

# Maternal and Child Health Inequalities in Ethiopia

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## Abstract

Recent surveys show considerable progress in maternal and child health in Ethiopia. The improvement has been in health outcomes and health services coverage. The study examines how different groups have fared in this progress. It tracked 11 health outcome indicators and health interventions related to Millennium Development Goals 1, 4, and 5. These are stunting, underweight, wasting, neonatal mortality, infant mortality, under-five mortality, measles vaccination, full immunization, modern contraceptive use by currently married women, antenatal care visits, and skilled birth attendance. The study explores trends in inequalities by household wealth status, mothers' education,

and place of residence. It is based on four Demographic and Health Surveys implemented in 2000, 2005, 2011, and 2014. Trends in rate differences and rate ratios are analyzed. The study also investigates the dynamics of inequalities, using concentration curves for different years. In addition, a decomposition analysis is conducted to identify the role of proximate determinants. The study finds substantial improvements in health outcomes and health services. Although there still exists a considerable gap between the rich and the poor, the study finds some reductions in inequalities of health services. However, some of the improvements in selected health outcomes appear to be pro-rich.

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## 1. Introduction

Improving maternal and child health is integral to the Millennium Development Goals (MDGs). In particular, Goals 4 and 5 call for, respectively, reduction in child and maternal mortality for the period between 1990 and 2015. Goal 4 targeted a reduction of under-five mortality by two-thirds, while Goal 5 set a 75 percent reduction in maternal mortality. The goals received national and global attention over the last decade and a half; countries and their international development partners mobilized support to expand childhood immunization and increase availability and utilization of maternal health services.

By the target date of 2015, different countries are at different stages in terms of achieving the MDG targets. Country level tracking of the MDGs shows that Ethiopia is one of those with satisfactory progress towards achieving the targets. A recent UN report shows that all the MDGs were either on track or likely to be on track.<sup>1</sup> A similar tracking by the Center for Global Development (CGDEV) reported satisfactory progress on all goals. The CGDEV tracking in 2011 ranks Ethiopia 33 of 137 countries, with an MDG progress index of 4.5 (on a scale of zero to 8 points).<sup>2</sup> The country's progress in the health sector is also documented in other recent surveys. For example, the 2014 mini-Demographic and Health Survey (DHS) shows reductions in child undernutrition

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<sup>1</sup> A UN tracking for Ethiopia shows that the country is on track on goals 1 and 4 and likely to be on track on goal 5. [http://www.et.one.un.org/index.php?option=com\\_content&view=article&id=14&Itemid=488](http://www.et.one.un.org/index.php?option=com_content&view=article&id=14&Itemid=488)

<sup>2</sup> MDG Progress Index: Gauging Country-Level Achievements, Center for Global Development (CGDEV) <http://www.cgdev.org/page/mdg-progress-index-gauging-country-level-achievements> accessed on 1/31/15.

and child mortality, as well as increases in coverage of maternal and child health services including antenatal cares, contraceptive prevalence and skilled birth attendance (CSA, 2014).<sup>3</sup>

Now with the MDG period coming to an end and new targets set in the Sustainable Development Goals, studies are investigating not only if the countries progressed towards achieving the targets, but also if the achievements were inclusive (Wagstaff et al., 2014). Indeed, health inequalities matter for several economic and non-economic reasons, as supported by vast empirical literature in this area. However, the available evidence on health inequality studies is mixed and context specific; there have been appreciable and widening inequalities in some countries and improvements in others (e.g., Barros et al. 2012; Wagstaff et al., 2014). These studies also point out important heterogeneities in the results arising from the type of health service or the way it is delivered. For example, Barros et al. (2012) find that those services that are traditionally delivered at health facilities, such as skilled birth attendant and antenatal care visits, have more socioeconomic inequalities than those delivered by outreach or mass campaigns. This would point to the role of various constraints that disproportionately affect health care utilization by the poor. Similarly, a recent multi-country study of progress in health MDGs by Wagstaff et al. (2014) finds that the poor are more likely to face health risks, including child undernutrition and mortality,

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<sup>3</sup> According to the 2014 mini DHS Survey, the reductions in undernutrition and child mortality levels from 2000 and 2005 are considerable. Similarly, during the same period, there has been considerable expansion in maternal health service. However, trend should not be confused with the overall health status.

and less likely to receive key health services (p. 137). The study also notes disconnect between health outcomes that were pro-rich and interventions that tended to be pro-poor. Another study by Victora et al. (2012) analyzed time trends in inequalities of selected health indicators from the MDGs.<sup>4</sup> In general, they note prevalent pro-rich inequalities, but services tend to be pro-poor when there are rapid changes in overall coverage.

There are a number of other health inequality studies on low-income countries. Some of these studies looked at one or more health status indicators (e.g., McKinnon et al. 2014 and Quentin et al. 2014), while others focused on health intervention indicators (e.g., Kruk et al. 2008). McKinnon et al. (2014) investigated wealth-related and educational inequalities in neonatal mortality (NMR) for 24 low- and middle-income countries with substantial heterogeneity in both the size and direction of NMR inequalities between countries. They find that inequalities declined in most of the studied countries. They also find pro-rich inequalities in NMR increased in a few countries, including Ethiopia.

While the evidence in multi-country studies offers some useful insight, an in-depth analysis of country-level inequalities would provide a more detailed description and a focused message based on the factors that are particularly relevant to the country's context. There are a few relevant studies on health inequalities in Ethiopia. Most of them analyzed one or two indicators at the national level (e.g., Onarheim et al.,

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<sup>4</sup> The indicators include skilled birth attendants, measles vaccination, and a composite coverage index, and examined coverage of a newly introduced intervention, use of insecticide-treated bednets by children. They use DHS and MICS data from 35 countries.

2013; World Bank, 2012; Yesuf and Calderon-Margalit, 2013), while others examined one or two indicators for a specific region or city (e.g., Mirkuzie, 2014; Yesuf et al., 2014). In this regard, a World Bank (2012) fact sheet on health equity and financial protection on Ethiopia provides progress on a comprehensive list of health and health-related indicators using multiple surveys from different sources.

In this study, we provide evidence on maternal and child health inequalities in Ethiopia. We expand the available empirical evidence on maternal and child health equity in Ethiopia by adding a more detailed inequality analysis using data from a series of comparable surveys from 2000 to 2014. The surveys allow us to analyze the trends in inequalities over a time period that overlaps with most of the MDGs' years. We also examine the contribution of the underlying socioeconomic determinants of maternal and child health outcomes, such as wealth, place of residence and mothers' education level.

The rest of the paper is organized as follows. Section 2 presents the methodology, focusing on the indicators and their definition, statistical analysis and data. Section 3 presents the results. Section 4 discusses the results and provides a conclusion.

## **2. Methods**

### *2.1 Indicators and definitions*

Table 1 presents the health status and intervention indicators analyzed in this study. Following recent health equity studies, we identified the indicators based on their relevance to the health MDGs and availability of data (Barros et al., 2012; Victora *et al.*,

2012; Wagstaff *et al.*, 2014). We focused on those MDG indicators that are relevant to maternal and child health. These include Goal 4 (reducing child mortality) and Goal 5 (improving maternal mortality). Goal 1 is relevant as well, owing to its role in reduction of undernutrition and hunger.

**Table 1. List of maternal and child health indicators analyzed in this study**

<b>Indicators</b>	<b>Definition</b>
Stunting	Percentage of children with a height-for-age z-score <-2 standard deviations from the reference median *
Wasting	Percentage of children with a weight-for-height z-score <-2 standard deviations from the reference median *
Underweight	Percentage of children with a weight-for-age z-score <-2 standard deviations from the reference median *
Neonatal mortality rate (NMR)	The number of neonates dying before reaching 28 days of age per 1000 live births
Infant mortality rate (IMR)	The number of deaths among children under 12 months of age per 1000 live births
Under-five mortality rate (U5MR)	The number of deaths among children under 5 years of age per 1000 live births
Full immunization	Percentage of children aged 12 to 23 months who received BCG, measles and three doses of Polio and DPT #,+
Measles vaccination	Percentage of children aged 12 to 23 months who received measles +, #
Contraceptive prevalence (Modern method)	Percentage of currently married women aged 15 to 49 who currently use a modern method of contraception
Antenatal care visits- 4 or more (ANC4+)	Percentage of mothers aged 15 to 49 who had a live birth in the past 5 years who received at least 4 antenatal care visits from any skilled personnel during pregnancy for the most recent birth
Skilled birth attendant (SBA)	Percentage of mothers aged 15 to 49 who had a live birth in the past years who were attended by skilled health attendant

Notes: \* Based on WHO 2006 growth standards are used to calculate z-scores. + Immunizations are either verified by card or based on recall of respondent. # Data not collected in 2014 mini-DHS survey.

We selected six health status indicators and five health intervention indicators. The five health status indicators include three child undernutrition and two mortality indicators, namely stunting, wasting, underweight, neonatal mortality rate (NMR),



infant mortality rate (IMR), and under-five mortality (U5MR). On health interventions, we included child and maternal health services. Two of the child health services indicators included in this study are child immunization indicators: measles vaccination and full immunization. The other three are maternal health services, namely prevalence of modern contraceptive use by married women, four or more antenatal care visits from a skilled professional (ANC4+), and delivery assistance from a skilled birth attendant (SBA).

## *2.2 Data sources and variable construction*

We used four demographic and health surveys (DHS) 2000, 2005, 2011 and 2014.<sup>5</sup> The surveys implemented in different periods follow standard and comparable questionnaires. The data provide nationally representative information on the health outcomes we selected for this study. The surveys also allow generating estimates for rural and urban areas and regions. In addition, the timeline of the surveys in general overlaps the larger part of the MDGs period.

The DHS data are organized in different files. Household level characteristics, such as wealth and housing conditions (e.g., water and sanitation facilities), are from the household data. Quintiles and other transformed variables, such as bottom 40% and top 60% wealth categories, are computed from the household wealth index that is

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<sup>5</sup> The 2014 survey did not cover immunizations. The analysis for immunization indicators (full immunization and measles immunization) is based on the first three surveys.

available with the data.<sup>6</sup> The DHS wealth index is constructed from selected household level variables, including housing characteristics, ownership of land and selected durable goods (Rutstein and Johnson, 2004).

For child undernutrition analysis, we computed anthropometric indicators from age, height/length and weight data following the WHO 2006 growth standards. We calculated height-for-age, height-for-weight, and weight-for-age z-scores and then stunting, wasting and underweight levels for children aged 0 to 59 months. Child mortality rates (NMR, U5MR and IMR) are calculated using the standard DHS methodology, using all data on all children deaths in the 5-year period preceding the survey (Rutstein and Rojas, 2006). We calculated prevalence of modern contraception use by currently married women, ANC4+, and SBA from the women's (aged 15-49 years) questionnaire.

### *2.3 Data Analysis*

We examined differential progress for groups by wealth ranking, place of residence and education. For wealth groups, we looked at socioeconomic inequalities in health by wealth ranking between the worse off (bottom 40%) and the better off (top 60%) and between the poorest (1<sup>st</sup> quintile) and the richest (5<sup>th</sup> quintile). The spatial dimension we investigated is place of residence: rural vs. urban residents. On education, we considered

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<sup>6</sup> For DHS 2000, we constructed quintiles from the wealth index. The bottom 40% comprises the first and the second quintiles, i.e., the poorest and the next poorest quintiles, and the top 60% represents the remaining three quintiles. The interest on the Bottom 40% of the wealth group is following the World Bank Group's current goals to end extreme poverty and promote shared prosperity. <http://www.worldbank.org/content/dam/Worldbank/document/WB-goals2013.pdf>

mothers' education on children's nutrition status and mortality and own education on access to health care.

For a more complete picture, we looked at a combination of approaches that are often used in inequality studies because each approach has its own limitations and can lead to different conclusions (e.g., Moser et al., 2007 and Mackinnon et al., 2014). We computed absolute and relative inequalities from rate differences and rate ratios. However, differences and ratios between different groups do not take into account inequalities by the whole population. We, therefore, examined inequalities using concentration indexes (CI) (Kakwani et al., 2002; O'Donnell et al., 2008). We used concentration curves to illustrate the movement of socioeconomic inequalities in health between the earlier and latest surveys.<sup>7</sup> Following the procedure in O'Donnell (2006) and O'Donnell et al. (2008), we conducted tests of dominance between concentration curves of the outcomes for the earlier and latest surveys. The welfare measure we used for CI analysis is the DHS wealth index. Our analysis also includes decomposition of wealth-related inequalities in health.<sup>8</sup>

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<sup>7</sup> Earlier survey year refers to the 2000 DHS. The latest survey is the 2011 DHS for immunization indicators (full immunization and measles vaccination) and the 2014 DHS is considered as the latest survey for the rest of the indicators ( undernutrition and mortality indicators, contraception, ANC4+, and SBA). The concentration curve shows the plot of cumulative proportion of a health outcome against the proportion of the population ranked by a welfare measure.

<sup>8</sup> We used STATA version 13.0 for most of the analyses, including trend analysis, rate difference and rate ratio analysis, concentration indexes, concentration curves and dominance tests. We used ADEPT Health to decompose the inequalities.

### 3. Results

#### *3.1 Progress in MNCH*

Over the last two decades, there has been considerable improvement in MNCH outcomes, though there still exist high levels of child undernutrition and mortality rates and limited coverage of maternal and health services. This holds true for all the health status and health service indicators analyzed in this study. Table 2 presents the progress at the national level and for rural and urban areas. The progress over the period is shown by a decline in ill health (under nutrition and mortality) and an increase in the coverage of health services (immunizations and maternal health services). For example, in the 2014 DHS, about 48.2% (6.3 million) of children under the age of five years were malnourished as measured by at least one of the three standard indicators of undernutrition: stunting, underweight or wasting. However, the current rates of undernutrition are much improved when compared to the 64.4% in the 2000 DHS. This decline, by 15 percentage points, is roughly equivalent to improvements in the nutritional status of over 2 million children under the age of five years.<sup>9</sup>

Looking at each indicator separately, in DHS 2000, at the national level, over half of children under five years old were stunted and over 4 in 10 were underweight (Table 2). Over the years covered by the surveys, however, stunting declined by 17 percentage points (from 57% to 40.6%); and prevalence of underweight declined by 15 percentage points (from 41.9% to 26.6%). There has also been a significant reduction in wasting,

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<sup>9</sup> The estimate is based on the 97.1 million total population in 2013 (World Bank data) and the proportion of the age group which is 13.6 % (DHS 2014) and the current prevalence of undernutrition which is 48% (DHS 2014).

which declined by about 4 percentage points, from 12.5% in 2000 to 8.5% in 2014. Another important measure of child health improvement over the last 15 years is the declining trend in child mortality rates. During this period, U5MR declined by over 83 deaths per 1,000 live births, from 164 deaths in 2000 to 80 deaths in 2014, and IMR declined by about 35 deaths per 1,000 live births, from 95.9 death per 1,000 live births in 2000 to 59.3 death per 1,000 live births in 2014.<sup>10</sup>

**Table 2. Trends in MNCH outcomes in Ethiopia, 2000-2014**

	National			Rural			Urban		
	Earlier Survey	Latest Survey	Change	Earlier Survey	Latest Survey	Change	Earlier Survey	Latest Survey	Change
Stunting	57.0	40.6	-16.4	58.2	42.5	-15.7	46.5	27.0	-19.5
Wasting	12.5	8.9	-3.6	13.0	8.9	-4.1	7.8	9.0	1.2
Underweight	41.9	26.6	-15.3	43.4	27.8	-15.6	28.4	18.7	-9.7
NMR	48.4	34.3	-14.1	48.8	32.8	-16.0	44.5	44.4	-0.1
IMR	95.9	59.3	-36.6	114.2	65.7	-48.5	96.3	60.7	-35.6
U5MR	163.9	80.1	-83.8	191.3	91.8	-99.5	148.3	67.3	-81.0
Measles vaccination	27.0	56.7	29.7	43.2	48.5	5.3	63.1	79.6	16.5
Full immunization	14.6	24.9	10.3	11.2	20.9	9.7	43.2	48.5	5.3
Contraceptive	7.2	45.2	38.0	3.8	42.0	38.2	32.9	61.8	28.9
ANC4+	10.4	24.2	13.8	3.2	37.1	33.9	28.5	56.2	27.7
SBA	5.7	15.5	9.8	2.3	9.1	6.8	34.6	58.4	23.8

Source: Authors' compilation from the DHS (2000, 2005, 2011 & 2014) data.

Note: The values are number of births per 1000 live births for NMR, IMR and U5MR and percentages for the rest. Earlier survey year is 2000 for all indicators. Latest survey year is 2014 for all but full immunization and measles vaccination, for which our latest source of information is the 2011 DHS.

<sup>10</sup> The mortality results reported here are based on birth history records collected as part of DHSs. Birth histories usually go back 3-5 years before the date of the survey. Hence, the results might refer to a period 1.5- 2.5 years before the survey report date. It is more than likely that under- five mortality level in 2014 could be even lower. The main focus of the current paper is on the distribution, which is consistent over the four surveys. However, for the actual levels of mortality readers can also refer to the UN Inter Agency Group estimate [http://www.unicef.org/publications/files/Child\\_Mortality\\_Report\\_2015\\_Web\\_8\\_Sept\\_15.pdf](http://www.unicef.org/publications/files/Child_Mortality_Report_2015_Web_8_Sept_15.pdf) accessed on 7 November 7, 2015 (UNICEF, 2015).

Table 2 also presents progress in child immunization and maternal health services. For example, full immunization coverage increased by over 10 percentage points, from 14.6% in 2000 to 24.9% in 2011. During the same period, measles vaccination coverage increased by 30 percentage points, from 27% in 2000 to 57% in 2011. The relatively better performance in measles vaccination might be because of additional deliveries through outreach campaigns that tend to reach more people (Barros et al., 2012). There has also been some expansion in coverage of all three maternal health services. For example, modern contraceptive use by married women (age 15-49 years) was just 6% in 2000 and increased to 40% in 2014. During the same period, antenatal care visits (4 or more) increased by 14 percentage points, from 10% in 2000 to 24% in DHS 2014. Although still very low in terms of its coverage, the skilled birth attendant rate also increased by over 10 percentage points from 5% in 2000 to about 16% in DHS 2014.

### *3.2 Inequalities*

One important observation from the overall trends in MNCH in Ethiopia is that services expanded and health outcomes improved broadly. However, our objective is on the distribution of the progress. How have different groups benefited from this progress? To answer this question, we disaggregated the trends for different groups, using different approaches of inequality analyses. We looked at the inequalities by wealth groups, place of residence and education. We analyzed the trends of overall progress in

MNCH (section 3.2.1). We also looked at the trends in rate differences (section 3.2.2), rate ratios (Section 3.2.3), and concentration indexes and curves (section 3.2.4).<sup>11</sup>

### *3.2.1 Trends in MNCH for different groups*

We disaggregated the trends in MNCH outcomes by selected background characteristics: rich vs. poor or top 60% compared to bottom 40%, wealth quintiles, place of residence (urban and rural) and mother's education. All the curves in each graph plot the values for all survey years and the 95% confidence intervals. In each graph, the vertical lines perpendicular to the years in the horizontal axis are 95% confidence intervals. Figures 1a through 1d present the results.

Figure 1a is on nutrition; Figure 1b - child mortality; Figure 1c- immunization; and Figure 1d is on modern contraceptive use by married women, ANC4+, and SBA. In all cases, outcome curves are downward and health services curves are upward sloping. This shows improvement in MNCH in all indicators on average. However, the distance between the curves and the slope of each curve in each graph shows that the performance has been different for different outcomes. For example, in Figure 1a, while the reduction in undernutrition occurred for both the bottom 40% and the top 60%, the curve for the top 60% is steeper than the bottom 40%. Similarly, the curve for the top 20% is steeper. Some four observations are noted from the disaggregated graphs in undernutrition rates over the period covered by the surveys. One is that the income-based inequality is starker because the poor-rich differences are driven by the richest

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<sup>11</sup> Mother's education is used in child health indicators, including stunting, wasting, underweight, IMR, UFR, measles vaccination and full immunization, while own education is used in maternal health services, including contraception, ANC4+, and SBA.

quintile. Proportionally more reductions in undernutrition occurred among children from the richest quintile. The rest, from the 1<sup>st</sup> to the 4<sup>th</sup> quintile, are within the 95% confidence intervals. Second, the widening income-related inequality in health is stronger in the long- than short-term nutritional status because the absolute gap clearly widened for stunting but not for wasting and underweight. Third, the rural-urban gaps are either constant or narrowing. Fourth, education followed the pattern exhibited in income; the improvement was higher among children whose mothers have more education, secondary education and above.

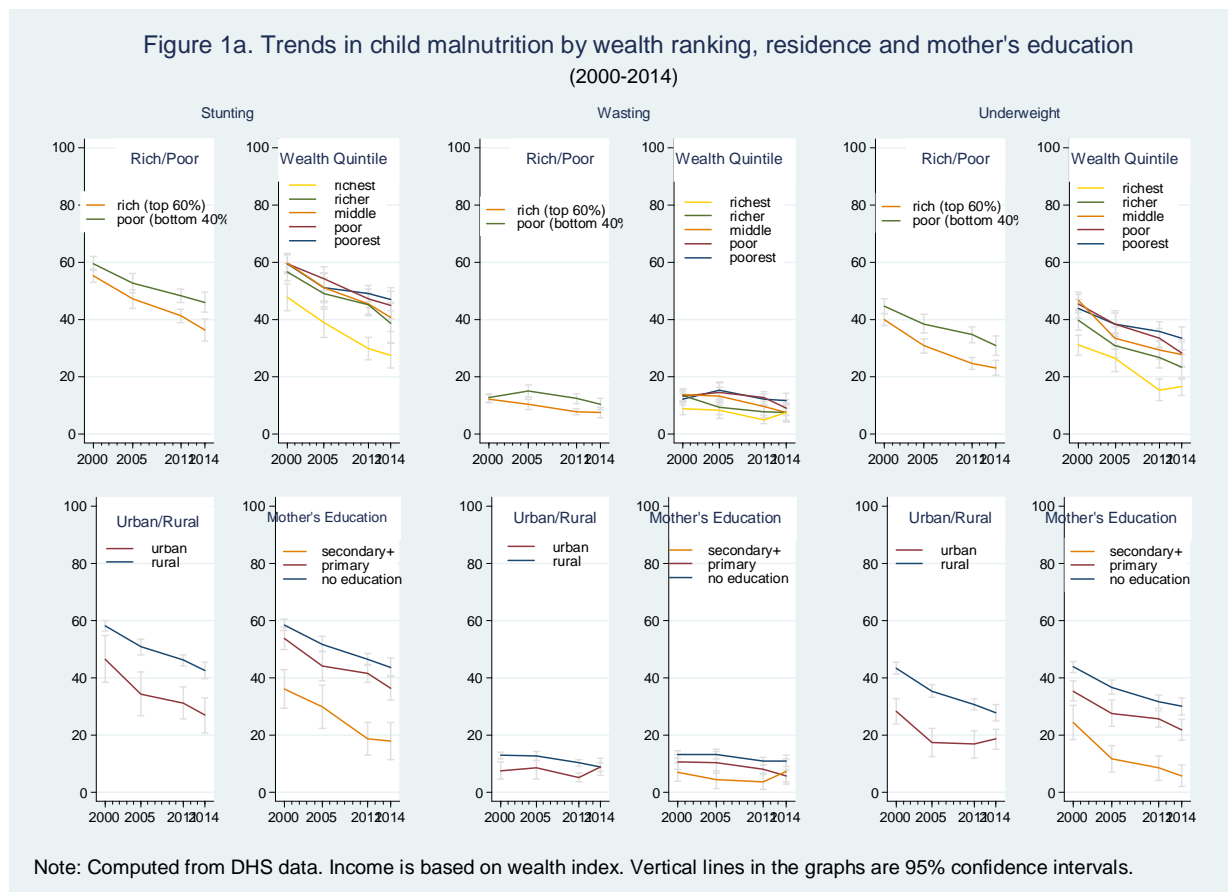
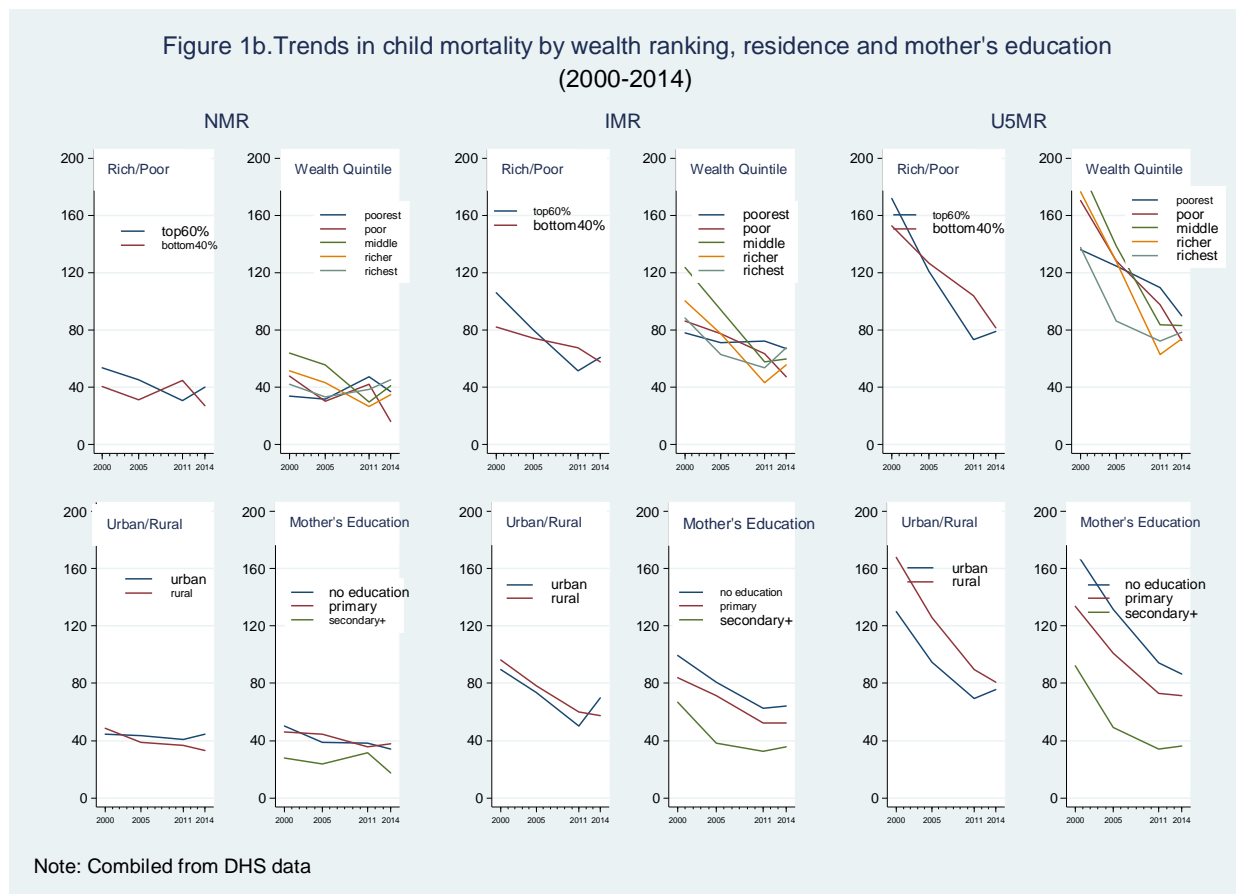


Figure 1b shows the trends for child mortality (NMR, IMR and U5MR). Child mortality is an important outcome that the country has substantially reduced over the



last two decades. The graphs show the reductions in mortality on average. The reduction is the smallest in NMR; the curves are less steep when compared to the curves in IMR and U5MR. Figure 1b also shows that the reductions by income group first exhibited reversals from a pro-poor trend (2000-2005) to a pro-rich inequality trend (2005-2011) and then back to pro-poor inequality trend (2011 to 2014). Overall, the trend presented in Figure 1b does not show a clear distinction in the distribution of reductions in mortality by income group.



In Figure 1c, the trends in immunization services show that the expansion has been for all groups by income, place of residence and mother's education. The curves

are upward sloping, showing expansion in immunization coverage over the period. The slope of the curves also shows that the rate of expansion was more rapid in the latest years than in earlier years. The figure also shows that expansion of the immunization coverage has been proportionally higher for the richest quintile.

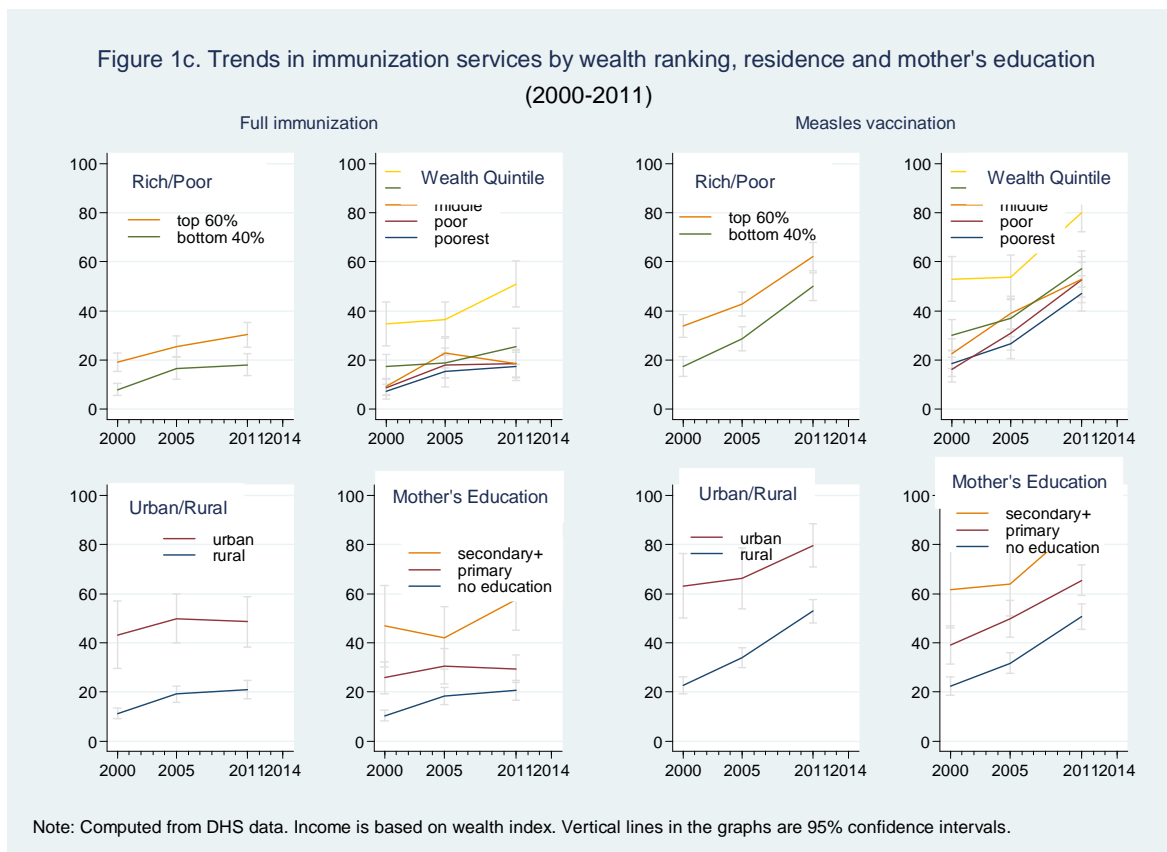
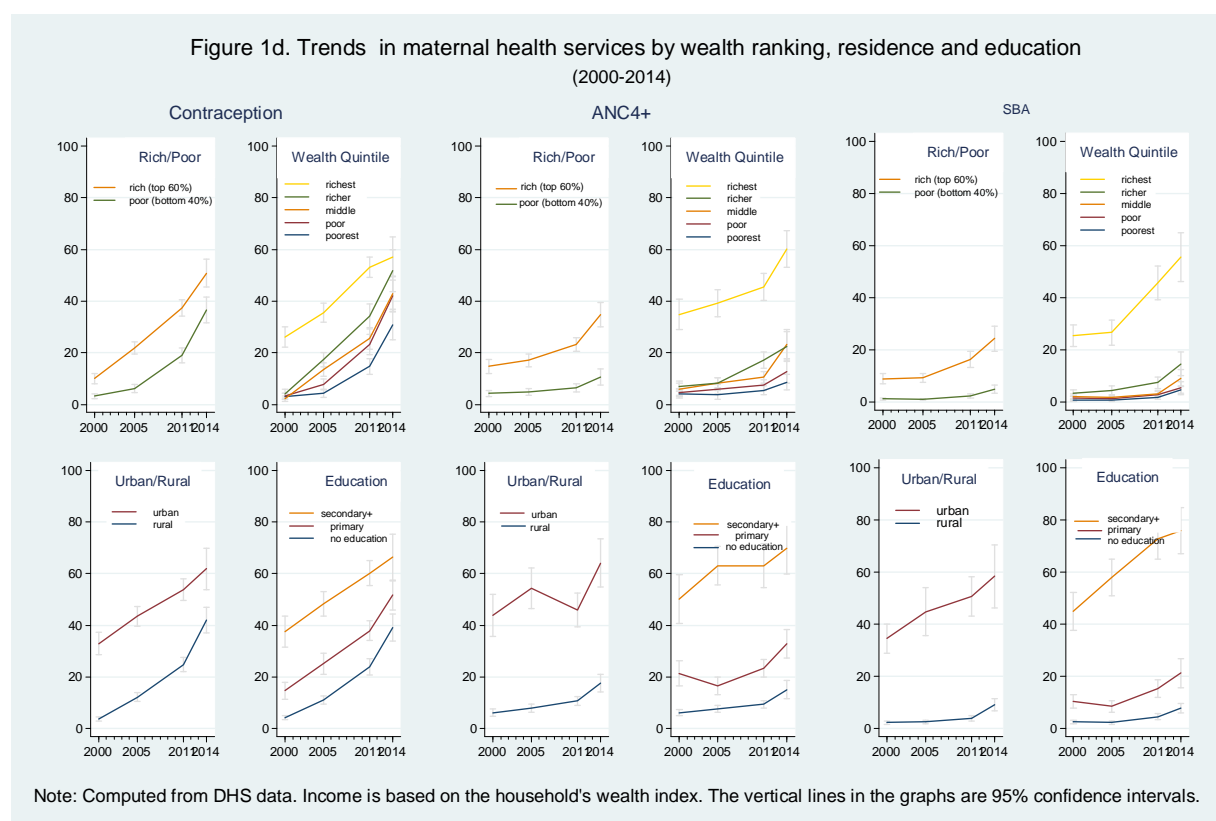


Figure 1d presents trends for maternal health services. It shows that utilization of modern contraception expanded for all groups. However, expansions in the utilization of antenatal care visits and delivery assistance for a skilled professional have been largely for the better off, for women in urban areas and for women with some secondary education and above. The relatively better performance in contraceptive use

among rural women might be due to health extension workers in rural areas whose major activities include delivering family planning services.



### 3.2.2 Absolute inequalities: Rate differences

Further to the graphical illustrations presented in the previous section, we examined whether the changes in absolute gaps between different groups were significant. We tested if these differences between groups at the earlier survey were significantly different to that of the differences at the latest survey available to the indicator. Tables 3a & b present the results. The values in the tables are percentage points except for NMR, IMR and U5MR where the number of births per 1,000 live births is reported. For all indicators, the earlier survey report year is 2000 (the first DHS). The latest survey report year is 2014 (the mini DHS) for the nutrition and mortality indicators and for the

three maternal health services included in this study, namely contraception, ANC4+, and SBA. As indicated earlier, the mini-DHS did not cover immunization indicators. Therefore, the latest survey for these indicators is the 2011 DHS.

**Table 3a. Trends in absolute gaps MNCH between poor and rich households, 2000-2014**

	Diff: Bottom40%-Top60%			Diff: Poorest-Richest		
	Earlier Survey	Latest Survey	P-value	Earlier Survey	Latest Survey	P-value
Stunting	4	10	<b>0.050</b>	12	20	0.123
Wasting	0	3	0.994	3	4	0.914
Underweight	5	8	<b>0.049</b>	13	17	0.574
NMR	-12.9	-13.2	NA	-8.6	-8.5	NA
IMR	-24	-3	NA	-10	-1	NA
U5MR	-19	3	NA	-2	11	NA
Measles Vaccination	-16	-12	<b>0.024</b>	-34	-33	<b>0.016</b>
Full Immunization	-11	-12	0.290	-28	-33	0.973
Contraceptive	-7	-14	<b>0.096</b>	-23	-26	0.136
ANC4+	-10	-24	0.488	-31	-52	0.770
SBA	-8	-19	0.130	-25	-51	0.632

Authors' compilation from the DHS (2000, 2005, 2011 & 2014) data.

Note: The p-values are for the F-test of the difference-in-differences (Diff-in-Diff). The first part of the results is for the test: *Is [(bottom40% in the Latest Survey) - (top60% in the Latest Survey)] equal to [(bottom40% in the Earlier Survey) - (top60% in the Earlier Survey)]?* And, in the second part the results are based on the following test: *Is [(bottom20% in the Latest Survey) - (top20% in the Latest Survey)] equal to [(bottom20% in the Earlier Survey) - (top20% in the Earlier Survey)]?* Test is not applicable for NMR, IMR and U5MR.

Table 3a shows the gap between the poor and the rich, and between the poorest and the richest.<sup>12</sup> Therefore, a positive value for an ill health outcome (child undernutrition or child mortality) shows a pro-rich absolute inequality, i.e., child undernutrition rates and mortality levels were lower among children from the better off households. Likewise, a negative value in any of the immunization and maternal health

<sup>12</sup> The poor and the rich classification refers to the bottom 40% and the top 60% respectively; whereas, the poorest and the richest classification refers to the bottom 20% (the first wealth quintile) and the top 20% (the fifth quintiles).

service indicators (good health outcomes) implies a pro-rich inequality. These socioeconomic differences are expected. However, the trends in the differences are relevant for interventions that could be adopted. Therefore, our interest is to show if the absolute gaps were widening or narrowing.

The results, in Table 3a, show that there has been a widening absolute pro-rich inequality between the poor and the rich in child nutritional outcomes. The pro-rich inequality was observed in all the three child nutrition status indicators. It is significant in stunting and underweight cases. In DHS 2000, the level of child stunting for the poor was higher by about 4.2 percentage points. In DHS 2014, the difference between the poor and the rich was 10 percentage points. Similarly, the gap in underweight increased from 5 to 8 percentage points. In both cases (stunting and underweight), the differences at the earlier survey and the latest survey were significantly different [ $p < 0.05$ ], implying a widening pro-rich inequality. Similarly, the declines in child mortality have been sharper /faster for the rich. For both IMR and U5MR, the differences at the earlier survey were actually more pro-poor and they crossed the line of equality in favor of the better off.

On the services side, there has been a larger increase in modern contraceptive use by married women among the better off. On all others, however, either the improvement has been pro-poor (e.g., measles vaccination [ $p < 0.5$ ]) or no indication of significant widening in inequality. Given the overall improvement in the mean, this suggests that both the poor and the rich benefited from the expansions in MNCH services.

Other important socioeconomic determinants of MNCH outcomes and services are education and place of residence. We examined differences in health inequalities by these two outcomes (Table 3b). An important observation in Table 3b is that of the improvement in the rural-urban gap. In all the indicators, the rural-urban difference in health inequality has either improved (narrowing inequalities) or shown no significant indication of worsening or widening inequalities. Although it is not as strong as the spatial dimension, there is also a similar profile by education-based health inequalities. The results for most of the indicators show that education-related absolute inequalities in health have been narrowing. The exceptions are undernutrition indicators, where mixed results were found.

**Table 3b. Trends in absolute gaps MNCH inequalities by education and place of residence, 2000-201**

	Diff: Primary & below- Secondary+			Diff: Rural-Urban		
	Earlier Survey	Latest Survey	P-value	Earlier Survey	Latest Survey	P-value
Stunting	22	23	0.649	12	16	0.147
Wasting	6	2	0.439	5	0	0.347
Underweight	18	22	<b>0.022</b>	15	9	<b>0.012</b>
NMR	21.4	17.6	NA	4.3	-11.6	NA
IMR	31	27	NA	10	-12	NA
U5MR	75	55	NA	38	5	NA
Measles Vaccination	-37	-35	0.112	-40	-27	<b>0.105</b>
Full Immunization	-34	-34	0.506	-32	-28	0.588
Contraceptive	-32	-23	0.362	-29	-20	0.110
ANC4+	-42	-49	0.411	-38	-47	0.545
SBA	-41	-64	0.131	-32	-49	0.376

Authors' compilation from the DHS (2000, 2005, 2011 & 2014) data.

Note: The p-values are for the F-test of the difference-in-differences (Diff-in-Diff). Tests for education and rural-urban difference in differences are: *Is [(less educated (primary and none) in the Latest Survey)- educated (secondary+) in the Latest Survey)] equal to [(less educated (primary and none) in the Earlier Survey)-( educated (secondary+) in the Earlier Survey)]?* And, in the second panel of Table 4: *Is [(rural in the Latest Survey) - (urban in the Latest Survey)] equal to [(rural in the Earlier Survey) - (urban in the Earlier Survey)]?* Test is not applicable for NMR, IMR and U5MR.

### 3.2.3 *Relative inequalities: Rate ratios*

Another perspective for analyzing health inequalities is using the rate ratio (RR). RR measures relative gap, i.e., if one group is more or less likely to have (or receive) a certain outcome (or service) than the other group. An RR value greater than one indicates a pro-rich inequality for an outcome. It shows a pro-poor inequality if the outcome is defined positively, such as immunization and maternal health services coverage. The correlations between these health indicators and the determinants, such as income, education and location, are well-established. The rich are more likely to have a better outcome compared with the poor. Similarly, urban residents are more likely to utilize maternal and child health services than rural residents. The interest, however, is in the changes in these RRs over time. Similar to the absolute gaps discussed earlier, the trends in these ratios reveal important information for policy and interventions. Tables 4a & b present the results. The p-values in the tables are based on the test of the equality of the RRs.

All the undernutrition indicators are greater than unity in both cases, implying that children from the poor households (bottom 40% or bottom 20%) have a higher rate of being undernourished compared to children from rich households (top 60% or top 20%). Similarly, children and women from the poor households are less likely to receive the health services analyzed. The poor face lower odds of receiving immunizations, using modern contraceptives, making required antenatal visits, and having deliveries attended by a skilled health professional. Although these differences might be expected, the changes in the relative inequalities over time are relevant to policy because it

indicates whether the poor are catching up or being left behind. For example, in DHS 2000, children from the bottom 40% had an almost equal chance of being stunted, wasted and underweight (Table 4a). However, in DHS 2014, the chance of being undernourished for this group is 27 to 40 percent higher than those of children from the top 60%.

**Table 4a. Trends in relative gaps MNCH between poor and rich households, 2000-2014**

	Ratio: Bottom40%/Top60%			Ratio: Poorest/Richest		
	Earlier Survey	Latest Survey	P-value	Earlier Survey	Latest Survey	P-value
Stunting	1.08	1.27	<b>0.077</b>	1.24	1.71	<b>0.096</b>
Wasting	1.03	1.40	0.991	1.37	1.58	0.861
Underweight	1.12	1.34	<b>0.090</b>	1.41	2.02	0.475
NMR						
IMR	0.78	1.31	NA	0.88	1.34	NA
U5MR	0.99	1.41	NA	0.99	1.52	NA
Measles Vaccination	0.51	0.80	<b>0.038</b>	0.35	0.59	<b>0.008</b>
Full Immunization	0.42	0.60	0.397	0.21	0.34	0.825
Contraceptive	0.32	0.72	0.425	0.12	0.54	<b>0.028</b>
ANC4+	0.29	0.30	0.158	0.12	0.14	0.257
SBA	0.13	0.21	<b>0.026</b>	0.03	0.08	<b>0.037</b>

Source: Authors' compilation from the DHS (2000, 2005, 2011 & 2014) data.

Note: The p-values are for the F-test of the equality of rate ratios. The test in the first part of the table: *Is [(bottom 40%, in the Latest Survey) / (top 60%, in the Latest Survey)] equal to [(bottom 40%, in the Earlier Survey) / (top 60%, in the Earlier Survey)]?* Similarly, in the second part of the table the quality of RR tests are: *Is [(bottom 20%, in the Latest Survey) / (top 20%, in the Latest Survey)] equal to [(bottom 20%, in the Earlier Survey) / (top 20%, in the Earlier Survey)]?* Test is not applicable for IMR and U5MR.

On the services side, over the study period, relative health inequalities declined for coverage of immunization services. For example, for measles vaccination, the RR in the latest survey is significantly different to that of the RR in the earlier survey. The RR changed from 0.51 to 0.8 [p <0.05] in favor of the bottom 40% and from 0.35 to 0.59 [p<0.01] in favor of the bottom 20% (Table 4a). Other services where wealth-related



inequalities significantly declined (or a significant increase in RRs) include modern contraceptive use and SBA. The poorest to the richest RRs of modern contraceptive use by married women increased from 0.12 to 0.54 [ $p<0.05$ ]. For SBA, both the poor to the rich RR and the poorest to the richest RRs increased significantly, respectively from 0.13 to 0.21 [ $p<0.05$ ] and 0.03 to 0.08 [ $p<0.05$ ]. However, the improvement in relative gap by wealth group is not significant for ANC visits.

**Table 4b. Trends in relative gaps MNCH inequalities by education and place of residence, 2000-2014**

	Ratio Primary & below/Secondary+			Ratio: Rural/Urban		
	Earlier	Latest	P-value	Earlier	Latest	P-value
	Survey	Survey		Survey	Survey	
Stunting	1.60	2.30	0.519	1.25	1.58	<b>0.102</b>
Wasting	1.80	1.29	0.279	1.68	0.98	0.432
Underweight	1.75	4.71	<b>0.001</b>	1.53	1.48	<b>0.036</b>
NMR	1.76	2.00	NA	1.10	0.74	NA
IMR	1.46	1.69	NA	1.19	1.27	NA
U5MR	1.81	2.27	NA	1.29	1.07	NA
Measles						
Vaccination	0.41	0.61	<b>0.012</b>	0.36	0.66	<b>0.008</b>
Full Immunization	0.27	0.40	0.363	0.26	0.43	0.822
Contraceptive	0.15	0.65	0.137	0.11	0.68	<b>0.036</b>
ANC4+	0.16	0.30	0.225	0.14	0.27	0.118
SBA	0.08	0.16	0.290	0.07	0.16	<b>0.029</b>

Source: Authors' compilation from the DHS (2000, 2005, 2011 & 2014) data.

Note: The p-values are for the F-test of the equality of rate ratios. The first part of the table is based on: *Is [(primary and none, in the latest survey) / (secondary and above, in the latest survey)] equal to [(primary and none in the Earlier Survey) / (secondary and above, in the Earlier Survey)]?* Similarly, in the second part of the table the quality of RR tests are: *Is [(rural, in the Latest Survey) / (urban, in the Latest Survey)] equal to [(rural, in the Earlier Survey) / (urban, in the Earlier Survey)]?* Test is not applicable for NMR, IMR and U5MR

Table 4b presents the education and spatial dimensions of relative gaps in health. The results, in general, indicate that there has been narrowing relative gap by education and place of residence for all services and nutrition and mortality indicators. Nine out of ten indicators show a narrowing relative gap between rural and urban areas. The

improvement is significant for most of the indicators. One indicator that significantly moved to the opposite direction is stunting.

#### *3.2.4 Concentration indexes and concentration curves*

In this section, we provide a more comprehensive analysis of wealth- related inequalities in MNCH. We present results from concentration indexes (Tables 5a & 5b). The Tables provide information on the survey-to-survey progression. Negative and positive values are due to the definition of the health outcome under consideration. We focus on the magnitudes in absolute terms. A smaller value in absolute terms indicates improvement in health equality. Results in each outcome show no differences in the standard errors across the survey years. This facilitates comparisons of wealth- related inequalities over time (Koolman and van Doorslaer, 2004).

**Table 5a. Concentration indexes of selected child health status indicators in Ethiopia (2000-2014)**

Year	CI	SE	norm CI	SE	abs CI	SE
<i>Stunting</i>						
2000	-0.033	0.007	-0.076	0.016	-0.019	0.004
2005	-0.042	0.011	-0.083	0.022	-0.021	0.005
2011	-0.064	0.009	-0.115	0.016	-0.028	0.004
2014	-0.085	0.015	-0.144	0.025	-0.035	0.006
<i>Wasting</i>						
2000	-0.034	0.020	-0.039	0.022	-0.004	0.002
2005	-0.117	0.028	-0.133	0.032	-0.015	0.004
2011	-0.159	0.022	-0.176	0.025	-0.016	0.002
2014	-0.099	0.037	-0.109	0.041	-0.009	0.003
<i>Underweight</i>						
2000	-0.054	0.009	-0.093	0.016	-0.023	0.004
2005	-0.075	0.015	-0.113	0.022	-0.025	0.005
2011	-0.129	0.012	-0.182	0.017	-0.038	0.003
2014	-0.118	0.019	-0.161	0.027	-0.032	0.005
<i>NMR</i>						
2000	0.050		0.052		0.002	
2005	0.036		0.037		0.001	
2011	-0.085		-0.088		-0.003	
2014	0.080		0.083		0.003	
<i>IMR</i>						
2000	0.038		0.042		0.004	
2005	-0.016		-0.018		-0.001	
2011	-0.083		-0.088		-0.005	
2014	0.013		0.013		0.001	
<i>U5MR</i>						
2000	0.015		0.018		0.002	
2005	-0.049		-0.056		-0.006	
2011	-0.105		-0.114		-0.009	
2014	-0.021		-0.023		-0.002	

Source: Authors' compilation from the DHS (2000, 2005, 2011 & 2014) data.

Note: CI is concentration index; norm CI is normalized concentration index; and abs CI is absolute concentration index.

**Table 5b. Concentration indexes of selected MNCH services in Ethiopia (2000-2014)**

Year	CI	SE	norm CI	SE	abs CI	SE
<i>Measles Vaccination</i>						
2000	0.242	0.029	0.331	0.040	0.065	0.008
2005	0.142	0.023	0.224	0.036	0.052	0.008
2011	0.096	0.016	0.223	0.036	0.055	0.009
<i>Full Immunization</i>						
2000	0.345	0.044	0.403	0.051	0.050	0.006
2005	0.173	0.035	0.220	0.044	0.037	0.008
2011	0.223	0.031	0.297	0.042	0.056	0.008
<i>ANC</i>						
2000	0.474	0.030	0.529	0.034	0.049	0.003
2005	0.467	0.025	0.530	0.028	0.056	0.003
2011	0.447	0.022	0.532	0.026	0.071	0.004
2014	0.382	0.024	0.503	0.032	0.092	0.006
<i>Contraception</i>						
2000	0.496	0.039	0.534	0.042	0.036	0.003
2005	0.382	0.019	0.453	0.023	0.060	0.003
2011	0.243	0.014	0.347	0.019	0.073	0.004
2014	0.120	0.014	0.218	0.026	0.054	0.006
<i>SBA</i>						
2000	0.665	0.037	0.705	0.040	0.038	0.002
2005	0.698	0.034	0.740	0.036	0.040	0.002
2011	0.650	0.028	0.722	0.031	0.065	0.003
2014	0.526	0.030	0.622	0.035	0.081	0.005

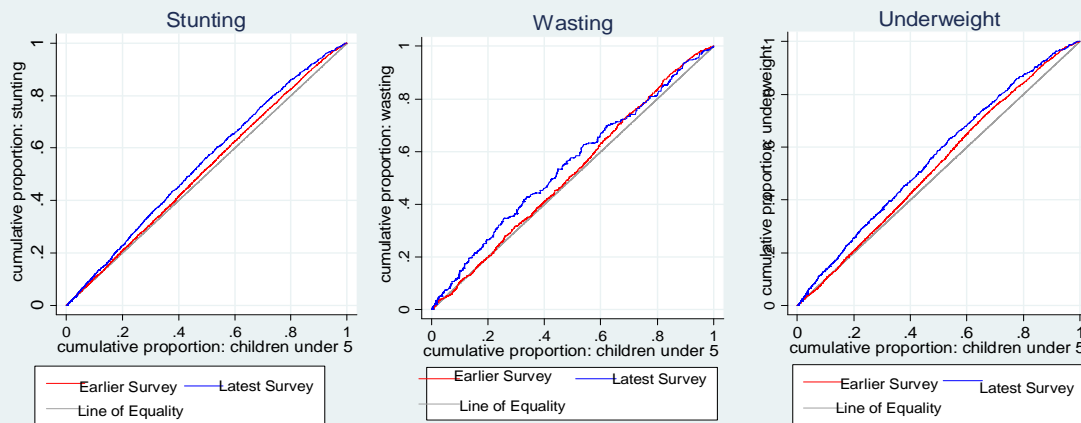
Source: Authors' compilation from the DHS (2000, 2005, 2011 & 2014) data.

Note: CI is concentration index; norm CI is normalized concentration index; and abs CI is absolute concentration index.

The CIs in all the three undernutrition indicators show widening pro-rich inequality; as data from the DHS 2000-2014 show, the CI in absolute value more than doubled for all undernutrition indicators. This is also illustrated in Figure 2a, which compares concentration curves in two periods. The concentration curves for the latest survey are on the top of the concentration curves for the earlier survey showing the increase of wealth-related inequalities in favor of the better off. The test of dominance between concentration curves in Figure 2a shows that the upward shift is significant in

the case of wasting and underweight, but not in stunting. However, the dominance test is significant only by multiple comparison approach (mca) rule. No significant dominance was found using the more strict, intersection union principle (iup) rule. Overall, the results presented here are in line with the findings from absolute and relative inequality analyses presented in earlier sections; the poor did not benefit equally from the improvements in child nutritional status. On the other hand, in Figure 2b, the concentration curves overlapped and in some cases crossed the line of equality.

Figure 2a. Concentration curves of selected child undernutrition indicators (2000-2014)



Note: Computed from DHS 2000 (Earlier Survey) and mini-DHS 2014 (Latest Survey). Values in the horizontal axis are ranked by wealth

Figure 2b. Concentration curves of NMR, IMR and U5MR (2000-2014)

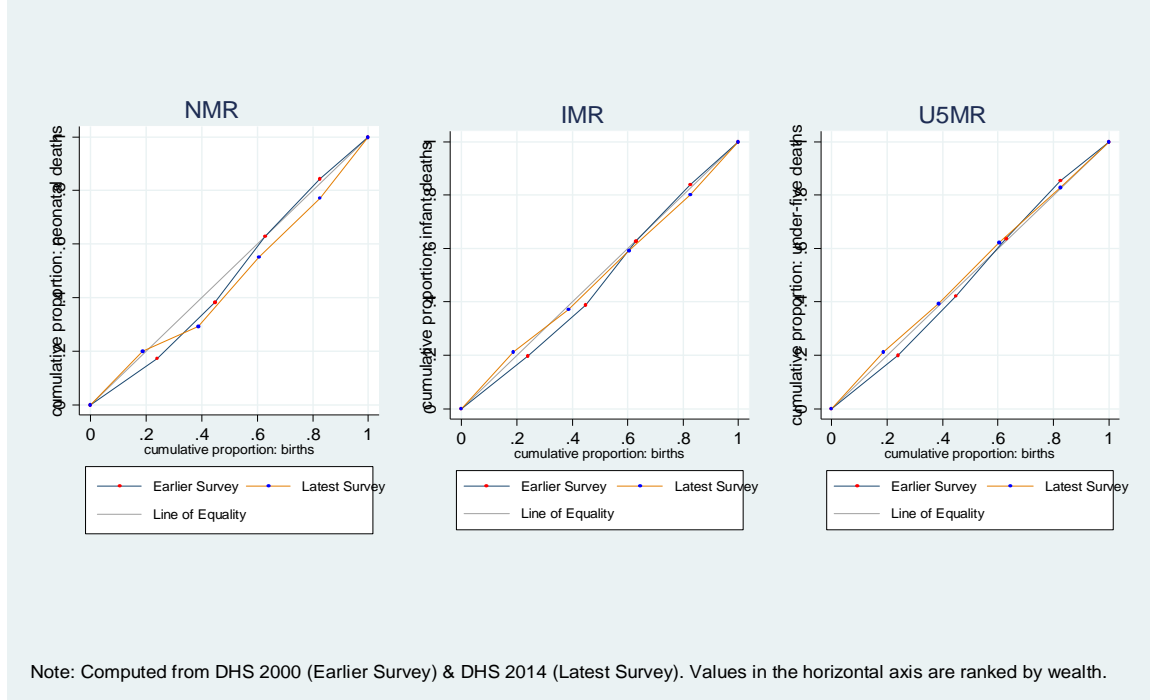
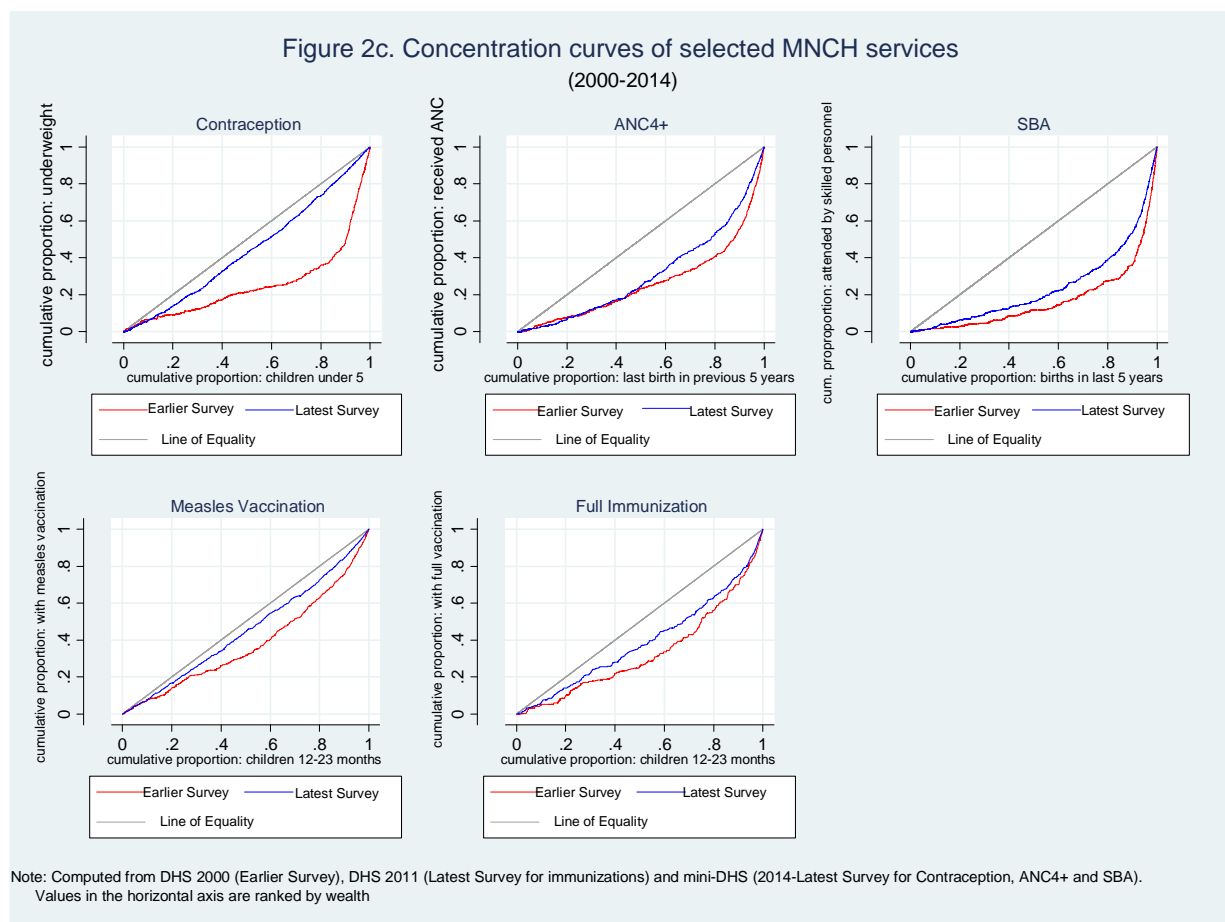


Figure 2c illustrates the movement of wealth-related inequalities in maternal health services and child immunizations. The curves, in both the earlier and latest surveys, are below the line of equality indicating the presence of pro-rich inequality in using these services. However, for all the MNCH services, the movement of the indexes and the curves illustrate progression towards the line of equality. For a given survey year, the CIs are smaller compared with the values in an earlier survey (Table 5). However, the magnitude of the change is different for different services. The move towards the line of equality is the biggest in modern contraception use; the standard CI declined from 0.496 in DHS 2000 to 0.12 in 2014. A similar performance is also observed in measles vaccination: standard CI declined from 0.242 in DHS 2000 to 0.096 in 2014.

Despite the progress, the inequalities are still substantial in the case of ANC4+ and SBA, although, in both cases, the curves moved closer to the line of equality.

The test of dominance between concentration curves finds significant improvements for measles vaccination, contraception, ANC4+, and SBA. The shift was not significant for full immunization. In addition, only the improvement in SBA is found to be significant when the stricter rule, iup, is used.



### *3.3 Decomposition of the inequalities*

The analyses in earlier sections show that, despite improvements, there are still considerable inequalities in some MNCH outcomes and services. In this section, we examine the contributors of the wealth -related inequalities in most of the indicators. Wealth- related inequality is less of a concern for mortality indicators (IMR and U5MR); both show concentration indexes that are close to zero (Table 6a). What contributes to the inequality in child nutritional status, immunization coverage, modern contraceptive use, antenatal care visits and skilled birth attendant?<sup>13</sup> What is the role of spatial, household and individual characteristics in explaining health inequalities in Ethiopia? What is the extent of inequity or unjustified inequality in MNCH outcomes? To answer these questions, we decomposed the concentration indexes of each indicator using the latest survey data, the Ethiopia mini-DHS 2014.

Tables 6a & 6b present the decomposition of concentration indexes. The decompositions are standardized for demographic variables to compute the inequity. Stunting, wasting, and underweight are standardized by age of the child, gender, and birth order. Measles and full immunizations are standardized by age of the mother. Health services, including contraceptive use, ANC 4+, and SBA are standardized by age. Wealth quintiles, place of residence (urban=1) and region dummies, education,



and household size indicators are included in all models. We added improved water and sanitation facilities in the child undernutrition models.<sup>14</sup>

The three undernutrition indicators have about the same level of inequality. However, the contributions of the various determinants are different in different indicators. For example, wealth ranking explains most of the inequity in stunting and underweight. Mother's education, and the head of household's education are the most important contributors to the inequity associated with wasting. It is also worth noting that that the contribution of wealth ranking is very small in wasting and underweight. Other important contributors are spatial variables, including place of residence and region. Other factors, including family size and water and sanitation, contributed very little to the total inequity associated with undernutrition.

The decomposition of the inequity in service utilization shows that the existing inequity is highest in SBA (0.525) and in ANC 4+ (0.380), followed by full immunization services. It is much lower in measles vaccination (0.096) and contraception use by married women (0.123). The household's wealth ranking is the most important factor in the inequity in the utilization of services. The next is education, although it is less important in equity in contraception use. The values range from 0.03 in contraception to 0.085 in skilled birth attendance.

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<sup>14</sup> Dummy variables included for Region and Region-1 (Tigray) is the reference region. Residual regression error is part of the concentration index that is not explained by the standardizing and control variables. Residual missing data is discrepancy between the CI and its decomposition due to the dropping of observations when estimating the model. Inequality is total concentration index. Inequity/Unjustified inequality is the unjustifiable inequality in the sense that it is not caused by the standardizing demographic variables.

**Table 6a. Decomposition of concentration index for child undernutrition, non-linear models**

	<b>Stunting</b>	<b>Wasting</b>	<b>Underweight</b>
<b>Standardizing (demographic) variables</b>			
Child age in months	-0.003	0.004	-0.004
Child sex (Male=1, Female=0)	0.000	0.001	0.000
Birth order number	0.001	-0.003	-0.006
<b>Subtotal</b>	<b>-0.002</b>	<b>0.002</b>	<b>-0.009</b>
<b>Control variables</b>			
Quintiles of wealth index	-0.062	0.001	-0.038
Education/ Mother's education level	-0.017	-0.032	-0.037
Education of HH Head	-0.010	-0.037	-0.017
Improved water source for drinking	0.010	-0.022	-0.006
Improved toilet facilities	-0.002	0.016	0.007
Number of household members	0.002	0.008	-0.004
Number of children 5 and under	0.001	0.007	-0.002
Area of residence (Urban=1, Rural=0)	-0.016	0.015	-0.002
Region	-0.004	-0.035	-0.022
<b>Subtotal</b>	<b>-0.098</b>	<b>-0.086</b>	<b>-0.118</b>
Residual: regression error	0.008	-0.008	0.011
Residual: missing data	0.008	-0.007	-0.002
Inequality (total)	-0.085	-0.099	-0.118
<b>Inequity/Unjustified inequality</b>	<b>-0.091</b>	<b>-0.094</b>	<b>-0.107</b>

Note: ADEPT software (health outcome module) is used to produce the results. The decompositions are based on mini-DHS 2014 Data.

Another observation from the decomposition is the differential effect of spatial variables. The effect of place of residence (being urban) is more important in services than in health status outcomes. This might be expected because there are proportionally more health facilities with skilled professionals in urban than rural areas. Also, for equity in MNCH services, the rural-urban classification is more important than region.

**Table 6b. Decomposition of concentration index for maternal health services, non-linear models**

	<b>Measles Vaccination</b>	<b>Full Immunization</b>	<b>Contra- ception</b>	<b>ANC4+</b>	<b>SBA</b>
<b>Standardizing (demographic) variables</b>					
Respondent Age (mother's age)	0.000	0.000	-0.003	0.001	0.001
<b>Subtotal</b>	<b>0.000</b>	<b>0.000</b>	<b>-0.003</b>	<b>0.001</b>	<b>0.001</b>
<b>Control variables</b>					
Quintiles of wealth index	0.057	0.175	0.061	0.215	0.268
Education	0.036	0.036	0.013	0.060	0.085
Number of household members	0.001	0.001	0.000	-0.001	-0.002
Number of children 5 and under	0.002	0.002	0.014	0.004	0.018
Area of residence (Urban=1, Rural=0)	0.013	-0.004	0.041	0.069	0.072
Region	0.002	0.017	-0.002	0.041	0.027
<b>Subtotal</b>	<b>0.106</b>	<b>0.226</b>	<b>0.127</b>	<b>0.387</b>	<b>0.468</b>
Residual: regression error	-0.010	-0.003	-0.004	-0.007	0.057
Residual: missing data	0.000	0.000	0.000	0.000	0.000
Inequality (total)	0.096	0.223	0.120	0.382	0.526
<b>Inequity/Unjustified inequality</b>	<b>0.096</b>	<b>0.223</b>	<b>0.123</b>	<b>0.380</b>	<b>0.525</b>

Note: ADEPT software (health utilization module) is used to produce the results. The decompositions are based on DHS 2011 data for Measles and Full Immunization and mini-DHS 2014 data for contraception, ANC4+ and SBA.

#### 4. Discussion and conclusion

Ethiopia is making significant progress in MNCH. The trends over the period covered by DHS 2000-2014 period show considerable declines in child undernutrition and mortality levels, as well as increases in health service coverage, such as immunization, contraceptive use, antenatal care visits and assistance from a skilled birth attendant. Although the current levels of services are still low and the health risks are still high compared to similar countries in Africa,<sup>15</sup> and hence much more needs to be done to

<sup>15</sup> Child undernutrition and mortality levels are among the highest in sub-Saharan Africa. Health services coverage is among the lowest. For example, in 2011, full immunization

expand the services and improve health status, the improvements so far in these outcomes provoke a further look at the distributions by different groups.

The main objective of our study has, therefore, been exploring the inequalities. We examined differential progress in health status and health services utilization by socioeconomic background, including wealth ranking of households, education and place of residence. We looked at a combination of approaches: rate differences, rate ratios and concentration indexes. The inequality analyses results are summarized in Table 7. The second and third columns, respectively, show results from rate differences and rate ratios. The third column reports direction of concentration indexes based on Tables 5a & 5b. Finally, the last column reports the test of dominance between the concentration curves of the outcome under consideration. Caution is, however, needed as analyses from these differences and ratios are sensitive to initial values. For the concentration index, an improvement is a decline in absolute terms. Improvement from the concentration curves is based on the test of dominance (see Supplemental Annex Table S1).

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coverage in Ethiopia was 25% compared with 90% in Rwanda, 83% in Burundi, 81% in Burkina Faso and Malawi, to mention but a few. Similarly, birth in a health facility in 2011 was 11% in Ethiopia compared with 31-92% in the rest of the 17 similar countries with comparable data.

**Table 7. Summary of results of trends in income related MNCH inequalities, (2000-2014)**

						Test of dominance: concentration curves	
Rate Differences			Rate Ratio		CI	mca rule	iup rule
Bottom 40% vs. Top 60%	Poorest (q1) vs. Richest (q5)	Bottom 40% vs. Top 60%	Poorest (q1) vs. Richest (q5)				
<i>Panel A: Health Status</i>							
Stunting	Worsened	NS	Worsened	Worsened	Worsened	NS	NS
Wasting	NS	NS	NS	NS	Worsened	Worsened	NS
Underweight	Worsened	NS	Worsened	NS	Worsened	Worsened	NS
NMR*	NA	NA	NA	NA	Improved	NA	NA
IMR*	NA	NA	NA	NA	Improved	NA	NA
U5MR*	NA	NA	NA	NA	Improved	NA	NA
<i>Panel B: Health Services</i>							
Measles Vaccination	Improved	Improved	Improved	Improved	Improved	Improved	NS
Full Immunization	NS	NS	NS	NS	Improved	NS	NS
Contraceptive	NS	NS	NS	Improved	Improved	Improved	NS
ANC4+	NS	NS	NS	NS	Improved	Improved	NS
SBA	NS	NS	Improved	Improved	Improved	Improved	Improved

Note: Table summarizes results of different approaches presented in Tables 3 thru 5 and the test of dominance. The test of dominance is based on O'Donnell (2006) and O'Donnell et al. (2008). The number of evenly spaced quintile points is 19 (from 5% to 95%) and the significance level is 5%. The dominance test rules, mca and iup, respectively denote multiple comparison approach and intersection union principle. NA is test not applicable. NS is no significant change from the earlier survey. \* The improvement for mortality indicators is a progression of the distribution from a more pro-poor towards the line of equality.

There are four key messages of this paper. First, broadly, socioeconomic inequalities in maternal health services (Contraception, ANC4+, and SBA) narrowed over time. The result is robust to changes in method of analysis and measures of socioeconomic characteristics; the inequality narrowed by wealth group and also place of residence. Expansions in measles vaccination have also been pro-poor and pro-rural.

We also note a similar trend for full immunizations, but not as strong as measles vaccination. What this suggests is that those outcomes that are directly dependent on a strong health system seem to be performing well, including the role of health extension workers who have been linked with improving sector performance in rural areas.

Second, in contrast with health services, we find mixed results on child health status (undernutrition and mortality). Although there has been a substantial reduction in child undernutrition, there has also been an increase in the inequality between the poor and the rich. Child nutritional outcomes are affected by many factors, including food security, feeding practice, availability of monitoring services and supplements, which was not captured by this study so as to explain the increasing inequality. It is also the case that multisector determinants play a key role in nutrition and in mortality. Having considered this limitation, pro-rich progress in health status coupled with pro-poor progress in health services would be due to differences in the quality of services accessed by different groups, as well as the role of other socio-economic factors beyond the health sector. This predicament might also point to the differential progress in other important determinants of these health outcomes. However, for child mortality, wealth-related health inequalities progressed from a much pro-poor inequality to more equality. Although the direction is towards the pro-rich inequality, the distribution has been around the equality line. It is important to note that various DHSs surveys have

shown inconsistent gradient between child mortality and wealth quintiles, which could be due to data errors or the construction of the wealth index itself.<sup>16</sup>

Third, the prevailing wealth-related inequalities in some services are not narrowing. Despite the pro-poor progress, the gap between the poor and the rich is still large; the utilization of these services is more concentrated among richer individuals. This is particularly the case for antenatal care visits and skilled birth attendance. For these services, the concentration curves for the latest survey are far below the equality line. This shows that the poor still faces lower odds of making the required antenatal care visits from a skilled health professional and delivering with the assistance of a skilled birth attendant. However, given the narrowing trends of the inequality, the poor would benefit proportionally more from further expansion of these services.

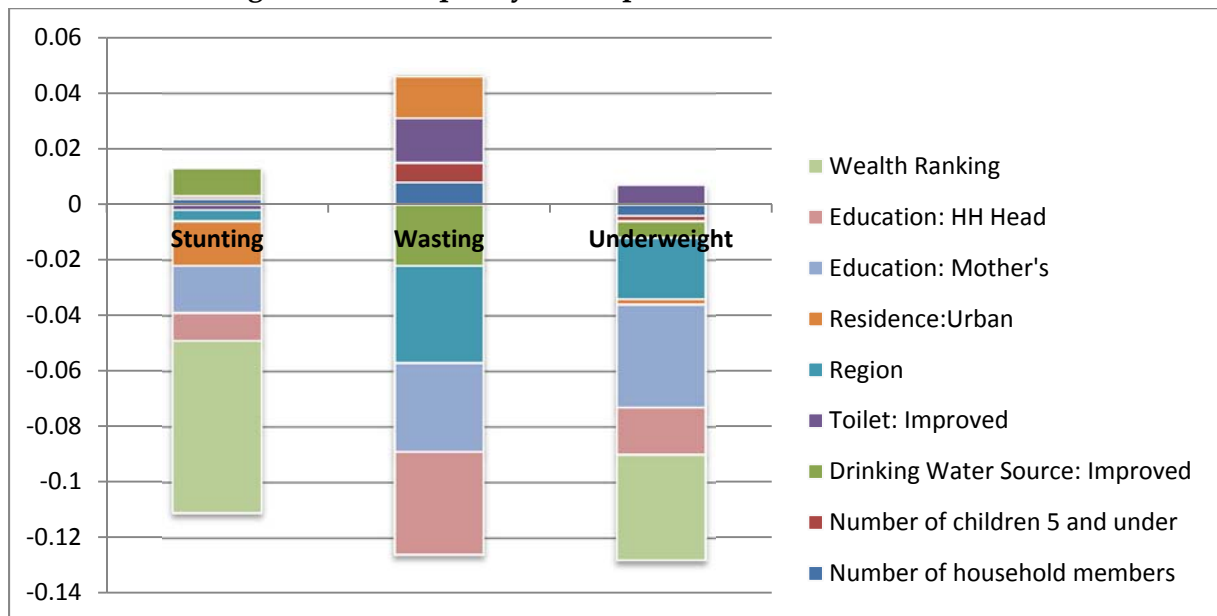
Fourth, decomposition of inequalities shows that differences in wealth ranking are the most important contributor to the inequity. Other major contributors to health inequity include education. It is either maternal education in child health models or own education in maternal health services. The decomposition also shows that location variables, including regional differences and place of residence, matter.

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<sup>16</sup> Observations from child mortality data compiled from DHS stat compiler  
<http://beta.statcompiler.com/>

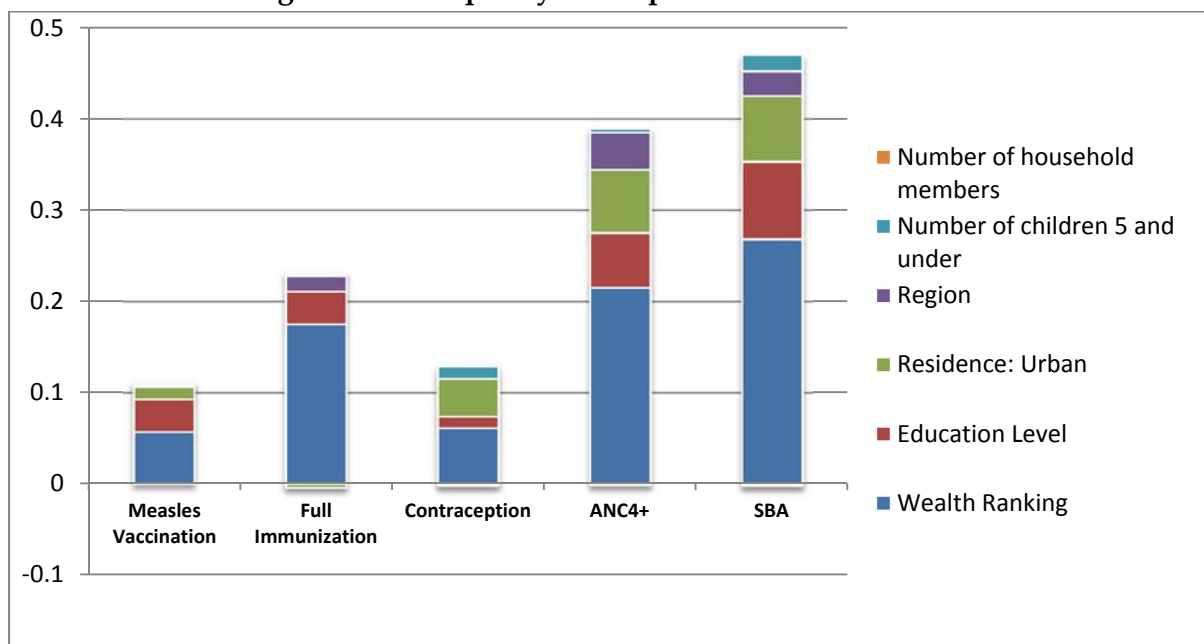
## Supplemental Annex:

**Figure- S1a. Inequality decomposition of child undernutrition**



Note: The decomposition chart excludes standardizing demographic variables, including age, sex and birth order of the child.

**Figure-S1b. Inequality decomposition of MNCH services**



Note: The decomposition chart excludes age (mother's age for immunizations and own age for services), which is the standardizing variable used the decomposition.



**Table S1. Test of dominance between concentration curves**

	Data 1	Data 2	Rule	
	Survey Year	Survey Year	mca	iup
Stunting	2000	2014	non-dominance	non-dominance
Wasting	2000	2014	2014 dominates 2000	non-dominance
Underweight	2000	2014	2014 dominates 2000	non-dominance
Measles Vaccination	2000	2011	2014 dominates 2000	curves cross
Full Immunization	2000	2011	non-dominance	curves cross
Contraception	2000	2014	2014 dominates 2000	non-dominance
ANC4+	2000	2014	2014 dominates 2000	non-dominance
SBA	2000	2014	2014 dominates 2000	2014 dominates 2000

Note: Test of dominance for concentration curves Figures 2a-d based on O'Donnell (2006) and O'Donnell et al. (2008). Significance level is 5% and the number of evenly spaced quintiles points is 19 (from 5% to 95%). The test is not applicable to the mortality concentration curves we developed in this study. However, curves cross in all illustrations of mortality concentration curves.

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