Socioeconomic Determinant of Exposure to Multiple Risk Factors for Child Mortality: Multi-Country Analysis from Demographic and Health Surveys

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Summary

Child mortality has received renewed attention as a part of the United Nation's Millennium Development Goals (MDGs). The contributions of specific risk factors (e.g. undernutrition and poor water, sanitation, and hygiene) to child mortality have been documented in different world regions. However, many childhood deaths are caused by multiple risk factors which may be concurrently higher in disadvantaged groups. The socioeconomic patterns of multi-risk exposure (i.e. causes) and mortality (i.e. outcomes) have not been adequately and comparatively studied. Using data from the Demographic and Health Surveys, this paper presents an analysis of socioeconomic gradients of childhood mortality and its major risk factors for 55 countries. We also provide a detailed analysis of similarities and differences of such gradients within and between countries and regions. This is an important step in considering how wealth or income may interact with other factors, from geography to policy, to affect child survival.

Introduction

Child mortality, commonly on the agenda of public health and international development agencies, has received renewed attention as a part of the United Nation's Millennium Development Goals (MDGs) (*1, 2*). Approximately 10 million infants and children under five years of age die each year, with large variations in under-five mortality rates between and within populations (*1, 3, 4*). The contributions of specific risk factors (e.g. undernutrition and poor water, sanitation, and hygiene) to child mortality have also been documented in some detail in different world regions (*1, 5, 6*). Many childhood diseases and deaths are caused by multiple risk factors (*7*). Multi-causality means that a range of preventive interventions and their combinations (as well as treatment) can be used for disease and death prevention.

It has been documented that child mortality is associated with socioeconomic factors such as income, both between different countries and within individual nations (*4, 8*). Socioeconomic gradients in important *risk factors* for childhood mortality have also been documented (*4, 9*). But few studies have documented the socioeconomic patterns of multi-risk exposure and mortality simultaneously, and none for a large number of countries using similar definitions.

This paper provides an analysis of the socioeconomic gradients of childhood mortality and its major risk factors for 35 countries in sub-Saharan African and Latin America. Because we use data collected and analyzed using similar instruments and methods, we also provide a detailed analysis of similarities and differences of such gradients within

and between countries and regions. This will be an important step in considering how wealth or income may interact with other factors, from geography to policy, to affect child mortality.

Methods and Data Sources

Demographic and health surveys (DHS)

The Demographic and Health Surveys (DHS), currently run by Macro International Inc, is a household survey program that largely focuses on collecting data on maternal and child health. The survey can be carried out through different questionnaires, with sample sizes ranging from 3,000 to 90,000 respondents. The core questionnaire is administered to a nationally representative sample of women aged 15-49, and includes questions on basic socio-demographic characteristics, birth history, contraception use, antenatal, delivery, and postpartum care, breastfeeding and nutrition, and children's health. A separate household questionnaire collects information on household characteristics, nutritional status of household members (including, in some cases, a haemoglobin test), and records a household roster. A men's questionnaire, generally with a smaller sample size than the women's questionnaire, is also included in some countries, focussing on socio-demographic characteristics, reproduction, sexual behaviour, tobacco and alcohol use, and AIDS knowledge.

The DHS have been initiated in four major waves (I,II,III, DHS+) with changes to the instrument in each wave. Several additional optional modules to the core questionnaires have been added over the years, including, but not limited to, questions on malaria,

anaemia, AIDS knowledge and testing, sibling survival, vitamin A supplement, status of women, and tobacco. The DHS program has provided the technical assistance necessary to implement more than 100 surveys in over 60 countries of the developing world, in Africa, Asia, the Near East, Latin America and the Caribbean. This paper presents results from 35 countries from Sub-Saharan Africa, and Latin and South America. For each country we used the latest DHS available; the year of data collection and sample sizes are shown in Annex Table 1. The variables used in the analysis are described in Table 1.

Countries have been grouped into four subregions using the geographical-mortality classification of the World Health Organization (*6*): AFR-D includes countries in sub-Saharan Africa that have high adult and high child mortality; AFR-E refers to countries in sub-Saharan Africa that have very high adult and high child mortality; AMR-B are countries in the Region of the Americas that have low adult and low child mortality; and AMR-D includes countries in the Region of the Americas that have high adult and high child mortality.

Mortality and risk data

Data on child mortality come from the birth history module in the DHS, where information is collected for all children born to each woman. The DHS have been used extensively as a reliable source of child mortality for countries with incomplete or no vital registration systems (*10*). In addition to collecting information on survival, the DHS also collect anthropometric data for children born in the 3 to 5 years preceding the interview. DHS reports anthropometric indices with respect to the number of standard

deviations from the mean of the international standard used by NCHS/CDC/WHO. In this paper, the measure of malnutrition used is weight-for-age as a measure of global malnutrition. Children are classified as moderately malnourished if they are more than 2 standard deviations below the standard and extremely malnourished if they are more than 3 standard deviations below the standard. Data on water and sanitation facilities are collected at the household level. In this analysis, households were grouped into three broad categories of risk, according to exposure to environmental faecal-oral pathogen load. We classify as very-high-risk households without basic sanitation facilities; high-risk households with basic sanitation but without clean water supply; and low risk households with improved sanitation and water supply.

Measuring economic status

There are several different ways of measuring economic status in household surveys, including monetary measures such as self-report income and expenditure, as well as non-monetary indices derived from socioeconomic variables and asset indicator variables. In this paper, we focus on the latter approach given that DHS do not collect data on self-reported income and expenditure, but do have information on ownership of asset indicator variables such as television, radio, electricity, etc. The asset-based approach is based on a long-term conceptualization of economic status, one that is arguably more relevant as a determinant of health status. Furthermore, this approach is robust to reporting biases that make the use of monetary income and expenditure data for measurement of economic status at the lower end of the spectrum especially problematic (*11*). The method we use is based on the premise that wealthier households are more

likely to own any given set of assets. However, the level of economic status at which a household becomes more likely to own a given asset is assumed to vary by asset. What this implies is that there is a "ladder" analogy in the method in that there are some assets or services, such as electricity, whose likely observed ownership occurs at relatively low levels of economic status. On the other end, there might be assets, such as a car, that are likely observed to be owned only at relatively higher ends of the economic spectrum. As long as the assets are "normal" goods -- in that higher levels of economic status lead to higher proportions of observed ownership -- the method can use the information content in a set of assets owned by a given household to estimate an economic status index for that household. The method, described in detail elsewhere (*12*), also allows for information using socio-demographic predictors of economic status – such as education, age, and rural-urban residence -- to be incorporated in the estimation process. The asset-based method is also easily adapted to construct an index of economic status that is comparable across countries. In order to do so, the method requires the identification of a sub-set of asset indicators that become more likely to be observed to be owned at roughly the same level on an internationally comparable underlying economic status scale. These asset indicators can then be used as anchors such that the resulting economic status index using pooled cross-country data is internationally comparable akin to a purchasing-power parity (PPP) scale, as described and validated elsewhere (*13*).

Results and Discussion

Figure 1 presents the relationship between economic status and childhood mortality for all countries with data. Because the quintiles of economic status are the same in all

countries, the patterns are comparable across countries or regions. In Africa results are presented only for the first four quintiles as there are not enough observations in the richest quintile to arrive at reasonable estimates in child mortality.

In all sub-regions child mortality decreased as economic status increased. There were nonetheless important differences across regions. At any level of economic status, child mortality was generally lower in the Region of the Americas than in sub-Saharan Africa. The gradients in child mortality across income quintiles were also greater in sub-Saharan Africa, especially in the subregion AFR-D, with very high levels of mortality in the poorest quintile across the region. There are also large variations across countries in rates of child mortality within the same quintile of income. Within AFR-D, in the poorest quintile, child mortality ranges from 140 (per 1,000 live births) in Ghana to 350 in Niger. The differences become even more pronounced when all regions are considered, with Colombia and Paraguay showing child mortality rates for the poorest quintiles of less than 65 per 1,000. This implies that across the set of countries included in this analysis there is as much as a five-fold difference in child mortality rates for populations at similar levels of income. The cross-country variations in the richest two quintiles were much smaller across countries and regions. It is also noteable that in some countries even the richest quintiles are at unacceptably high levels of childhood mortality. For example, child mortality rate in the richest quintile in Chad is 162 per 1000. This mortality rate is higher than that of the poorest quintile in Ghana (140 per 1000); Ghana is the country in AFR-D with the lowest mortality rate in the poor.

Similar trends are also seen for malnutrition, both moderate and severe, with the Region of the Americas having lower level of malnutrition than the African regions, as with mortality (Figures 2 and 3). The inter-region differences however were less pronounced than those of child mortality. The income gradients for both moderate and severe malnutrition are quite pronounced. As with child mortality, within-income variations across countries are greatest for the poorest quintile with a range of 9 to 24% of children severely malnourished in the African region and 6-26% severely malnourished in the region of the Americas. As with mortality, for the richest quintiles the differences across countries are less pronounced. In the Region of the Americas, Guatemala and Brazil exhibit the most pronounced income-related inequalities in both moderate and severe malnutrition. The other countries in the region have similar trends across income quintiles. In the African regions studied in this analysis, most countries exhibit similar income-related inequalities, i.e. the slope across income quintiles is similar across a wide set of countries. Niger and Mozambique are the two countries with the most pronounced income–related inequalities in malnutrition; however, the gradients observed are not as steep as those seen in Guatemala and Brazil.

Economic patterns of exposure to the risks associated with poor water and sanitation are shown in Figure 4. The two African regions show similar patterns of water and sanitation facilities, with the largest percentage of the population at very high or high risk of faecal-oral transmission across all quintiles, and a gradual improvement in water and sanitation with increasing economic status. The gradient is more steep in the region of the Americas, where the percentage of households in the category “very high risk” is large

for the first three quintiles. The poorest quintile is almost exclusively in the very high risk category in the AMR-B subregion and 80% in the AMR-D subregion. As with malnutrition, the income gradient is much more pronounced in the region of the Americas than in Africa.

In summary, comparing the economic gradients of childhood mortality and two of its major risk factors in countries in 4 geographical-epidemiological regions of the world illustrates that those countries with large inequalities in health outcomes also show large inequalities in risk factors. At the same time, the income-gradients in outcome (mortality) are generally steeper than those of its major risks, possibly indicating concentration of risk factors and lack of access to case management which magnify the effects of one another. There is variation in outcomes and risk factors for the richest quintiles across countries in all regions, but these differences are much smaller in the higher economic status quintiles. The largest variations observed are within the poorest quintile – further research should be addressed at why some countries are more effective than others at delivering services and improving health outcomes of the poorest subgroups of their populations.

References

1. Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? Lancet 361:2226-2234(2003).
2. The Bellagio Child Survival Study Group. Knowledge into Action for Child Survival. Lancet 362:323-327(2003).
3. Ahmad OB, Lopez AD, Inoue M. The Decline in Child Mortality: A Reappraisal. Bulletin of the World Health Organization 78:1175-1191(2000).

4. Victora CG, Wagstaff A, Schellenberg JA, Gwatkin D, Claeson M, Habicht JP. Applying an equity lens to child health and mortality: more of the same is not enough. Lancet 362:233-241(2003).
5. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJL, Comparative Risk Assessment Collaborative Group. Selected major risk factors and global and regional burden of disease. Lancet 360:1347-1360(2002).
6. World Health Organization (WHO). World Health Report 2002: Reducing Risks, Promoting Healthy Life. Geneva:World Health Organization, 2002.
7. Ezzati M, Vander Hoorn S, Rodgers A, Lopez AD, Mathers CD, Murray CJL, Comparative Risk Assessment Collaborative Group. Estimates of global and regional potential health gains from reducing multiple major risk factors. Lancet 362:271-280(2003).
8. Wagstaff A. Socioeconomic inequalities in child mortality: comparisons across nine developing countries. Bulletin of the World Health Organization 78:19-29(2000).
9. Blakely T, Hales S, Kieft, Wilson N, Woodward A. Distribution of Risk Factors by Poverty. In: Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors (Ezzati M, Lopez AD, Rodgers A, Murray CJL, eds). Geneva:World Health Organization, 2004.
10. Mathers CD, Stein C, Ma Fat D, Rao C, Inoue M, Tomijima N, Bernard C, Lopez AD, Murray CJL. The Global Burden of Disease 2000: Version 2, Methods and Results (GPE Discussion Paper No. 50). Geneva:Global Programme on Evidence for Health Policy, World Health Organization (available online http://www.who.int/evidence), 2002.
11. Visaria P. Poverty and Living Standards in Asia: An Overview of the Main Results and Lessons of Selected Household Surveys (Living Standards Measurement Survey Working Paper No. 2). Washington, DC:World Bank, 1980.
12. Ferguson B, Murray CJL, Tandon A, Gakidou E. Estimating permanent income using asset and indicator variables. In: Health systems performance assessment: debate, new methods, and new empiricism (Murray CJL, Evans DB, eds). Geneva:World Health Organization, 2003.
13. Tandon A, Gakidou E, Sousa A, Murray CJL. Cross-Population Comparability and PPPs: Using Micro-Data on Indicators of Consumer Durables. In: Population Association of America (PAA) annual meeting, Boston, 2004.

Table 1: Analysis variables and definitions

Outcome, risk factor, or covariate	**Definitions of variables**
Economic status	Indicator based on ownership of assets and availability of services (e.g. electricity) at the household level (*12*). Quintiles were constructed using the distribution of economic status across developing counties
(all-cause) childhood (< 5) mortality	Probability of dying before age of five
Moderate childhood underweight	Children with weight-for-age below -2 standard deviations compared to the international reference group
Severe childhood underweight	Children with weight-for-age below – 3 standard deviations compared to the international reference group
Water and sanitation	Exposure categories to faecal-oral pathogens: (i) Very High = households without basic sanitation; (ii) High = households with basic sanitation but without clean water supply; (iii) Low = households with improved sanitation and water supply.

Annex Table 1: Data used in the analysis

Country	DHS survey year	Sample Size (# women)
AFR-D		
Cameroon	1998	5501
Madagascar	1997	7060
Mali	1996	9704
Niger	1998	7577
Nigeria	1990	8781
Togo	1998	8569
Burkina Faso	1998	6445
Ghana	1998	4843
Guinea	1999	6753
Chad	1997	7454
Senegal	1993	6310
Benin	2001	6219
AFR- E		
Burundi	1987	3970
Central African Republic	1995	5884
Mozambique	1997	8779
Namibia	1992	5421
Rwanda	1992	6551
Zambia	1996	8021
Zimbabwe	1999	5907
United Republic of Tanzania	1999	4029
Kenya	1998	7881
Ethiopia	2000	15367
Cote d'Ivoire	1998	3040
Malawi	2000	13220
Uganda	1988	4730
AMR- B		
Brazil	1996	12612
Dominican Republic	1996	8422
Paraguay	1990	5827
Trinidad and Tobago	1987	3806
Colombia	2000	11585
AMR- D		
Haiti	1995	5356
Nicaragua	1998	13634
Guatemala	1998	6021
Bolivia	1998	11187
Peru	2000	27843

Note: The classification of countries into regions follows the 14 epidemiological subregions of WHO. AFR= African Region; AMR = Region of the Americas; B = Subregions have low adult, low child mortality; D = High adult, high child mortality; E = Very high adult, high child.

Figure 1: Childhood (under five) mortality rate by economic status in Africa and the Region of the Americas. (Sample sizes in the highest quintile were too small to obtain stable estimates in the 2 African subregions.)

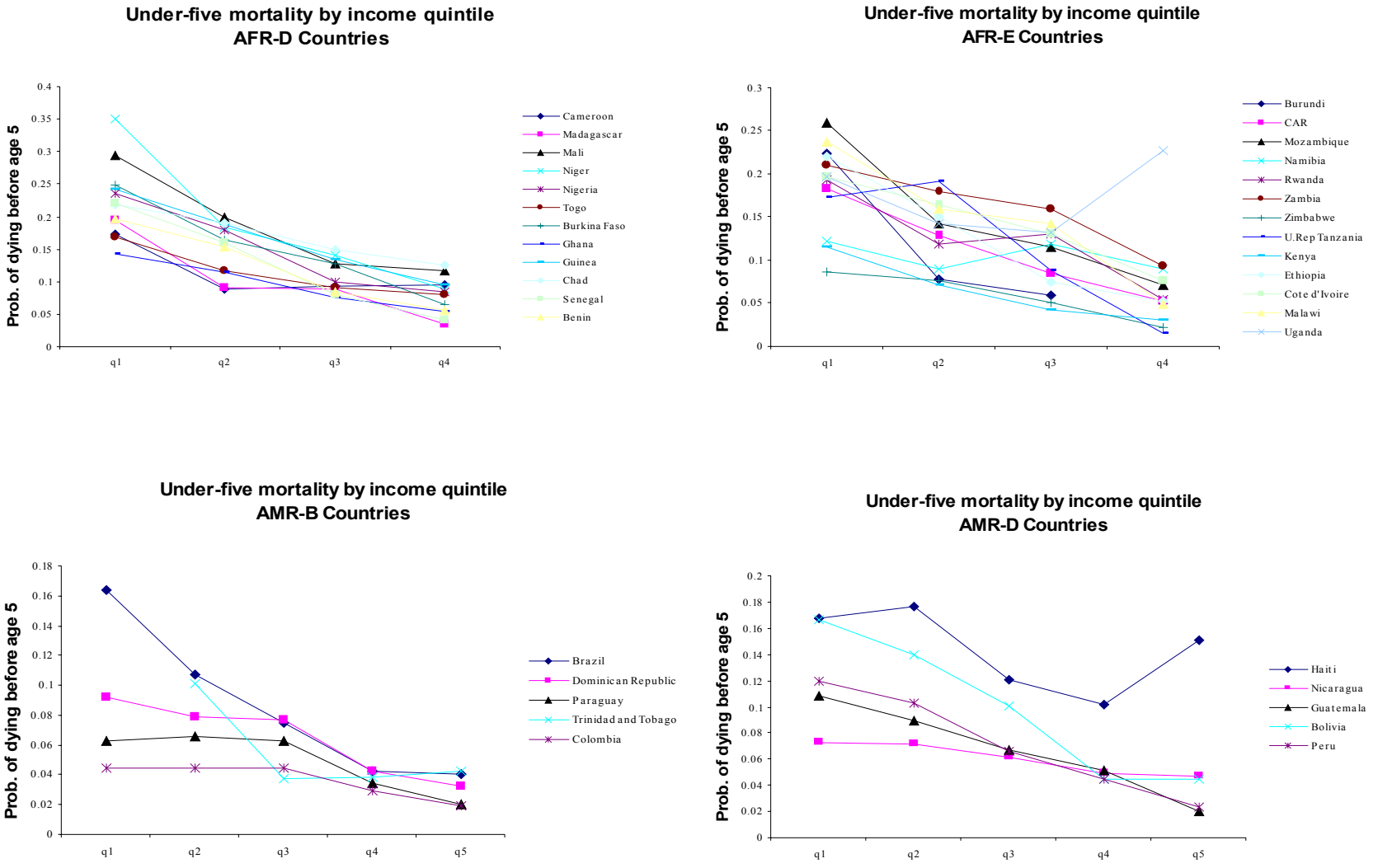

Figure 2: Moderate undernutrition (measured as low weight-for-age) rate by economic status. Sample sizes in the highest quintile were too small to obtain stable estimates in the 2 African subregions.

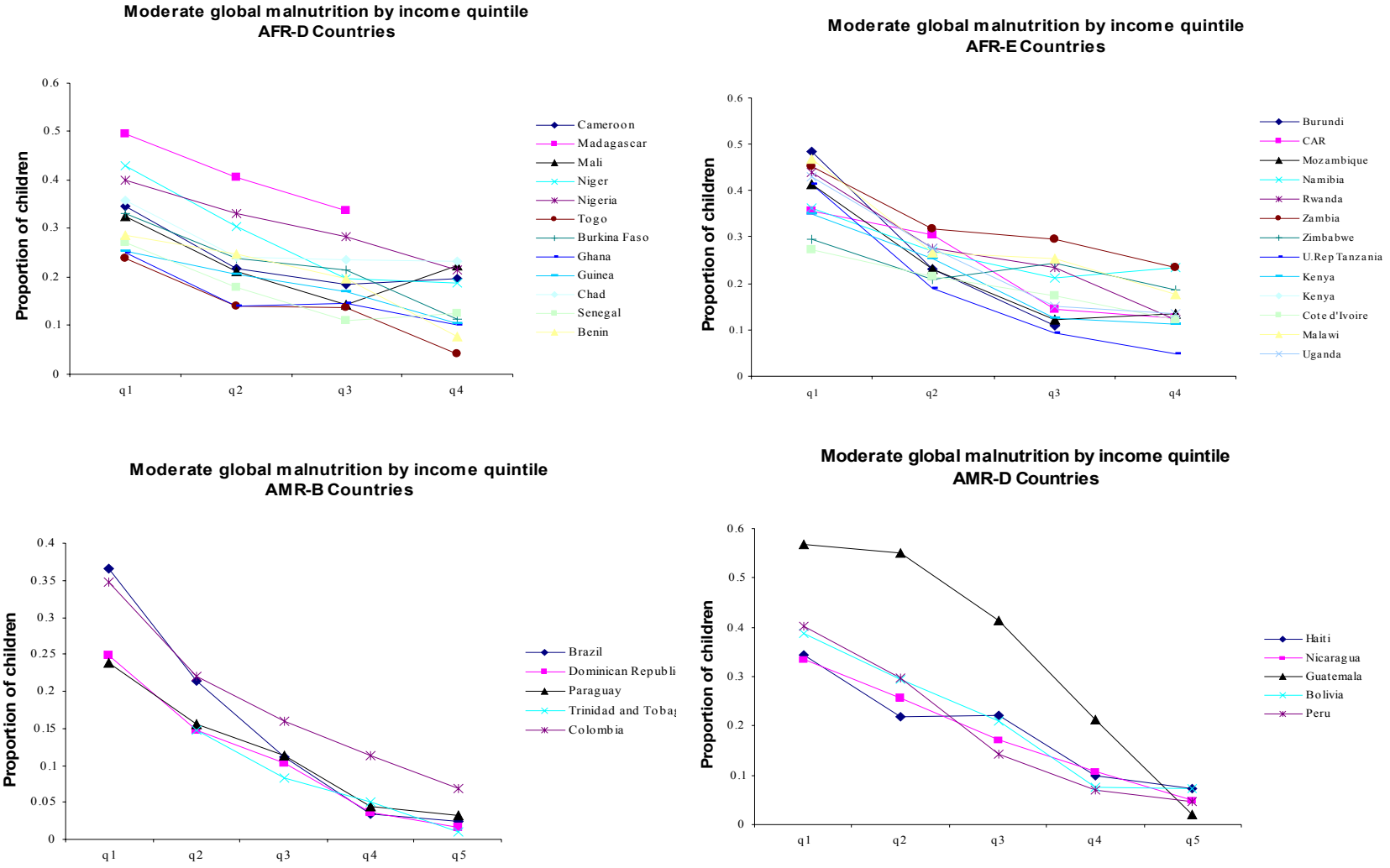

Figure 3: Severe undernutrition (measured as low weight-for-age) rate by economic status. Sample sizes in the highest quintile were too small to obtain stable estimates in the 2 African subregions.

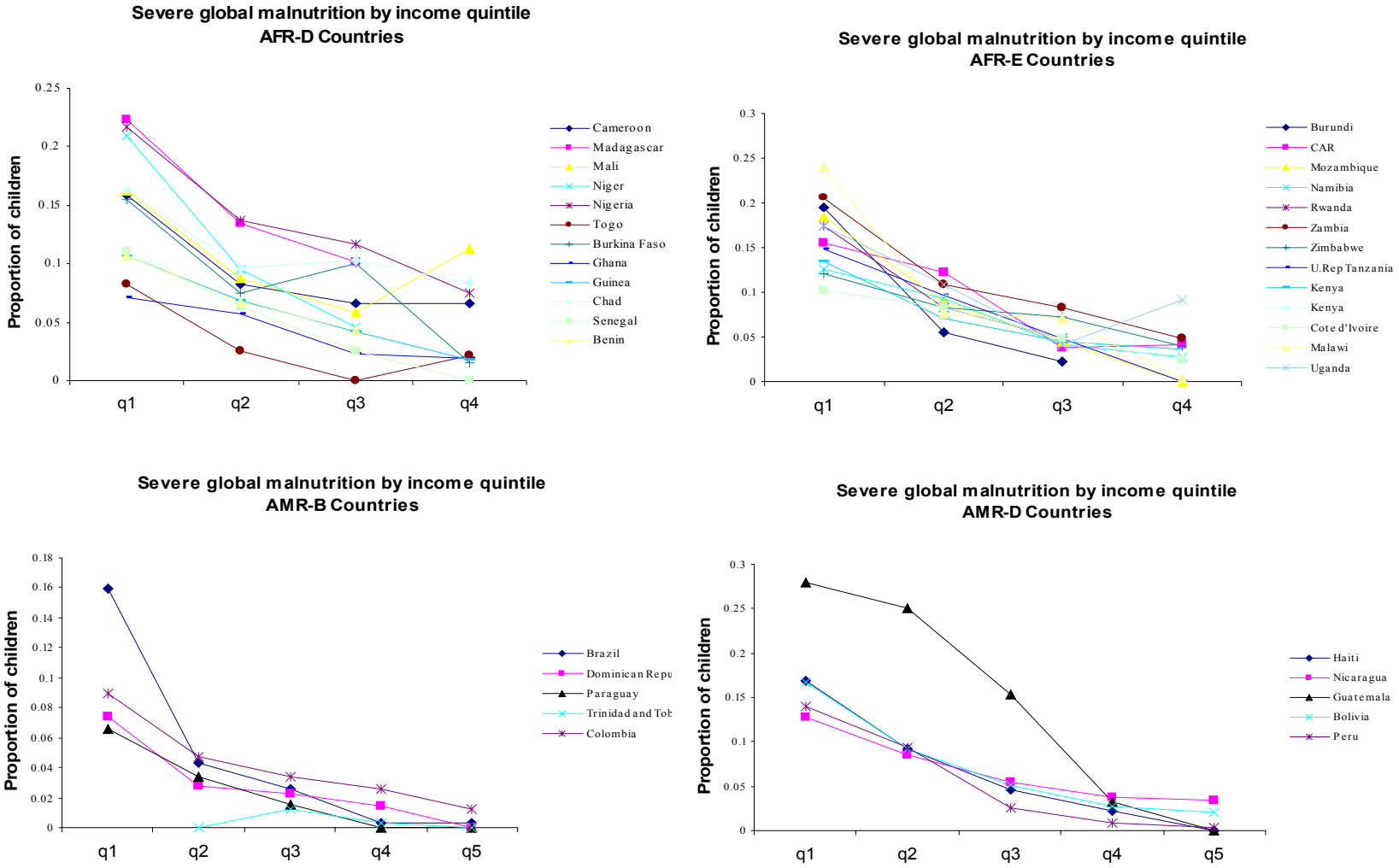

Figure 4: Exposure to the risk of faecal-oral transmission from poor water and sanitation. Each bar chart shows, for each income quintile, the proportion of the population at each level of risk.