What Do Poor Children Die From?
Some Evidence From Cebu, The Philippines

by

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Summary

Evidence that poor children have a higher risk of dying in childhood than better-off children is accumulating fast. This evidence relates to deaths from all causes. This paper reports evidence showing the socio-economic gradient of child mortality *by cause of death*. It uses retrospective survey data from Cebu (the Philippines), and measures inequality using an index that is closely related to the index widely used by epidemiologists and others in the measurement of inequalities in health and mortality. The index used here has the advantage of being additively decomposable, so we can make statements to the effect that x% of the inequality in child mortality is accounted for inequality in deaths from just four causes. The index also has the advantage of allowing accurate standard errors to be derived, allowing us to see whether inequalities are statistically significant. Deaths amongst children under five in Cebu over the period 1981-91 were significantly concentrated amongst the poor. Deaths from most causes are concentrated amongst the poor, but not all, and not all concentration indices are significantly different from zero. Mortality from the big killers is more concentrated amongst the poor than mortality from all causes. Four causes—measles, diarrhea, pneumonia, and fever/febrile convulsions—account for a little over 50% of all under-five deaths, but account for nearly 70% of *inequality* in under-five deaths.

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I. **INTRODUCTION**

There is accumulating hard empirical evidence of a phenomenon known for many years to people familiar with developing countries—poor children have a higher risk of dying in childhood than better-off children [1, 2]. These inequalities vary across countries, and reducing them has become a major priority for a number of international organizations, including the World Bank [3] and the World Health Organization [4], as well as several national governments in their development assistance programs [5].

The evidence to date on inequalities in child survival relates to deaths from all causes. This paper reports evidence showing the socio-economic gradient of child mortality by cause of death. It is known that inequalities in adult mortality in industrialized countries vary by cause of death [6], and it seems likely that the same is true of child mortality in the developing world. One issue of interest is whether socioeconomic inequalities in deaths from the four big killers (pneumonia, diarrhea, measles, and malaria) are larger than inequalities in mortality from other causes. Knowing the distribution of child deaths from specific conditions can help in assessing how successful different programs are in reaching those with the greatest medical needs. If, for example, illness and mortality from condition X is more concentrated amongst the poor than illness and mortality from concentration Y, utilization of services aimed at treating condition X will need to be more unequally distributed in favor of the poor than utilization of services aimed at treating condition Y if equity is to be achieved [7].

The paper uses retrospective survey data from Cebu (the Philippines), and measures inequality using an index that is closely related to the index widely used by epidemiologists and others in the measurement of inequalities in health and mortality. The index used here has the advantage of being additively decomposable, so we can make statements to the effect that x% of the inequality in child mortality is accounted for inequality in deaths from just four causes. The index also has the advantage of allowing accurate standard errors to be derived, allowing us to see whether inequalities are statistically significant. The paper is organized as follows. Section II outlines the data. Section III outlines the methods used to measure and decompose inequality, and discusses the issue of statistical inference. Section IV contains the results, and section V the conclusions.

II. **DATA AND VARIABLE DEFINITIONS**

The data are taken from the second wave of the Cebu Longitudinal Health and Nutrition Survey (CLHNS). The full sample comprises 2,572 households. A complete fertility history is available for the main mother of the household, along with the cause of death—in the mother's opinion—of any children who died. We describe in this section the definitions of the two key variables—income and mortality.

Income

We measure income in a broad sense. In fact, it is better thought of as a measure of consumption rather than of income. We have followed as close as is possible the methodology employed in the World Bank's Living Standards Measurement Study (LSMS) [8], the aim of which is to arrive at a measure of household consumption of food, housing and other non-food items, that reflects not only outlays by the household, but also any production of food and non-food items by the household, and the rental value of the household's home and other durables. In the case of the CLHNS, a broad measure of income was constructed, including wage and non-wage income, in-kind income received from non-family members, the value of home-grown vegetables and other produce, and the rental value of the family's home and other consumer durables.

We equivalize household consumption. The two extreme positions on equivalization are (a) to assume that there are no economies of scale in household consumption (it costs two people twice as much to live as one) and (b) to assume that there are maximum economies of scale (two can live as cheaply as one). These two extremes, and certain intermediate positions, can be represented by the following relationship between equivalent consumption and actual consumption:

(1) $E = A/H^e$

where E is equivalent consumption, A is actual consumption, H is household size, and e an equivalence scale elasticity [9]. Under the assumption that there no economies of scale, e is set equal to 1, and equivalent consumption is simply per capita consumption. Under the assumption that two (or three, or four, of five,…) can live as cheaply as one, e is set equal to 0, and equivalent consumption is simply aggregate household consumption. Although it is not uncommon to find to find e set equal to one (the per capita adjustment), a more plausible position, at least in countries where a sizeable proportion of consumption is on non-food items, is that there are some economies of scale, but that the elasticity e is greater than zero. In their survey of equivalence scales in OECD countries, Buhmann et al. [9] found that most equivalence scales could be approximated quite closely by eqn (1) and that, on average, the implied value of the elasticity e was around 0.4. Hentschel and Lanjouw [10], in their work on Ecuador, experiment with three values of e: 0.4, 0.6, and 1.0. In what follows, we set e equal to 0.5, which seems a reasonable intermediate position.

Mortality

Rather than estimating mortality rates, we analyze the inequality in the number of deaths—by condition—amongst children aged five or under at the time of death. In the sample, we select all children born within the last 10 years. It is these children who are then assigned an equivalent consumption figure—on the basis of their household's consumption and size at the interview date—and who are then ranked and assigned to quintiles. We then examine the inequality across quintiles in the number of deaths overall and in deaths from specific conditions. The cause-of-death categories used in the survey are: (1) Accident, (2) Birth asphyxia, (3) Complication during labor, (4) Congenital abnormalities, (5) Diarrhea, (6) Digestive disorders, (7) Fever/febrile convulsion, (8) Heart disease, (9) Malnutrition/nutritional deficiencies, (10) Measles etc., (11) Meningitis, (12) Pneumonia, (13) Pregnancy-related complications, (14) Prematurity, (15) Severe cough, (16) Sorcery/witchcraft, (17) Sudden Infant Death Syndrome, (18) Tetanus, and (19) Other.

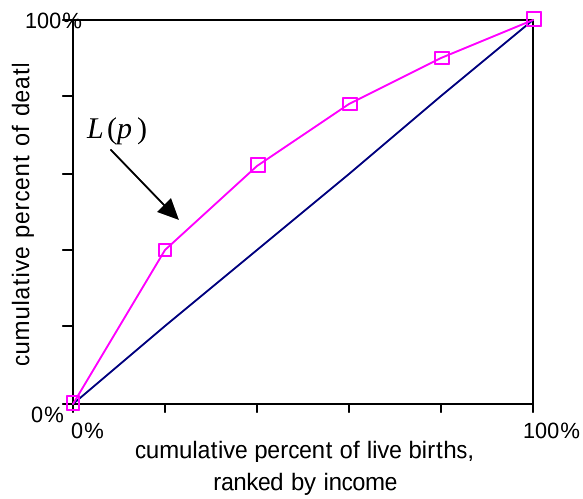
III. **MEASURING INEQUALITIES IN MORTALITY**

In addition to presenting the distribution of child deaths across quintiles, we also compute a summary measure indicating the degree of inequality in mortality across quintiles. This allows us to see more easily whether child deaths from some conditions are more concentrated amongst the poor than others.

The concentration index and its relationship to the relative index of inequality

The curve labelled $L(p)$ in Figure 1 is a mortality concentration curve. It plots the cumulative proportion of deaths (on the y-axis) against the cumulative proportion of children born (on the x-axis), ranked by equivalent income, beginning with the most disadvantaged child. The similarity with the Lorenz curve is obvious, but one should bear in mind that here we are not ranking by the variable whose distribution we are investigating. We are looking here at the distribution of mortality, not across quintiles grouped by mortality, but rather across income quintiles. If the curve $L(p)$ coincides with the diagonal, deaths are equally distributed across quintiles. If, as is more likely, $L(p)$ lies above the diagonal, the poorer quintiles experience more deaths than the better-off quintiles; we will call such inequalities *pro-rich*. If $L(p)$ lies *below* the diagonal, we have *pro-poor* inequalities in mortality (inequalities to the disadvantage of the better-off). The further $L(p)$ lies from the diagonal, the greater the degree of inequality in mortality across income quintiles. If $L(p)$ for cause of death X is everywhere closer to the diagonal than that of cause of death Y, then the concentration curve for X is said to dominate the concentration curve for Y, and it seems reasonable to say that inequality in mortality from cause X is unambiguously lower than inequality in mortality from cause Y.

Fig 1: Mortality concentration curve



Where concentration curves cross, or where, in any case, one wants a numerical measure of health inequality, one can use the concentration index, denoted below by C, defined as twice the area between $L(p)$ and the diagonal. C takes a value of zero when $L(p)$ coincides with the diagonal and is negative (positive) when $L(p)$ lies above (below) the diagonal. In the general case, where there are T income groups, C can be calculated [11] as

(2) $$C = \frac{2}{m}\sum_{t=1}^{T} f_t m_t R_t - 1,$$

where $m = \sum_{t=1}^{T} f_t m_t$ is the overall mean mortality rate, m_t is the rate of the tth economic group, and R_t is its relative rank, defined as

(3) $$R_t = \sum_{g=1}^{t-1} f_g + \tfrac{1}{2} f_t ,$$

and indicating the cumulative proportion of the population up to the midpoint of each group interval.

The concentration index, C, is closely related to the relative index of inequality (RII). This has been used extensively by epidemiologists and others in the measurement of socioeconomic inequalities in health and mortality [12-15]. C can be computed on grouped data using the following "convenient" regression [11]

(4) $$2\sigma_R^2\left[m_t / m\right]\sqrt{n_t} = \alpha_1 \cdot \sqrt{n_t} + \beta_1 \cdot R_t\sqrt{n_t} + u_t,$$

where σ_R^2 is the variance of R_t, n_t is the number of ever-born children in group t, α_1 and β_1 are coefficients, and u_t is an error term. The estimator of β_1 is equal to

$$(5) \qquad \hat{b}_1 = \frac{2}{m}\sum_{t=1}^{T} f_t\left(m_t - m\right)\left(R_t - \tfrac{1}{2}\right),$$

which, from eqn (2), shows that $\hat{b}_1$ is equal to C. Readers familiar with the RII will note that eqn (4) is essentially the same as the regression equation used to compute the RII, the difference being that the left-hand side (LHS) of the equation is multiplied through by twice the variance of the relative rank variable, R_t. There is thus a simple relationship between C and RII [16], namely

$$(6) \qquad C = 2s_R^2 \cdot RII,$$

Since the variance of the relative rank approaches 1/12 as the sample size grows, it can be treated approximately as a constant, and the RII and C ought to rank distributions the same. There is little to choose between the two measurement approaches, though the concentration curve has the attraction of facilitating graphical comparisons of malnutrition inequalities.

Breaking down all-cause inequalities into cause-specific inequalities

It is fairly well known that over one half of child deaths in developing countries are due to just five communicable diseases (pneumonia, diarrhea, measles, malaria, and HIV/AIDS) and malnutrition [17]. Can one break down inequality in a similar way? Can one say, for example, that over half of the inequality in all-cause mortality is due to inequality in deaths from these conditions? It turns out that one can. Using a result developed in the income inequality literature [18], the concentration index for all-cause mortality can be written:

$$(7) \qquad C = \sum_i s_i C_i,$$

where s_i is the share of deaths from condition i, and C_i is the concentration index for deaths from condition i. Thus C is a weighted average of the concentration indices for the individual causes of death. One can then compute for each cause of death, i, the value of $s_i C_i / C$—this shows what share of overall inequality, as measured by C, is accounted for by inequality in deaths from cause i.

Sampling variability and standard errors

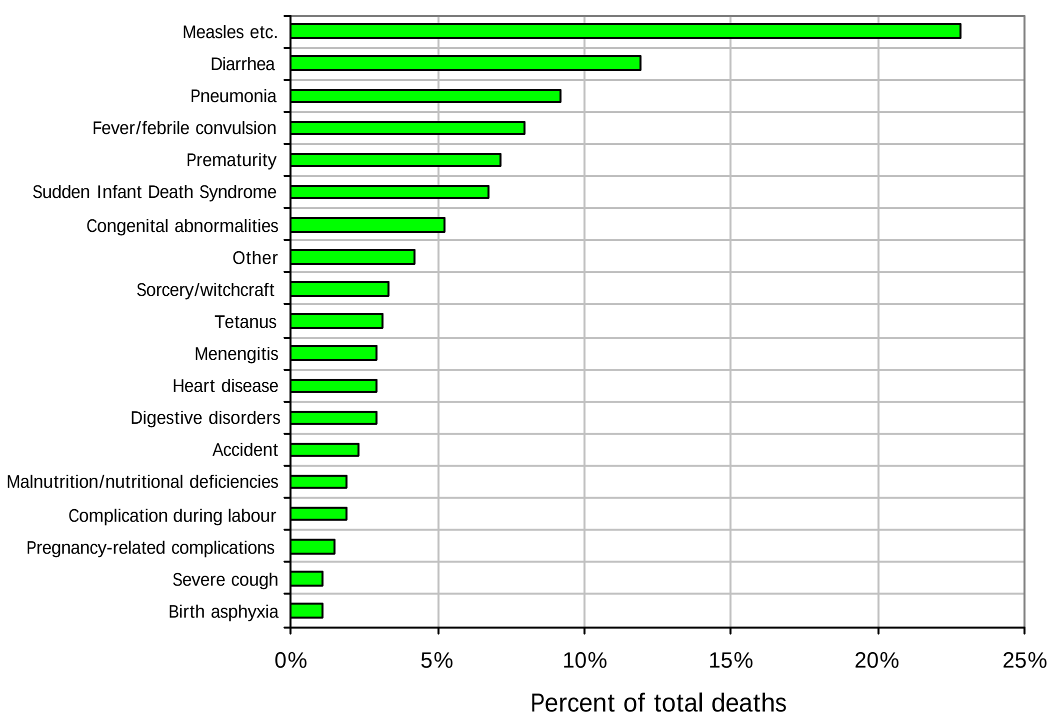
Being derived from survey data, the mortality rates are, of course, subject to sampling variation. It is useful, therefore, to have alongside numerical values of the index C standard errors that allow one to see whether the inequality is significantly different from zero. An attraction of the convenient regression—eqn (4) above—is that it provides a standard error for the concentration index C. This standard error is not, however, wholly accurate, since the observations in each regression equation are not independent of one another due to the nature of the R_t variable. Kakwani et al. [11] derive an accurate estimator which is used in what follows.

IV. **RESULTS**

Composition of child deaths

Table 1 and Figure 2 report for the full CLHNS sample the proportion of under-five deaths over the period 1981-91 accounted for by various causes of death. The ranking of causes of deaths of under-five children in Cebu is similar—though not identical—to that reported in WHO [19]. Measles and related causes are the single most common cause of death, accounting for nearly 23% of child deaths over the period 1981-91. This figure is a good deal higher than the figure reported by WHO for the developing world as a whole in 1995 (10%) and is somewhat higher up our league table than WHO's (Measles is ranked third in the WHO table). Second in Cebu is diarrhea, accounting for 12% of child deaths—somewhat lower than the WHO figure of 19%, but in the same place in the child deaths league table. Third in Cebu is pneumonia, accounting for 9% of deaths, a good deal below WHO's 20%. Fourth is fever and febrile convulsions. Insofar as this is picking up mostly malaria deaths, the figure of 7% is very close to that for the world as a whole reported by WHO. These four causes alone account for 52% of under-five deaths in Cebu over the period in question. Prematurity, SIDS and congenital abnormalities all account for between 5-7% of child deaths.

Fig 2: Main causes of death amongst under-five children, Cebu 1981-91



Inequalities in child deaths

Table 1 shows the distribution of deaths across consumption quintiles. Where the total number of deaths is small, it would be unwise to read too much into the distribution across quintiles. This is reflected in the large confidence intervals around the concentration indices—

see Fig 3. Overall, child deaths are concentrated amongst the poor, as indicated by the negative value of *C*. Most causes of death have negative concentration indices—but not all. The exceptions are birth asphyxia, heart disease, prematurity, congenital abnormalities, and pregnancy-related complications. Deaths from malnutrition are especially concentrated amongst the poor, according to the concentration index, but there are thirteen other causes of death—including the catch-all "other" category—where the concentration index is smaller than -0.15. several have indices that are less than -0.2. Many of these numbers need, however, to be interpreted with caution, given the small numbers of deaths involved. In Fig 3, many of the confidence intervals include zero, meaning that the concentration index is not significantly different from zero. These are typically cases where the number of deaths does not decline monotonically—or even nearly monotonically—as one moves up through the income distribution. In these cases, the non-zero concentration index indicates that on balance the inequality is either pro-rich or pro-poor, while the confidence interval indicates that the inequality is not statistically significant. The clear-cut cases where inequality is significant are those where the deaths decline monotonically or very nearly monotonically, and the gradient is fairly steep. These include two causes that are concentrated amongst the better-off—birth asphyxia and heart disease—and six causes that are concentrated amongst the poor, notably pneumonia, fever and febrile convulsion, diarrhea, tetanus, "other", and accidents. The perverse gradients for heart disease and birth asphyxia may be reflect differential reporting by poor and better-off women, and at least in the case of heart disease may reflect the fact that children vulnerable to heart disease may already have died from infections diseases.

The concentration indices in Table 1 show clearly that it is indeed the case that, amongst children under five, deaths from the big killers are even more concentrated amongst poor children than deaths in general. The first four causes listed in Table 1, which together account for 52% of all deaths, all have concentration indices that are more negative than the concentration index for deaths overall. The last two columns of Table 1 use the result in eqn (7). The penultimate column indicates the value of s_iC_i, and the last column gives the value of this expressed as a proportion of *C*. Thus measles accounts for 23% of under-five deaths, but inequality in deaths from measles accounts for 30% of inequality in under-five deaths. The first four causes of death account for a little over 50% of total deaths *but account for nearly 70% of inequality in child deaths*. This is shown graphically in Fig 4.

Table 1: Deaths, by cause of death and consumption quintile, Cebu 1981-91

	Number of deaths per consumption quintile					Total no. deaths		Inequality		
Cause	**1**	**2**	**3**	**4**	**5**	**No. deaths**	**Share of deaths (*s*)**	**CI (*C*)**	**Contribution to inequality (sC)**	**Share of inequality**
Measles etc.	31	24	26	22	6	109	23%	-0.1908	-0.0435	29%
Diarrhea	22	11	11	7	6	57	12%	-0.2526	-0.0301	20%
Pneumonia	11	13	9	5	6	44	9%	-0.1636	-0.0151	10%
Fever/febrile convulsion*	13	7	7	5	6	38	8%	-0.1684	-0.0134	9%
Prematurity	4	7	8	9	6	34	7%	0.0706	0.0050	-3%
SIDS	5	10	11	4	2	32	7%	-0.1500	-0.0100	7%
Congenital abnormalities	6	6	0	4	9	25	5%	0.0640	0.0033	-2%
Other*	6	7	4	1	2	20	4%	-0.2800	-0.0117	8%
Sorcery/witchcraft	5	3	2	5	1	16	3%	-0.1500	-0.0050	3%
Tetanus*	6	3	2	3	1	15	3%	-0.2667	-0.0084	6%
Menengitis	3	4	2	2	3	14	3%	-0.0571	-0.0017	1%
Heart disease*	2	3	2	3	4	14	3%	0.1143	0.0033	-2%
Digestive disorders	3	3	6	2	0	14	3%	-0.2000	-0.0059	4%
Accident*	3	4	3	0	1	11	2%	-0.2909	-0.0067	4%
Malnutrition	4	1	4	0	0	9	2%	-0.4000	-0.0075	5%
Complication during labor	2	2	4	1	0	9	2%	-0.2222	-0.0042	3%
Pregnancy complications	1	2	0	3	1	7	1%	0.0571	0.0008	-1%
Sev cough	2	0	2	1	0	5	1%	-0.2400	-0.0025	2%
Birth asphyxia*	1	0	0	2	2	5	1%	0.3200	0.0033	-2%
All	*130*	*110*	*103*	*79*	*56*	*478*	*100%*	*-0.1498*	*-0.1498*	*100%*

Fig 3: Inequalities in child mortality by cause of death, Cebu 1981-91

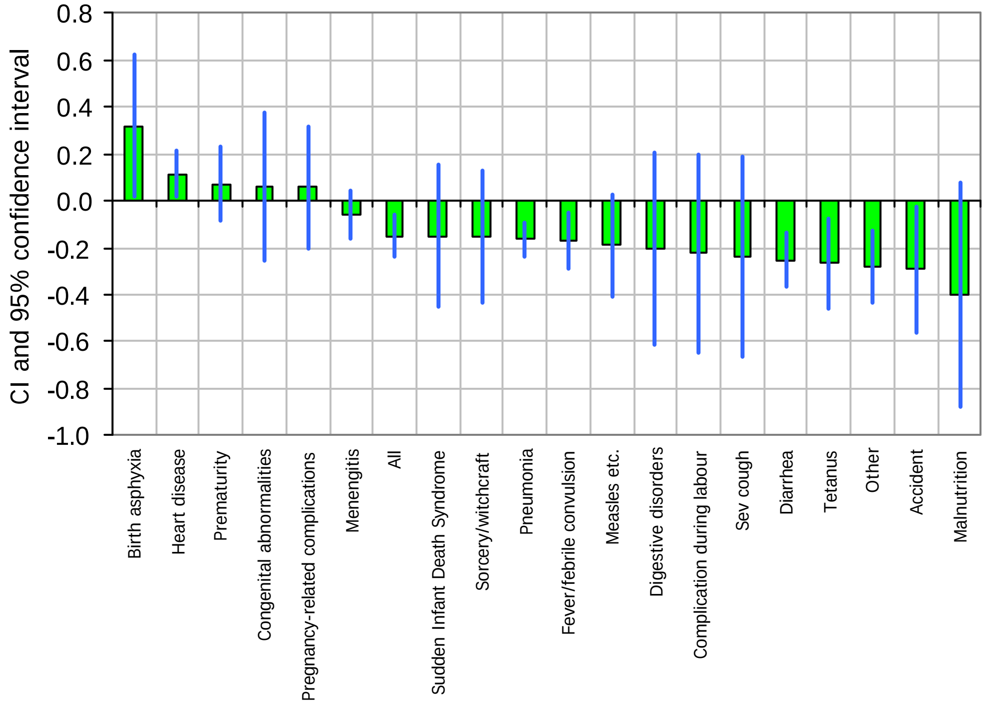
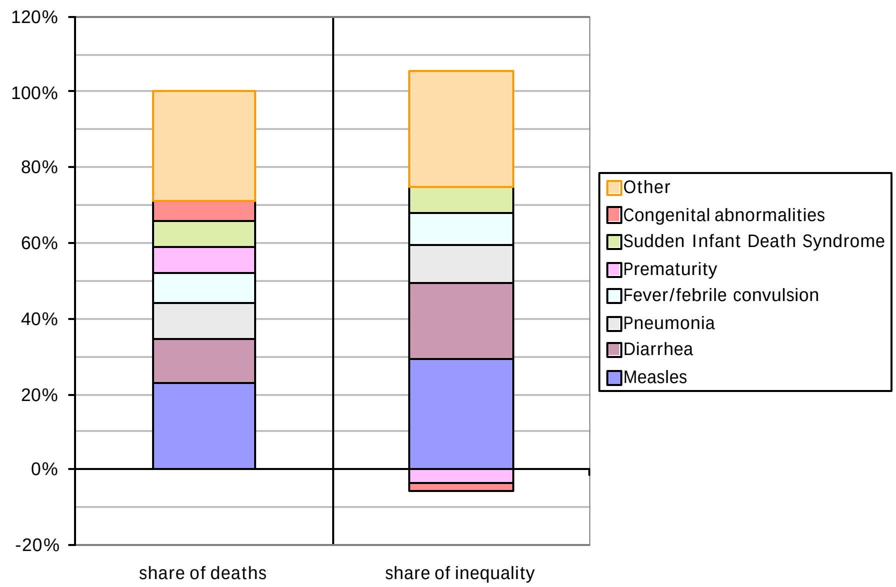


Fig 4: Shares of deaths and inequality in deaths, Cebu 1981-91



V. **CONCLUSIONS**

The conclusions can be summarized briefly. On the basis of survey data from the Cebu Longitudinal Health and Nutrition Survey, deaths amongst children under five in Cebu over the period 1981-91 were concentrated amongst the poor. The concentration index for deaths from all causes was significantly different from zero. Deaths from most causes are concentrated amongst the poor, but not all, and not all concentration indices are significantly different from zero. Six causes are significantly concentrated amongst the poor, notably pneumonia, fever and febrile convulsion, diarrhea, tetanus, "other", and accidents. Four communicable diseases—measles, diarrhea, pneumonia, and fever/febrile convulsions—account for a little over 50% of all under-five deaths in the sample, but account for *nearly 70% of inequality in under-five deaths*.

The findings of this paper are consistent with those of Gwatkin et al. [20, 21], who report estimates of the main causes of death amongst the poorest 20% and richest 20% of the world's population. They find that the poorest 20% accounts for 47% of deaths from communicable diseases but the richest 20% accounts for only 4% of such deaths. By contrast, the poorest 20% accounts for 16% of deaths from non-communicable diseases, while the richest 20% accounts for as much as 29% of such deaths. These figures are for all age groups, and are derived on the assumption that everyone within a given region of the world has the same income. The approach adopted in this paper involves asking what the burden of disease looks like amongst the poorest and richest 20% within a particular country. Despite the difference in methods, the same broad conclusions emerge in both papers. The poor-nonpoor inequality in deaths from communicable diseases in Cebu is apparent in Table 1. The poorest 20% of children account for 31% of deaths from the four main communicable diseases, while the richest 20% account for only 10%. This gradient is steeper than the overall gradient—the poorest 20% of children in Cebu account for 27% of under-five deaths, while the richest 20% account for 12%. The gradient difference between deaths from communicable diseases and all-cause mortality is smaller across income groups in Cebu than it seems to be across income groups of the global population, but this is scarcely surprising.

References

1. Gwatkin, D., S. Rutstein, K. Johnson, R. Pande, and A. Wagstaff, *Socioeconomic Differences in Health, Nutrition and Population*. 2000, Washington DC: The World Bank, Health, Nutrition & Population Discussion Paper.

2. Wagstaff, A., Socioeconomic inequalities in child mortality: comparisons across nine developing countries. *Bulletin of the World Health Organization*, 2000. **78**(1): p. 19-29.

3. World Bank, *Health, Nutrition and Population Sector Strategy*. 1997, Washington DC: The World Bank.

4. World Health Organization, *The World Health Report 1999: Making a Difference*. 1999, Geneva: The World Health Organization.

5. Department for International Development, *Better Health for Poor People*. 1999, London: Department for International Development.

6. Kunst, A., *Cross-National Comparisons of Socioeconomic Differences in Mortality*. 1997, Den Haag: CIP-Gegevens Koninklijke Bibliotheek.

7. van Doorslaer, E., A. Wagstaff, and F. Rutten, eds. *Equity in the Finance and Delivery of Health Care: An International Perspective*. 1993, OUP: Oxford.

8. Deaton, A. and M. Grosh, Consumption, in *Designing Household Survey Questionnaires for Developing Countries: Lessons from 15 Years of the Living Standards Measurement Study*, M. Grosh and P. Glewwe, Editors. 2000, The World Bank: Washington, DC.

9. Buhmann, B., L. Rainwater, G. Schmaus, and T. Smeeding, Equivalence scales, well-being, inequality and poverty. *Review of Income and Wealth*, 1988. **34**: p. 115-142.

10. Hentschel, J. and P. Lanjouw, *Constructing an indicator of consumption for the analysis of poverty: Principles and illustrations with reference to Ecuador*. 1996, Washington DC: World Bank, LSMS Working Paper Number 124.

11. Kakwani, N., A. Wagstaff, and E. Van Doorlsaer, Socioeconomic inequalities in health: Measurement, computation and statistical inference. *Journal of Econometrics*, 1997. **77**(1): p. 87-104.

12. Kunst, A.E., J.J. Geurts, and J. van den Berg, International variation in socioeconomic inequalities in self reported health. *J Epidemiol Community Health*, 1995. **49**(2): p. 117-23.

13. Pamuk, E., Social class inequality in mortality from 1921-1972 in England and Wales. *Population Studies*, 1985. **39**: p. 17-31.

14. Pamuk, E., Social class inequality in infant mortality in England and Wales from 1921 to 1980. *European Journal of Population*, 1988. **4**: p. 1-21.

15. Schalick, L.M., W.C. Hadden, E. Pamuk, V. Navarro, and G. Pappas, The widening gap in death rates among income groups in the United States from 1967 to 1986. *International Journal of Health Services*, 2000. **30**(1): p. 13-26.

16. Wagstaff, A., P. Paci, and E. van Doorslaer, On the measurement of inequalities in health. *Social Science and Medicine*, 1991. **33**: p. 545-557.

17. World Bank, *Child Health at a Glance*. 2001, Washington DC: World Bank, Health, Nutrition & Population "At a Glance" Series.

18. Podder, N., The disaggregation of the Gini coefficient by factor components and its applications to Australia. *Review of Income and Wealth*, 1993. **39**(1): p. 51-61.

19. World Health Organization, *The World Health Report 1998: Life in the 21st Century--A Vision for All*. 1998, Geneva: World Health Organization.

20. Gwatkin, D.R., M. Guillot, and P. Heuveline, The burden of disease among the global poor. *The Lancet*, 1999. **354**(9178): p. 586-589.

21. Gwatkin, D.R. and M. Guillot, *The Burden of Disease Among the Global Poor: Current Situation, Future Trends, and Implications for Strategy*. 2000, Washington DC: World Bank.