Selected analyses on inequalities in underfive mortality rates and related indicators in low and middle income countries, 2000-2010

WORKING PAPER FOR THE COMMISSION ON INVESTING IN HEALTH

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1. Background

These analyses were requested by the Commission on Investing in Health (CIH) to elucidate specific aspects of within-country inequalities in underfive mortality, fertility and related indicators. The analyses addressed four general themes:

1) Levels of inequalities in underfive mortality rates (U5MR) according to socioeconomic position (SEP) and sex of the child;
2) Trends over time in U5MR inequalities by SEP and sex;
3) Concentration in the total fertility rate (TFR) and in the proportions of births and deaths according to SEP;
4) Analyses in selected countries of gender discrimination in births and deaths according to SEP.

The analyses were carried out by the International Center for Equity in Health at the Federal University of Pelotas, Brazil, using methods that have been described in previous publications.(1-3)

2. Methods

2.1. Data sources

Data analyses were carried out using publicly available Demographic and Health Surveys (DHS) (http://www.measuredhs.com/aboutsurveys/dhs/start.cfm) datafiles as of late 2012. In total, 154 surveys were analyzed (Annex 1). Comprehensive overviews of health inequalities based on data from these surveys are available elsewhere. (1, 4, 5)

2.2. Definitions

The following definitions are used in the present working paper:

U5MR – underfive mortality rate, or the probability of dying by the age of five years, calculated on the basis of full birth histories collected by women of reproductive age (10-49 years). Mortality rates refer to the 10-year period before the survey. National estimates are reported by DHS based on the 5 years previous to the survey. However, to reduce sampling variability we have chosen to use a longer period. Nevertheless, precision is still relatively poor in some surveys, as can be seen by the standard errors of the U5MR estimates (calculated using the jackknife method).

TFR – total fertility rate, or the average number of children a hypothetical cohort of women would have at the end of their reproductive period if they were subject during their whole lives to the fertility rates observed at the time of the survey; it is expressed as children per woman.

Wealth quintiles based on household assets – these are derived through principal component analysis from a list of household assets and building characteristics (6); Q1 represents the poorest 20% of households, Q2 to Q4 are the intermediate quintiles, and Q5 the wealthiest.

Maternal education – this variable was grouped according to the number of years of schooling achieved: none, primary (incomplete or complete) and secondary (incomplete, complete or beyond).

Extreme group difference measures – these were obtained, respectively, by subtracting U5MR in the lowest mortality group (the richest wealth quintile, mothers with secondary education, or girls) from U5MR in the highest mortality group (the poorest quintile, mothers with no schooling or boys).

Extreme group ratio measures – as for difference measures, these were obtained by dividing U5MR in the highest mortality group from U5MR in the lowest group.

Slope index of inequality (SII) - inequality indicator defined as the slope of a regression model where the outcome is a health status indicator and the predictor is relative rank of wealth. It can be interpreted as the absolute difference in health between the top and bottom of the wealth scale, in the same units used for the outcome (e.g. deaths per thousand).

Concentration index (CIX) - inequality indicator that measures how much a health attribute is concentrated towards the rich or the poor. Its magnitude is given by twice the area formed by a figure that plots the cumulative proportion of the population, from poorest to richest (x axis), against cumulative proportion of ill health (y axis) and is limited by the equity line (y=x). Positive values indicate pro-rich distributions (for example, intervention coverage) while negative values indicate pro-poor distributions (for example, mortality). Zero values indicate perfect equality.

2.3. Analyses

All data analyses took into account the DHS sampling weights and the clustered nature of the sample.

2.3.1. Cross-country analyses of inequalities in U5MR by wealth, maternal education and sex of the child.

The countries included in these analyses, with corresponding survey dates, are listed in annex I and full results are presented in an Excel spreadsheet *("Additional file I. U5MR by wealth quintile, sex and maternal schooling.xls"*). A total of 154 DHS surveys in 67 countries were analyzed. Several countries have had more than one survey over time.

For each survey we present U5MR for five wealth quintiles (Q1 is the poorest, Q5 the wealthiest), for boys and girls, and for three maternal schooling categories: none; primary (including incomplete or complete primary) and secondary (including incomplete or complete secondary school, or higher education).For each measure we present the actual mortality estimate (r) and its standard error (SE) whenever it was possible to calculate the latter.

We also present selected measures of inequality: for asset indices, the concentration index, the slope index of inequality, the difference in U5MR between the poorest and wealthiest quintiles, and the ration between these quintiles; for sex of the child, the difference and ratio

between boys and girls; and for maternal schooling, the difference and ratio between those with no schooling and those with secondary schooling.

In the attached spreadsheet (*Additional file I*), some cells were left blank, either when the stratification variable was not available in the survey dataset, or when sample size was too small in a particular group (e.g. mothers without any schooling in some countries).

In the Results section below (section 3.1), we only present the summary results for three World Bank regions for the latest survey: Africa, Americas and Asia. Data from Europe are not presented in the graphs because only 3 countries had a DHS. Results for these countries are available in the spreadsheet.

Interpretation of sex differences in U5MR is more complex than that for socioeconomic disparities, for which it may be assumed that children in all social groups should present the same mortality levels, were it not for suboptimal social, environmental and health care conditions faced by underprivileged families.(7)

When interpreting differences by sex, one must correct for the higher risk of death faced by boys due to biological reasons, which is present even in societies where there is no gender discrimination in terms of child care. Hill and Upchurch(8) carried out a historical study of trends in the female to male mortality ratio in Western European countries, and produced a series of correction factors for the biological disadvantage of boys, which vary according to mortality levels.

Their analyses show that the excess mortality of boys is greater at lower levels of overall U5MR. This is likely due to the fact that more easily preventable causes of death (for example infectious diseases) tend to affect boys and girls to a similar extent, whereas causes that are more difficult to prevent (for example neonatal causes) tend to affect boys to a greater extent than girls, in the absence of gender bias. Therefore, as overall mortality falls, one would expect faster rates of decline for girls than for boys. The correction factors proposed by Hill and Upchurch were incorporated in the present analyses.

2.3.2. Analyses of changes over time in inequalities in U5MR by wealth and sex of the child

These analyses are presented in section 3.2, below. They were restricted to countries with two or more surveys. The first survey (a) was the earliest one available, as long as it had been carried out up to (and including) year 2000 (in Indonesia and Philippines, we did not use the earliest DHS in these countries because they did not record asset indices, but used instead a later survey, still from the 1990s. The second survey (b) was the most recent DHS, as long as it had been carried out after 2000.

The average interval between the two surveys was 10.7 years. In these analyses, we did not include any other surveys carried out between (a) and (b) above. There were 39 countries with available data for analyses by sex, and 38 for analyses by wealth quintile (In Nigeria the earlier survey did not collect information on assets).

Next, we calculated the annual rate of change in U5MR for the extreme wealth quintiles (Q1 and Q5) and for boys and girls. In the graphs presented in the Results section, countries are

ranked according to mortality in the earlier survey, from highest (top of the graph) to lowest (bottom).

2.3.3. Analyses on the TFR and the numbers and proportions of births and deaths by quintile

A third set of analyses addresses the distribution of births and deaths by wealth. According to standard DHS methodology, quintiles are calculated on the basis of a classification of households, with each including approximately 20% of all households in the national sample (the proportion is sometimes slightly different from 20% because there may be tied values in the asset index which means that a quintile may have more or less than exactly 20% of all households).

Because fertility and mortality vary with wealth, in this third set of analyses we examined the proportion of births and death by quintile.

The number of births per quintile was obtained directly from the data on the full birth histories collected from women of reproductive age. It refers to births that occurred in the 10 years before the date of the DHS interview. Applying the quintile specific U5MR to the number of births, we estimated the number of deaths in the sample.

Unweighted regional averages of these variables are presented in the Results section.

2.3.4. Analyses of births and deaths by sex and quintile for India and Colombia

For these detailed analyses, we selected two countries with large DHS samples, one with evidence of gender bias in child survival (India) and another with little or no evidence of such bias (Colombia). Large sample sizes were necessary because the microdata from the survey were stratified by both gender and wealth quintile, and the following indicators were calculated for all 10 cells of this double tabulation: number of births, number of deaths and underfive mortality rates.

3. Results

This section is divided into four sub-sections, according to the analyses requested by the CIH and described above.

3.1. Cross-country analyses of inequalities by wealth, maternal education and sex of the child.

Results are available for the most recent DHS for 67 countries: 37 from Africa, 17 from Asia, 10 from the Americas and Caribbean, and 3 from Europe. Full results are presented in the supplementary materials ("*Additional file I. U5MR by wealth quintile, sex and maternal schooling.xls*"). Figures 1-3 show a summary of the results. Because DHS were available for only three countries from Europe, this region is not displayed in the figures.

Figure 1 shows the unweighted regional averages. In the three regions, average U5MR decreases with increasing wealth. In Africa, the wealthiest quintile tended to have U5MR levels

that were substantially lower than the other four quintiles. Mortality levels in Q5 were 36% lower than those in Q1, on average. Compared to Africa, all wealth groups in Asia and the Americas had substantially lower mortality rates. The patterns in these two regions were very similar, showing linear trends of decreasing U5MR with increasing wealth. Mortality in Q5 for these two regions is less than half of that observed for Q1.

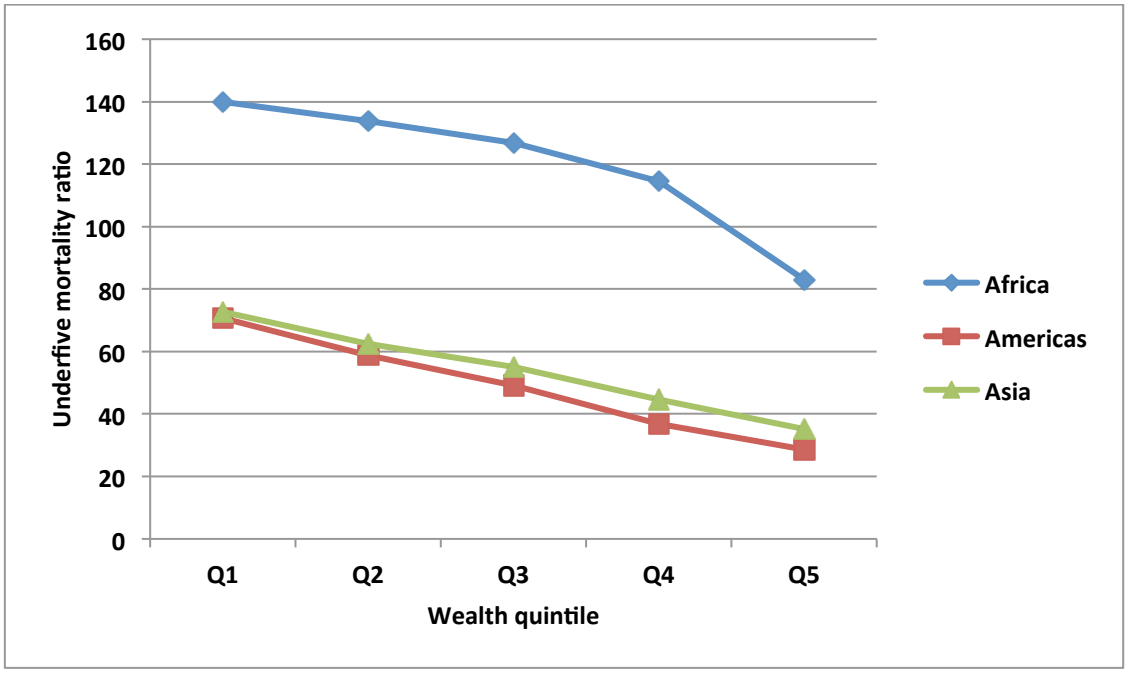

Figure 1.U5MR levels by wealth quintile in the most recent DHS, average of 64 countries, by region.

Similar patterns of social inequalities are observed for maternal education (Figure 2). As in the analyses by wealth quintile, U5MR levels in Africa are substantially higher than those in Asia or the Americas, for any given category of maternal education.

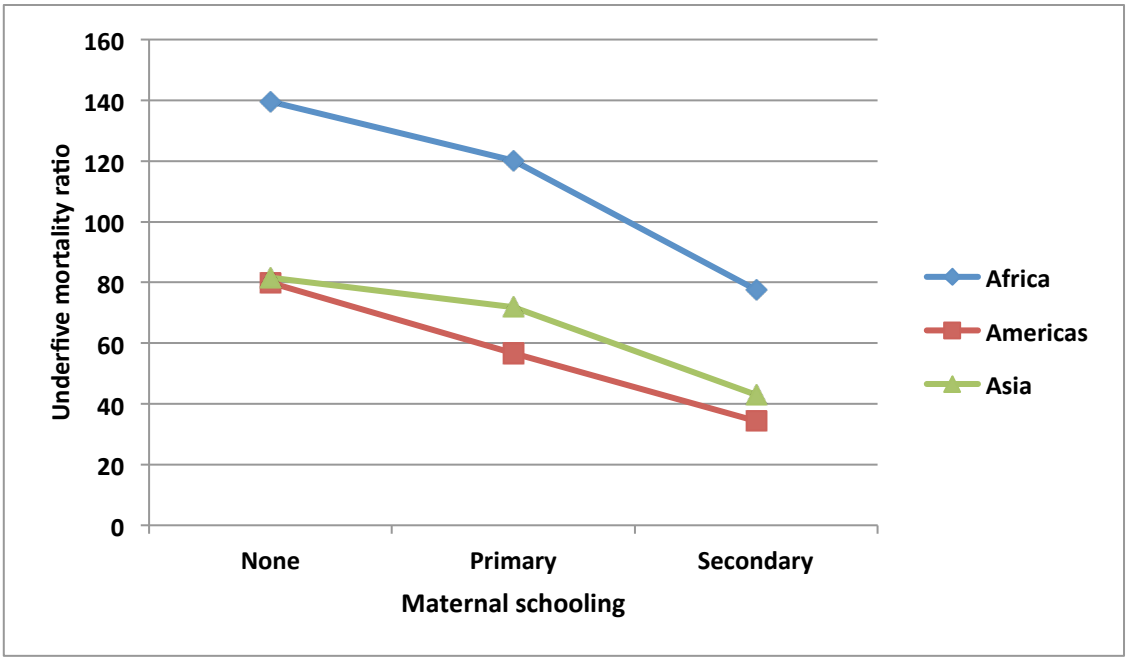

Figure 2.U5MR levels by maternal education in the most recent DHS, average of 64 countries, by region.

The analyses of U5MR by sex are presented in Figure 3. To interpret these results, it is necessary to take into account the higher biological risk of boys, compared to girls, as described in the Methods section (item 2.3.1). In Africa, the observed male U5MR of 130 per 1,000 corresponds to a predicted U5MR of 109 for females, whereas the observed rate was 115. In Asia, the predicted female U5MR mortality was 47, and the observed rate 53. In the Americas, the corresponding figures were 43 and 49. In the three European countries included in the analyses (but not shown in Figure 3) the predicted female mortality was 22 per thousand, but the observed level was even lower (16 per thousand), unlike what was observed in the other regions. These results suggest that gender bias is present in Africa, Asia and the Americas, but not in the three European countries with a DHS.

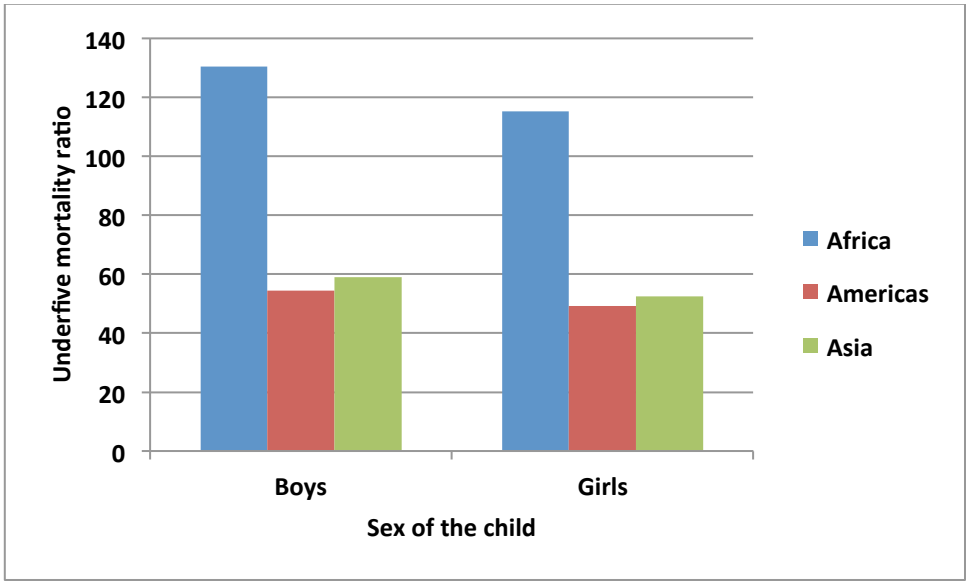

Figure 3.U5MR levels by sex of the child, average of 64 countries, by region.

The excess mortality of girls, relative to what be expected on the basis of mortality among boys, is presented in Table 1 for the most recent survey in each country. For most countries, the estimate of excess deaths per thousand girls is positive, indicating some extent of gender bias.

Table 1. U5MR for boys and girls in the most recent surveys, showing the observed male/female mortality ratio, the ratio that would be expected on the basis of the higher biological risk of boys, and the excess number of observed female deaths per thousand births relative to what be expected from the corresponding male mortality level.

Country	Survey year	U5MR		Male/female ratio		Excess female deaths / 1,000
		Male	Female	Observed	Expected	
Albania	2008	27.3	16.1	1.70	1.28	-5.23
Armenia	2010	21.3	21.7	0.98	1.29	5.26
Azerbaijan	2006	64.3	49.0	1.31	1.25	-2.59
Bangladesh	2007	75.0	71.3	1.05	1.24	10.62
Benin	2006	138.8	132.1	1.05	1.19	15.21
Bolivia	2008	79.1	71.1	1.11	1.23	7.03
Brazil	1996	58.9	53.3	1.10	1.25	6.29
Burkina Faso	2010	152.6	141.0	1.08	1.18	11.48
Burundi	2010	134.1	116.0	1.16	1.19	3.33
Cambodia	2010	76.0	58.8	1.29	1.24	-2.64
Cameroon	2011	134.8	121.3	1.11	1.19	8.01
CAR	1994	165.3	152.6	1.08	1.17	11.40
Chad	2004	207.2	198.5	1.04	1.15	18.01
Colombia	2010	23.8	19.3	1.24	1.29	0.77
Comoros	1996	121.9	103.1	1.18	1.20	1.48
Congo (Brazzaville)	2005	128.4	118.0	1.09	1.19	10.55
Congo D.R.	2007	161.3	148.1	1.09	1.17	10.60
Cote dIvoire	1998	204.6	146.3	1.40	1.15	-31.83
Dominican Republic	2007	39.7	33.9	1.17	1.27	2.65
Egypt	2008	38.4	27.7	1.38	1.27	-2.43
Ethiopia	2011	120.8	97.4	1.24	1.20	-3.21
Gabon	2000	103.1	80.2	1.29	1.21	-4.71
Ghana	2008	93.2	74.9	1.24	1.22	-1.32
Guatemala	1998	63.7	65.2	0.98	1.25	14.18
Guinea	2005	198.9	173.6	1.15	1.15	0.92
Guyana	2009	40.6	39.0	1.04	1.27	6.98
Haiti	2005	104.6	98.9	1.06	1.21	12.62
Honduras	2005	38.8	34.4	1.13	1.27	3.90
India	2005	81.8	88.2	0.93	1.23	21.72
Indonesia	2007	55.3	45.9	1.21	1.26	1.85
Jordan	2007	21.7	23.0	0.94	1.29	6.23
Kazakhstan	1999	72.3	53.8	1.34	1.24	-4.54
Kenya	2008	89.9	77.0	1.17	1.22	3.62
Kyrgyz Republic	1997	81.6	69.3	1.18	1.23	3.03

Lesotho	2009	122.8	87.1	1.41	1.20	-15.32
Liberia	2007	147.1	131.4	1.12	1.18	6.99
Madagascar	2008	84.8	78.0	1.09	1.23	8.98
Malawi	2010	136.5	115.8	1.18	1.19	1.08
Maldives	2009	28.7	25.0	1.15	1.28	2.65
Mali	2006	221.7	206.3	1.07	1.14	11.97
Moldova	2005	32.5	19.7	1.65	1.28	-5.74
Morocco	2003	59.2	47.8	1.24	1.25	0.51
Mozambique	2003	179.8	175.9	1.02	1.16	21.15
Namibia	2006	79.7	57.9	1.38	1.23	-6.73
Nepal	2011	62.2	62.2	1.00	1.25	12.47
Nicaragua	2001	48.1	40.2	1.19	1.26	2.17
Niger	2006	220.2	213.0	1.03	1.14	20.16
Nigeria	2008	174.7	166.4	1.05	1.17	16.40
Pakistan	2006	93.0	93.5	0.99	1.22	17.41
Peru	2004	46.9	35.8	1.31	1.26	-1.27
Philippines	2008	40.6	33.6	1.21	1.27	1.64
Rwanda	2010	104.2	96.0	1.09	1.21	10.04
Sao Tome & Principe	2008	85.8	54.5	1.57	1.23	-15.33
Senegal	2010	89.5	81.9	1.09	1.23	8.88
Sierra Leone	2008	176.0	159.6	1.10	1.16	8.43
South Africa	2003	36.8	73.1	0.50	1.27	44.21
Swaziland	2006	108.7	103.9	1.05	1.21	13.99
Tanzania	2010	96.5	87.6	1.10	1.22	8.43
Timor-Leste	2009	83.4	75.8	1.10	1.23	8.08
Togo	1998	155.3	131.2	1.18	1.18	-0.77
Turkey	2003	48.2	44.8	1.08	1.26	6.55
Uganda	2011	113.5	97.4	1.17	1.21	3.21
Ukraine	2007	23.4	13.4	1.75	1.29	-4.77
Uzbekistan	1996	64.5	45.4	1.42	1.25	-6.32
Vietnam	2002	34.2	30.8	1.11	1.28	4.03
Zambia	2007	151.0	121.9	1.24	1.18	-6.17
Zimbabwe	2010	87.6	68.4	1.28	1.23	-2.99

3.2 Analyses of changes over time in inequalities by wealth and sex of the child

These analyses are based on 39 countries with two DHS surveys carried out 10.7 years apart, on average. The mean decline in U5MR in this period was of 39 deaths per thousand live births. One country (Nigeria) did not have data on wealth quintiles for the earlier survey so that analyses are limited to 38 countries.

Figure 4 shows annual rates of reduction over time for the poorest and richest quintiles. Countries are ranked by mortality level, from highest to lowest. Across all countries, the average rates of reduction were very similar: 3.8% both for the poorest and richest quintiles. There is no clear pattern according to baseline mortality levels. Correlations between baseline mortality and percent reductions among the poorest and richest were small and non-significant (-0.09 and -0.13, respectively). Figure 4 should be interpreted with caution because

the number of deaths by quintile is often small, and confidence intervals are wide (see *Additional file I* for the standard errors of the estimates).

We also examined changes over time in the concentration index for U5MR by wealth quintile. Because concentration indices take into account the whole distribution of U5MR in the five quintiles of the population, they are more stable in statistical terms than a simple comparison of extreme quintiles (poorest and richest). Positive changes indicate that U5MR became more inequitable, or more pro-rich; negative changes signal improved equity. Of the 38 countries analyzed, 14 showed reduced and 24 increased inequalities. However, the magnitude of changes was in general very small, and the overall average change across the 38 countries was 0.02, slightly pro-rich. Countries where inequities became worse (change of more than 0.05 points in the concentration index) included Armenia, Burkina Faso, Egypt, Dominican Republic, Kenya and Uganda. In contrast, equity seems to have improved over time (change of -0.05 or greater) in Bolivia, Ethiopia, Haiti, Nicaragua, Rwanda and Vietnam.

Changes in concentration indices were not correlated to baseline mortality levels (correlation coefficient of -0.01), nor with change in mortality over time (coefficient of -0.10).

Summing up, there is no overall evidence that equity improved over time, in spite of the fact that virtually all countries presented a decline in U5MR.

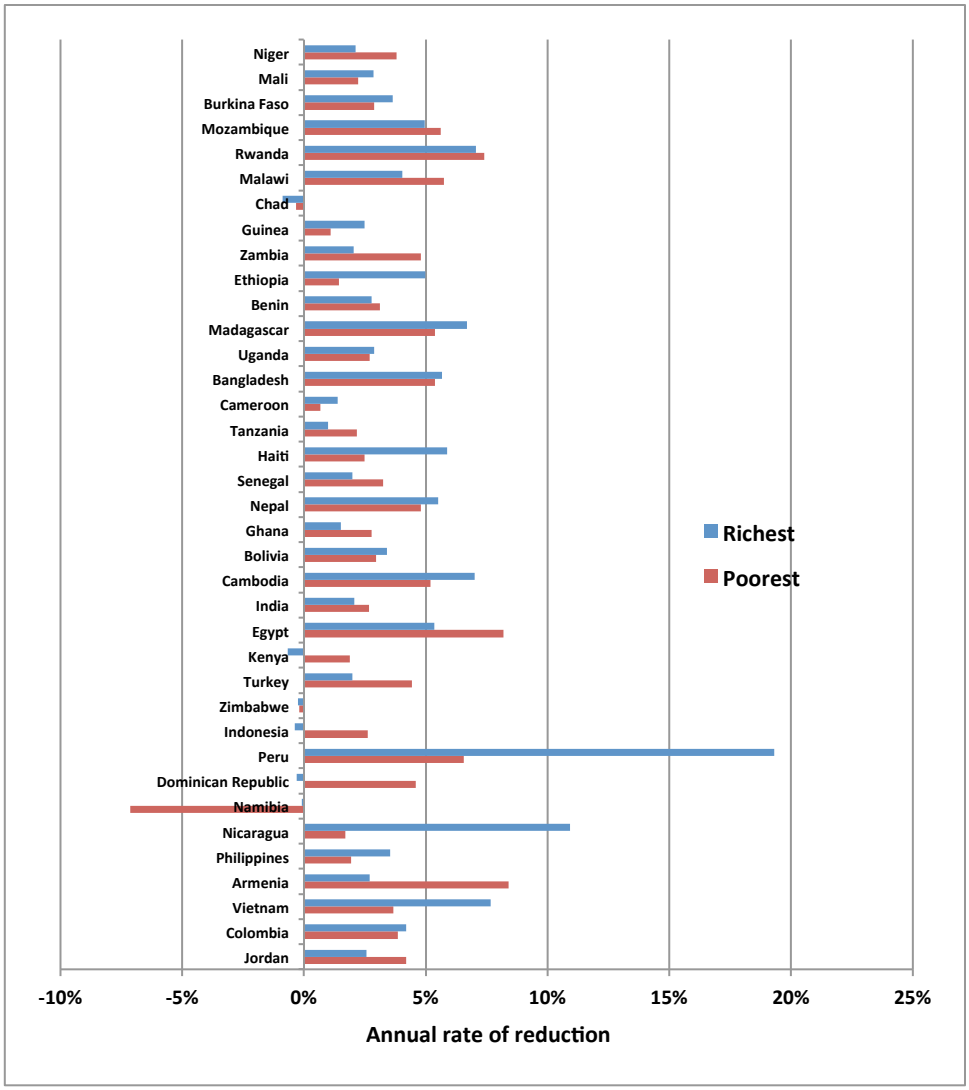

Figure 4. Annual rates of reduction in underfive mortality in the poorest and richest wealth quintiles, for countries with a first survey up to year 2000 and a second survey after 2000.

Figure 5 shows annual rates of reduction over time for boys and girls. Across all countries, the average annual rate for boys was 3.6% and for girls 3.2%. This goes against what is expected on the basis of biological knowledge, as faster reductions should be expected for girls than for boys, as discussed above. Boys, however, remained at higher levels of mortality in virtually every country (see below for a more detailed discussion of mortality by sex).

In Nigeria and Namibia, mortality increased for both girls and boys, while in Chad, mortality increased for boys but not for girls. In contrast, U5MR in Zimbabwe increased for girls but not for boys.

Countries with higher baseline mortality levels tended to show greater reductions over time for boys (correlation coefficient -0.20) but not for girls (correlation coefficient 0.09).

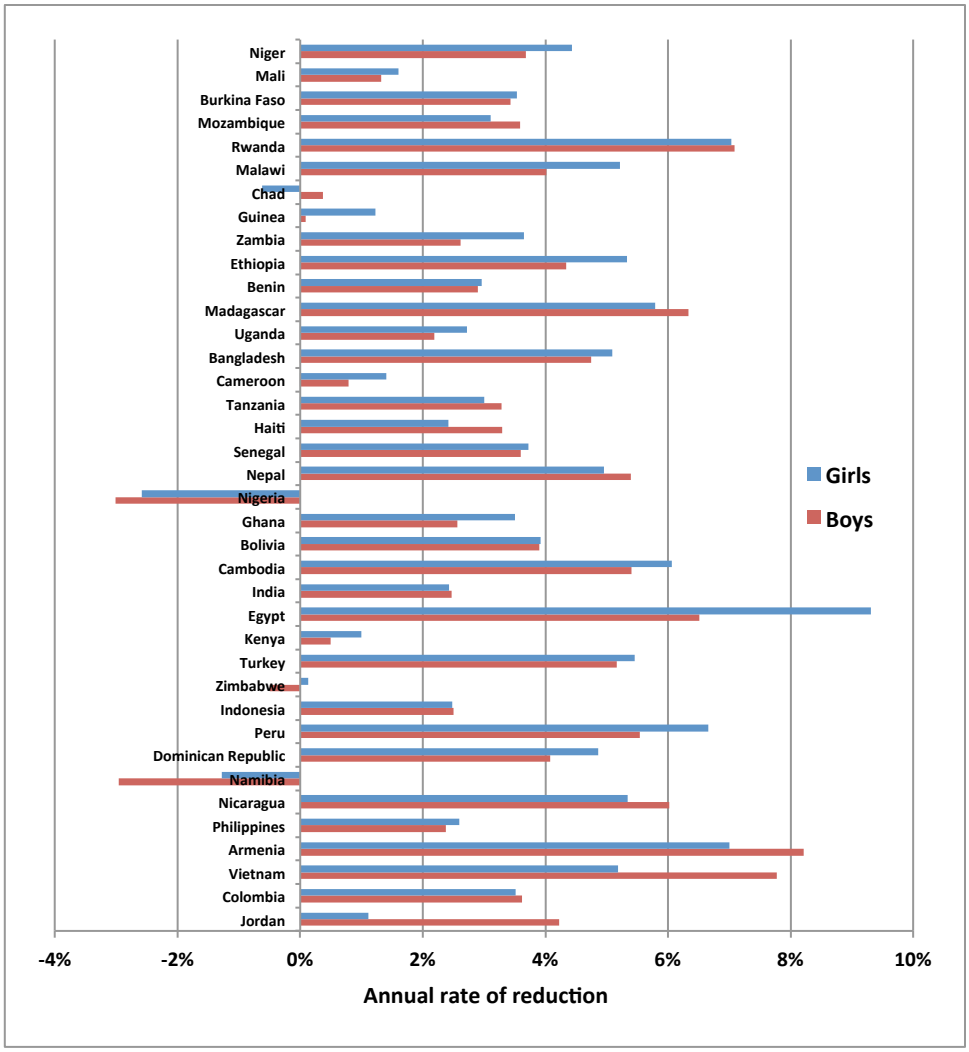

Figure 5. Annual rates of reduction in underfive mortality in boys and girls, for countries with a first survey up to year 2000 and a second survey after 2000.

3.3 Proportions of births and deaths, and total fertility rates, by wealth quintiles

A third set of analyses addresses the distribution of the proportions of births and deaths by wealth. Because 20% of households in the sample are allocated to each wealth quintile, one would expect 20% of births and 20% of deaths to also take place in each quintile, in the absence of differential fertility and mortality. However, because fertility is inversely associated with wealth, more children are born in poor than in rich households. Figure 6 shows the average values of total fertility rates by wealth quintile and region of the world. Fertility tends to be highest in Africa, intermediate in the Americas, and lowest in the Asian countries with data, but in all regions the inverse association is evident.

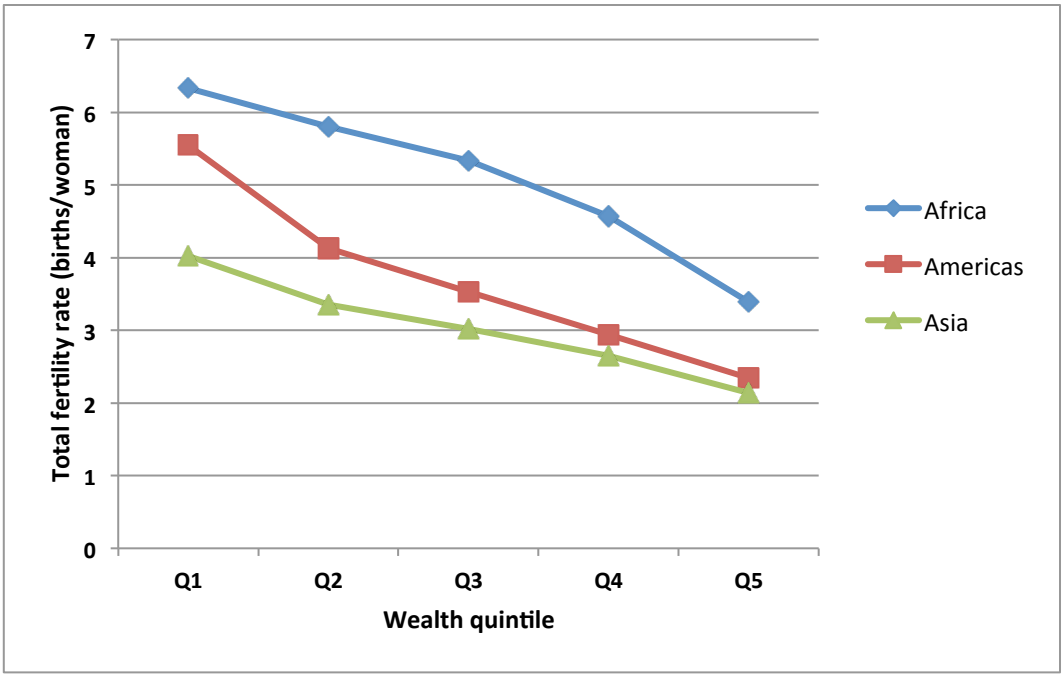

Figure 6. Total fertility rates by wealth quintiles, average of 64 countries, by region.

As a consequence of differential fertility, the proportions of total births are higher in the poorest quintiles, and lower in the wealthier quintiles (Figure 7). It is interesting to note that in spite of important differences in the TFR by region (Figure 6), the proportionate distributions of births are very similar.

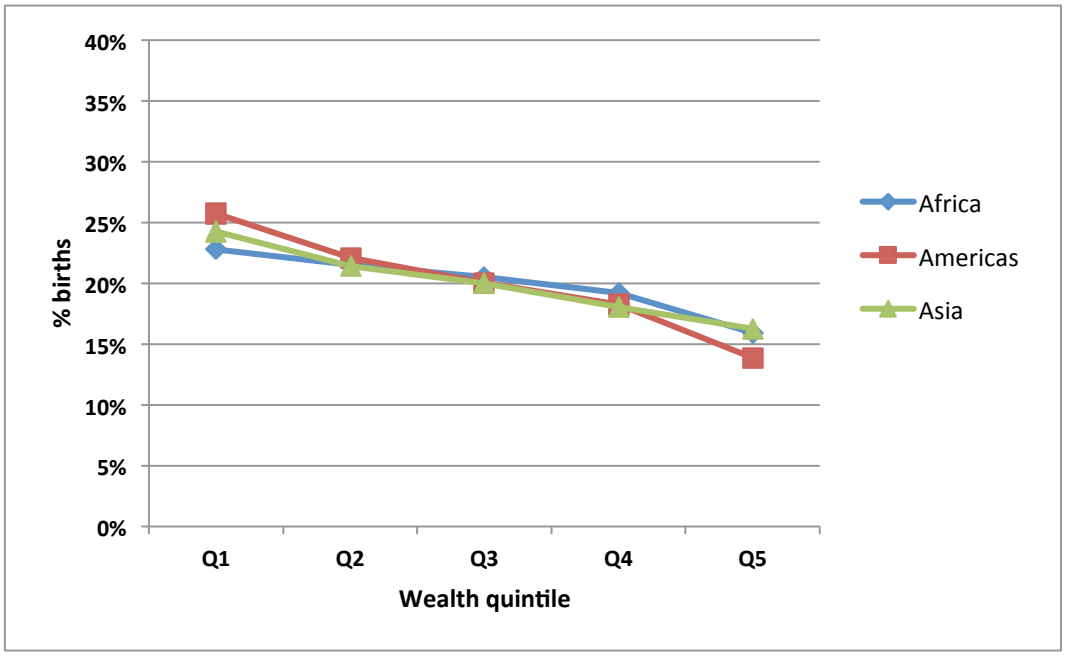

Figure 7. Proportion of all births by wealth quintile, average of 64 countries, by region.

Because mortality levels are also greater among the poor, as shown in section 3.1, deaths are even more concentrated than births among the poor (Figure 8). This is most marked in the Americas, followed by Asia and Africa.

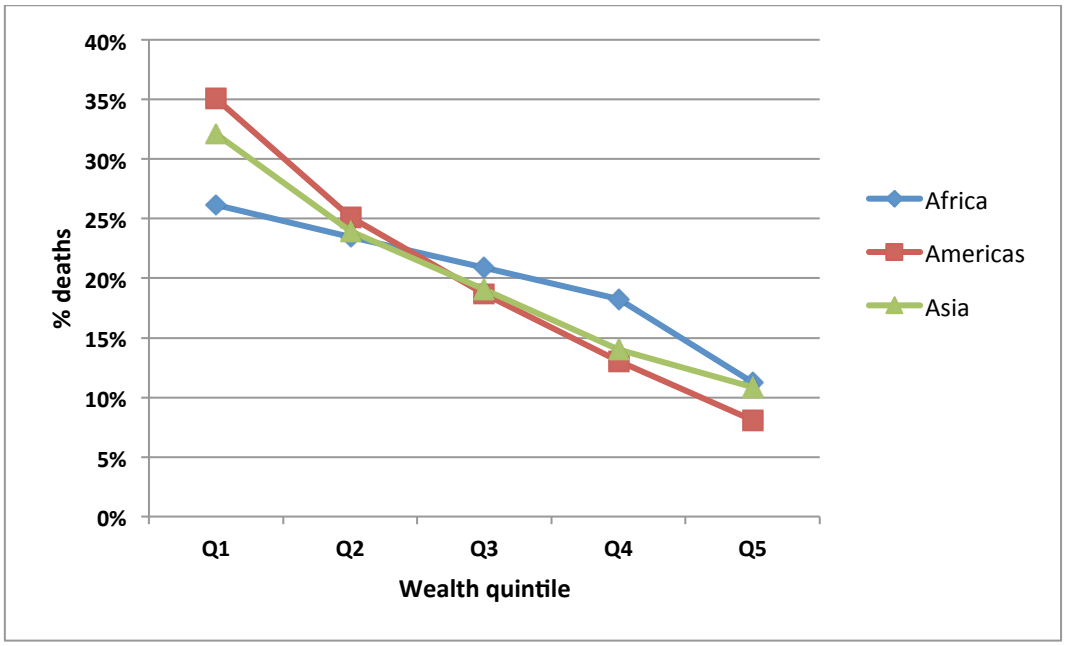

Figure 8. Proportion of all deaths by wealth quintile, average of 64 countries, by region.

Figure 9 shows the concentration of births and deaths by wealth quintile in the 2005 Indian DHS. The poorest 20% of all households account for 36% of all deaths, compared to only 6% in the richest 20% of households.

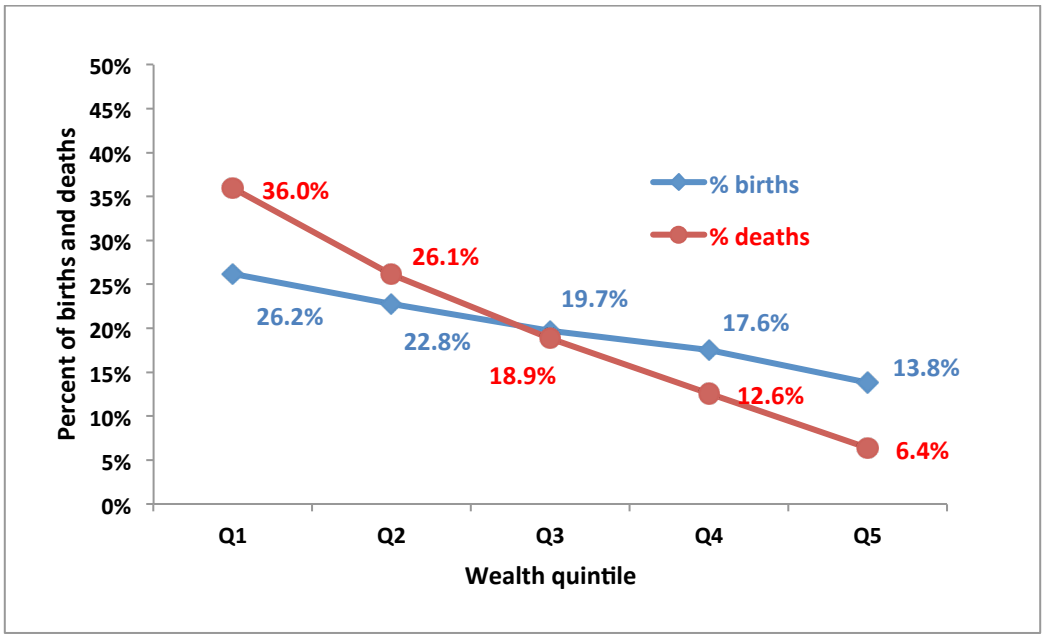

Figure 9. Percent of births and deaths by wealth quintiles, India 2005 DHS.

Full results on TFR and on the proportions of births and deaths by quintile, sex of the child and maternal education for all available surveys are included in "*Additional file II. TFR and proportions of births and deaths by wealth, sex and schooling*".

3.4 Double stratification by sex and wealth quintile for India and Colombia

In this last set of analyses, we selected one country for which there was evidence of gender bias and another where there was little evidence of such bias. We chose countries with large DHS samples to allow double stratification into 10 cells (2 sexes and 5 wealth quintiles). Confidence intervals for the U5MR estimates are presented in Annex 3.

In India (see Table 1) the overall mortality of boys is actually lower than that of girls (with a ratio of 0.93), a clear indication of gender bias because given the levels of mortality one would expect a male/female ratio of 1.23, that is, a 23% excess of male deaths rather than a 7% deficit. For comparison purposes, we selected Colombia, where the male/female mortality ratio was equal to 1.24, which was quite close to the expected ratio of 1.29.

These countries were selected in order to investigate whether gender bias varied by wealth. Figure 10 suggests that this is indeed the case in India. The dotted red line is the expected level of female mortality on the basis of male U5MR in each quintile. The full red line shows the observed mortality rates. Among the poorest, female mortality is substantially larger than expected, but the gap is reduced by increasing wealth, up to the point where the observed and expected U5MR are virtually the same in the richest quintile.

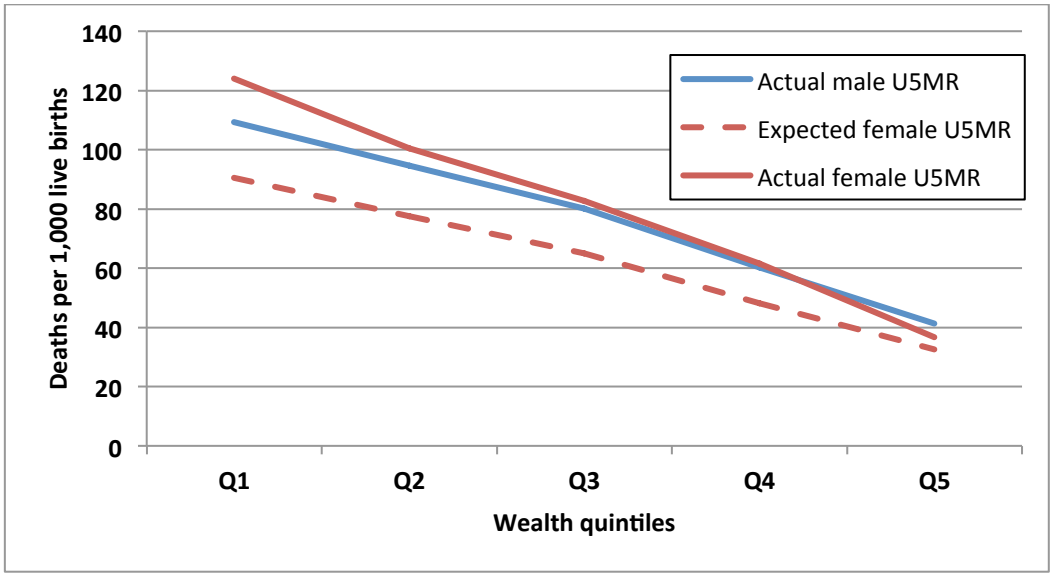

Figure 10. Male and female U5MR by wealth quintile in the India 2005 DHS, also shown the levels of female U5MR that would be expected on the basis of the observed male U5MR.

The situation in Colombia is rather different (Figure 11). First, there is more variability in U5MR because results from India are based on about 120,000 births and those from Colombia on approximately 30,000 births, and also because underfive deaths are much less common in Colombia U5MR (22 per thousand) than in India (85 per thousand). In spite of the variability, it

is evident that the pattern in Figure 11 is quite different from that in India (Figure 10). Observed female mortality appears to be higher than predicted mortality among the poorest; there are virtually no differences in the second poorest and in the middle quintile; and in the two top quintiles female deaths are below predicted levels. These differences have to be interpreted with caution in light of the large standard errors of mortality estimates broken down by both sex and quintile (see Table XXX).

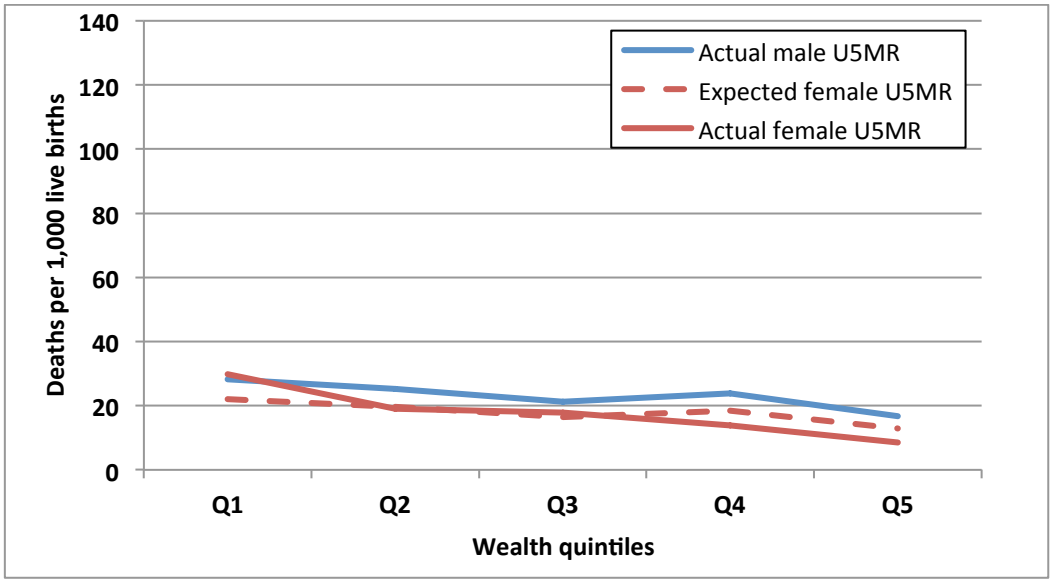

Figure 11. Male and female U5MR by wealth quintile in the Colombia 2010 DHS, also shown the levels of female U5MR that would be expected on the basis of the observed male U5MR.

Finally, Figure 12 shows the male/female ratio among births reported in the India and Colombia surveys. The number of births was obtained from the full birth histories corresponding to the 10-year period prior to the survey. National sex ratios at birth, in the absence of selective abortion, tend to be around 1.05 plus or minus 0.02. (https://www.cia.gov/library/publications/the-world-factbook/fields/2018.html) In Colombia, sex ratios fluctuate around this expected range and there is no evidence of differential patterns by wealth. In contrast, in India there is a clear increase in the sex ratio with growing wealth, reaching a level of 1.16 in the top quintile.

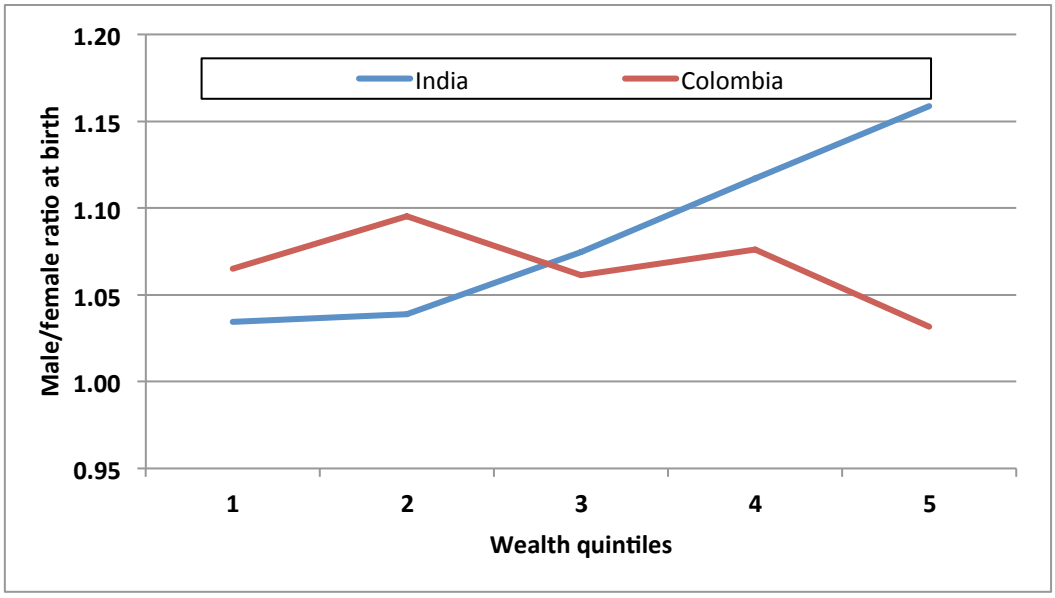

Figure 12. Male/female ratio of births by wealth quintiles in the India 2005 and Colombia 2010 DHS.

4. Key findings

The key findings from this review may be summarized as follows:

- Levels of inequalities in underfive mortality rates (U5MR) according to socioeconomic position (SEP) and sex of the child in 67 countries with a recent DHS
    - In Africa, Asia and the Americas, in spite of different levels of overall mortality U5MR showed clear inverse associations with wealth quintiles; mortality in the poorest quintile being approximately twice as high as in the richest quintile.
    - Similar social gradients were observed in the three regions for U5MR according to maternal education.
    - Mortality of boys was higher than that of girls in the three regions, but when adjustment was made for the higher biological risk of boys, there was some evidence of gender bias, with female U5MR being on average 6 deaths per thousand greater than would be predicted on the basis of male U5MR in the same countries. In the three European countries with a DHS, there was no evidence of higher than expected female mortality.

- Trends over time in U5MR inequalities by SEP and sex, based on 39 countries with 2 DHS with a median interval of 11 years
    - All but two countries showed reductions in U5MR during this period, but there was no overall evidence of changes in relative socioeconomic inequalities.
    - Average annual reductions in U5MR across all countries were slightly greater for boys (3.6% a year) than for girls (3.2%).

- Proportions of births and deaths, and total fertility rates (TFR) according to SEP
    - The number of children per woman decreases with increasing wealth, and in the three regions (Africa, Asia and Americas) women in the poorest quintile have on average twice or more children than those in the top quintile.
    - In spite of marked differences in fertility among the three regions (highest in Africa and lowest in Asia) the proportionate distributions of births by SEP are very similar: about 25% of all children are born in the poorest quintile of households, and only 15% in the richest quintile.
    - Underfive deaths tend to be even more concentrated than births: 25% of all deaths in Africa, 32% in Asia and 35% in the Americas take place in the lowest wealth quintile, and only 11%, 10% and 8%, respectively, in the richest quintile.

- Analyses of gender discrimination in births and deaths according to SEP in India and Colombia
    - Observed U5MR among girls were compared to those expected on the basis of the corresponding mortality levels among boys; in India, actual mortality of girls in the poorest quintiles was about 30% higher than expected, but the gap closed with increasing wealth so that in the richest quintile the observed and expected mortality levels were very similar.

- In Colombia, expected and observed mortality levels for girls were very similar in all quintiles, with the possible exception in the poorest group in which observed mortality was higher than what would be expected.
- In India, the male to female ratio at birth increased with wealth, and in the wealthiest quintile it reached 1.16, well above what is biologically plausible; in Colombia, the ratios in all quintiles were within the expected range, and there was no evidence of an association with wealth.

Our analyses of selected aspects of mortality and fertility patterns reveal consistent socioeconomic inequities in virtually all countries studied. Gender inequities in mortality become evident once adjustments are made for the higher biological risk of death among boys, and also appear to be present in many countries. Gender and socioeconomic inequities interact in countries such as India, where there are more male births than expected among the rich than the poor (likely related to selective abortions), and more female deaths than expected among the poor than the rich (likely due to gender bias in patterns of child and health care). Systematic measurements of socioeconomic and gender inequalities must become an essential aspect of monitoring, planning, programming and evaluation.

Annex I. Surveys included in the analyses.

Country	World Bank Classification			Year
	Country code	Region	Income levels	
Cambodia	KHM	East Asia & Pacific	Low income	2005
Cambodia	KHM	East Asia & Pacific	Low income	2010
Cameroon	KHM	East Asia & Pacific	Low income	1998
Indonesia	IDN	East Asia & Pacific	Lower middle income	1994
Indonesia	IDN	East Asia & Pacific	Lower middle income	1997
Indonesia	IDN	East Asia & Pacific	Lower middle income	2002
Indonesia	IDN	East Asia & Pacific	Lower middle income	2007
Philippines	PHL	East Asia & Pacific	Lower middle income	1993
Philippines	PHL	East Asia & Pacific	Lower middle income	1998
Philippines	PHL	East Asia & Pacific	Lower middle income	2003
Philippines	PHL	East Asia & Pacific	Lower middle income	2008
Timor-Leste	TMP	East Asia & Pacific	Lower middle income	2009
Vietnam	VNM	East Asia & Pacific	Lower middle income	1997
Vietnam	VNM	East Asia & Pacific	Lower middle income	2002
Albania	ALB	Europe & Central Asia	Lower middle income	2008
Armenia	ARM	Europe & Central Asia	Lower middle income	2000
Armenia	ARM	Europe & Central Asia	Lower middle income	2005
Armenia	ARM	Europe & Central Asia	Lower middle income	2010
Azerbaijan	AZE	Europe & Central Asia	Upper middle income	2006
Kazakhstan	KAZ	Europe & Central Asia	Upper middle income	1995
Kazakhstan	KAZ	Europe & Central Asia	Upper middle income	1999
Kyrgyz Republic	KGZ	Europe & Central Asia	Low income	1997
Moldova	MDA	Europe & Central Asia	Lower middle income	2005
Turkey	TUR	Europe & Central Asia	Upper middle income	1993
Turkey	TUR	Europe & Central Asia	Upper middle income	1998
Turkey	TUR	Europe & Central Asia	Upper middle income	2003
Ukraine	UKR	Europe & Central Asia	Lower middle income	2007
Uzbekistan	UZB	Europe & Central Asia	Lower middle income	1996
Bolivia	BOL	Latin America & Caribbean	Lower middle income	1994
Bolivia	BOL	Latin America & Caribbean	Lower middle income	1998
Bolivia	BOL	Latin America & Caribbean	Lower middle income	2003
Bolivia	BOL	Latin America & Caribbean	Lower middle income	2008
Brazil	BRA	Latin America & Caribbean	Upper middle income	1996
Colombia	COL	Latin America & Caribbean	Upper middle income	1995
Colombia	COL	Latin America & Caribbean	Upper middle income	2000
Colombia	COL	Latin America & Caribbean	Upper middle income	2005
Colombia	COL	Latin America & Caribbean	Upper middle income	2010
Dominican Rep	DOM	Latin America & Caribbean	Upper middle income	1996
Dominican Rep	DOM	Latin America & Caribbean	Upper middle income	1999
Dominican Rep	DOM	Latin America & Caribbean	Upper middle income	2002
Dominican Rep	DOM	Latin America & Caribbean	Upper middle income	2007
Guatemala	GTM	Latin America & Caribbean	Lower middle income	1995

Guatemala	GTM	Latin America & Caribbean	Lower middle income	1998
Guyana	GUY	Latin America & Caribbean	Lower middle income	2009
Haiti	HTI	Latin America & Caribbean	Low income	1994
Haiti	HTI	Latin America & Caribbean	Low income	2000
Haiti	HTI	Latin America & Caribbean	Low income	2005
Honduras	HND	Latin America & Caribbean	Lower middle income	2005
Nicaragua	NIC	Latin America & Caribbean	Lower middle income	1997
Nicaragua	NIC	Latin America & Caribbean	Lower middle income	2001
Peru	PER	Latin America & Caribbean	Upper middle income	1996
Peru	PER	Latin America & Caribbean	Upper middle income	2000
Peru	PER	Latin America & Caribbean	Upper middle income	2004
Egypt	EGY	Middle East & North Africa	Lower middle income	1995
Egypt	EGY	Middle East & North Africa	Lower middle income	2000
Egypt	EGY	Middle East & North Africa	Lower middle income	2005
Egypt	EGY	Middle East & North Africa	Lower middle income	2008
Jordan	JOR	Middle East & North Africa	Upper middle income	1997
Jordan	JOR	Middle East & North Africa	Upper middle income	2002
Jordan	JOR	Middle East & North Africa	Upper middle income	2007
Morocco	MAR	Middle East & North Africa	Lower middle income	2003
Bangladesh	BGD	South Asia	Low income	1993
Bangladesh	BGD	South Asia	Low income	1996
Bangladesh	BGD	South Asia	Low income	1999
Bangladesh	BGD	South Asia	Low income	2004
Bangladesh	BGD	South Asia	Low income	2007
India	IND	South Asia	Lower middle income	1998
India	IND	South Asia	Lower middle income	2005
Maldives	MDV	South Asia	Upper middle income	2009
Nepal	NPL	South Asia	Low income	1996
Nepal	NPL	South Asia	Low income	2001
Nepal	NPL	South Asia	Low income	2006
Nepal	NPL	South Asia	Low income	2011
Pakistan	PAK	South Asia	Lower middle income	2006
Benin	BEN	Sub-Saharan Africa	Low income	1996
Benin	BEN	Sub-Saharan Africa	Low income	2001
Benin	BEN	Sub-Saharan Africa	Low income	2006
Burkina Faso	BFA	Sub-Saharan Africa	Low income	1998
Burkina Faso	BFA	Sub-Saharan Africa	Low income	2003
Burkina Faso	BFA	Sub-Saharan Africa	Low income	2010
Burundi	BDI	Sub-Saharan Africa	Low income	2010
Cambodia	CAF	Sub-Saharan Africa	Low income	2000
Cameroon	CMR	Sub-Saharan Africa	Lower middle income	2004
Cameroon	CMR	Sub-Saharan Africa	Lower middle income	2011
CAR	CMR	Sub-Saharan Africa	Lower middle income	1994
Chad	TCD	Sub-Saharan Africa	Low income	1996
Chad	TCD	Sub-Saharan Africa	Low income	2004
Comoros	COM	Sub-Saharan Africa	Low income	1996
Congo (Brazzaville)	COG	Sub-Saharan Africa	Lower middle income	2005

Congo Dem Rep	ZAR	Sub-Saharan Africa	Low income	2007
Cote dIvoire	CIV	Sub-Saharan Africa	Lower middle income	1994
Cote dIvoire	CIV	Sub-Saharan Africa	Lower middle income	1998
Ethiopia	ETH	Sub-Saharan Africa	Low income	2000
Ethiopia	ETH	Sub-Saharan Africa	Low income	2005
Ethiopia	ETH	Sub-Saharan Africa	Low income	2011
Gabon	GAB	Sub-Saharan Africa	Upper middle income	2000
Ghana	GHA	Sub-Saharan Africa	Lower middle income	1993
Ghana	GHA	Sub-Saharan Africa	Lower middle income	1998
Ghana	GHA	Sub-Saharan Africa	Lower middle income	2003
Ghana	GHA	Sub-Saharan Africa	Lower middle income	2008
Guinea	GIN	Sub-Saharan Africa	Low income	1999
Guinea	GIN	Sub-Saharan Africa	Low income	2005
Kenya	KEN	Sub-Saharan Africa	Low income	1993
Kenya	KEN	Sub-Saharan Africa	Low income	1998
Kenya	KEN	Sub-Saharan Africa	Low income	2003
Kenya	KEN	Sub-Saharan Africa	Low income	2008
Lesotho	LSO	Sub-Saharan Africa	Lower middle income	2004
Lesotho	LSO	Sub-Saharan Africa	Lower middle income	2009
Liberia	LBR	Sub-Saharan Africa	Low income	2007
Madagascar	MDG	Sub-Saharan Africa	Low income	1997
Madagascar	MDG	Sub-Saharan Africa	Low income	2003
Madagascar	MDG	Sub-Saharan Africa	Low income	2008
Malawi	MWI	Sub-Saharan Africa	Low income	2000
Malawi	MWI	Sub-Saharan Africa	Low income	2004
Malawi	MWI	Sub-Saharan Africa	Low income	2010
Mali	MLI	Sub-Saharan Africa	Low income	1995
Mali	MLI	Sub-Saharan Africa	Low income	2001
Mali	MLI	Sub-Saharan Africa	Low income	2006
Mozambique	MOZ	Sub-Saharan Africa	Low income	1997
Mozambique	MOZ	Sub-Saharan Africa	Low income	2003
Namibia	NAM	Sub-Saharan Africa	Upper middle income	2000
Namibia	NAM	Sub-Saharan Africa	Upper middle income	2006
Niger	NER	Sub-Saharan Africa	Low income	1998
Niger	NER	Sub-Saharan Africa	Low income	2006
Nigeria	NGA	Sub-Saharan Africa	Lower middle income	1999
Nigeria	NGA	Sub-Saharan Africa	Lower middle income	2003
Nigeria	NGA	Sub-Saharan Africa	Lower middle income	2008
Rwanda	RWA	Sub-Saharan Africa	Low income	2000
Rwanda	RWA	Sub-Saharan Africa	Low income	2005
Rwanda	RWA	Sub-Saharan Africa	Low income	2010
Sao Tome and Principe	STP	Sub-Saharan Africa	Lower middle income	2008
Senegal	SEN	Sub-Saharan Africa	Lower middle income	1997
Senegal	SEN	Sub-Saharan Africa	Lower middle income	2005
Senegal	SEN	Sub-Saharan Africa	Lower middle income	2010
Sierra Leone	SLE	Sub-Saharan Africa	Low income	2008
South Africa	ZAF	Sub-Saharan Africa	Upper middle income	1998

South Africa	ZAF	Sub-Saharan Africa	Upper middle income	2003
Swaziland	SWZ	Sub-Saharan Africa	Lower middle income	2006
Tanzania	TZA	Sub-Saharan Africa	Low income	1996
Tanzania	TZA	Sub-Saharan Africa	Low income	1999
Tanzania	TZA	Sub-Saharan Africa	Low income	2004
Tanzania	TZA	Sub-Saharan Africa	Low income	2010
Togo	TGO	Sub-Saharan Africa	Low income	1998
Uganda	UGA	Sub-Saharan Africa	Low income	1995
Uganda	UGA	Sub-Saharan Africa	Low income	2000
Uganda	UGA	Sub-Saharan Africa	Low income	2006
Uganda	UGA	Sub-Saharan Africa	Low income	2011
Zambia	ZMB	Sub-Saharan Africa	Lower middle income	1996
Zambia	ZMB	Sub-Saharan Africa	Lower middle income	2001
Zambia	ZMB	Sub-Saharan Africa	Lower middle income	2007
Zimbabwe	ZWE	Sub-Saharan Africa	Low income	1994
Zimbabwe	ZWE	Sub-Saharan Africa	Low income	1999
Zimbabwe	ZWE	Sub-Saharan Africa	Low income	2005
Zimbabwe	ZWE	Sub-Saharan Africa	Low income	2010

Annex 2. U5MR for boys and girls, showing excess deaths in girls after adjustment for biological differences in child survival.
(numbers in red font show relative excesses of 15% or greater)

Country	Observed male U5MR	Observed female U5MR	Observed male/ female ratio	Observed male female difference	Expected male/ female ratio	Expected female U5MR	Absolute female excess U5MR	Relative female excess U5MR
Albania	27.3	16.1	1.70	11.3	1.28	21.3	-5.2	-32.6%
Armenia	21.3	21.7	0.98	-0.5	1.29	16.5	5.3	24.2%
Azerbaijan	64.3	49.0	1.31	15.3	1.25	51.6	-2.6	-5.3%
Bangladesh	75.0	71.3	1.05	3.8	1.24	60.6	10.6	14.9%
Benin	138.8	132.1	1.05	6.7	1.19	116.9	15.2	11.5%
Bolivia	79.1	71.1	1.11	8.0	1.23	64.1	7.0	9.9%
Brazil	58.9	53.3	1.10	5.6	1.25	47.0	6.3	11.8%
Burkina Faso	152.6	141.0	1.08	11.6	1.18	129.5	11.5	8.1%
Burundi	134.1	116.0	1.16	18.2	1.19	112.6	3.3	2.9%
Cambodia	76.0	58.8	1.29	17.2	1.24	61.4	-2.6	-4.5%
Cameroon	134.8	121.3	1.11	13.6	1.19	113.3	8.0	6.6%
CAR	165.3	152.6	1.08	12.7	1.17	141.2	11.4	7.5%
Chad	207.2	198.5	1.04	8.6	1.15	180.5	18.0	9.1%
Colombia	23.8	19.3	1.24	4.6	1.29	18.5	0.8	4.0%
Comoros	121.9	103.1	1.18	18.8	1.20	101.6	1.5	1.4%
Congo (Brazzaville)	128.4	118.0	1.09	10.4	1.19	107.5	10.5	8.9%
Congo DR	161.3	148.1	1.09	13.2	1.17	137.5	10.6	7.2%
Cote dIvoire	204.6	146.3	1.40	58.3	1.15	178.1	-31.8	-21.8%
Dominican Republic	39.7	33.9	1.17	5.8	1.27	31.3	2.7	7.8%
Egypt	38.4	27.7	1.38	10.7	1.27	30.2	-2.4	-8.7%
Ethiopia	120.8	97.4	1.24	23.4	1.20	100.7	-3.2	-3.3%
Gabon	103.1	80.2	1.29	22.9	1.21	84.9	-4.7	-5.9%

Ghana	93.2	74.9	1.24	18.3	1.22	76.3	-1.3	-1.8%
Guatemala	63.7	65.2	0.98	-1.5	1.25	51.0	14.2	21.8%
Guinea	198.9	173.6	1.15	25.3	1.15	172.7	0.9	0.5%
Guyana	40.6	39.0	1.04	1.7	1.27	32.0	7.0	17.9%
Haiti	104.6	98.9	1.06	5.7	1.21	86.3	12.6	12.8%
Honduras	38.8	34.4	1.13	4.4	1.27	30.5	3.9	11.3%
India	81.8	88.2	0.93	-6.3	1.23	66.4	21.7	24.6%
Indonesia	55.3	45.9	1.21	9.4	1.26	44.1	1.9	4.0%
Jordan	21.7	23.0	0.94	-1.4	1.29	16.8	6.2	27.1%
Kazakhstan	72.3	53.8	1.34	18.5	1.24	58.3	-4.5	-8.4%
Kenya	89.9	77.0	1.17	12.9	1.22	73.4	3.6	4.7%
Kyrgyz Republic	81.6	69.3	1.18	12.3	1.23	66.2	3.0	4.4%
Lesotho	122.8	87.1	1.41	35.7	1.20	102.4	-15.3	-17.6%
Liberia	147.1	131.4	1.12	15.7	1.18	124.4	7.0	5.3%
Madagascar	84.8	78.0	1.09	6.8	1.23	69.0	9.0	11.5%
Malawi	136.5	115.8	1.18	20.6	1.19	114.7	1.1	0.9%
Maldives	28.7	25.0	1.15	3.7	1.28	22.3	2.7	10.6%
Mali	221.7	206.3	1.07	15.4	1.14	194.4	12.0	5.8%
Moldova	32.5	19.7	1.65	12.8	1.28	25.4	-5.7	-29.2%
Morocco	59.2	47.8	1.24	11.4	1.25	47.3	0.5	1.1%
Mozambique	179.8	175.9	1.02	3.9	1.16	154.7	21.2	12.0%
Namibia	79.7	57.9	1.38	21.8	1.23	64.6	-6.7	-11.6%
Nepal	62.2	62.2	1.00	-0.1	1.25	49.7	12.5	20.0%
Nicaragua	48.1	40.2	1.19	7.8	1.26	38.1	2.2	5.4%
Niger	220.2	213.0	1.03	7.1	1.14	192.9	20.2	9.5%
Nigeria	174.7	166.4	1.05	8.3	1.17	150.0	16.4	9.9%
Pakistan	93.0	93.5	0.99	-0.5	1.22	76.1	17.4	18.6%
Peru	46.9	35.8	1.31	11.1	1.26	37.1	-1.3	-3.5%
Philippines	40.6	33.6	1.21	7.0	1.27	32.0	1.6	4.9%

Rwanda	104.2	96.0	1.09	8.3	1.21	85.9	10.0	10.5%
Sao Tome and Principe	85.8	54.5	1.57	31.3	1.23	69.9	-15.3	-28.1%
Senegal	89.5	81.9	1.09	7.6	1.23	73.1	8.9	10.8%
Sierra Leone	176.0	159.6	1.10	16.4	1.16	151.1	8.4	5.3%
South Africa(*)	36.8	73.1	0.50	-36.3	1.27	28.9	44.2	60.5%
Swaziland	108.7	103.9	1.05	4.8	1.21	89.9	14.0	13.5%
Tanzania	96.5	87.6	1.10	8.9	1.22	79.2	8.4	9.6%
Timor-Leste	83.4	75.8	1.10	7.5	1.23	67.8	8.1	10.7%
Togo	155.3	131.2	1.18	24.1	1.18	132.0	-0.8	-0.6%
Turkey	48.2	44.8	1.08	3.5	1.26	38.2	6.5	14.6%
Uganda	113.5	97.4	1.17	16.2	1.21	94.1	3.2	3.3%
Ukraine	23.4	13.4	1.75	10.0	1.29	18.2	-4.8	-35.6%
Uzbekistan	64.5	45.4	1.42	19.1	1.25	51.7	-6.3	-13.9%
Vietnam	34.2	30.8	1.11	3.4	1.28	26.8	4.0	13.1%
Zambia	151.0	121.9	1.24	29.2	1.18	128.0	-6.2	-5.1%
Zimbabwe	87.6	68.4	1.28	19.2	1.23	71.4	-3.0	-4.4%

(*) The 2003 DHS from South Africa had several implausible results, and it was excluded from the main analyses presented in this working paper.

Annex 3. Confidence intervals for U5MR estimates by sex and wealth quintile, India and Colombia.

Country	Quintile and sex	U5MR	95% CI	
Colombia	Q1 female	29.9	24.0	35.7
	Q1 male	28.3	22.5	34.1
	Q2 female	19.1	14.1	24.2
	Q2 male	25.3	19.8	30.8
	Q3 female	17.9	12.6	23.2
	Q3 male	21.3	15.0	27.5
	Q4 female	13.9	8.0	19.9
	Q4 male	23.9	15.9	31.9
	Q5 female	8.5	3.4	13.7
	Q5 male	16.7	9.2	24.3
India	Q1 female	124.0	116.2	131.7
	Q1 male	109.3	101.9	116.7
	Q2 female	100.6	92.6	108.5
	Q2 male	94.7	87.4	102.0
	Q3 female	82.6	75.2	90.1
	Q3 male	80.1	73.1	87.0
	Q4 female	61.5	54.7	68.2
	Q4 male	60.1	53.9	66.4
	Q5 female	36.7	30.8	42.5
	Q5 male	41.3	35.8	46.8

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