviews. Birth histories include information on the date of birth and current status (alive/dead) of each child that each woman has had. This information is used to construct the dependent variable: whether each child survived to the age of two years.

Health histories collect information on immunization of the children, the type of attendant present at the birth of the child (skilled or unskilled), and the type and number, if any, of antenatal care visits that the mother received for each pregnancy. With this information a proxy variable was constructed for the household's access to health services. This variable is derived from a factor analysis based on the proportion of children of each mother that received a measles vaccine, the proportion that received a DTP vaccine, the proportion of pregnancies for which the mother received at least four antenatal care visits, and the proportion of deliveries that were attended by skilled personnel. This proxy variable is referred to as "health services access."

Table 36.1 Demographic and Health Surveys used in this analysis: country name, three-letter acronym, survey year, and sample size

Country	*Code*	*Survey year*	*Sample size*
Bangladesh	BGD	1997	9 127
Benin	BEN	1996	5 491
Bolivia	BOL	1994	8 603
Brazil	BRA	1996	12 612
Burkina Faso	BFA	1993	6 354
Cameroon	CAM	1998	5 501
Central African Republic	CAR	1995	5 884
Colombia	COL	1995	11 140
Comoros	COM	1996	3 050
Cote d'Ivoire	CIV	1994	8 099
Dominican Republic	DOR	1996	8 422
Egypt	EGY	1995	14 779
Eritrea	ERI	1995	5 054
Ghana	GHA	1994	4 562
Guatemala	GUA	1995	12 403
Haiti	HAI	1995	5 356
Indonesia	IDN	1994	28 168
Kenya	KEN	1993	7 540
Madagascar	MDG	1997	7 060
Malawi	MWI	1992	4 849
Mali	MAL	1996	9 704
Morocco	MOR	1992	9 256
Mozambique	MOZ	1997	8 779
Namibia	NAM	1992	5 421
Nepal	NEP	1996	8 429
Niger	NER	1998	7 577
Nigeria	NIG	1990	8 781
Pakistan	PAK	1991	6 611
Paraguay	PAR	1990	5 827
Peru	PER	1996	28 951
Philippines	PHI	1998	13 983
Rwanda	RWA	1992	6 551
Togo	TOG	1998	8 569
Uganda	UGA	1995	7 070
United Republic of Tanzania	TZA	1996	8 120
Uzbekistan	UZB	1996	4 415
Yemen	YEM	1992	6 010
Zambia	ZAM	1996	8 021
Zimbabwe	ZWE	1994	6 128

The DHS also collect information on indicators of permanent income for each household. The indicators used in this analysis were: ownership of a radio, television, bicycle, motorbike, car, and fridge; whether the household has electricity and running water; the type of material that the floor, walls and roof of the house are made of; and the type of toilet that the household has. These indicators were used in a hierarchical ordered probit model to arrive at an estimate of permanent income for each household. This method of estimating permanent income from indicator variables is similar to methods developed to construct an asset index from the DHS (*13;14*). Details of the estimation of permanent income and a validation of the model are presented in Ferguson et al. (*15*).

Statistical Model

A previous study measuring total health inequality used the extended beta-binomial model to estimate the distribution of mortality risk (*10*). This chapter presents a conceptually similar approach using a modified logit model. In the standard logit model, all variation in the probability of child survival depends on the quality of available covariates, and so any measure of inequality derived from such a model would underestimate total inequality. For this analysis, the usual logit model is modified to include an additional term that captures systematic variability not picked up by the measured covariates. This hierarchical logit model can be estimated with commonly used statistical software such as Stata.

To define the model, let Y_i be 1 for death and 0 for survival to age two, and X_i denote a vector of covariates measured shortly after birth, for child i. Then under the hierarchical logit model, the probability of survival is:

$$\Pr(Y_i \mid \eta_i)=[1 + \exp(-X_i\beta - \eta_i)]^{-1} \qquad [2]$$

where η_i is an extra, but unmeasured, explanatory variable. Since η_i is unmeasured but assumed independent normal, it can be integrated out during estimation:

$$\Pr(Y_i)=\int[1+\exp(-X_i\beta-\eta_i)]^{-1}N(\eta_i|0,\omega^2)d\eta_i \quad [3]$$

where ω is the standard deviation of η_i and is estimated along with β. When X_i predicts well, ω is small and η_i is superfluous. When X_i omits information and predicts poorly, ω is larger and so η_i corrects the estimated probability by adding the appropriate amount of variability. This model therefore corrects for some, but obviously not all, sources of omitted information in the covariates. It is especially useful for situations where interest lies in measuring variability (or inequality).

The hierarchical logit model is fit to the data for each country separately and the *ex ante* probability that each child will die before age two is estimated. Then the sample variance of these probabilities is computed, which is decomposable according to equation [1] and which correlates with the other measures of inequality, such as the Gini coefficient, presented in Gakidou and King (*10*), at better than 0.95. The variance is the measure of inequality used in this analysis because it can be additively decomposed into between- and within-group components: i.e. equation [1] holds exactly, not merely as a conceptual framework.

Between-group inequality is measured here by computing the variance across income quintiles of the average probability of child mortality. Obviously, this only includes income-group inequalities and excludes between-group inequalities for other types of groups. However, most research on between-group inequality in child mortality has focused on disparities between income groups or groups highly correlated with income. We have also computed between-group inequality on the basis of several other definitions of groups, such as educational attainment, and the results are similar.

Decomposition Analysis

We now decompose total health inequality by studying the effects of income inequality and inequality in access to health services. We first explore what portions of total inequality can be accounted for by inequality in permanent income and inequality in access to health services. Then we estimate the reduction in total inequality that would result if all households with incomes or levels of health services access below the mean were raised to the mean.

To compute an estimate of these effects, the analysis is performed sequentially, studying the effect of one variable at a time. To estimate the full effect of permanent income, a hierarchical logistic regression model is run where the only covariate is permanent income and the hierarchical error term picks up all systematic variation across mothers not correlated with income. This model is an estimate of the total effect of income on mortality. Maternal education, health system access, birth interval and age of the mother at birth are excluded, as some of the effects of income are mediated through these (post-treatment) covariates. The hierarchical error term picks up the remainder effect of these covariates, i.e. the effect that is independent of income.

The goal is to estimate the effect of permanent income inequality on inequality in total child mortality. To do that, the value of the permanent income index for each mother is replaced with the average value of all mothers in her country, and the regression model is used to recalculate the probability of mortality for each child. The new sample variance for this counterfactual scenario is then computed. This procedure simulates what would happen to the total variance if income were equally distributed in each country.

A similar procedure is employed to estimate the effect of health services access. The proxy for health services access is introduced in the hierarchical logit model. The effect of health services access inequality is estimated by replacing the value of this proxy variable for each mother with the average level for the country. The additional reduction in total variance, after removing variation due to permanent income inequality, is then considered as the effect of health services access inequality on total child mortality inequality.

From a policy perspective, it is also interesting to explore the effect of improving the situation of the worst off. This analysis is conducted in two steps as well. First, we simulate the reduction in total inequality that would occur if we raised to the mean the level of income for households with incomes lower than the mean. Second, we estimate the additional reduction in total inequality that would occur if the level of health services access were raised to the mean for households with access below the mean.

Results

Between-Group, Within-Group, and Total Health Inequality

Figure 36.1 plots, by country, total inequality by the average risk of death for the 39 countries in this analysis. The horizontal axis is the average probability of

Figure 36.1 Relationship of total child survival inequality with average level of child mortality

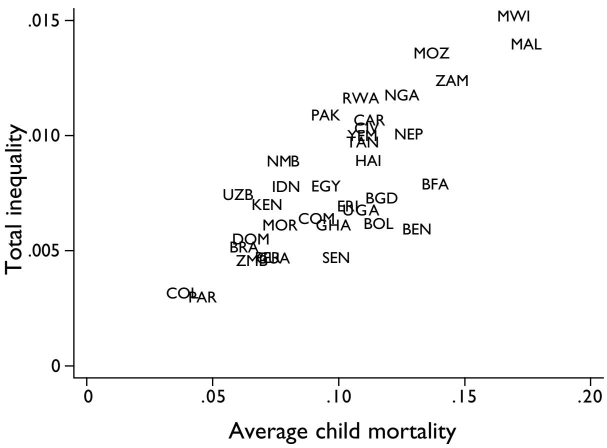
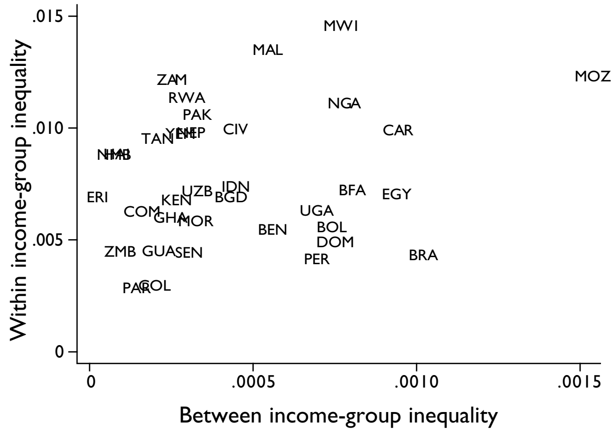


Figure 36.2 Within- vs. between-group inequality for 39 countries



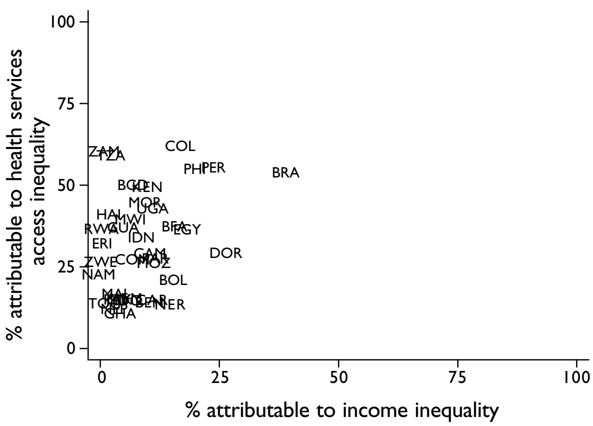
death for all children in the country. The vertical axis is the total variance in risk of death. The figure highlights that as average probability of dying increases, so does total inequality. Even though the relationship is strong, it is far from perfect, as demonstrated by countries such as Benin and Mozambique, which are at approximately the same average level of child mortality (about 135 per 1 000) but have very different levels of total inequality. Benin has a total inequality of 0.006, which is moderate for this sample, while Mozambique has one of the highest levels measured at 0.013.

Figure 36.2 plots between-income-group inequality (horizontally) by within-group inequality (vertically). Mozambique stands out with a high level of both between- and within-group inequality, while Paraguay has low levels of both. The figure indicates that there exists a small relationship between the two, but highlights that knowing one does not help much in predicting the other. Figure 36.2 also demonstrates that between-group inequality is a relatively small fraction of total health inequality. Indeed, within-group inequality is larger than between-group inequality in all 39 countries.

Quantifying the Sources of Health Inequality

We now present the results of the decomposition analysis of total inequality into the effects of permanent income and access to health services. The reduction in total health inequality that would result if there were no inequality in permanent income is indicated in the horizontal axis of Figure 36.3. Brazil, Peru, and the Dominican Republic are three of the countries which would benefit the most from a reduction in economic inequality. As was indicated in Figure 36.2, the contribution of economic inequality does not appear to be consistently greater in countries with higher inequality in child mortality. There is large variation in the contribution of economic inequality to total inequality in child mortality, ranging from very small (close to no effect, as in Namibia), up to almost 40% in Brazil. This implies that the sources of total inequality vary significantly across countries and economic inequality may not be a large source of inequality in health for several countries. As mentioned earlier, this counter-

Figure 36.3 Per cent reduction in total inequality resulting from removing income inequality versus removing health services access inequality

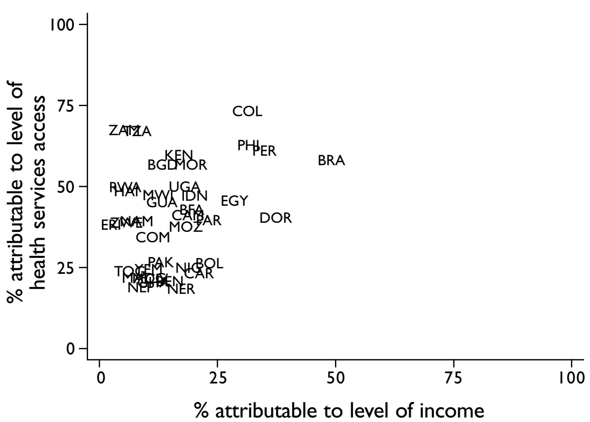


factual scenario attempts to capture the full effect of economic status on child mortality.

The vertical axis of Figure 36.3 shows the per cent reduction in total inequality that would result if there were no inequality in access to health services in each country. In most countries, the effect of inequality in health services access is larger than that of income inequality. The magnitude of the effect varies significantly across countries; in Colombia, Zambia, the United Republic of Tanzania, Peru, Philippines, and Brazil, more than 50% of the inequality in child mortality would be eliminated if access to health services were equal within each country. The effect of access to health services is larger than the effect of income inequalities in all included countries except Niger, which suggests that a good start for policies to reduce inequalities in child survival might be addressing inequalities in, and increasing the level of access to, health services in most countries.

Figure 36.4 presents the results of the second set of counterfactual analyses, examining the effect of potential policies to increase the income and health system access for the worst off. The horizontal axis displays the per cent reduction in total inequality that would result if the income of households currently below the mean were raised to the average level for their country. The figure shows that the countries that would benefit most from such a policy would be Brazil, Peru, and the Dominican Republic, with Brazil showing a decrease in total inequality of 50%. The vertical axis depicts the reduction in total child mortality inequality after raising the level of health system access for those households below the average for their country. Colombia, Zambia, and the United Republic of Tanzania appear to be the countries where increasing health services access would have the greatest effect. It is interesting to note that there are a few countries which would benefit greatly from both an increase in income of the poorest and in level of access for those lacking access. In countries such as Colombia, Peru, Egypt, Brazil, Dominican Republic, and the Philippines, most inequality in child mortality would be eliminated by policies to reduce economic and health services access inequalities.

Figure 36.4 Per cent reduction in total inequality resulting from raising income to the mean versus raising health services access to the mean for those below the mean



Discussion

This chapter presents a decomposition of total inequality in two ways. First, it divides total inequality into between-income-group and within-income-group components and shows that most of the variation occurs within groups. Second, it examines the effect of two major policy-relevant determinants of total health inequality. Under the analytical assumptions presented, areas of intervention for public policy are identified that would seem most likely to be successful in producing large reductions in total inequality. In the vast majority of countries, a variable approximating access to health services accounts for a significant proportion of inequality, although the results indicate that public policy needs to be formulated on a country by country basis, as there are significant differences across the set of countries in this analysis.

Income-related inequalities, while important in their own right, appear to be a major component of total inequality in child survival in only a handful of countries. In most countries, they explain less than ⅕ of total inequality. In some countries, particularly in Brazil, Peru, and the Dominican Republic, income-related inequalities account for more than a quarter of total health inequality. It is worth highlighting that the analytical approach followed here attempts to capture the full effect of permanent income on child survival.

The surprising and encouraging finding of this chapter is the size of the effect of health services access on total inequality. In all countries in this analysis except for Niger, the effect of health services access is larger than the effect of permanent income. The types of services that constitute the health services access proxy are amenable to interventions within the health sector, whether they are health education or family planning programmes, or programmes to improve accessibility to health services in particular areas. In terms of policy implications, the present findings suggest that the most effective ways to reduce inequalities in child survival would be by reducing inequalities in health services access and increasing coverage of health services.

In this analysis, health services access has been approximated by four related variables which were available in the dataset. It is likely that jointly these four variables are a good proxy for access to health services; however, it is also possible that they are capturing different effects in different countries. These variables and their significance depend on the structure of a country's health system and a more in-depth analysis is required to arrive at concrete policy recommendations to reduce total health inequality for each country. With the variables currently available in the data, it is not possible to distinguish whether financial or physical access is of greater importance, as these cannot be differentiated in the present analysis.

As in all counterfactual analyses, the results of the procedures in this chapter can be sensitive to assumptions. In the present analysis in particular, the order in which terms are introduced and hypothetical scenarios are implemented influences the estimate of the effect of each component of total inequality. Some, but not all, of these effects can be studied by reordering the manipulations. When the scenarios are reordered so that the health system access variables are introduced first, the size of the effect of permanent income inequality drops. As such, the results here should be considered conservative estimates of the effects of health interventions on total health inequality.

The results also suggest that the causes of inequality in child mortality are related to, but are quite distinct from, the causes of average level of childhood mortality, and that they vary significantly across countries. Therefore, variables which predict inequality need to be further researched, even if they do not predict average levels of health attainment.

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