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Abstract:

This paper contributes to the understanding of child health inequalities in Sub-Saharan African (SSA), the poorest and the second most unequal region in the world. Since health inequality begins at birth, correcting it during childhood is crucial to improving future opportunities for development and fighting against other forms of inequality during adulthood. For 33 SSA countries, we estimate child health inequality by cohorts: from 0-1 up to 4-5 years old. We pay special attention to the part of inequality explained by factors widely used in the literature, such as family background, the mother socio-demographic and anthropometric characteristics, household structure, household facilities and the region of residence. Our starting measure of child health is the standardized height-for-age z-score. We show that child health inequality is systematically lesser for the older cohort than for the younger one. However, the aforementioned set of factors is impeding a further reduction in health inequality, as far as the share caused by these factors has risen along the age distribution in more than 80% of the countries. We do not find evidences that these results are caused by a mortality-selection bias. Instead, we find that family background, followed by household facilities and the region of residence contribute to explaining the differences observed in child health inequality along the age distribution in SSA.

Keywords: Child health inequality, child age distribution, Sub-Saharan Africa, family background, anthropometric.

JEL-Code: I14, I15, O10, P52

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1-. Introduction

Health plays an important role in the intergenerational transmission of economic status and the development of cognitive abilities (Case et al., 2002, 2005; Oreopoulos et al., 2008; Currie, 2009; Case and Paxson, 2010). Health inequality translates into inequalities in other dimensions (education, income, welfare), which are reproducible over time (Sen, 2002; World Bank, 2006; Fleurbaey and Schokkaert, 2012). Since health inequality begins at birth, correcting it during childhood is crucial to improving ongoing opportunities for economic development and fighting against other forms of inequality.[1]

This paper contributes to the understanding of child health inequalities in Sub-Saharan African (SSA), the poorest and the second most unequal region in the world (Thorbecke, 2013; Alvaredo et al., 2018). Despite SSA has experienced a faster growth process in the last decade, their levels of poverty and income inequality remain high compared to other regions (Beegle et al., 2016; Chancel et al., 2019). Recent evidence reveals that consumption inequality caused by factors beyond the individual's control, such as parental background or place of birth, represents a high fraction of total inequality in the region (Brunori et al., 2019). Regarding life expectancy and under-five mortality rate, the SSA region shows also a disadvantage position with respect to developed countries (WHO, 2018, 2019; Liou et al., 2020).[2]

For children below five years old, we estimate child health inequality for a set of 33 SSA countries. We pay special attention to inequality differences by cohorts: 0-1 years old, 1-2 years old, 2-3 years old, 3-4 years old and 4-5 years old. We consider a set of factors widely used in the related literature to understand the generation of early-life heath inequality in SSA (Strauss and Thomas, 2008; Currie and Vogl, 2013; Almond et al., 2018). These factors are family background (e.g., mother's education or wealth of the household), socio-demographic and anthropometric characteristics of the mother (e.g., mother's height and age), household structure (e.g., number of offspring), household facilities (e.g., water and toilet facilities) and geography (e.g., the region of residence).[3] Including all factors simultaneously allows us to

[1] A related literature, which analyzes the social determinants of health (Marmot and Wilkinson, 2005; Almond et al., 2018), emphasizes the close relationship between social inequality and health inequality, and also highlights the influence of early childhood in posterior life outcomes. The evidence shows that prenatal and early childhood periods are the most critical time in child development, laying the foundation for physical, emotional, and intellectual well-being, and how exposure to biological and psychosocial risk factors affects brain structure and function and compromises children's development and developmental trajectory (Barker, 2003; Currie, 2011; Walker et al., 2011).

[2] SSA continues to be the region with the highest under-five mortality rate in the world (78 deaths per 1.000 live births in 2018), 15 times greater than the average of the high-income countries (5 deaths per 1.000 live births). Regarding life expectancy, there is a difference of 20 years between the life expectancy in SSA and the most developed countries (61 and 81 years old, respectively) (World Bank, 2019).

[3] Several papers analyze the relationship between child health and some of these factors: family background (Case et al., 2002; Currie, 2009; Lindeboom et al., 2009); socio-demographic and anthropometric characteristics of the

identify the partial contribution of each factor in the generation of child health inequality, for the entire sample and by cohorts, and for each country.

Although we do not have longitudinal information (i.e., information for the same children over time), our analysis by cohorts can provide insights into the following relevant questions: is health inequality during the first year of life corrected during the next four years or, on the contrary, differences are maintained or even accentuated? Which factors are behind the changes in child health inequality along the age distribution and, hence, can explain these potential results? Are there similar patterns and factors across countries?

We gather information from comparable household surveys, the Demographic and Health Surveys (DHS) VI and VII, covering 33 SSA countries in the 2009-2016 period. In all cases, our estimations consider the sample design of the surveys (Deaton, 1997; O'Donnell et al., 2008) to ensure their representativeness at national, regional and residence levels (urban-rural). Our measure of health is the standardized height-for-age z-score, corrected by age (months of age) and gender (Pradhan et al., 2003). Using a reference gender-age group (i.e., girls at 24 months of age from "the WHO standards"), the standardized measure must be converted into a measure in centimeters in order to use inequality indexes such as the Gini or the Mean Log Deviation (MLD).

However, the resultant measure of inequality is influenced by the age and gender distribution, and any inequality or decomposition analysis might be influenced by these two factors. To counter this situation, following the literature on labor economics (Katz and Autor, 1999; Kambourov and Manovskii, 2009), we regress child height with the age structure of the child (in months, including linear, quadratic and cubic terms), gender and their cross effects, and take the residual (including the constant term) for each country. This adjusted height measure is the one we use in our analysis, whose inequality may change along the age distribution, but this change is not caused by differences in the composition of child gender and/or age across country-years.

To estimate the part of child health inequality explained by the aforementioned set of factors, we follow a regression-based approach extracted from the inequality-of-opportunity literature (Ferreira and Gignoux, 2011) and estimate an auxiliary regression that relates the (adjusted) child height with the aforementioned set of factors. This regression-based approach allows us to consider a large set of factors simultaneously. Then, we apply the Gini index and the Mean

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mother (Subramanian et al., 2009; Black et al., 2013; Victora et al., 2021); household structure (Millimet and Wang, 2011; Jayachandran and Pande, 2017; Zhong, 2017); household facilities (de Barros et al., 2009; Headey, 2013; Choudhuri and Desai, 2021); the region/place of residence (Smith et al., 2005; Van de Poel et al., 2007; Ameye and De Weerdt, 2020).

Log Deviation (MLD) to the fitted part of this regression and calculate the part of inequality explained by these factors. We then compute the fraction of inequality that is caused by this set of factors. Depending on the inequality measure used, this fraction is closely related with the R^2 obtained from the commented auxiliary regression.[4] Next, for each country, we use a Shapley decomposition approach (Sastre and Trannoy, 2002; Shorrocks, 2013) to estimate the fraction of inequality explained by each set of factors. We do that for the whole sample and for each age group.

We show that child health inequality is systematically lesser in the 4-5 years old cohort than in the younger cohorts. For the cross-section, we find that these differences in health inequality by cohorts are not correlated with child mortality in the previous age group. This is an indicative that a mortality-selection bias is not causing our results (Moradi and Baten, 2005; Victora et al., 2010). Indeed, a more detailed analysis of our results reveals that the factors commented above are impeding a further reduction of child health inequality in the SSA region, as far as its relative importance (its ratio with respect to total inequality) rises in more than 80% of the countries. More concretely, we show that family background, followed by the household facilities and the place of residence of the child, are the factors that are contributing more to explain this result in most of the countries analyzed.

Our paper focus on understanding child health inequality in SSA. We find a significant number of papers analyzing this type of inequality and the part of this inequality explained by a particular set of determinants in SSA (Zoch, 2015; Hussien and Ayele, 2016; Sanoussi, 2017; Ebaidalla, 2019; Tsawe and Susuman, 2020, among many others), but most of them are for a single country and do not look at health differences along the age distribution for children under five years old. To the best of our knowledge, this is the first attempt to evaluate health inequality in children in such a large set of SSA countries, and analyze the factors explaining their changes along their age distribution.

Our paper also relates with the health inequality-of-opportunity literature (see Rosa Dias, 2009; Trannoy et al., 2009; Fleurbaey and Schokkaert, 2012; Jusot and Tubeuf, 2019, among many others).[5] This literature emphasizes that individual's health depends on variables beyond and within the individual's control, called circumstances and effort, respectively. As a result, total health inequality can be seen as a combination of inequality caused by different circumstances

[4] When the inequality measure is the variance of the (adjusted) child height (in logs), the resultant R^2 is exactly the fraction of inequality that is caused by the set of factors.
[5] Empirical research on inequality of opportunity in health and healthcare are mostly based on data from European countries for adult populations, such as Rosa Dias (2009) and Li Donni et al. (2013) for United Kingdom or Trannoy et al. (2009) for France. More recently, other works have been carried out for developing countries, for example Fajardo-González (2016) for Colombia or Ding et al. (2021) for China.

(inequality of opportunity) and inequality caused by factors more related to preferences of the inherent willingness to exert effort. This distinction can be made for adult's health. However, since health inequality starts as early as the prenatal period, all the factors around the child must be seen as factors beyond his/her control and their entire health inequality must be considered as inequality of opportunity (de Barros et al., 2009; Assaad et al., 2012; Jusot and Tubeuf, 2019).[6] For that reason, although we use a similar approach to estimate the part of child health inequality explained by concrete determinants, we do not refer it as inequality of opportunity. Our distinction is between the part of child health inequality explained by a set of socioeconomic, demographic or region-specific determinants, and the part that is not. Consequently, fighting against any source of child health inequality would be a way to equalize opportunities during adulthood and foster posterior economic growth (Marrero and Rodríguez, 2013; 2019).

The rest of the paper is structured as follows. In Section 2, we describe the dataset used and show a descriptive analysis of the main variables in the sample. In Section 3, we present the methodology employed to perform the required transformations to the data. In Section 4, we estimate, for each SSA country, health inequality and the part of health inequality explained by our set of factors. Next, we show how child health inequality evolves along the child age distribution. In Section 5, we show results of the Shapley decomposition, their evolution along the child age distribution and analyze the factors behind the differences observed in health inequality. Finally, Section 6 shows the main conclusions.

2-. Data

We collect data from the Demographic and Health Surveys (DHS) - waves VI and VII - for 33 different SSA countries, referred to years between 2009 and 2016, depending on the country (see Table 1 for details). This set of countries represents about 90% of total population in SSA in the 2013-2018 period, which would represent almost one billion of inhabitants by 2019 (World Bank, 2019).[7]

The DHS are household surveys providing data for a wide range of monitoring and impact evaluation indicators in the areas of population, health and nutrition. The questionnaires are homogenous, allowing for comparison between countries. They utilize a minimum of two questionnaires, one for the household and another for women of reproductive age (15-49 years old) (Croft et al., 2018). In general, DHS surveys are representative at the national, regional

[6] Studies analyzing inequality of opportunity in children are usually based on low- and middle-income countries, as Assaad et al. (2012) or Aizawa (2019), among others.

[7] Results obtained throughout the paper are not affected by the year of the surveys (analysis are available upon request).

(departments, states) and residence level (urban-rural). To achieve this degree of representativeness in our results, we take into account the sample design of the surveys and use sampling weights to ensure unbiased estimates (Deaton, 1997; O'Donnell et al., 2008).

In this paper, we use information extracted from the Children Recode module, which includes information on children under five years old born to the woman interviewed in the household. Understanding health inequality in this age range is of utmost importance because of the strong correlation found between childhood health and health, human capital and economic status during adulthood (Steckel, 1995; Grantham-McGregor et al., 2007; Victora et al., 2008; Case and Paxson, 2008, 2010; Almond et al., 2018).

2.1-. Child health

Child height has been used in modeling child health status in developing countries (Behrman and Deolalikar, 1988; Strauss and Thomas, 1995, 1998; Pradhan et al., 2003). This is because, among other reasons, their distributions are strictly comparable between countries (Habicht et al., 1974; de Onis et al., 2006; WHO, 2006) and it is positively correlated with adult health, economic status, income and educational attainment. Our primary measure of child health is the standardized height-for-age z-scores, which measures the deviation of a child height from the median height of a reference population, divided by the standard deviation of the reference population (WHO, 1995, 2006; O'Donnell et al., 2008).[8]

Table 1 shows general information about the set of DHS surveys used: the countries, the year(s) of the survey, the sample size, the number of regions in the country (used to control regional fixed effects in the regressions of Section 4), as well as the number of strata and clusters, information used in the sample design to perform estimations.[9] The table also summarizes information on child height: the average and the standard deviation of the child height-for-age z-score, and the prevalence of stunted children. A zero value of the z-score means that a child follows a healthy (optimal) growth pattern, equal to the median height of the reference population. Meanwhile, a positive or negative z-score means that a child has a higher or delayed growth pattern, respectively. The WHO highlights two critical situations: above +3, which indicates an "endocrine disorder"; below -2, which is referred to as "stunting" and is a widely used indicator of an unhealthy population in the country (WHO, 2008).

[8] For the reference population, the World Health Organization Child Growth Standards ("the WHO standards") are used as representative of the healthy, well-nourished child population for the same sex and age (de Onis et al., 2006).

[9] The sample is usually based on a stratified two-stage cluster design, where first the primary sampling units or clusters (PSUs), typically enumeration areas from census files, are selected and then a sample of households is selected in each enumeration areas.

In our sample, all countries show negative z-scores and their sample average is -1.39. The countries with the lowest z-scores are Burundi (-2.11), Malawi (-1.77) and Rwanda (-1.75), while Ghana (-0.98), Gabon (-0.99) and Namibia (-1.04) are the countries with the highest z-scores in our sample. On average for all countries, 34.7% of children are stunted, although we observe notable differences between countries. As expected, low average z-scores are associated with high percentages of stunting child population. Thus, Ghana (19.2%), Gabon (23%) and Namibia (23.1%) are also the countries with the lowest prevalence of stunted children, while Burundi (55.3%) and Malawi (46.2%), together with Democratic Republic of the Congo (44.2%), are the countries with the highest percentage of stunted children. The cross-country correlation between the percentages of stunted child population and the average z-score is -0.9689.

Table 1. Summary of DHS surveys: coverage, details and child height

ISO code	Country	DHS year	Sample size (unweighted)	Number of regions	Number of strata	Number of clusters	Height-for-age z-score (mean)	Height-for-age z-score (standard deviation)	Prevalence stunted (%)
AO	Angola	2015-2016	6304	18	36	627	-1.53	1.56	37.5
BF	Burkina Faso	2010	6477	13	26	574	-1.39	1.59	34.3
BJ	Benin	2012	7606	12	135	750	-1.57	2.34	44.0
BU	Burundi	2010	3432	5	33	376	-2.11	1.42	55.3
CD	Democratic Republic of the Congo	2013-2014	7967	11	66	540	-1.66	1.84	44.2
CG	Congo	2011-2012	4253	12	25	384	-1.14	1.49	26.8
CI	Cote d'Ivoire	2011-2012	3146	11	21	352	-1.25	1.55	29.9
CM	Cameroon	2011	4841	12	24	580	-1.25	1.68	31.9
ET	Ethiopia	2011	9443	11	23	650	-1.61	1.76	42.3
GA	Gabon	2012	3281	10	20	336	-0.99	1.53	23.0
GH	Ghana	2014	2659	10	20	427	-0.98	1.29	19.2
GM	Gambia	2013	3061	8	14	281	-1.08	1.54	25.8
GN	Guinea	2012	3042	8	15	300	-1.11	1.80	30.9
KE	Kenya	2014	18302	8	92	1612	-1.18	1.42	27.2
KM	Comoros	2012	2381	3	7	252	-1.06	1.90	27.8
LB	Liberia	2013	3125	5	30	322	-1.28	1.62	31.1
LS	Lesotho	2009	1560	10	20	400	-1.54	1.55	39.6
ML	Mali	2012-2013	4296	6	11	585	-1.43	1.88	37.7
MW	Malawi	2010	4538	3	54	849	-1.77	1.58	46.2
MZ	Mozambique	2011	9216	11	21	611	-1.58	1.60	39.4
NG	Nigeria	2013	24335	6	73	904	-1.34	2.00	36.2
NI	Niger	2012	4759	8	19	480	-1.67	1.67	41.9
NM	Namibia	2013	1527	13	26	554	-1.04	1.44	23.1
RW	Rwanda	2010	4043	5	30	492	-1.75	1.40	43.8
SL	Sierra Leone	2013	4063	4	27	435	-1.34	1.97	37.7
SN	Senegal	2010-2011	3445	14	28	392	-1.21	1.60	28.9
TD	Chad	2014-2015	9740	21	41	626	-1.61	1.94	43.0
TG	Togo	2013-2014	3125	6	11	330	-1.27	1.39	28.2
TZ	Tanzania	2010	6543	26	51	475	-1.64	1.44	40.0
UG	Uganda	2011	2038	10	19	712	-1.39	1.54	32.6
ZA	South Africa	2016	1080	9	26	750	-1.15	1.42	25.9
ZM	Zambia	2013-2014	11182	10	20	722	-1.58	1.61	39.6
ZW	Zimbabwe	2010-2011	4184	10	18	406	-1.35	1.43	31.6

Note: Construct by the authors using data from the DHS databases (2009-2016).

While the overall correlation between the stunted child population and the standard deviation of the z-score is positive but low (0.3466), that correlation turns strongly positive if we compare countries with similar z-score averages (e.g., compare Cote d'Ivoire with Cameroon, or Gabon with Ghana). Indeed, its partial correlation (i.e., given the average z-score) is 0.8869. Given average levels, the dispersion of the distribution can play a key role in explaining the percent of stunted children in a country. Thus, the inequality analysis performed in the next sections will provide important insights into the fight against stunting, although this latter issue is beyond the scope of the paper.

2.2-. The set of factors explaining health inequality

The surveys contain information that we use to characterize the factors explaining differences in child health during childhood. As we will explain in more details in Section 3, we follow an inequality-of-opportunity approach to characterize the effect of these factors on child health. In our case, as commented above, all child health (child height) inequality must be considered as inequality of opportunity.

We classify the set of factors in five categories: family background, including mother's education, wealth index and mother's occupation; socio-demographic and anthropometric characteristics of the mother (socio-demographic), such as mother's height, mother's body mass index and mother's age; household structure of the child, including number of offspring, birth order and type of childbirth; household facilities, such as the source of drinking water, the type of toilet facilities and the type of cooking fuel; and geography, including the region of residence and place (urban or rural) of residence. We choose this set of factors for two main reasons: first, because they are available for almost all countries, hence our analysis allows for better comparability (see Table A1 in Appendix A for details);[10] second, they are widely used in the related literature, hence our results are comparable with these works.

Numerous studies have examined the association between child health and parental socioeconomic status (as measured by income, wealth, education or occupation), finding that these dimensions are strongly and positive correlated (Case et al., 2002; Currie, 2009; Lindeboom et al. 2009). Maternal nutrition also plays an important role in determining child health. Short maternal height and low body mass index (BMI) are associated with lower height-for-age at age 24 months (Subramanian et al., 2009; Black et al., 2013; Victora et al., 2021). There are also empirical evidences about the association between maternal age at childbirth and child outcomes (Fall et al., 2015). Regarding the influence of household structure, there

[10] The only exception is Angola, which does not have data on mother's height, mother's body mass index and mother's age. However, we decided to keep it in our sample of countries.

exists a quantity-quality trade-off in children's health (child height-for-age) and the birth order (Millimet and Wang, 2011; Jayachandran and Pande, 2017; Zhong, 2017). Also, an inadequate access to sanitation facilities (within and outside households), such as piped water, toilets and clean fuel, can harm child's health (de Barros et al., 2009; Headey, 2013; Choudhuri and Desai, 2021). Finally, urban-rural differences in child health are well-documented: children living in urban areas have, on average, better health compared to children in rural areas (Smith et al., 2005; Van de Poel et al., 2007; Ameye and De Weerdt, 2020).

Table 2 shows the descriptive statistics of main factors included in the sample. The average of mothers with at least secondary education is 25.8%, although we observe notable differences between countries: South Africa (88.7%), Namibia (68%) and Zimbabwe (64.8%) show high percentages in this variable, while Ethiopia (4.9%), Burkina Faso (5.3%) or Niger (6.0%) show much lower percentages. Notice that the education of the mother is not only related with the household's wealth, but also with cultural and religious factors.[11] Regarding the wealth index, on average, almost one third of households (32%) belong to the richer and richest quintiles of wealth. This variable shows less between-country variability than the education of the mother. Thus, Niger (45.3%), Mozambique (43.6%) and Burundi (42.2%) are the countries with the highest percentages of households belonging to the top two wealth quintiles, while Congo (16.3%), Liberia (16.9%) and Gabon (17.7%) are the countries with the lowest percentages.

The average height of the mother is between 155 and 162 centimeters, and the average age of the mother when they have the child is about 26 years old. On average, the mothers have three offspring. With respect to household facilities, the average number of households with access to an improved source of drinking water is 68.5%, and just two countries show a percentage below 50% (Democratic Republic of the Congo and Tanzania). Regarding toilet facilities, on average, 70.1% of households have toilet facilities, although in nine countries in the sample less than 50% of households have these sorts of facilities. Finally, except in Angola, Gabon and South Africa, more than 50% of households live in a rural residence.

Regarding remaining factors (not shown in the table), the average percentage of mothers working in services-sales occupations and agriculture is about 22% and 35%, approximately; the average body mass index (BMI) of the mothers in our sample is between 20.3 (Ethiopia) and 27.9 (South Africa); with respect to the birth order of children, the third is the average

[11] For example, these three countries are majority Muslims (61% in Burkina Faso and 99% in Niger) or Muslim is one of the main religion (28% in Ethiopia). Conversely, countries with the Christianity as the majority religion, like Congo, Gabon, Ghana or South Africa, are characterized by high percentages of mother with at least secondary education and percentages of households in the top two wealth quintiles below the average (ICF, 2016).

position, while around 97% of births are single birth; the average of households that use solid cooking fuel is 88%.

Table 2. Descriptive statistics of main factors

ISO code	Country	Mothers with at least secondary education (%)	Household in the richer and richest wealth index quintile (%)	Mother's height (cm)	Mother's age (years)	Number of offspring	Improved source of drinking water (%)	Toilet facilities (%)	Rural (%)
AO	Angola	27.08	22.24	-	26	3	59.87	63.49	44.73
BF	Burkina Faso	5.28	37.32	161.6	27	3	75.79	31.98	78.66
BJ	Benin	10.20	33.67	159.7	27	3	75.61	35.45	63.22
BU	Burundi	9.49	42.15	155.5	28	3	75.32	97.01	82.65
CD	Democratic Republic of the Congo	33.59	29.76	156.6	27	3	38.78	83.13	70.85
CG	Congo	49.27	16.34	158.1	26	3	53.27	82.69	74.55
CI	Cote d'Ivoire	9.20	29.31	158.7	26	3	76.45	58.76	66.86
CM	Cameroon	33.15	33.44	160.0	26	3	64.26	92.29	60.22
ET	Ethiopia	4.89	34.60	157.3	27	3	52.44	48.37	82.98
GA	Gabon	53.68	17.75	158.0	26	3	80.76	97.21	38.52
GH	Ghana	44.52	27.41	159.1	28	3	83.90	67.97	60.01
GM	Gambia	22.17	28.80	162.3	27	3	88.18	97.10	65.73
GN	Guinea	9.95	35.19	159.5	26	3	73.09	82.39	71.27
KE	Kenya	25.25	28.18	159.9	26	3	62.16	76.14	67.43
KM	Comoros	31.26	32.99	156.5	27	3	90.35	99.39	65.92
LB	Liberia	19.57	16.95	156.6	26	3	64.35	40.29	68.32
LS	Lesotho	36.91	29.43	156.9	25	2	74.32	49.93	83.26
ML	Mali	8.67	39.98	161.3	26	3	66.30	87.99	75.59
MW	Malawi	13.52	32.07	155.9	26	3	78.71	87.29	90.52
MZ	Mozambique	14.38	43.29	155.4	26	3	56.17	62.70	67.67
NG	Nigeria	32.48	34.01	158.3	27	3	60.42	69.47	67.15
NI	Niger	6.01	45.32	160.5	27	4	67.20	32.03	78.10
NM	Namibia	67.96	34.06	161.0	26	2	86.08	43.97	54.61
RW	Rwanda	9.40	36.01	156.6	28	3	72.24	98.76	86.42
SL	Sierra Leone	17.90	36.78	157.7	27	3	56.46	77.70	69.36
SN	Senegal	6.65	22.29	162.8	27	3	68.57	76.48	70.67
TD	Chad	8.32	39.59	161.9	26	4	55.14	28.75	78.67
TG	Togo	19.87	30.73	158.9	28	3	60.47	36.53	71.70
TZ	Tanzania	11.07	35.44	156.3	27	3	48.35	78.68	81.47
UG	Uganda	22.17	36.37	159.1	26	3	72.47	84.88	78.87
ZA	South Africa	88.72	28.23	158.4	26	2	91.37	95.97	46.92
ZM	Zambia	32.90	29.30	157.3	26	3	58.43	83.12	63.04
ZW	Zimbabwe	64.78	36.62	159.9	25	2	74.98	65.81	71.10

Note: Construct by the authors using data from the DHS databases (2009-2016).

3-. Methodology: child health inequality and determinants

3.1-. Child health inequality

The height-for-age z-score is the most common measure of child health. However, it prevents using common inequality indexes, such as the Gini or the Mean Log Deviation (MLD) to measure health inequality, since they present positive and negative values. Using child height is an alternative, but this possibility shows an additional problem: it is influenced by the age structure of the child population (Pradhan et al., 2003). Moreover, the height distribution for each age can be different for boys and girls.

Following Pradhan et al. (2003) and Assaad et al. (2012), the literature applies a standardization to the original series of height through the height-for-age z-score of the child, using a fixed age/sex reference group (i.e., girls at 24 months of age). Thus, the z-score of any child is transformed, using the reference WHO standards distribution, into the equivalent height for a 24 months old female with the same z-score. In principle, this transformation allows the comparability of standardized heights of children at different ages and gender.[12] However, Pradhan et al. (2003) alerts to the problem of an arbitrary choice in the reference group to transform the heights, since that choice can influence the resultant level of inequality. Moreover, this strategy does not remove the age and gender structure entirely from the child height distribution, hence any inequality measure would still be affected by these aspects.

To overcome this problem, we proceed as follows. First, we transform the original height series into the aforementioned standardized height, H. We corroborate that the resultant standardized height still shows correlation with child age and gender (results are available upon request). Next, we follow the literature on wage inequality (Katz and Autor, 1999; Kambourov and Manovskii, 2009), and use a log-linear regression to remove the effect caused by these variables from the distribution of H (Palomino et al., 2020 and 2021 uses this approach to adjust individual's income and wealth, respectively).[13] For each country, we regress (by OLS) the standardized child height (in logs) with the age structure of the child (in months, including linear, quadratic and cubic terms), gender and their cross terms. We also include regional fixed effects to control for the potential differences in the age and gender distribution between regions in the same country,

$$\ln(H_{ic}) = \alpha_c + \delta_c D_{ic} + \sum_{j=1}^{3} \beta_{jc} (A_{ic})^j + \sum_{j=1}^{3} \gamma_{jc} D_{ic} (A_{ic})^j + \omega_c R_c + \varepsilon_{ic}, \quad (1)$$

where the sub-index i refers to a child and c to a country; α_c is a constant term (country specific); D_{ic} is a dummy variable (country and gender specific) taking the value 1 when the i-th child is a boy and 0 otherwise; A_{ic} is the age (in months) of the child; and R_c represents a

[12] For example, a 40 months old male and 84.4 centimeters has a z-score of -3.77, so the equivalent height for a 24 months old female with the same z-score of -3.77 would be 73.5 centimeters. The standardized height is constructed such that the position, in terms of percentiles, is the same for the actual height in its original age/sex group and the transformed height in the reference group WHO standards distribution.

[13] Our results are not influenced by taking logs of H in equation (1) and in equation (3). The alternative is to include H in levels in both equations. To better interpret the estimated coefficients in the regressions (as a quasi-elasticity), we take logs in estimated models. Results when using levels in the regressions are available upon request.

set of regional fixed effects (recall from Table 1 that the number of regions is different for each country), and ω_c represents their associated coefficients.

For most countries, the estimated OLS coefficients are significant and with the expected sign. First, the boy's dummy is positive and significant; second, the estimated sequence of parameters β_{jc}, j=1,2,3, shows a positive correlation between child height and age, and the significance of the squared and even the cubic terms in some countries indicate that the height-age structure is non-linear; third, the estimated cross-terms indicate that the correlation between age and height is more relevant for boys than for girls, although this latter effect is significant in few countries.

Next, the adjusted height, $\widehat{H}$, (within-group – in age and gender – child height measure) is calculated as follows (the "hat" indicates OLS estimations):

$$\widehat{H}_{ic} = \exp\left[\ln(H_{ic}) - \widehat{\delta}_c D_{ic} - \sum_{j=1}^{3} \widehat{\beta_{jc}} (A_{ic})^j - \sum_{j=1}^{3} \widehat{\gamma_{jc}} D_{ic}(A_{ci})^j\right]. \tag{2}$$

This within-group adjusted variable is the one used for child height hereinafter.[14] We corroborate that this adjusted height does not present any structure with respect to age and gender. Our measures of health inequality are based on the distribution of $\widehat{H}_{ic}$: $I(\widehat{H}_{ic})$, where I represents our inequality index (Gini and MLD in our case).

3.2-. Determinants of child health inequality

To estimate the importance of the aforementioned set of factors in child health, as commented above, we adopt a strategy based on the measurement of inequality of opportunity. Among the different existing methods (Roemer and Trannoy, 2015), we use the regression-based approach proposed by Ferreira and Gignoux (2011).[15] This approach allows to take full advantage of the high number of factors in our database (14 factors, with more than 2000 possible combinations), but it also allows us to analyse the partial intensity and significance that each group of factors has in explaining health inequality.

This method is based on the estimation of the following reduced form that, in our case, relates our previously constructed child adjusted height (in logs) and the set of factors:

[14] We could also consider gender as an additional factor in the estimation of child health inequality in Section 4.1. The analysis of the gender child height gap deserves an independent analysis, which goes beyond the scope of this paper. Also, the joint significance of the cross terms (gender iterated with age) for some countries makes it difficult to isolate the effect of gender to age in inequality.

[15] See, among others, Marrero and Rodriguez (2012) and Palomino et al. (2019) for an application to income inequality in Europe.

$$\ln(\widehat{H}_{ic}) = \lambda_c + \sum_{k=1}^{5} \theta'_{kc} C_{kic} + v_{ic}, \quad (3)$$

where C_1, C_2, C_3, C_4 and C_5 corresponds to the five sets of factors described in Section 2 (each set contains a particular number of variables); the residual v is the part of the adjusted height not explained by the set of observed factors, and we assume it is i.i.d. and normally distributed, with constant country-specific variance, σ^2_{vc}. We estimate this equation for each country, for the overall sample (children below 5 years old) and for each age group (between 0 and 1, 1 and 2, 2 and 3, 3 and 4, and between 4 and 5 years old). In all cases, we take into account the sample design of the surveys and the sampling weights, as commented above.

The OLS estimation of equation (3) is used to obtain the *'smoothed child height distribution*':

$$\hat{\mu}_{ic} = \exp\left[\hat{\lambda}_c + \sum_{k=1}^{5} \widehat{\theta'}_{kc} C_{kic}\right]. \quad (4)$$

Finally, the part of child health inequality explained by our set of factors is computed by applying the inequality index I to the 'smoothed distribution', i.e., $I(\hat{\mu}_{ic})$. In this literature, the inequality applied to the smoothed distribution can also be interpreted as a between-group inequality component.

Although the Gini is not additively decomposable into a between- and a within-group term, it is the most widely used index to measure total inequality. In addition, authors such as Aaberge et al. (2011), Brunori et al. (2019) or Ramos and Van de Gaer (2020), propose using the Gini (instead of the MLD) for one main reason. Since the MLD is more sensitive to extreme values than the Gini, the reduction of inequality by going from the original to the smoothed distribution is much higher for the MLD than for the Gini. Therefore, since the smoothed distribution, by construction, does not contain extreme values, the resultant $I(\hat{\mu}_{ic})/\,I(\widehat{H}_{ic})$ ratio (i.e., I-ratio) when using the MLD can be strongly affected by the presence of extreme values and be downward bias. In the following sections, we use the Gini as our baseline inequality measure. Results for the MLD (for the majority of our analysis) are shown in Online Appendix B. Qualitatively, results are strongly robust to the use of the Gini or the MLD.

4-. Results

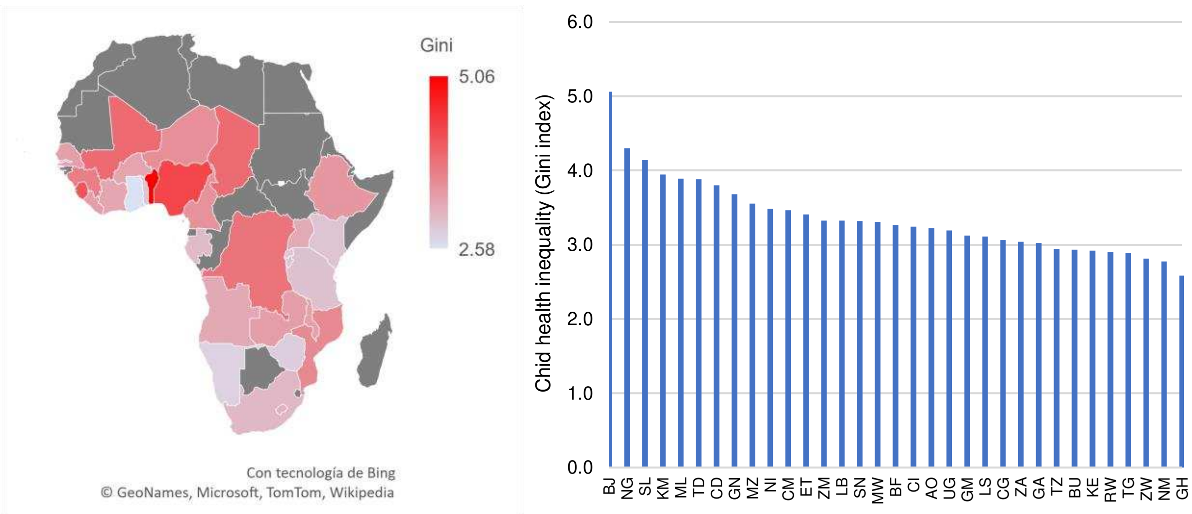
We first provide health inequality estimates for children under five years old. Second, we analyze main determinants affecting child health inequality and estimate the fraction of inequality explained by these determinants. Finally, we analyze health inequality along the child age distribution.

4.1-. Child health inequality and determinants

Figure 1 show child health inequality estimates (using the Gini index) for children below 5 years old and each country. In the left graphic we show results in a Map. The highest levels of child health inequality are found in the interior, central and northwest areas. These areas, in general, coincide with poorer and tropical zones, with a higher prevalence of infectious diseases; the coast, the south and the south-east generally have lower levels of health inequality.

In the right graphic in Figure 1, countries are sorted from the highest to the lowest inequality estimates. Figure B1 in Appendix B shows these results for the MLD. Both measures (the Gini index and the MLD) present a similar ranking, with Benin, Nigeria, Sierra Leone, Comoros and Mali as the countries with the highest levels of inequality, while Rwanda, Togo, Zimbabwe, Namibia and Ghana showing the lowest levels. Regarding the levels of child health inequality, the Gini index coefficient ranges from 2.5% to 5%, while the MLD goes from 0.1% to 0.4%, approximately. These values are in the range of previous estimations of child health inequality in the literature using similar approaches (Assaad et al., 2012; Krafft, 2015; Hussien and Ayele, 2016).

Figure 1. Child health inequality in SSA (Gini, x100)



Notes: Construct by the authors using data from the DHS databases (2009-2016). In the Map, dark grey means missing data. The acronym of each country is as follows: AO: Angola; BF: Burkina Faso; BJ: Benin; BU: Burundi; CD: Democratic Republic of the Congo; CG: Congo; CI: Cote d'Ivoire; CM: Cameroon; ET: Ethiopia; GA: Gabon; GH: Ghana; GM: Gambia; GN: Guinea; KE: Kenya; KM: Comoros; LB: Liberia; LS: Lesotho; ML: Mali; MW: Malawi; MZ: Mozambique; NG: Nigeria; NI: Niger; NM: Namibia; RW: Rwanda; SL: Sierra Leone; SN: Senegal; TD: Chad; TG: Togo; TZ: Tanzania; UG: Uganda; ZA: South Africa; ZM: Zambia; ZW: Zimbabwe.

For each country, we estimate equation (3) by weighted-OLS and show results in Table A2 (Appendix A). In general, coefficients have the expected sign, and we comment next most relevant and robust results for all countries. Regarding the first group of factors (family background), mother's education is highly significant in most countries, and its partial correlation with children's height is positive. With respect to the omitted category (mothers without education), having secondary or tertiary education is associated with about 0.7% and 1.9% more height, respectively. In countries such as Angola, Ethiopia, Rwanda or Senegal, this percentage could even rise between 2.8% and 4.4%.[16] The wealth index is also positively correlated with child height. Taking the poorest category as the reference group, children in households within the two richest wealth quintiles show between 0.7% and 1.3% more height on average. This variable is of special relevance in countries such as Burundi, Cameroon, Democratic Republic of the Congo and Kenya. The mother's occupation (the omitted category is "not have a job"), for given levels of education, wealth index of the household and all other factors, tends to be positively correlated with child height, but it is only significant in four countries (Benin, Chad, Cote d'Ivoire and Kenya).

For the second group of factors (socio-demographic factors), mother's height is strongly correlated with children's height in all countries. This correlation reflects the intergenerational transmission of height between mothers and children (Subramanian et al., 2009; Venkataramani, 2010; Bhalotra and Rawlings, 2011). Taking the average estimated coefficient for all countries, our estimation predicts an elasticity of 0.279 (evaluated at the sample mean): mothers with differences in height of 10% is translated to differences in the – adjusted - height of their children of about 2.8%.[17] Regarding the age of the mother at childbirth, the linear coefficient is positive while the quadratic term is, in general, negative, which indicates the existence of an inverted U-shaped relationship between this variable and child height: being too young and too old are negatively associated with child height. The relationship between the body mass index of the mother and child height is similar: under- or over-weight mothers are negatively associated with their child height.

Regarding the third group of factors (household structure), the type of childbirth is the most significant factor affecting child height. For instance, taking "single birth" as the reference group, being the first or the second child in a multiple birth is associated (on average) with about 2.8% lower height. The birth order is negatively correlated with child height and significant in half of the countries. Regarding the number of offspring, it is positively correlated with child height (and significant) in almost half of the countries. Since the estimations refer to

[16] From Table 2, notice that these four countries show small percentages of mothers with at least secondary education (partially explained by cultural and religious issues). Thus, in these countries, where women have less access to education, having the mother at least secondary educations plays an even more significant role favoring child health.

[17] The average of all estimated coefficients for this variable is 0.00176: ten more centimeters of the mother is associated with 1.76% more centimeters of the child (for our adjusted height measure). Using the average height level of the mother for the whole sample (159 cm.), and taking the average estimated coefficient of 0.00176, the elasticity between these variables evaluated at this average height of the mother, is equal to 0.279 (0.00176x159).

partial coefficients, our interpretation of this latter result is that having more children in households with the same wealth index, education of the mother and all other factors included in the model, is associated with wealthier families, which, for instance, devote more resources on child health care.

For the fourth group of factors (household facilities), the variables included in this category are not individually significant with respect to their omitted category in most of the cases, although the estimated coefficients present the expected signs.[18] For example, the estimated coefficient of "having an improved source of drinking water" (with respect to an "unimproved source of drinking water") is in general positive but only significant in Mali. In general, households with toilet facilities are positively correlated with child height, but its coefficient is positive and only significant in Burkina Faso, Cote d'Ivoire and Niger. Regarding the cooking fuel, taking "solid cooking fuel" as the reference group, having non-solid cooking fuel is positive and significant in Congo, Guinea and Sierra Leone, but it is negative and significant in Burundi, Cote d'Ivoire, Gambia, Tanzania and Zambia.

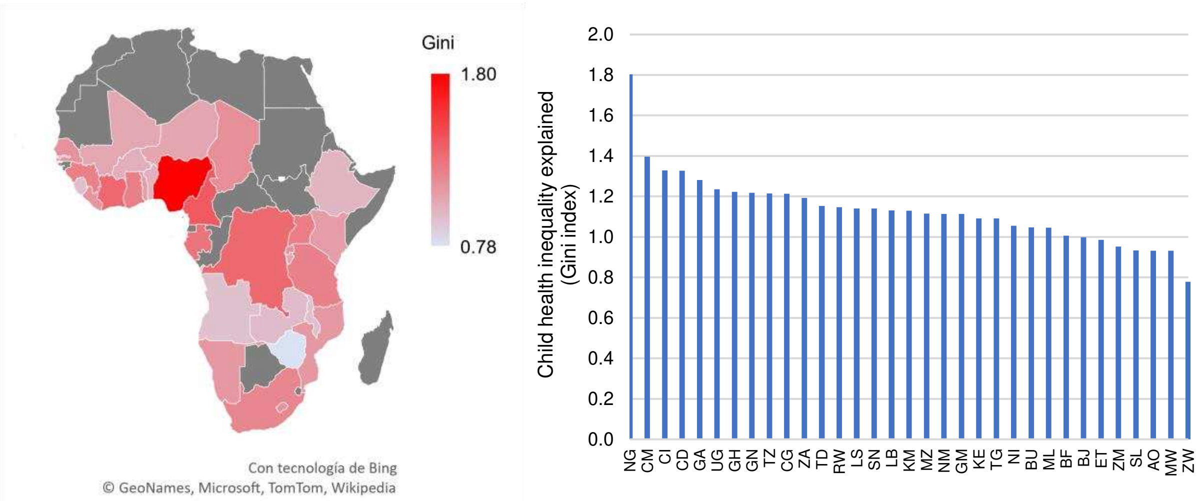
Finally, regarding the fifth set of factors (geography), living in an urban area is rarely significant (taking a rural residence as the reference group), and it is positively correlated with children's height in Congo, Comoros and South Africa, but negatively correlated in Cameroon and Zambia. Dummy regions are generally strongly significant in all countries, showing the existence of specific regional (within-country) fixed effects, which are related to geography, climate, local governments, conflicts or the risk of diseases such as malaria, that are relevant to explaining child height differences within the same country.

Figure 2 and 3 show the estimated levels of child health inequality explained by our set of factors and its resultant I-ratio (using the Gini index), i.e., the share of total child health inequality that is explained by the set of factors described above. Measuring and understanding this explained part of inequality (and its ratio) is relevant to implement policies that correct the origin of child heath inequality. The non-explained part of child health inequality would be associated with other non-observed factors, such as luck, genetic aspects or unexpected shocks. Since these latter factors cannot be measured, direct interventions might be difficult to implement.

[18] The reduced number of significant coefficients is partially because household facilities are strongly correlated with the wealth index and other factors already included in the first and second group of factors. For instance, if we omit the wealth index (jointly with the regional dummies) from the regression, the variables drinking water, toilet facilities and/or cooking fuel becomes significant (and with the expected sign) in more countries, such as in Cameroon, Congo, Liberia, Mozambique, Niger, Nigeria or Rwanda.

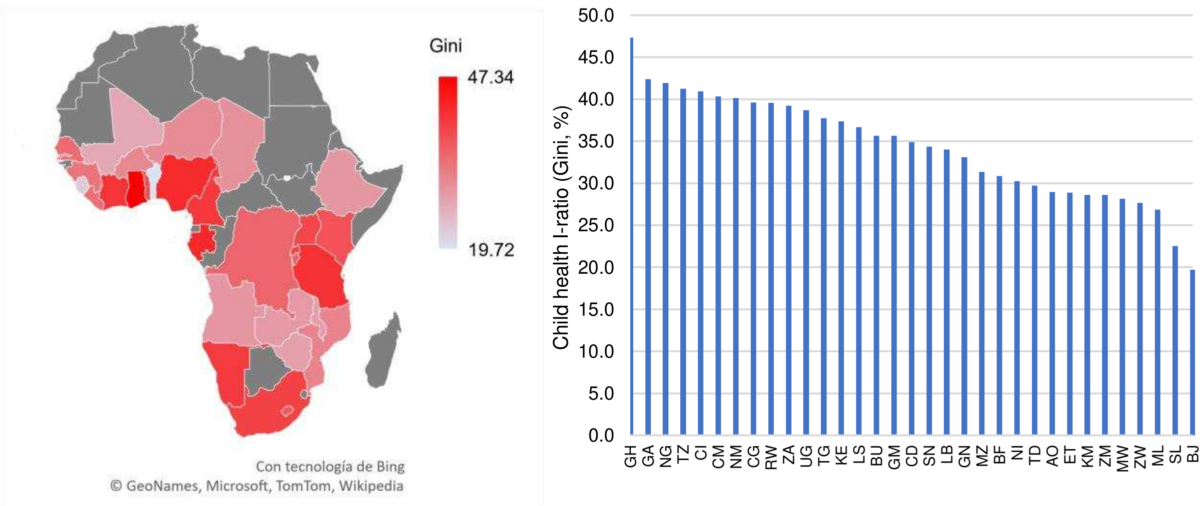
As in Figure 1, these two figures present the Map in the left graphic and the ranking in the right. Unlike for total inequality, in these two cases we do not find a clear geographical pattern. For example, we find countries in the south, the interior, and in the west and east coast with similar I-ratios. Regarding the ranking of the I-ratio, Ghana, Gabon, Nigeria, Tanzania and Cote d'Ivoire now show the highest shares of I-ratio (about 41%-47% for the Gini), while Malawi, Zimbabwe, Mali, Sierra Leone and Benin experience the lowest shares (about 20-28% for the Gini).

Figure 2. Child health inequality explained by the set of factors in SSA (Gini, x100)



Notes: Construct by the authors using data from the DHS databases (2009-2016). See note Figure 1 for the meaning of the acronym.

Figure 3. Child health I-ratio in SSA (Explained Gini / Gini, %)



Notes: Construct by the authors using data from the DHS databases (2009-2016). See note Figure 1 for the meaning of the acronym.

For our set of 33 countries, Table 3 compares the position of the three measures analyzed (total, explained inequality and the I-ratio). The table shows the division of our sample of countries according to its position (using key percentiles) in the ranking of these three measures. It classifies countries as low-inequality (below the 25th percentile, p25), mid-inequality (between the 25th and 75th percentiles) and high-inequality (above the 75th percentile, p75). Additionally, the countries in bold letters show an I-ratio above p75 (high I-ratio) and countries underlined are those with an I-ratio below p25 (low I-ratio); all other countries have an intermediate level of the I-ratio (between p25 and p75).

For example, Zimbabwe is below p25 both in total inequality and in explained inequality, while Democratic Republic of the Congo, Guinea and Nigeria are above p75 in both measures. Benin and Sierra Leone are above the p75 in total inequality but below p25 in explained inequality, and the contrary occurs with Ghana. Other countries, such as Mozambique, Senegal and South Africa, are in intermediate positions in both measures. We find that, in general, countries with the lowest (highest) levels of explained inequality present also the lowest (highest) levels of the I-ratio. We find some exceptions: Namibia, Tanzania and Congo, which show intermediate levels of explained inequality and are above p75 in the I-ratio; or Comoros and Mali, which also belong to the intermediate levels of explained inequality but present low levels of the I-ratio.[19]

Table 3. Low, mid and high child health inequality, explained inequality and I-ratio in SSA

	Low explained inequality (<p25)	***Mid explained inequality (p25-p75)***	***High explained inequality (>p75)***
Low total inequality (<p25)	Zimbabwe	Burundi, Kenya, **Namibia**, Rwanda, Togo, **Tanzania**	**Ghana**
Mid total inequality (p25-p75)	Angola, Burkina Faso, Ethiopia, Malawi, Zambia	**Congo**, Gambia, Lesotho, Liberia, Mozambique, Niger, Senegal, South Africa	**Cameroon, Cote d'Ivoire**, **Gabon**, Uganda
High total inequality (>p75)	Benin, Sierra Leone	Chad, Comoros, Mali	Democratic Republic of the Congo, Guinea, **Nigeria**

Note: Construct by the authors using data from the DHS databases (2009-2016). In rows, child (total) health inequality; in columns, child health inequality explained by the set of factors. The notation (<p25) and (>p75) means to be below and above the 25th and 75th percentile in the ranking of the corresponding health inequality measure, respectively. Countries in underlined are those below p25 in child health I-ratio (low I-ratio), while countries in bold letter are those above p75 in this measure (high I-ratio).

[19] Results for the MLD estimates are similar, and they are available upon request.

4.2-. Child health inequality along the age distribution

The DHS is not a longitudinal survey. Hence, we cannot follow the health status of the children over time. However, its large sample size allows for distinguishing child health along the age distribution for each country (from 0-1 up to 4-5 years old). The evidence provided in this section is based on comparing inequality at different age groups for each country.

We estimate total child health inequality and the explained inequality by age groups (less than one year, between one and two, two and three, three and four, and four and five). For inequality, we calculate the Gini (and the MLD) for the adjusted series of child height in these different age groups. We estimate equation (3) for each country and age group, and then apply the inequality index to the resultant fitted child height distribution.[20] Results of these estimations show, in general, the expected signs, and the most significant factors are similar to those found for the overall sample. However, the significance and the magnitude of the coefficients may change with the age group.[21]

Figure A1 in Appendix A shows child health inequality and explained inequality (for the Gini) at different age groups for each of the 33 SSA countries analyzed. To focus on the differences between age groups, we set a value of one to the younger age group. We also show the I-ratio for each age group. There is a common result to almost all countries: total child health inequality shows a downward slope along the age distribution (the exception is Chad, where the slope is flat).[22] However, results are mixed for explained inequality, and we find that, with respect to the 0-1 year old group, its level is lower for the 4-5 years old group in 18 countries (55% of the sample), while it is higher in 15 countries (45% of the sample). On the contrary, 27 countries increase their I-ratio between 0-1 and 4-5 years old, while only 6 countries reduce this ratio along the age distribution.

Figures 4, 5 and 6 summarize these findings in a more compact way. They confront child health inequality, child health explained inequality and the I-ratio (using the Gini), respectively, for the one year (x-axis) and the five years old group (y-axis) for the 33 SSA countries. All countries

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[20] Estimation results for each child age and country are available upon request.

[21] For instance, we find that mother's education and the wealth index remain the most important variables within the family background group, and mother's job remains rarely significant. Regarding the socio-demographic group, mother's height is highly significant in almost all countries, while mother's age and mother's BMI are significant for a reduced number of countries and age group. A similar situation is detected for the number of offspring and the birth order in the "household structure" group; the type of childbirth is the variable with highest significance in this group. As for the "household facilities" group, they are significant for a reduced number of subsamples. Place of residence remains rarely significant, and something similar occurs with region dummies.

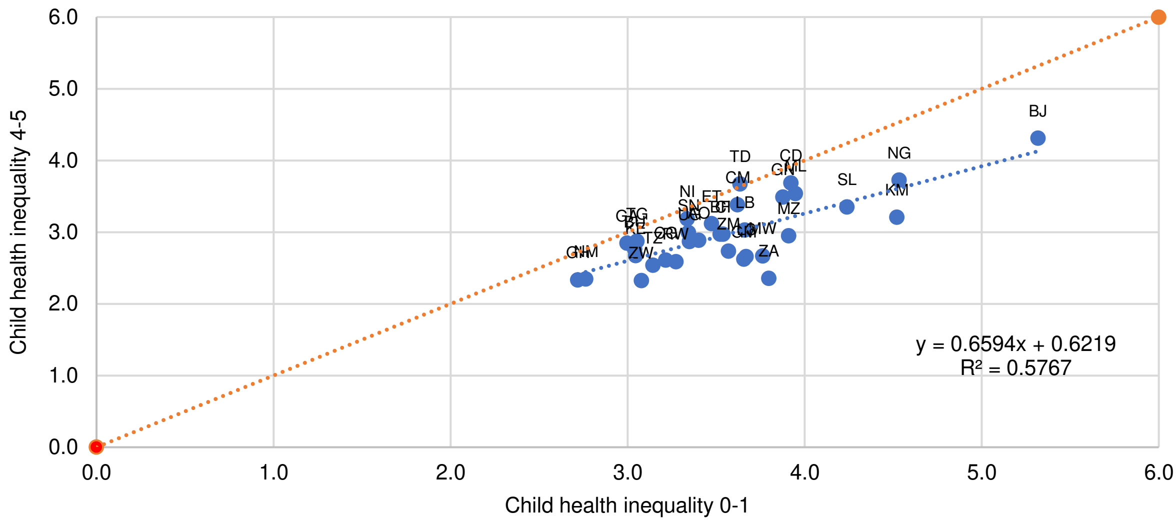
[22] This result would be consistent with the existence of catch-up in health. Within a particular country or region, catch-up in health between children occurs when there is a reduction in the deficit in height compared to the reference standards between two points in time, which implies that children with the worst health improve their health faster than expected (Leroy et al., 2015; Desmond and Casale, 2017). Hence, although we are not able to analyze properly the catch-up in health in our sample (our database is not longitudinal), reducing child health inequality along the age distribution is consistent with catch-up in child health.

are below the 45-degree line for overall inequality (Figure 4), almost half are below and half over the line for health explained inequality (Figure 5), and the 80% are above the regression line for the I-ratio (Figure 6).

It is worth noting that a mortality-selection bias (Moradi and Baten, 2005; Victora et al., 2010) could motivate the reduction in child health inequality along the age distribution (Figure 4). It can be the case that higher mortality rates in children with worsen health during their first years of life (and showing higher inequality) will reduce posterior inequality faster. We analyze this possibility for our sample in Figures A2 and A3 in Appendix A. To check for this possibility, we first construct the series of mortality ratios for each country and each age group (data comes also from the DHS Children Recode module).[23] Then, for each age group and for a cross-country analysis, we compare these shares with the changes in health inequality and health explained inequality in posterior age groups. We interpret the absence of significant correlations in all age groups as an indicative that the mortality-selection bias is not generating our results.

Thus, the reduction of health inequality along the age distribution must be due to improvements in the way that certain factors are affecting child health and how they evolve along the age distribution, or to global health improvements coming from public health interventions or health technology discoveries that are spread across all SSA countries (Sen and Bonita, 2000; Jamison et al., 2013).

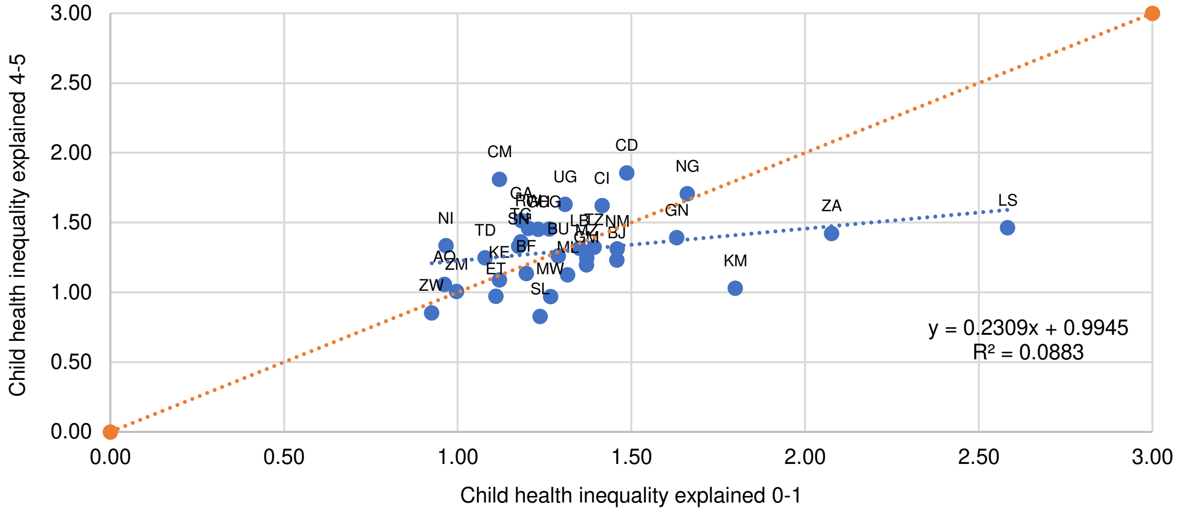
Figure 4. Correlation between child health inequality 0-1 and 4-5 years in SSA (Gini, x100)



Note: Construct by the authors using data from the DHS databases (2009-2016).

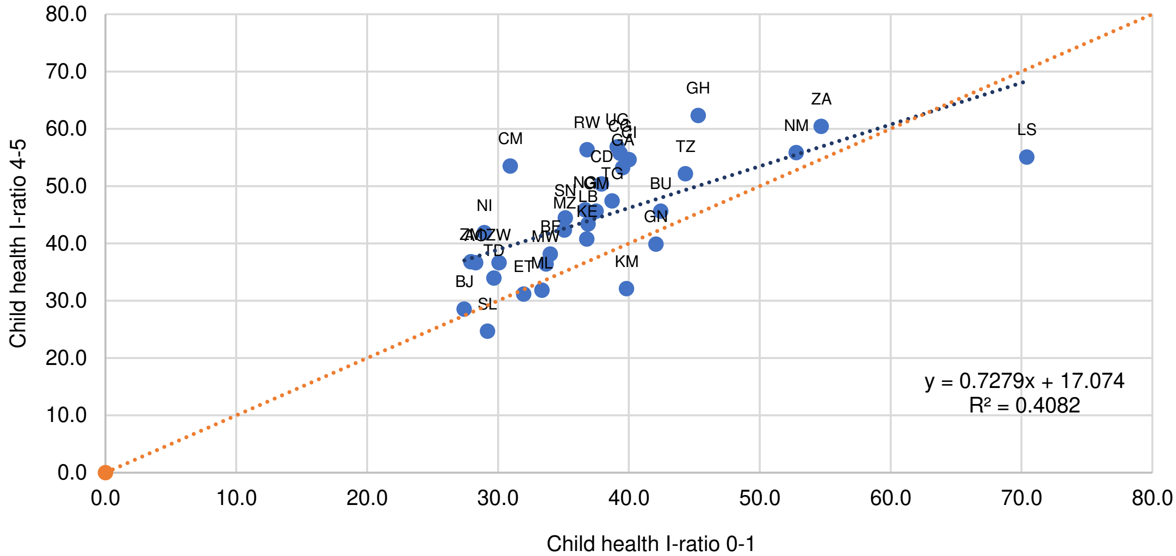
[23] The mortality share by age is constructed taking into account a series of dead children (below 5 years old) by age. Thus, dividing this series between the total number of children below 5 years old ever born (which is the sum of living children and deceased children), we can measure the proportion of children who died in each age group.

Figure 5. Correlation between child health inequality explained 0-1 and 4-5 years in SSA (Gini, x100)



Note: Construct by the authors using data from the DHS databases (2009-2016).

Figure 6. Correlation between child health inequality ratio (I-ratio) 0-1 and 4-5 years in SSA (Gini, %)



Note: Construct by the authors using data from the DHS databases (2009-2016).

This analysis helps us to classify countries according to common trends (along the child age distribution) in total inequality, explained inequality and the I-ratio. Table 4 summarizes these results. A first group (11 countries) is characterized by a reduction in total inequality, an increase in explained inequality and an implied large increase in the I-ratio along the age distribution (above 30%): Angola, Cameroon, Congo, Democratic Republic of the Congo, Cote d'Ivoire, Gabon, Ghana, Niger, Rwanda, Uganda and Zambia. A second group is composed by 16 countries, where total health inequality falls but explained inequality increases or decreases slightly and, in all cases, the I-ratio rises along the age distribution but less than in group 1. These countries are Benin, Burkina Faso, Burundi, Chad, Gambia, Kenya, Liberia, Malawi, Mozambique, Namibia, Nigeria, Togo, Senegal, South Africa, Tanzania, Togo and Zimbabwe. A third group, characterized by a greater reduction in explained inequality than in total inequality, so the I-ratio decreases, is formed by 4 countries: Ethiopia, Guinea, Mali and Sierra Leone. Finally, a fourth group composed by Comoros and Lesotho, where explained inequality falls much more than total health inequality, and hence it makes the I-ratio drops much more than in group 3 (a reduction greater than 20%).

Moreover, it is noteworthy that, between the eight countries above p75 of explained inequality in Table 4, six of them – Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Gabon, Ghana, Uganda – show a large increase in the I-ratio between the 0-1 and the 4-5 age groups.

Table 4. Trends in child health inequality, explained inequality and I-ratio between 0-1 and 4-5 years old in SSA

	Explained Ineq. (4-5) << Explained Ineq. (0-1)	**Explained Ineq. (4-5) <=> Explained Ineq. (0-1)**
I-ratio (4-5) < I-ratio (0-1)	Comoros and Lesotho. ***(Large decrease of I-ratio)***	Ethiopia, Guinea, Mali and Sierra Leone. ***(Moderate decrease I-ratio)***
I-ratio (4-5) > I-ratio (0-1)	Benin, Burkina Faso, Burundi, Chad, Gambia, Kenya, Liberia, Malawi, Mozambique, Namibia, Nigeria, Senegal, South Africa, Tanzania, Togo and Zimbabwe ***(Moderate increase of I-ratio)***	Angola, Cameroon, Congo, Democratic Republic of the Congo, Cote d'Ivoire, Gabon, Ghana, Niger, Rwanda, Uganda and Zambia ***(Large increase of I-ratio)***

Note: Construct by the authors using data from the DHS databases (2009-2016). In rows, the evolution of the child health I-ratio; in columns, the evolution of child health inequality explained by the set of factors.

In summary, we have shown that total child health inequality decreases along the age distribution in almost all SSA countries. However, the child health I-ratio has increased with the age distribution in most countries.[24] These results indicate that, in most SSA countries, the child health inequality explained by our set of factors is becoming more important as children become older. Hence, a further reduction of inequality in children's health inevitably involves levelling these set of factors at early-life and/or reducing the impact that these factors have on

[24] A potential concern is that these results are influenced by the presence of outliers. Thus, we analyze its possible influence on potentially conflicting variables: the height-for-age z-score of the child, the mother's height and the mother's body mass index. Once big outliers are eliminated of these variables, the results are almost the same.

child health by implementing compensatory policies. In the next section, among the five sets of factors considered, we analyse which ones are more correlated with changes in child health inequality along the age distribution in a cross-country analysis.

5-. Decomposing child health inequality

In this section, we focus on the decomposition of the explained child health inequality and estimate the fraction of child height explained variability attributed to each of the five aforementioned set of factors. To this goal, we perform a Shapley decomposition (Sastre and Trannoy, 2002; Chantreuil and Trannoy, 2013; Shorrocks, 2013). We follow Israeli (2007) and apply the Shapley decomposition to the R^2 resultant from the linear regression estimated in equation (3).[25] Decomposing the R^2 does not deviate us from the achievement of our goal, as far as the R^2 also represents an I-ratio, as commented above (i.e., the ratio of log-variances): the child height variability or dispersion explained by the set of factors. Moreover, in our sample, the cross-country correlation between the estimated R^2 and the I-ratio from equation (3) is 0.986 for the Gini and 0.999 for the MLD.

For children under-5 years old, Table 5 shows the decomposition for all countries.[26] On average, we find that the "socio-demographic" group, which includes mother's height, mother's age and mother's body mass index, is the most important one. This group, on average, is responsible of 44% child health variability explained by all factors. "Family background", with an average relevance of 20.7%, and "geography", with an average share of 20.6%, are the second and third more relevant set of factors. Finally, "household structure" and "household facilities" are the least important groups, representing, on average, about 9% and 6% of the explained child health variability, respectively.[27] As we will show below, results might change when we look at the set of factors explaining changes of inequality along the age distribution.

[25] The Shapley decomposition is computationally intensive, and its intensity increases exponentially with the number of factors included in the analysis: 2^K (k = number of factors) combinations must be considered. Moreover, for the Gini, this decomposition is even more intensive (Wendelspiess and Soloaga, 2014). In fact, according to these authors, the computation of the Shapley decomposition is advisable with only a few factors (no more than 20). In our case, not considering the geography group, in which for some countries we have 26 regions, we have 23 possible individual factors. In addition, we apply this decomposition to 33 countries, for the overall sample and five age groups (198 times). For all these reasons, we apply the Shapley decomposition to the R^2, which is computationally much less intensive than the MLD or the Gini. Moreover, in our case, the R^2 of the log-linear regression (3) is strongly correlated with the estimated I-ratio for the Gini and for the MLD. Hence, our decomposition can be seen as a decomposition of any of the I-ratios estimated in Section 4.

[26] Angola does not have information about "socio-demographic factors". Hence, we show their results just for illustrative purposes, as far as their results are not comparable with those of the other countries.

[27] In general, the contribution of household facilities increases in almost all countries, even more than double in some of them (for example, in Cameroon, Congo or Nigeria) when the regional dummies and wealth variables are dropped from the equation. This result connects with our comment in footnote 18.

Table 5. Distribution of the factors' contribution explaining child health inequality in SSA (%): Shapley decomposition

ISO code	Country / Factors	Family background	Socio-demographic	Household structure	Household facilities	Geography
AO	Angola*	48.50	--	11.43	14.84	25.23
BF	Burkina Faso	16.61	46.14	6.92	9.17	21.15
BJ	Benin	19.46	20.61	5.08	3.07	51.79
BU	Burundi	28.92	49.66	4.00	1.04	16.39
CD	Dem. Rep. of Congo	21.80	38.59	6.79	4.05	28.77
CG	Congo	14.71	55.73	7.41	5.42	16.73
CI	Cote d'Ivoire	21.12	48.94	6.85	12.35	10.75
CM	Cameroon	26.85	33.60	5.99	11.30	22.26
ET	Ethiopia	15.65	48.53	16.30	2.02	17.49
GA	Gabon	18.55	53.49	5.66	6.56	15.74
GH	Ghana	16.57	51.79	9.79	6.76	15.09
GM	Gambia	26.51	47.84	6.54	0.95	18.17
GN	Guinea	18.74	40.45	14.99	4.19	21.64
KE	Kenya	24.77	49.11	8.62	6.92	10.57
KM	Comoros	23.78	27.26	4.73	5.38	38.85
LB	Liberia	15.64	60.95	13.92	3.10	6.39
LS	Lesotho	26.48	38.63	9.95	6.83	18.11
ML	Mali	24.17	37.26	8.63	9.69	20.26
MW	Malawi	12.39	63.39	20.07	2.74	1.41
MZ	Mozambique	18.15	42.31	9.11	7.70	22.73
NG	Nigeria	22.71	21.15	5.28	8.90	41.96
NI	Niger	8.90	45.89	15.85	7.68	21.68
NM	Namibia	24.12	42.41	7.59	11.20	14.68
RW	Rwanda	30.34	46.47	6.99	1.15	15.05
SL	Sierra Leone	18.19	45.55	6.35	1.52	28.39
SN	Senegal	22.85	41.63	8.25	9.03	18.24
TD	Chad	16.94	29.96	4.46	3.54	45.10
TG	Togo	25.28	44.02	8.06	9.09	13.56
TZ	Tanzania	13.14	48.00	7.04	10.03	21.80
UG	Uganda	21.21	48.70	8.87	0.26	20.96
ZA	South Africa	18.01	41.26	10.83	7.27	22.63
ZM	Zambia	13.99	58.10	7.45	8.66	11.80
ZW	Zimbabwe	8.19	77.92	7.69	1.58	4.62

Notes: Construct by the authors using data from the DHS databases (2009-2016). * Shown for illustrative purposes, their results are not comparable with those of the other countries.

A closer inspection of the results reveals some important differences in the contribution of these factors between countries. For example, the "socio-demographic" contribution is 78% in Zimbabwe, 42% in Mozambique and 20.6% in Benin. Regarding "family background", the percentage ranges from 8.2% in Zimbabwe to 30.3% in Rwanda, while it represents 15.6% and 24.8% in Liberia and Kenya, respectively. The "geography" is the most important factor in Benin (51.8%), Chad (45%), Comoros (38.8%) and Nigeria (42%), but it has very little influence in Malawi (1.4%). With respect to the “household structure” group, the maximum contribution is 20% in Malawi, while the minimum is 4% in Burundi. Finally, “household facilities” show, in general, a contribution below 10% in 29 countries out of 33 (12.4% is the maximum in Cote d’Ivoire).

Next, we look at the Shapley decomposition at different age groups. In general, for all age groups, the most relevant factors are the same than for the overall sample: first, “socio-demographic”, followed by “family background” and “geography”, and finally “household structure” and “household facilities”. We focus on the changes of their contributions along the age distribution, so we can connect them with the changes in child health inequality characterized in the previous section.

Table 6 and Figure 7 summarize these changes (their average levels) along the age distribution. On average, the group of factors related to “family background” shows a clear upward trend along the age distribution, with an average share of 19.6% for the 0-1 group and 29.3% for the 4-5 age group (a change of 9.7 p.p.). The “household facilities” group, in spite of showing one of the smallest percentages (on average) in Table 5, shows also an upward trend, although less pronounced than for “family background”: it represents 5.8% for the 0-1 age group and 7.4% for the 4-5 group (a change of 1.6 p.p.).

On the contrary, the contribution of “geography” and “household structure” decrease along the child age distribution. For instance, the “household structure” group is less important for the older group: it reduces its contribution from 15.5% for the 0-1 age group to 6.1% for the 4-5 group (9.4 p.p.), which basically compensates the increase of “family background”. Meanwhile, “geography” reduces its contribution from 24.4% for 0-1 to 22.8% for the 4-5 age group (1.6 p.p.), which compensates the increase in the share of “household facilities”. Finally, the “socio-demographic” group, which is the most important one (recall from Table 5), shows a stable trend: its relevance is almost constant, around 34.5%, along the entire age distribution of the children.

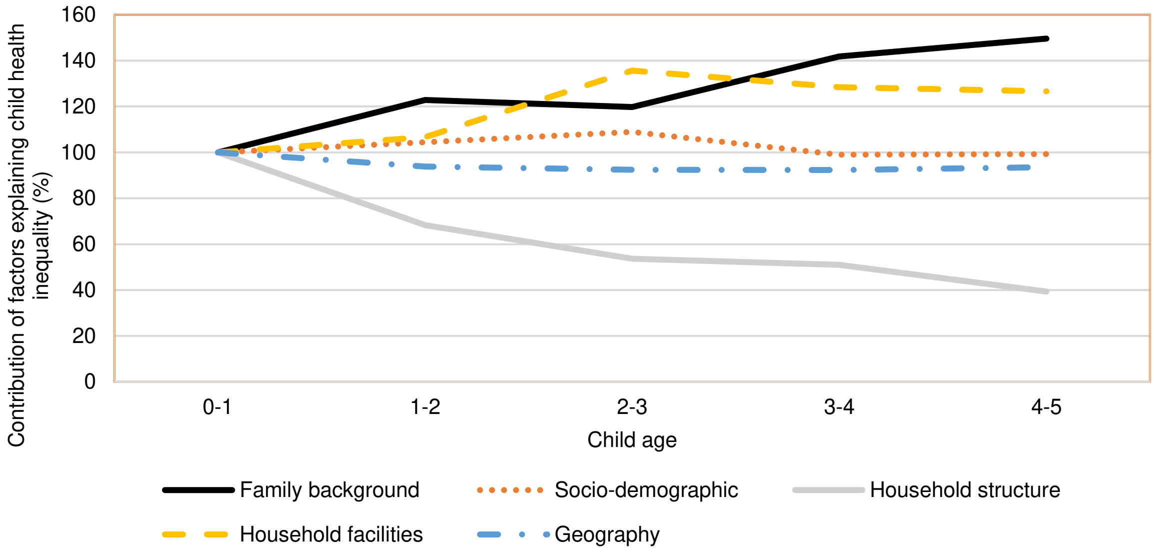
This previous analysis corresponds to an average overview of SSA countries. However, a closer look at data finds relevant differences between countries. Figure C1 in Online Appendix C collects the set of graphics for this decomposition for each country. For instance, contrary to the average trend, “family background” reduces its contribution to explain child health inequality in Chad, Namibia or Senegal; also, the importance of “socio-demographic” increases in Burkina Faso, Lesotho or Rwanda, and decreases in Gabon, Liberia or Uganda; or, for example, “household structure” shows an upward trend along the age distribution in Burundi, Ethiopia or Gambia. Are these differences in changes in the contributions correlated with changes in explained health inequality?

Table 6. Evolution of the average contribution of factors explaining child health inequality along the age distribution in SSA (%)

	All sample	0-1	1-2	2-3	3-4	4-5
Family background (C1)	20.70 (7.40)	19.59 (8.91)	24.08 (8.76)	23.48 (7.46)	27.78 (9.40)	29.32 (8.91)
Socio-demographic (C2)	43.80 (13.92)	34.64 (13.05)	36.20 (13.71)	37.74 (15.36)	34.30 (13.45)	34.38 (10.94)
Household structure (C3)	8.71 (3.75)	15.56 (8.22)	10.64 (5.29)	8.35 (4.72)	7.95 (5.58)	6.12 (3.27)
Household facilities (C4)	6.18 (3.79)	5.80 (3.97)	6.19 (4.51)	7.87 (5.09)	7.45 (4.54)	7.35 (4.09)
Geography (C5)	20.61 (10.98)	24.40 (9.96)	22.90 (11.44)	22.56 (11.47)	22.53 (10.12)	22.83 (8.66)

Notes: Construct by the authors using data from the DHS databases (2009-2016). In rows, the groups of factors explaining child health inequality; in columns, the age groups. Standard deviations in parenthesis.

Figure 7. Average contribution of factors explaining child health inequality along the age distribution in SSA (%)

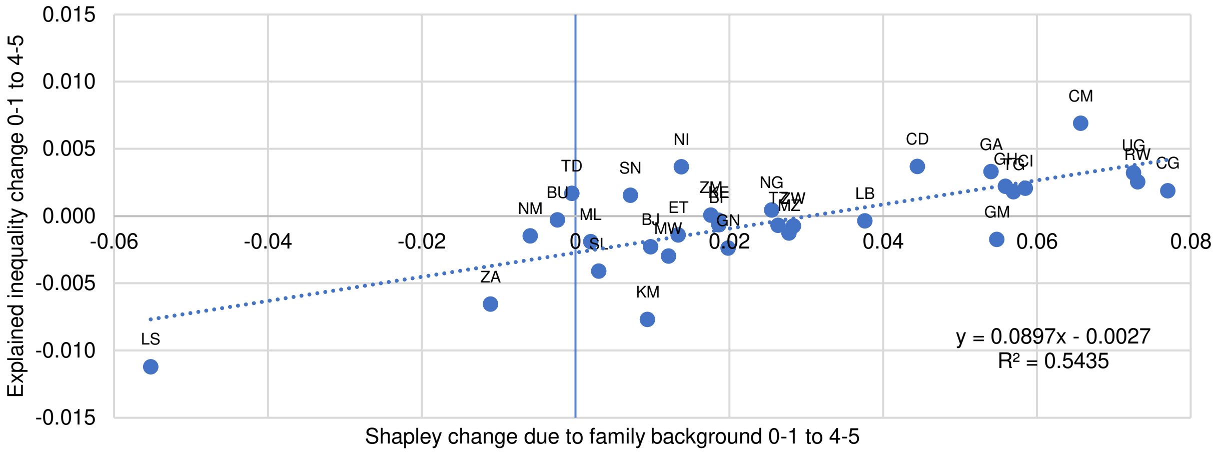


Note: Construct by the authors using data from the DHS databases (2009-2016).

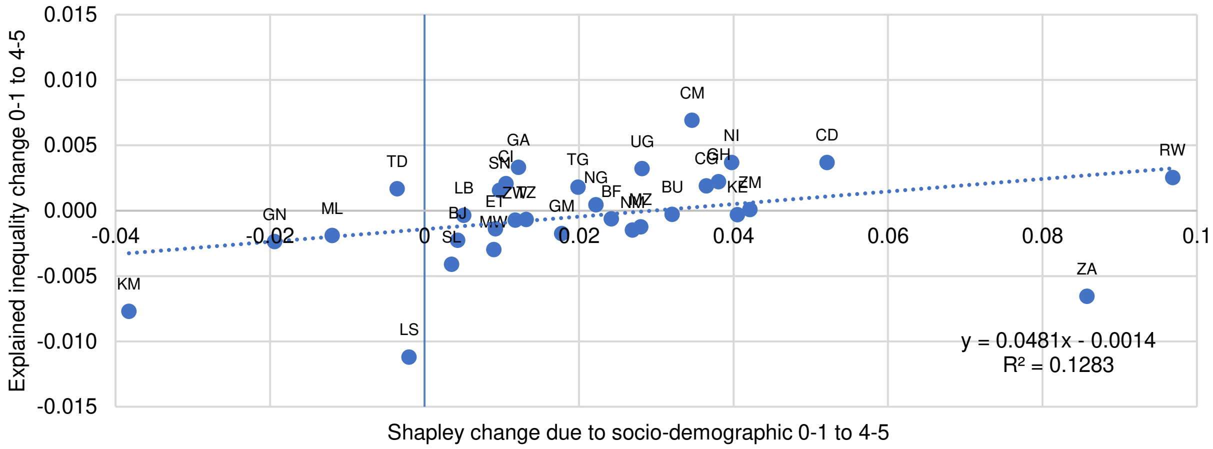
To provide some insights to this question, Figure 8(a-e) shows the cross-country correlation between the 0-1 and 4-5 age group differences of the explained child health inequality and the changes in the Shapley value for each group of factors. We find a positive and highly significant cross-country correlations for three groups: “family background”, “household facilities” and "geography". On the contrary, the cross-country correlation is almost null for "household structure", while the correlation is positive but hardly significant for "socio-demographic" factors. Far from being a causality analysis, this cross-country exercise can shed some light on understanding what group of factors must be intervened to correct health inequality as children become older. Nevertheless, in no case should the results be interpreted as policy recommendations.

Figure 8(a-e). Correlation between changes in Shapley values of factors and changes in explained child health inequality between 0-1 and 4-5 years in SSA

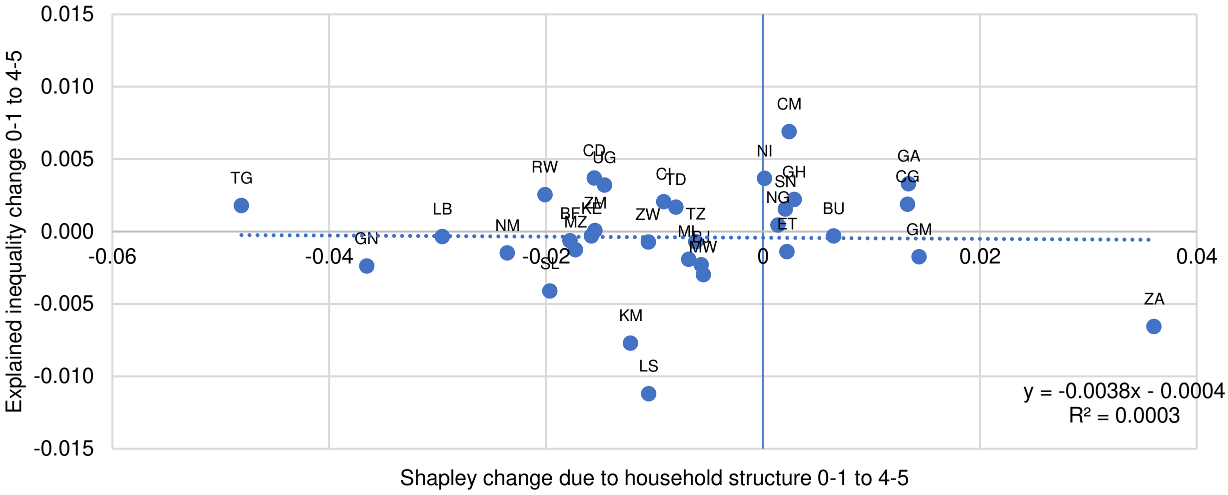
a) Family background



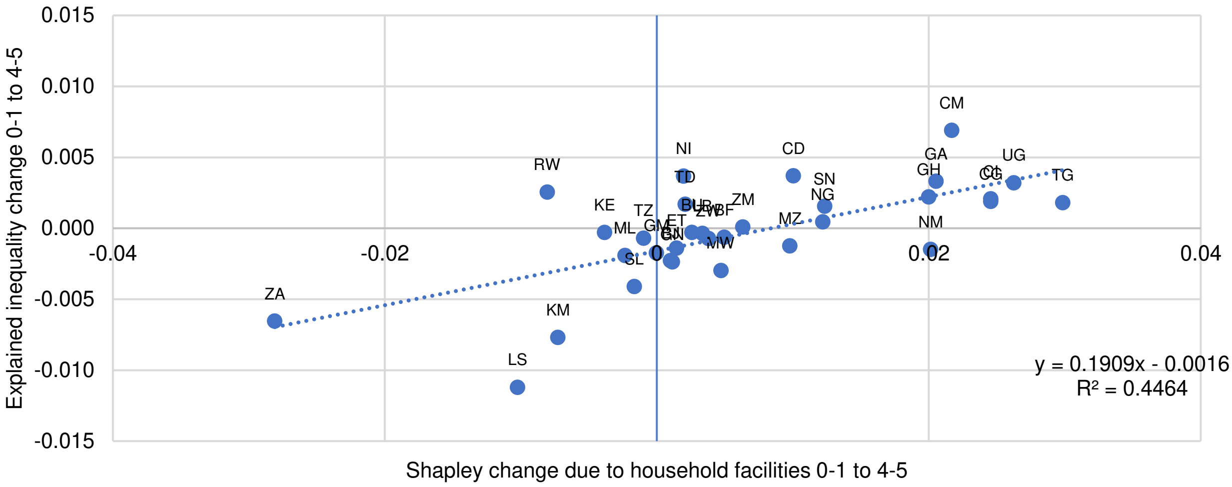
b) Socio-demographic factors of the mother



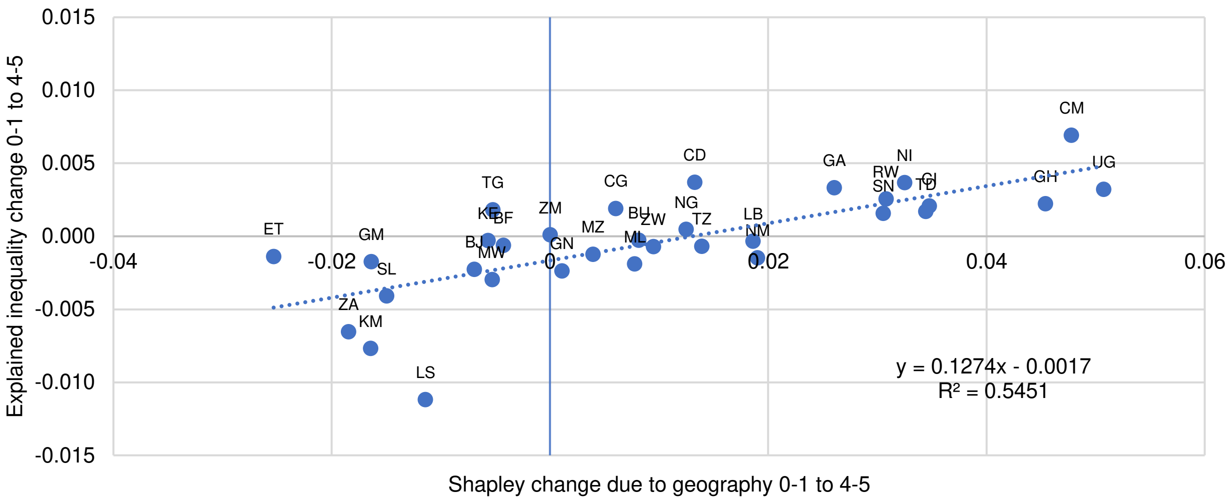
c) Household structure



d) Household facilities



e) Geography



Note: Construct by the authors using data from the DHS databases (2009-2016).

6-. Conclusions

Since health inequality begins at birth, correcting it during childhood is crucial to improving future opportunities for development and fighting against other forms of inequality (education, income, wealth) during adulthood. This paper contributes to the understanding of child health inequalities in Sub-Saharan African (SSA) countries, one of the poorest and the second most unequal region in the world.

We first characterize the determinants of child health inequality by country. Then, we analyze whether the initial levels of health inequality (children below 1 year) are corrected with age (up to 5 years old) or, on the contrary, health differences are maintained or even accentuated. Finally, we use a Shapley decomposition approach to characterize the factors causing the changes in child health inequality along the age distribution. Our measure of health is the standardized height-for-age z-score corrected by age (in months) and gender. The set of determinants considered are family background, socio-demographic factors of the mother, household structure, facilities at home, and a set of geographical factors. We collect data from the Demographic and Health Survey (DHS) VI and VII (Children Recode module), covering a total of 33 SSA countries in the 2009-2016 period.

First, our results show that, for the overall sample and for each age group, mother's education, household wealth, mother's height, the type of childbirth and the region of residence are the most important factors affecting child height. For example, with respect to mothers without education, on average, having secondary or tertiary education can be associated with about 0.7% or 1.9% more height, respectively. Or, taking average estimates, mothers with differences in height of 10% is translated to differences in the – adjusted - height of their children of about 2.8%. Using the entire set of determinants, we can explain between 40% and 45% of child heath inequality in countries such as Ghana, Gabon, Nigeria, Tanzania or Cote d'Ivoire; or just between 20% and 25% in Benin, Sierra Leone or Mali.

Second, we can use our results to classify countries according to their health inequality levels. For example, Democratic Republic of the Congo, Guinea and Nigeria show high levels of health inequality and also large levels of health inequality explained by the selected set of factors; only Zimbabwe show low levels of both measures of inequality; Ghana shows low levels of child health inequality but high levels of inequality explained by our set of factors; or Benin and Sierra Leone, which show high total inequality and low explained health inequality.

Third, we find that child health inequality decreases along the age distribution in all countries (the exception is Chad). On the contrary, the importance of the aforementioned set of factors (i.e., the ratio between the explained health inequality and total health inequality, I-ratio) increases along the age distribution in the 80% of countries. Thus, in general, the aforementioned set of factors are impeding a further reduction of child health inequality in SSA. Moreover, we do not find evidences that these results are caused by a mortality-selection bias.

Fourth, on average and for all age groups, we find that, in general, “socio-demographic” are the most important factors explaining child health inequality in SSA, followed by “family background” and “geography”. “Household structure” and “household facilities” are the least important set of factors. However, we find that the contribution of these aspects might change along the age distribution, and these changes are not uniform across countries. For instance, on average, the contribution of “family background” and “household facilities” show an upward trend along the age distribution, while the contribution of “geography” and “household structure” decreases along the age distribution; “socio-demographic” factors show a flat trend.

Finally, in a cross-country analysis, we find that child health inequality differences between the 0-1 and 4-5 age group are positive correlated with the differences in the contributions of “family background”, “household facilities” and “geography” factors; on the contrary, “socio-demographic” factors and “household structure” do not significantly correlate with differences in child health inequality.

Our results are descriptive and based on regressions or correlations analysis. Therefore, they should be taken as potential lines of exploration and not as policy recommendations. In this sense, our results indicate that a further reduction of child health inequality inevitably involves levelling factors affecting early life or reducing the impact that these factors might have on health by implementing compensatory policies. Thus, early-life health interventions are needed to equalize future opportunities. Any comprehensive strategy for resolving the problem of child malnutrition must include an integrated and inter-sectoral approach considering child health actions (Smith and Haddad, 2000; UNICEF, 2012).

Among all factors analyzed, education is a key one that can change a disadvantage initial health situation. For instance, improving and equalizing mother´s education is one of the most important factor to correct child health inequality during childhood (Smith and Haddad, 2000, 2002; Harttgen, Klasen and Vollmer 2013; Headey, 2013). Besides, policies related to enhancing health environment quality and access to health services can reduce the effect of the place of residence.

The Covid-19 crisis opens a totally new situation in the SSA region in the fighting against child health inequality. The growth collapse triggered by the pandemic is estimated to have raised extreme poverty in developing countries by some 100 million individuals in 2020 (Lakner et al., 2021). Moreover, some rough estimates (IMF, 2020) suggest that the Covid-19 pandemic is leading to a substantial increase in inequality in developing countries, especially poorer ones. This new situation would accentuate the impact of adverse factors on child health inequality and would make it difficult to implement measures to correct health inequality at early-life. Prioritizing the fight against Covid-19 in SSA is not only a matter of containing the current mortality, but also of reducing inequality in child health and generating future fair prosperity.

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Appendix A

Table A1. Description of main factors

Circumstances	*Definition*	*Categories*
Mother's education	Mother's highest education level attended	No education (omitted) Primary Secondary Higher
Wealth index	Composite measure (within country) of a household's cumulative living standard, using data on a household's ownership of selected assets, such as televisions and bicycles; materials used for housing construction; and types of water access and sanitation facilities. This index is divided in five wealth quintiles	Poorest (omitted) Poorer Middle Richer Richest
Mother's occupation	Standardized mother's occupation groups, based on women who are currently working or who have worked in the last 12 months	Not working (omitted) Services-sales: sales, services Agriculture: agricultural employee, agricultural self-employed (include fishermen, foresters and hunters) Others: professional/technical/managerial, clerical, household and domestic, skilled manual, unskilled manual, don't know
Mother's height	Mother's height in centimeters	Not categories; 500-2000 centimeters
Mother's body mass index	Mother's weight in kilograms divided by the square of her height in meters	Not categories; 12-60
Mother's age	Mother's age in years at childbirth	Not categories; 11-49 years
Offspring	Total number of sons and daughters	Not categories; 0-16 children
Birth order	Order number in which the children were born	Not categories; 1-18
Type of childbirth	Order number for each child of a multiple birth	Single birth (omitted) First of multiple birth Second of multiple birth
Source of drinking water	Major source of drinking water for members of the household	Unimproved (omitted): unprotected well, unprotected spring, river, dam, lake, ponds, stream, canal/irrigation channel Improved: piped water, piped into dwelling, piped to yard/plot, public tap/standpipe, tube well or borehole, protected well, protected spring, rainwater, tanker truck, cart with small tank, bottled water
Type of toilet facility	Type of toilet facility in the household	Not have toilet facilities (omitted): no facility/bush/field Have toilet facilities: flush toilet, flush to piped sewer system, flush to septic tank, flush to pit latrine, flush to somewhere else, flush don't know where, pit toilet latrine, ventilated improved pit latrine (VIP), pit latrine with slab, pit latrine without slab/open pit, composting toilet, bucket toilet, hanging toilet/latrine, other
Type of cooking fuel	Type of cooking fuel	Non-solid (omitted): electricity, LPG, natural gas, biogas, kerosene Solid: coal, lignite, charcoal, wood, straw/shrubs/grass, agricultural crop, animal dung
Region of residence	De jure region of usual residence	Country specific
Place of residence	De jure type of place of usual residence	Rural (omitted) Urban

Note: Construct by the authors using information from the DHS databases (2009-2016).

Table A2. Child height and factors: OLS estimates for overall sample by country

Variable/Country	AO	BF	BJ	BU	CD	CG	CI
primary	-0.000161	0.00490**	0.00959***	-0.00191	0.00193	-0.00497	0.00690**
	(0.00255)	(0.00233)	(0.00330)	(0.00218)	(0.00294)	(0.00396)	(0.00269)
secondary	0.00998***	0.0132***	0.00145	0.0102*	0.00694**	0.00118	0.0113**
	(0.00351)	(0.00493)	(0.00488)	(0.00558)	(0.00319)	(0.00435)	(0.00522)
higher	0.0445***	0.00721	0.0114	0.0305***	0.0104	0.00192	0.0273***
	(0.0105)	(0.0176)	(0.0125)	(0.00968)	(0.00644)	(0.00739)	(0.00813)
poorer	0.00540	0.000247	0.00187	0.00965***	0.00742*	0.00203	0.00303
	(0.00339)	(0.00278)	(0.00381)	(0.00286)	(0.00395)	(0.00296)	(0.00334)
middle	0.00949*	-0.00337	0.0101**	0.00913***	0.00795**	0.00459	0.00522
	(0.00497)	(0.00313)	(0.00438)	(0.00302)	(0.00342)	(0.00500)	(0.00474)
richer	0.0234***	0.000197	0.00768	0.0142***	0.0123***	0.00695	0.00266
	(0.00617)	(0.00316)	(0.00505)	(0.00339)	(0.00391)	(0.00502)	(0.00582)
richest	0.0270***	0.00608	0.0126*	0.0181***	0.0275***	0.0103	0.0117*
	(0.00676)	(0.00447)	(0.00658)	(0.00366)	(0.00504)	(0.00625)	(0.00685)
services-sales	0.00123	0.00513*	0.00850**	-0.00102	0.000362	-0.00146	0.00614*
	(0.00369)	(0.00295)	(0.00329)	(0.00525)	(0.00286)	(0.00369)	(0.00324)
agriculture	-0.00318	0.00409	0.0104***	0.00163	-0.00223	-0.00235	-0.00794**
	(0.00356)	(0.00261)	(0.00393)	(0.00393)	(0.00373)	(0.00376)	(0.00345)
other jobs	-0.00271	0.00344	0.00416	0.00951	-0.00380	0.000266	-0.00703
	(0.00518)	(0.00354)	(0.00407)	(0.00641)	(0.00563)	(0.00455)	(0.00647)
height mother		0.00167***	0.000685***	0.00189***	0.00184***	0.00209***	0.00246***
		(0.000139)	(0.000182)	(0.000161)	(0.000170)	(0.000262)	(0.000207)
BMI mother		0.00419***	0.00369**	0.00206	0.00262	0.00826***	0.00139
		(0.00143)	(0.00180)	(0.00149)	(0.00231)	(0.00230)	(0.00251)
BMI mother2		-0.0000490*	-0.0000390	0.000000650	-0.0000331	-0.000140***	-0.0000136
		(0.0000279)	(0.0000335)	(0.0000271)	(0.0000421)	(0.0000434)	(0.0000478)
age mother		0.000697	0.00275*	-0.00248**	0.000631	0.00262**	0.00254**
		(0.000892)	(0.00161)	(0.00105)	(0.00101)	(0.00119)	(0.00120)
age mother2		0.000000664	-0.0000479*	0.0000437**	0.00000488	-0.0000196	-0.0000358*
		(0.0000146)	(0.0000279)	(0.0000176)	(0.0000167)	(0.0000205)	(0.0000205)
offspring	0.00331***	0.000618	-0.0000143	-0.00211*	0.00145	-0.000441	-0.00270*
	(0.00114)	(0.00100)	(0.00156)	(0.00125)	(0.00122)	(0.00160)	(0.00145)
bord	-0.00162*	-0.00168*	-0.00123	0.000402	-0.00328**	-0.00374**	0.00167
	(0.000921)	(0.000957)	(0.00152)	(0.00110)	(0.00129)	(0.00147)	(0.00139)
first multibirth	-0.0338***	-0.0295***	-0.0204***	-0.0270***	-0.0189**	-0.0211***	-0.0329***
	(0.00614)	(0.00647)	(0.00644)	(0.00861)	(0.00813)	(0.00596)	(0.00857)
second multibirth	-0.0400***	-0.0221***	-0.0132*	-0.0229*	-0.0360***	-0.0282***	-0.0152
	(0.00814)	(0.00525)	(0.00672)	(0.0124)	(0.00808)	(0.00781)	(0.00992)
drinking water	-0.000517	0.00177	-0.00127	0.00229	-0.000263	0.00179	-0.000577
	(0.00225)	(0.00232)	(0.00333)	(0.00231)	(0.00318)	(0.00382)	(0.00307)
toilet facility	0.0000909	0.00453*	-0.000783	-0.00417	-0.00164	0.00119	0.00976***
	(0.00303)	(0.00271)	(0.00414)	(0.00500)	(0.00316)	(0.00316)	(0.00328)
cooking fuel	0.000671	-0.00396	-0.00516	-0.0135*	-0.0109**	0.00836**	0.00455
	(0.00345)	(0.00544)	(0.00784)	(0.00762)	(0.00544)	(0.00415)	(0.00806)
urban	-0.00151	0.00406	0.000907	0.000408	-0.000551	0.0157**	0.00107
	(0.00308)	(0.00289)	(0.00348)	(0.00478)	(0.00373)	(0.00632)	(0.00440)
constant	4.424***	4.123***	4.239***	4.149***	4.121***	3.962***	3.998***
	(0.00689)	(0.0320)	(0.0448)	(0.0340)	(0.0423)	(0.0549)	(0.0491)
N	6303	6436	7525	3398	7881	4214	3061
R-square	0.083	0.094	0.039	0.138	0.120	0.150	0.159

Table A2. Child height and factors: OLS estimates for overall sample by country (continued)

Variable/Country	CM	ET	GA	GH	GM	GN	KE
primary	0.00587	0.00192	-0.00635	-0.000887	-0.00336	0.00143	-0.00670***
	(0.00399)	(0.00254)	(0.00608)	(0.00286)	(0.00448)	(0.00423)	(0.00257)
secondary	0.0113**	0.0138***	0.000914	0.00259	0.00911**	0.00854*	-0.00119
	(0.00439)	(0.00524)	(0.00578)	(0.00296)	(0.00389)	(0.00496)	(0.00302)
higher	0.0174***	0.0315***	0.000962	0.00853	-0.0184	0.0185	0.000296
	(0.00664)	(0.00679)	(0.00745)	(0.00608)	(0.0132)	(0.0118)	(0.00406)
poorer	0.00475	0.00300	0.00822*	-0.00595*	0.00315	-0.00736	0.00739***
	(0.00472)	(0.00278)	(0.00473)	(0.00322)	(0.00315)	(0.00481)	(0.00239)
middle	0.0125***	0.00391	0.00551	-0.00155	0.00634*	-0.00279	0.0132***
	(0.00434)	(0.00360)	(0.00514)	(0.00420)	(0.00323)	(0.00456)	(0.00267)
richer	0.0178***	0.00737**	0.0114*	0.00288	-0.00173	-0.00308	0.0125***
	(0.00522)	(0.00371)	(0.00623)	(0.00494)	(0.00503)	(0.00524)	(0.00296)
richest	0.0226***	0.0150***	0.0128*	0.0107*	0.0132**	0.00357	0.0247***
	(0.00594)	(0.00547)	(0.00699)	(0.00581)	(0.00637)	(0.00866)	(0.00356)
services-sales	-0.000609	-0.000420	-0.000234	-0.00312	-0.000298	0.00491	-0.00211
	(0.00314)	(0.00298)	(0.00340)	(0.00316)	(0.00391)	(0.00418)	(0.00346)
agriculture	-0.00712**	0.00205	-0.00297	-0.00228	-0.00330	0.00276	-0.00670***
	(0.00361)	(0.00268)	(0.00411)	(0.00379)	(0.00288)	(0.00435)	(0.00205)
other jobs	0.00178	-0.00471	-0.00347	-0.00278	-0.00670	0.00645	-0.00351*
	(0.00310)	(0.00363)	(0.00481)	(0.00331)	(0.00759)	(0.00707)	(0.00191)
height mother	0.00171***	0.00182***	0.00201***	0.00206***	0.00191***	0.00169***	0.00176***
	(0.000199)	(0.000171)	(0.000288)	(0.000175)	(0.000213)	(0.000214)	(0.000119)
BMI mother	0.0000740	-0.00285	0.00421*	0.00190*	-0.000553	0.00100	0.00472***
	(0.00191)	(0.00218)	(0.00216)	(0.00113)	(0.00201)	(0.00200)	(0.000962)
BMI mother2	0.0000209	0.0000956**	-0.0000616	-0.00000602	0.0000366	0.0000144	-0.0000664***
	(0.0000358)	(0.0000460)	(0.0000385)	(0.0000192)	(0.0000384)	(0.0000390)	(0.0000183)
age mother	0.00161	-0.00164	0.00110	0.00290**	0.00235*	0.00270**	0.00171**
	(0.00113)	(0.00107)	(0.00126)	(0.00121)	(0.00132)	(0.00132)	(0.000852)
age mother2	-0.0000140	0.0000242	0.00000575	-0.0000354*	-0.0000407*	-0.0000372	-0.0000135
	(0.0000191)	(0.0000177)	(0.0000216)	(0.0000197)	(0.0000221)	(0.0000225)	(0.0000145)
offspring	0.00137	0.00540***	0.00163	-0.00281**	0.00344**	0.00427**	0.000501
	(0.00133)	(0.00117)	(0.00212)	(0.00135)	(0.00143)	(0.00174)	(0.000991)
bord	-0.00201	-0.00288***	-0.00452**	-0.000731	-0.00276*	-0.00434***	-0.00317***
	(0.00126)	(0.00101)	(0.00227)	(0.00124)	(0.00144)	(0.00162)	(0.00100)
first multibirth	-0.0267***	-0.0303***	-0.0236**	-0.0256***	-0.0390***	-0.0435***	-0.0247***
	(0.00849)	(0.0108)	(0.0113)	(0.00647)	(0.00915)	(0.00814)	(0.00594)
second multibirth	-0.0312***	-0.0426***	-0.0216***	-0.0209***	-0.0262***	-0.0408***	-0.0292***
	(0.00786)	(0.00678)	(0.00784)	(0.00674)	(0.00596)	(0.00915)	(0.00550)
drinking water	0.00454	-0.000130	-0.00204	-0.00466	-0.00114	0.00561	0.00236
	(0.00322)	(0.00266)	(0.00359)	(0.00286)	(0.00563)	(0.00379)	(0.00157)
toilet facility	0.000101	-0.00176	-0.0141	-0.000675	0.000562	0.00299	-0.00730***
	(0.00504)	(0.00218)	(0.0111)	(0.00286)	(0.00659)	(0.00450)	(0.00258)
cooking fuel	-0.00555	0.000146	-0.00354	0.00195	-0.0235**	0.0197***	0.00290
	(0.00400)	(0.00649)	(0.00373)	(0.00368)	(0.0103)	(0.00651)	(0.00374)
urban	-0.00725**	0.00355	-0.000304	-0.00131	0.00828	0.00313	-0.000888
	(0.00295)	(0.00639)	(0.00351)	(0.00285)	(0.00583)	(0.00453)	(0.00190)
constant	4.139***	4.203***	4.060***	4.056***	4.136***	4.111***	4.070***
	(0.0402)	(0.0382)	(0.0724)	(0.0359)	(0.0463)	(0.0448)	(0.0270)
N	4801	9284	3143	2646	2982	3017	8748
R-square	0.156	0.086	0.170	0.211	0.122	0.112	0.137

Table A2. Child height and factors: OLS estimates for overall sample by country (continued)

Variable/Country	KM	LB	LS	ML	MW	MZ	NG
primary	-0.00263	0.00314	0.0183	0.00212	0.00102	0.00392**	0.00132
	(0.00524)	(0.00336)	(0.0213)	(0.00403)	(0.00339)	(0.00198)	(0.00209)
secondary	0.0104*	0.00132	0.0290	-0.00103	0.00241	0.0111***	0.00408*
	(0.00581)	(0.00356)	(0.0221)	(0.00545)	(0.00517)	(0.00296)	(0.00221)
higher	0.0118	0.0312**	0.0424*	0.0118	0.0250	0.0207**	0.0132***
	(0.0111)	(0.0158)	(0.0236)	(0.0125)	(0.0155)	(0.00830)	(0.00344)
poorer	0.00182	0.00184	0.000425	0.00514	0.00748**	0.000164	0.00318
	(0.00642)	(0.00366)	(0.00702)	(0.00392)	(0.00368)	(0.00319)	(0.00247)
middle	0.00139	0.00440	0.00336	0.00569	0.00502	0.00124	0.00568*
	(0.00655)	(0.00449)	(0.00907)	(0.00399)	(0.00354)	(0.00344)	(0.00302)
richer	0.000572	0.00939*	0.00848	0.00988**	0.00894**	0.00517	0.00946***
	(0.00765)	(0.00563)	(0.0123)	(0.00496)	(0.00389)	(0.00341)	(0.00290)
richest	0.0103	0.0165**	0.0107	0.0161**	0.0117**	0.0157***	0.0155***
	(0.00895)	(0.00745)	(0.0159)	(0.00652)	(0.00466)	(0.00465)	(0.00359)
services-sales	-0.00905	-0.00660		-0.00209	-0.00362	0.000558	-0.000235
	(0.0206)	(0.00417)		(0.00314)	(0.00370)	(0.00284)	(0.00171)
agriculture	0.00542	0.000728	0.0121	-0.00590	-0.00423	0.00353	0.00290
	(0.00652)	(0.00329)	(0.00757)	(0.00371)	(0.00317)	(0.00252)	(0.00255)
other jobs	0.00910*	-0.00826	0.00572	0.00365	0.00239	0.00180	-0.00262
	(0.00525)	(0.00642)	(0.00666)	(0.00405)	(0.00386)	(0.00422)	(0.00206)
height mother	0.00135***	0.00213***	0.00160***	0.00124***	0.00199***	0.00165***	0.00155***
	(0.000337)	(0.000271)	(0.000467)	(0.000191)	(0.000207)	(0.000156)	(0.000106)
BMI mother	0.00481**	0.00266	0.00210	0.00267**	0.00357**	0.00149	0.00262***
	(0.00214)	(0.00323)	(0.00317)	(0.00124)	(0.00154)	(0.00141)	(0.000937)
BMI mother2	-0.0000770**	-0.0000120	-0.0000258	-0.0000154	-0.0000412	0.00000125	-0.0000303*
	(0.0000353)	(0.0000634)	(0.0000561)	(0.0000225)	(0.0000280)	(0.0000260)	(0.0000178)
age mother	0.000928	0.00232	-0.00294	0.00205	0.00282**	0.00303***	0.00101*
	(0.00218)	(0.00156)	(0.00308)	(0.00140)	(0.00121)	(0.000842)	(0.000593)
age mother2	-0.0000143	-0.0000299	0.0000305	-0.0000302	-0.0000396*	-0.0000376**	-0.00000886
	(0.0000382)	(0.0000251)	(0.0000558)	(0.0000240)	(0.0000204)	(0.0000146)	(0.0000100)
offspring	0.000780	-0.000288	0.00422	0.00332**	0.00234	0.00280**	0.00256***
	(0.00292)	(0.00168)	(0.00370)	(0.00140)	(0.00145)	(0.00114)	(0.000607)
bord	-0.00148	-0.000979	-0.00182	-0.00381***	-0.00301*	-0.00342***	-0.00364***
	(0.00290)	(0.00154)	(0.00385)	(0.00121)	(0.00165)	(0.00109)	(0.000573)
first multibirth	-0.0232**	-0.0460***	-0.0535***	-0.0255***	-0.0545***	-0.0332***	-0.0206***
	(0.0105)	(0.0119)	(0.0135)	(0.00912)	(0.00907)	(0.00547)	(0.00444)
second multibirth	-0.0118	-0.0396***	-0.0250	-0.0271***	-0.0297***	-0.0311***	-0.0229***
	(0.0111)	(0.0143)	(0.0223)	(0.00902)	(0.00697)	(0.00581)	(0.00457)
drinking water	0.00804	-0.00337	-0.00689	0.00594*	0.00333	0.00270	0.00192
	(0.00779)	(0.00310)	(0.00518)	(0.00309)	(0.00320)	(0.00205)	(0.00192)
toilet facility	-0.000999	0.00264	0.00328	0.00433	-0.00124	0.00280	0.00321
	(0.0235)	(0.00286)	(0.00742)	(0.00464)	(0.00385)	(0.00241)	(0.00208)
cooking fuel	0.0125		0.00664	0.00582	0.0135	-0.00551	0.00100
	(0.00825)		(0.00938)	(0.0303)	(0.0131)	(0.00468)	(0.00253)
urban	0.0152***	-0.00221	0.000444	0.00833	-0.00133	-0.00337	0.00184
	(0.00483)	(0.00327)	(0.00800)	(0.00638)	(0.00390)	(0.00291)	(0.00203)
constant	4.159***	4.041***	4.173***	4.172***	4.017***	4.086***	4.167***
	(0.0677)	(0.0693)	(0.0864)	(0.0486)	(0.0444)	(0.0367)	(0.0219)
N	2238	3106	651	4243	4486	9124	23977
R-square	0.076	0.118	0.127	0.072	0.080	0.098	0.167

Table A2. Child height and factors: OLS estimates for overall sample by country (continued)

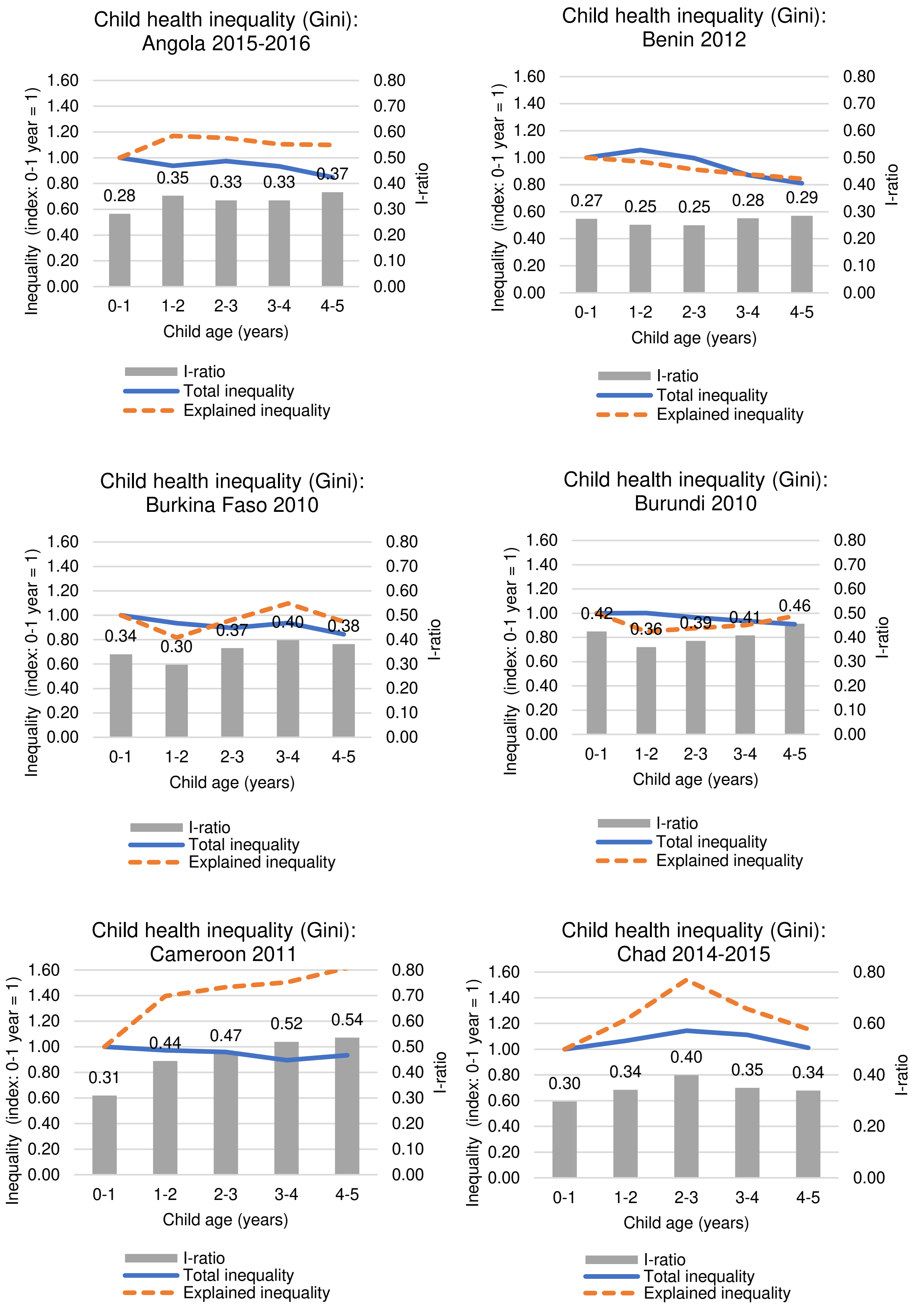
Variable/Country	NI	NM	RW	SL	SN	TD	TG
primary	-0.00493	-0.000735	0.00127	-0.00463	0.00587	0.00211	0.00133
	(0.00360)	(0.00488)	(0.00227)	(0.00403)	(0.00364)	(0.00241)	(0.00250)
secondary	0.00829	-0.00132	0.0110***	-0.00206	0.0171***	0.00987**	0.00315
	(0.00548)	(0.00518)	(0.00416)	(0.00428)	(0.00572)	(0.00463)	(0.00321)
higher	0.0341**	0.00103	0.0282***	0.0361**	0.0430***	0.0204*	0.0174
	(0.0154)	(0.0110)	(0.00957)	(0.0182)	(0.0132)	(0.0110)	(0.0112)
poorer	-0.00655*	0.00135	0.00427	-0.00360	0.00155	0.00591**	-0.00431
	(0.00350)	(0.00397)	(0.00259)	(0.00429)	(0.00310)	(0.00279)	(0.00336)
middle	0.00171	0.00104	0.0104***	-0.00187	0.000962	0.00650**	-0.00676*
	(0.00387)	(0.00469)	(0.00271)	(0.00452)	(0.00376)	(0.00280)	(0.00358)
richer	-0.00795**	0.00741	0.0130***	0.00156	0.00311	0.00547*	0.00527
	(0.00383)	(0.00682)	(0.00284)	(0.00534)	(0.00595)	(0.00301)	(0.00603)
richest	-0.0100*	0.0223***	0.0211***	-0.00428	0.00827	0.0109***	0.0128*
	(0.00549)	(0.00860)	(0.00370)	(0.00804)	(0.00686)	(0.00403)	(0.00716)
services-sales	0.000713	0.00369	0.00292	-0.00373	-0.00454	0.00851***	0.000637
	(0.00254)	(0.00357)	(0.00467)	(0.0124)	(0.00311)	(0.00232)	(0.00323)
agriculture	-0.00780	0.0182	0.00225	-0.00415	-0.00484	0.00453	-0.00638
	(0.00523)	(0.0114)	(0.00336)	(0.00448)	(0.00379)	(0.00320)	(0.00403)
other jobs	-0.00626	0.0113**	0.00921**	-0.00185	0.00354	-0.00416	0.00338
	(0.00414)	(0.00574)	(0.00449)	(0.00449)	(0.00777)	(0.00463)	(0.00378)
height mother	0.00178***	0.00168***	0.00205***	0.00158***	0.00156***	0.00124***	0.00153***
	(0.000195)	(0.000222)	(0.000153)	(0.000235)	(0.000200)	(0.000169)	(0.000180)
BMI mother	-0.00102	0.00254*	0.00217	0.00198	0.00124	-0.00103	0.00554***
	(0.00104)	(0.00151)	(0.00237)	(0.00191)	(0.00205)	(0.00151)	(0.00129)
BMI mother2	0.0000509***	-0.0000254	-0.0000112	-0.0000151	0.00000860	0.0000508*	-0.0000772***
	(0.0000164)	(0.0000256)	(0.0000487)	(0.0000350)	(0.0000407)	(0.0000306)	(0.0000232)
age mother	0.000211	0.000864	0.000686	0.00204	0.00194	0.000127	-0.000493
	(0.00112)	(0.00177)	(0.00110)	(0.00148)	(0.00141)	(0.000890)	(0.00119)
age mother2	0.00000606	-0.0000121	-0.00000648	-0.0000295	-0.0000271	0.00000993	0.0000192
	(0.0000192)	(0.0000298)	(0.0000178)	(0.0000246)	(0.0000241)	(0.0000147)	(0.0000191)
offspring	0.00468***	0.00231	-0.000331	-0.0000586	0.00266*	0.00430***	-0.000640
	(0.000985)	(0.00248)	(0.00101)	(0.00132)	(0.00145)	(0.000965)	(0.00134)
bord	-0.00411***	-0.00367	-0.00198**	-0.000597	-0.00335**	-0.00457***	-0.000753
	(0.000981)	(0.00245)	(0.000962)	(0.00122)	(0.00150)	(0.000927)	(0.00125)
first multibirth	-0.0397***	-0.0123	-0.0328***	-0.0144	-0.0231***	-0.00868	-0.0282***
	(0.00942)	(0.0120)	(0.0100)	(0.0112)	(0.00816)	(0.00930)	(0.00801)
second multibirth	-0.0300***	-0.0375***	-0.0230***	-0.0321***	-0.0237***	-0.00654	-0.0250***
	(0.00595)	(0.00930)	(0.00806)	(0.00902)	(0.00900)	(0.0103)	(0.00650)
drinking water	0.00194	0.00169	0.00207	0.000858	0.00137	0.000258	-0.00214
	(0.00272)	(0.00413)	(0.00204)	(0.00343)	(0.00295)	(0.00246)	(0.00252)
toilet facility	0.0156***	0.00219	-0.00307	0.000251	0.00125	0.000724	0.00215
	(0.00402)	(0.00493)	(0.00900)	(0.00398)	(0.00342)	(0.00290)	(0.00283)
cooking fuel	-0.00602	-0.00846	0.0138	0.0737***	-0.00596	-0.00484	-0.000249
	(0.0103)	(0.00513)	(0.00950)	(0.0204)	(0.00695)	(0.00641)	(0.00554)
urban	-0.00216	-0.00496	0.00666*	0.00700	0.00259	0.00167	0.00227
	(0.00432)	(0.00375)	(0.00372)	(0.00514)	(0.00354)	(0.00325)	(0.00490)
constant	4.157***	4.223***	4.050***	4.048***	4.141***	4.267***	4.108***
	(0.0376)	(0.0500)	(0.0432)	(0.0556)	(0.0519)	(0.0328)	(0.0408)
N	4683	1488	4022	3969	3392	9602	3113
R-square	0.093	0.156	0.157	0.052	0.114	0.086	0.137

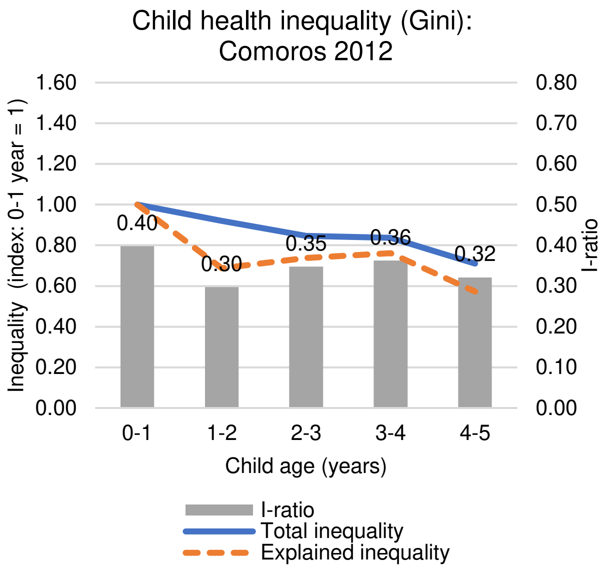
Table A2. Child height and factors: OLS estimates for overall sample by country (continued)

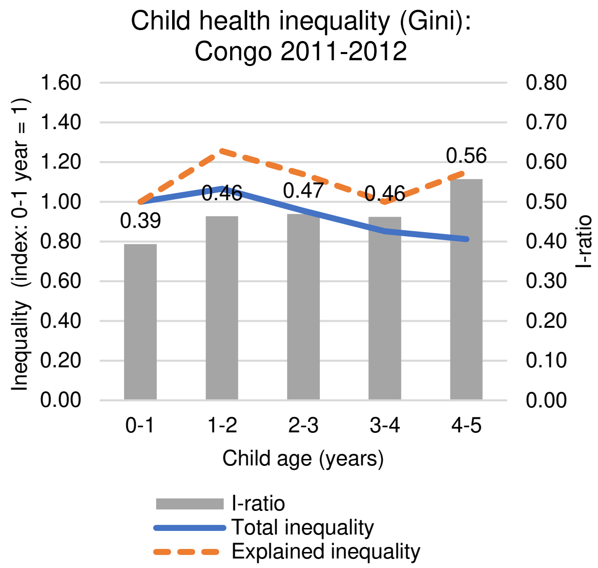
Variable/Country	TZ	UG	ZA	ZM	ZW
primary	0.0000363	0.00355	-0.00269	0.00259	0.00630
	(0.00258)	(0.00524)	(0.0121)	(0.00245)	(0.00627)
secondary	0.00690*	0.00450	-0.000738	0.00410	0.00758
	(0.00414)	(0.00710)	(0.0117)	(0.00272)	(0.00646)
higher	0.0397***	0.0277*	0.0121	0.0107*	0.0170*
	(0.0122)	(0.0148)	(0.0130)	(0.00563)	(0.00889)
poorer	0.00299	0.00395	-0.00214	0.00469**	0.00265
	(0.00303)	(0.00534)	(0.00656)	(0.00187)	(0.00259)
middle	0.00691**	-0.00420	0.00657	0.00300	-0.00160
	(0.00290)	(0.00706)	(0.00736)	(0.00209)	(0.00330)
richer	0.00925***	0.0132**	0.00625	0.00566**	0.00439
	(0.00350)	(0.00664)	(0.00941)	(0.00258)	(0.00349)
richest	0.0146***	0.00951	0.00748	0.00845*	0.00633
	(0.00457)	(0.00839)	(0.00982)	(0.00466)	(0.00458)
services_sales	0.00924	0.00519	0.0141	0.000497	0.00177
	(0.00610)	(0.00540)	(0.0108)	(0.00209)	(0.00245)
agriculture	-0.00205	0.000207	0.0160	-0.000365	-0.00189
	(0.00335)	(0.00451)	(0.0127)	(0.00193)	(0.00306)
other_jobs	0.00129	-0.0267*	0.00138	0.00302	0.000271
	(0.00356)	(0.0161)	(0.00522)	(0.00360)	(0.00259)
height_mother	0.00238***	0.00213***	0.00187***	0.00174***	0.00185***
	(0.000158)	(0.000290)	(0.000361)	(0.000128)	(0.000140)
BMI_mother	0.00454***	0.00138	0.00251	0.00397***	0.00347**
	(0.00174)	(0.00518)	(0.00181)	(0.00146)	(0.00157)
BMI_mother2	-0.0000681*	-0.00000332	-0.0000260	-0.0000479*	-0.0000448
	(0.0000352)	(0.000106)	(0.0000279)	(0.0000285)	(0.0000300)
age_mother	0.00203**	0.00293	0.00152	0.00119	0.00135
	(0.000929)	(0.00185)	(0.00218)	(0.000789)	(0.000981)
age_mother2	-0.0000333**	-0.0000125	-0.0000175	-0.00000774	-0.0000201
	(0.0000154)	(0.0000328)	(0.0000391)	(0.0000134)	(0.0000173)
offspring	0.000785	-0.00312*	-0.00281	0.000435	0.000694
	(0.00101)	(0.00166)	(0.00386)	(0.000912)	(0.00155)
bord	-0.00136	-0.00132	-0.00196	-0.00201**	-0.00227
	(0.00110)	(0.00172)	(0.00409)	(0.000952)	(0.00155)
first_multibirth	-0.0380***	-0.0206**	-0.0389***	-0.0280***	-0.0284***
	(0.00875)	(0.00983)	(0.0113)	(0.00649)	(0.00760)
second_multibirth	-0.0340***	-0.0387***	-0.0133	-0.0240***	-0.0212**
	(0.00636)	(0.0129)	(0.0158)	(0.00627)	(0.00984)
drinking_water	0.00166	0.00254	0.000603	0.00139	0.000821
	(0.00236)	(0.00457)	(0.00834)	(0.00158)	(0.00222)
toilet_facility	0.00182	-0.000631	0.0101	0.000592	-0.00267
	(0.00322)	(0.00672)	(0.00697)	(0.00204)	(0.00243)
cooking_fuel	-0.0160***	0.00879	-0.00912	-0.00947**	0.00352
	(0.00576)	(0.0222)	(0.00600)	(0.00447)	(0.00361)
urban	-0.00302	0.00700	0.0110**	-0.00476**	0.00347
	(0.00314)	(0.00629)	(0.00496)	(0.00238)	(0.00389)
_cons	3.970***	4.018***	4.063***	4.098***	4.077***
	(0.0358)	(0.0679)	(0.0683)	(0.0281)	(0.0327)
N	5006	1851	1019	11071	4150
R-sq	0.166	0.146	0.150	0.079	0.075

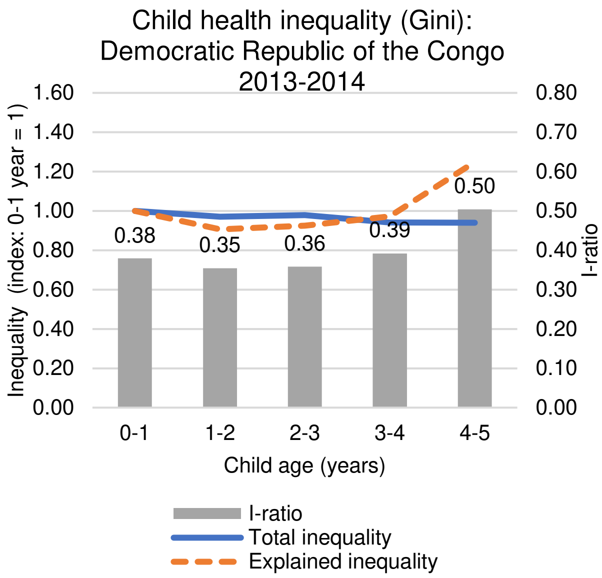
Note: Construct by the authors using data from the DHS databases (2009-2016).
The estimates of dummy regions mentioned in the table 1 are not shown for reasons of space.
Standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001

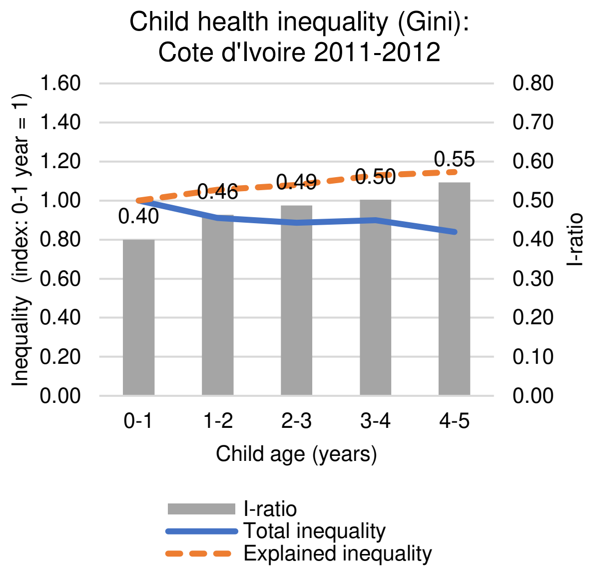
Figure A1. Child health inequality, explained inequality and I-ratio along the age distribution in SSA countries

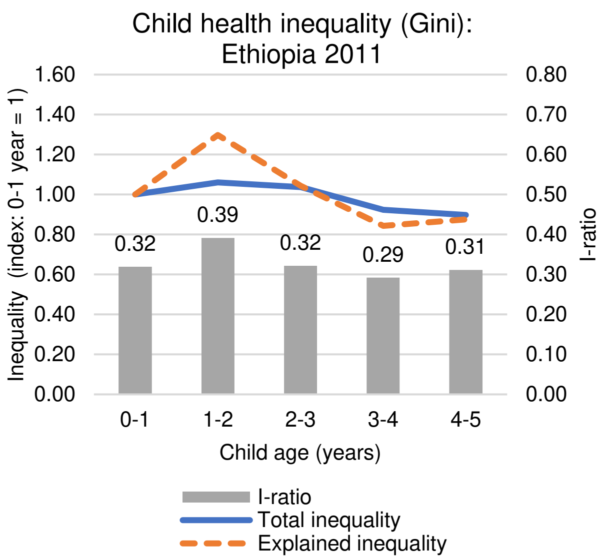


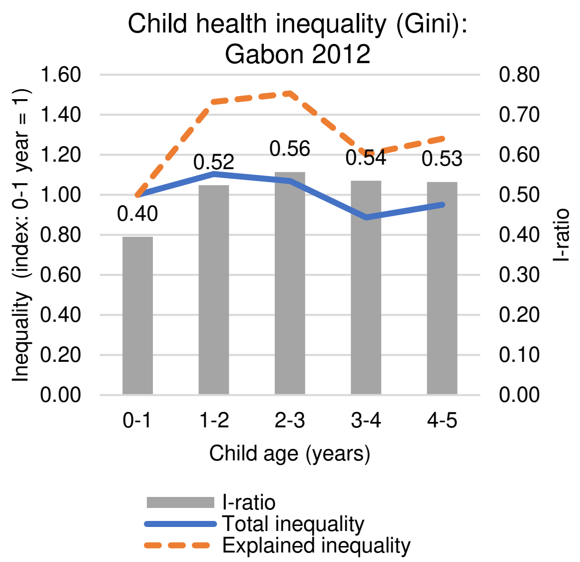

Child health inequality (Gini):
Comoros 2012
Inequality (index: 0-1 year = 1)
I-ratio
0.40
0.30
0.35
0.36
0.32
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

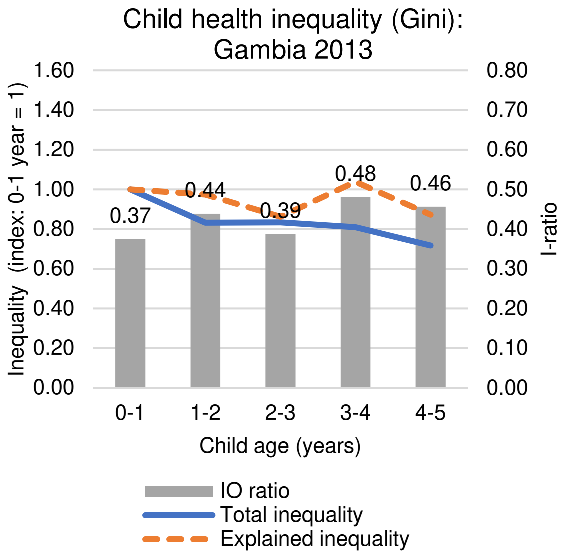

Child health inequality (Gini):
Congo 2011-2012
Inequality (index: 0-1 year = 1)
I-ratio
0.39
0.46
0.47
0.46
0.56
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

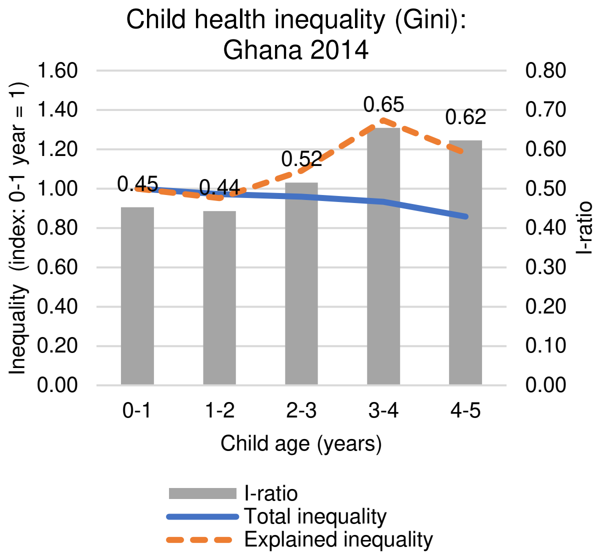

Child health inequality (Gini):
Democratic Republic of the Congo
2013-2014
Inequality (index: 0-1 year = 1)
I-ratio
0.38
0.35
0.36
0.39
0.50
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

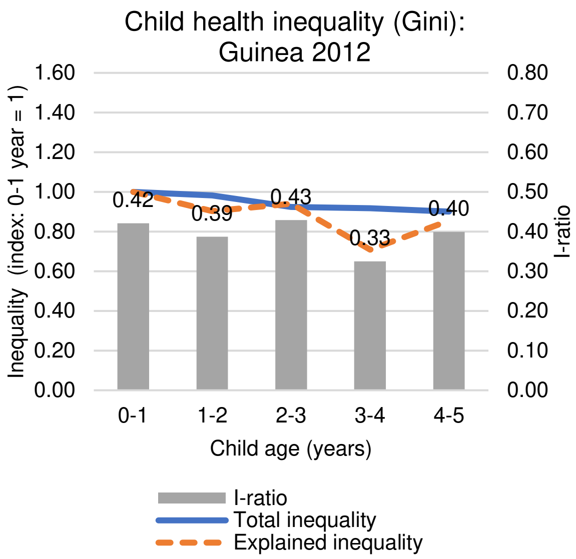

Child health inequality (Gini):
Cote d'Ivoire 2011-2012
Inequality (index: 0-1 year = 1)
I-ratio
0.40
0.46
0.49
0.50
0.55
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

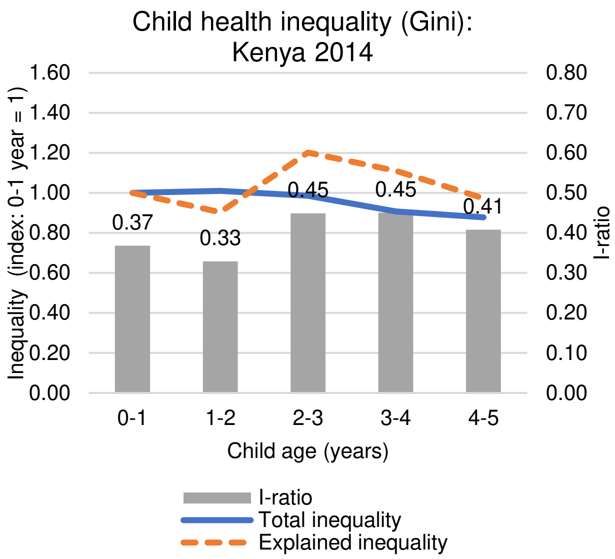

Child health inequality (Gini):
Ethiopia 2011
Inequality (index: 0-1 year = 1)
I-ratio
0.32
0.39
0.32
0.29
0.31
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

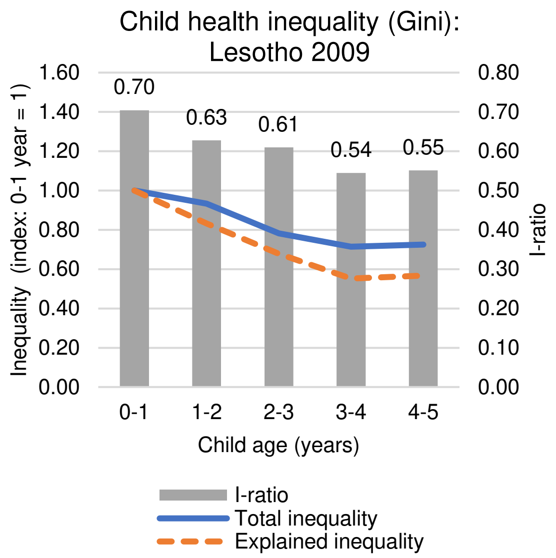

Child health inequality (Gini):
Gabon 2012
Inequality (index: 0-1 year = 1)
I-ratio
0.40
0.52
0.56
0.54
0.53
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

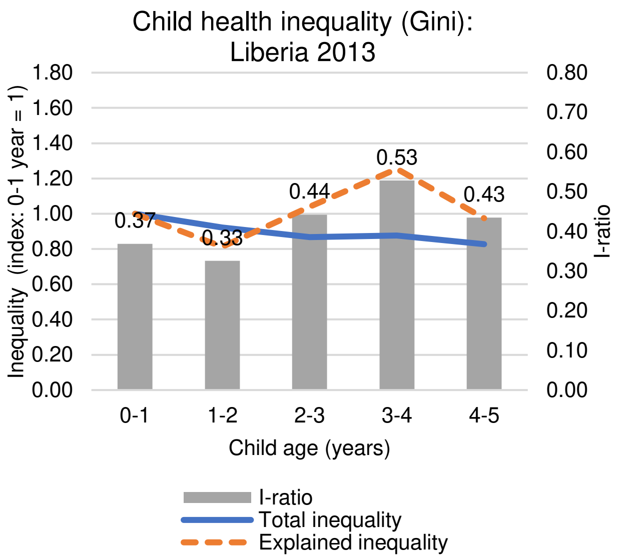

Child health inequality (Gini):
Gambia 2013
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.37
0.44
0.39
0.48
0.46
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
Explained inequality

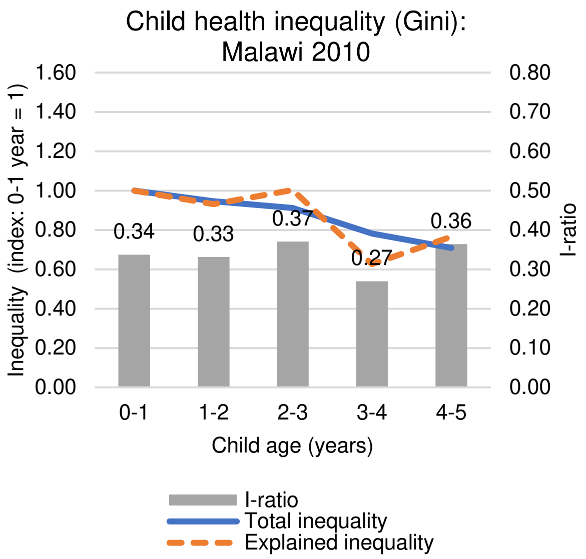

Child health inequality (Gini):
Ghana 2014
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.45
0.44
0.52
0.65
0.62
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

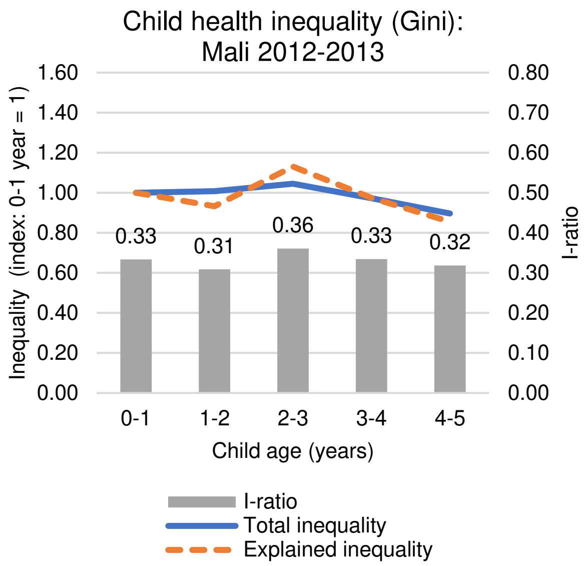

Child health inequality (Gini):
Guinea 2012
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.42
0.39
0.43
0.33
0.40
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

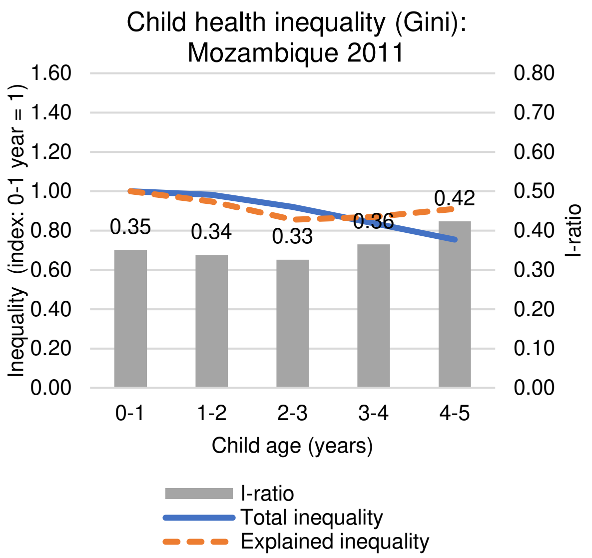

Child health inequality (Gini):
Kenya 2014
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.37
0.33
0.45
0.45
0.41
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

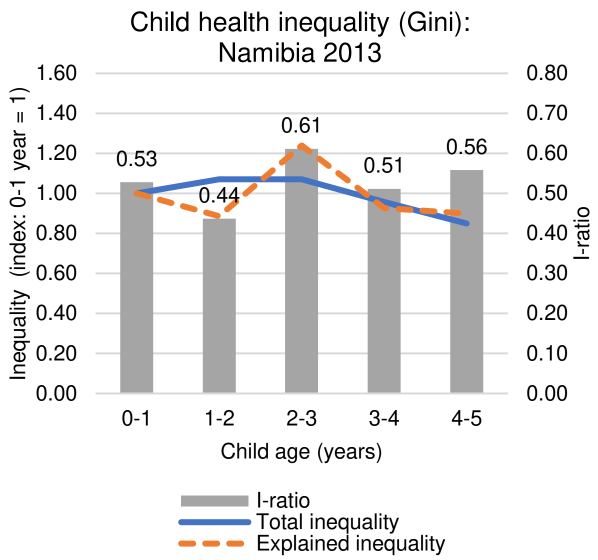

Child health inequality (Gini):
Lesotho 2009
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.70
0.63
0.61
0.54
0.55
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

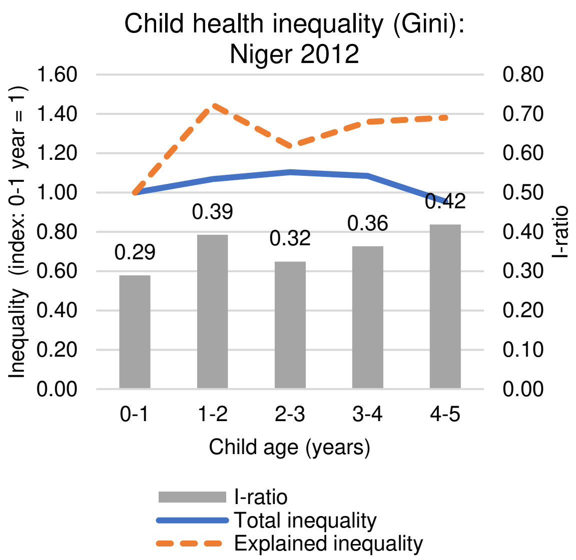

Child health inequality (Gini):
Liberia 2013
Inequality (index: 0-1 year = 1)
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.37
0.33
0.44
0.53
0.43
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

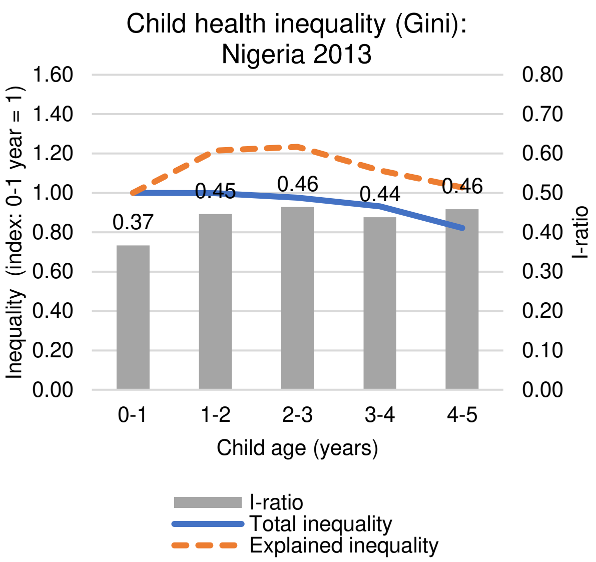

Child health inequality (Gini):
Malawi 2010
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.34
0.33
0.37
0.27
0.36
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

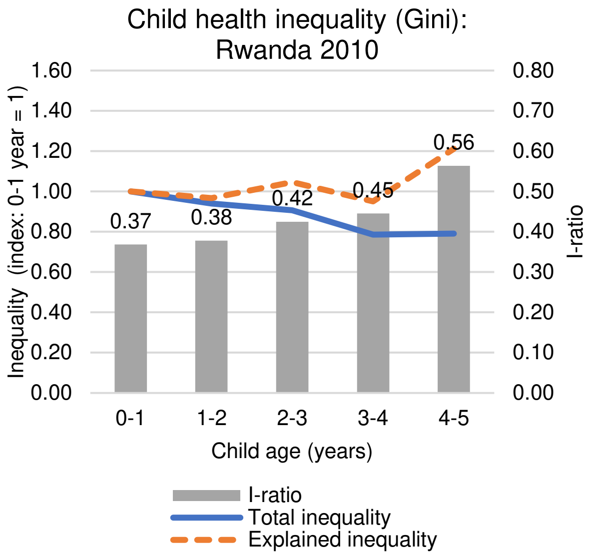

Child health inequality (Gini):
Mali 2012-2013
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.33
0.31
0.36
0.33
0.32
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

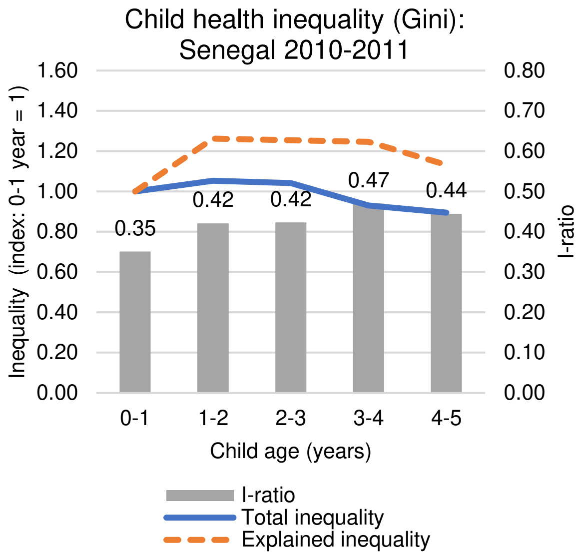

Child health inequality (Gini):
Mozambique 2011
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.35
0.34
0.33
0.36
0.42
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

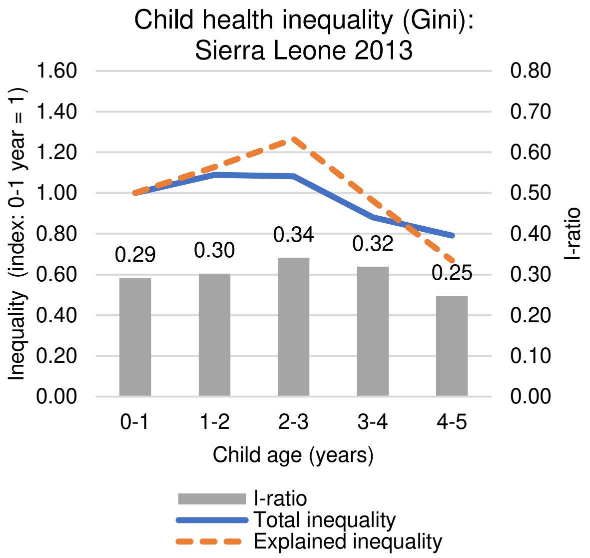

Child health inequality (Gini):
Namibia 2013
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.53
0.44
0.61
0.51
0.56
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

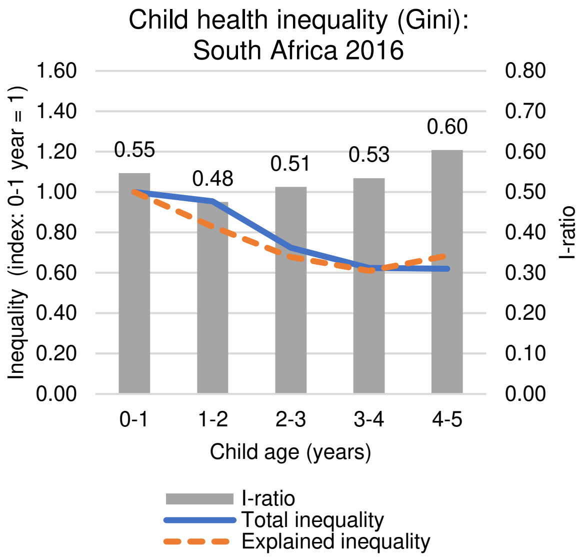

Child health inequality (Gini):
Niger 2012
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.29
0.39
0.32
0.36
0.42
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

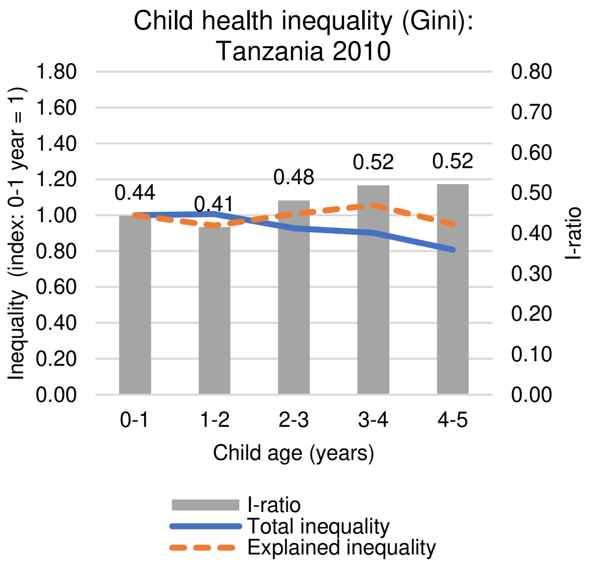

Child health inequality (Gini):
Nigeria 2013
Inequality (index: 0-1 year = 1)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I-ratio
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.37
0.45
0.46
0.44
0.46
0-1
1-2
2-3
3-4
4-5
Child age (years)
I-ratio
Total inequality
Explained inequality

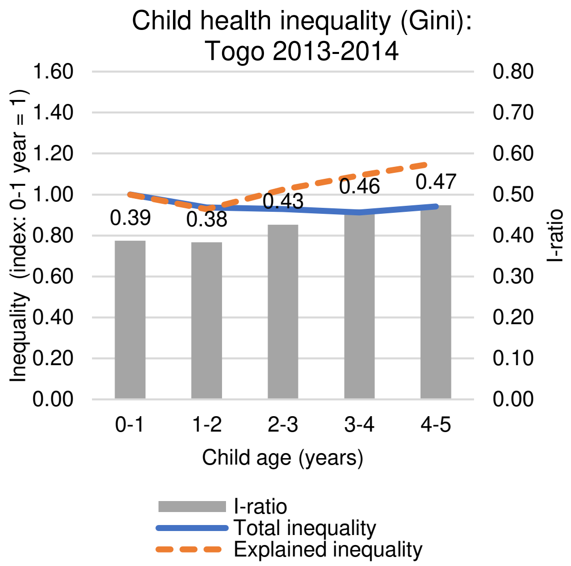

Child health inequality (Gini):
Rwanda 2010
Inequality (index: 0-1 year = 1)
I-ratio
0.37
0.38
0.42
0.45
0.56
Child age (years)
0-1
1-2
2-3
3-4
4-5
I-ratio
Total inequality
Explained inequality

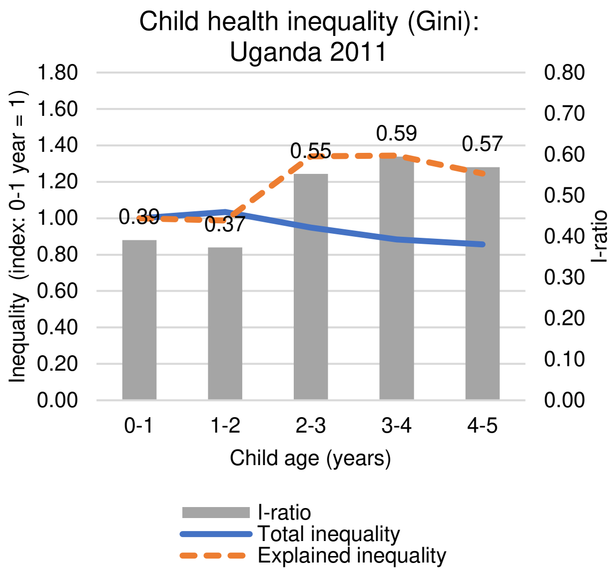

Child health inequality (Gini):
Senegal 2010-2011
Inequality (index: 0-1 year = 1)
I-ratio
0.35
0.42
0.42
0.47
0.44
Child age (years)
0-1
1-2
2-3
3-4
4-5
I-ratio
Total inequality
Explained inequality

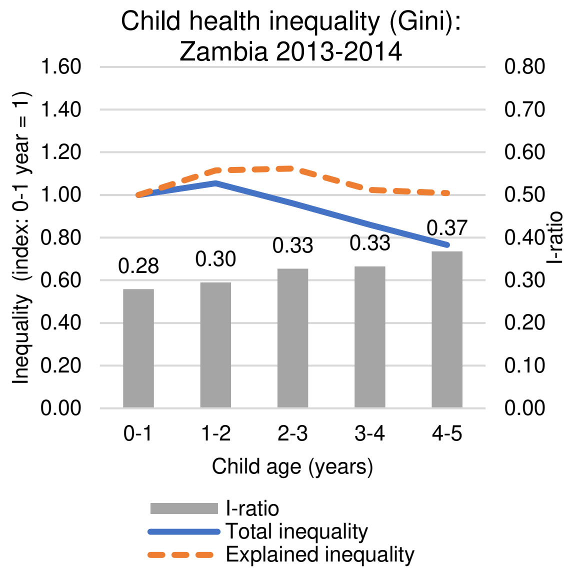

Child health inequality (Gini):
Sierra Leone 2013
Inequality (index: 0-1 year = 1)
I-ratio
0.29
0.30
0.34
0.32
0.25
Child age (years)
0-1
1-2
2-3
3-4
4-5
I-ratio
Total inequality
Explained inequality

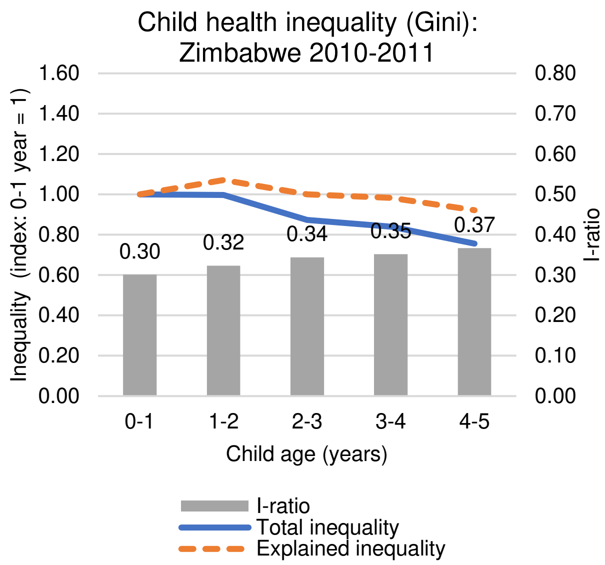

Child health inequality (Gini):
South Africa 2016
Inequality (index: 0-1 year = 1)
I-ratio
0.55
0.48
0.51
0.53
0.60
Child age (years)
0-1
1-2
2-3
3-4
4-5
I-ratio
Total inequality
Explained inequality


Child health inequality (Gini):
Tanzania 2010
Inequality (index: 0-1 year = 1)
I-ratio
0.44
0.41
0.48
0.52
0.52
Child age (years)
0-1
1-2
2-3
3-4
4-5
I-ratio
Total inequality
Explained inequality


Child health inequality (Gini):
Togo 2013-2014
Inequality (index: 0-1 year = 1)
I-ratio
0.39
0.38
0.43
0.46
0.47
Child age (years)
0-1
1-2
2-3
3-4
4-5
I-ratio
Total inequality
Explained inequality



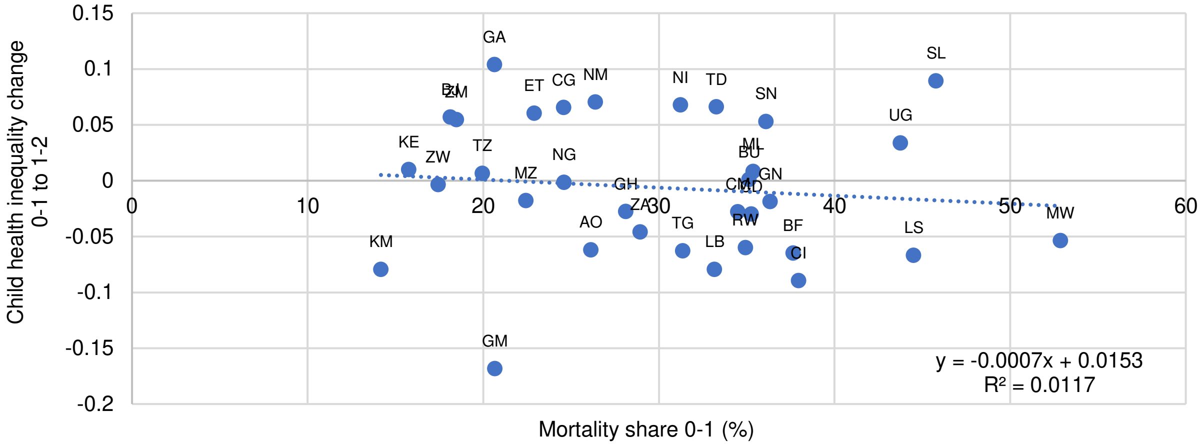




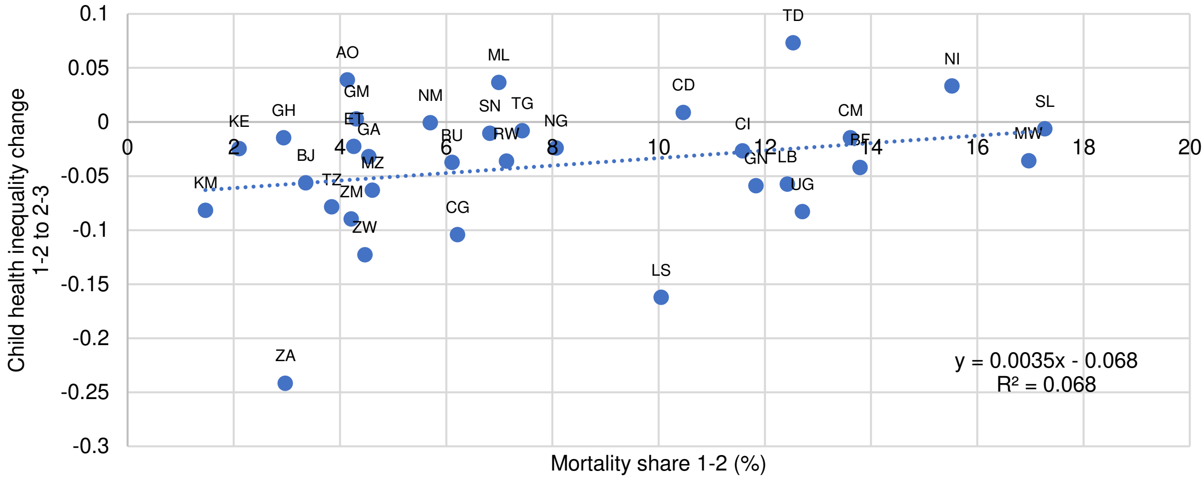
Note: Construct by the authors using data from the DHS databases (2009-2016).

Figure A2. Mortality shares and changes in child health inequality along the age groups in SSA

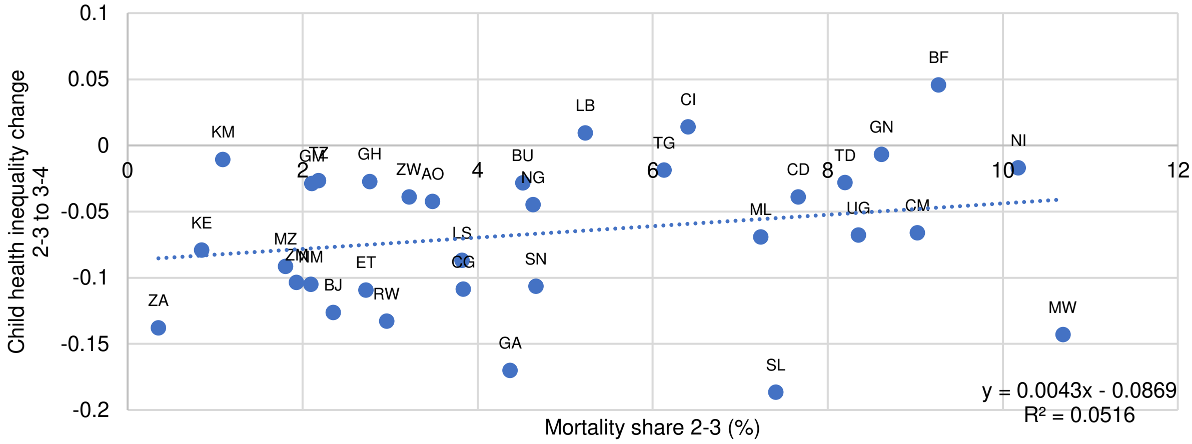
a) Children with 0-1 vs. 1-2 years old



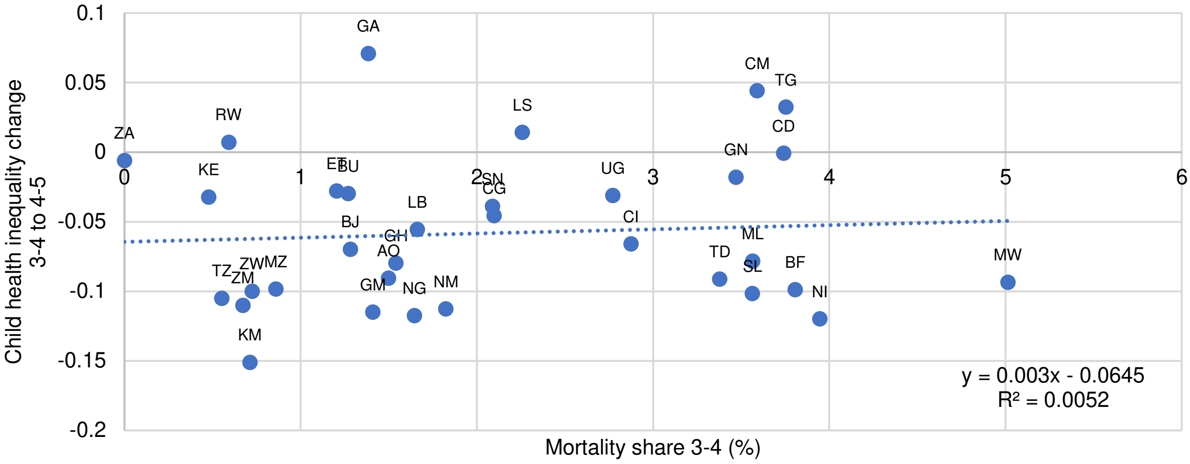
b) Children with 1-2 vs. 2-3 years old



c) Children with 2-3 vs. 3-4 years old



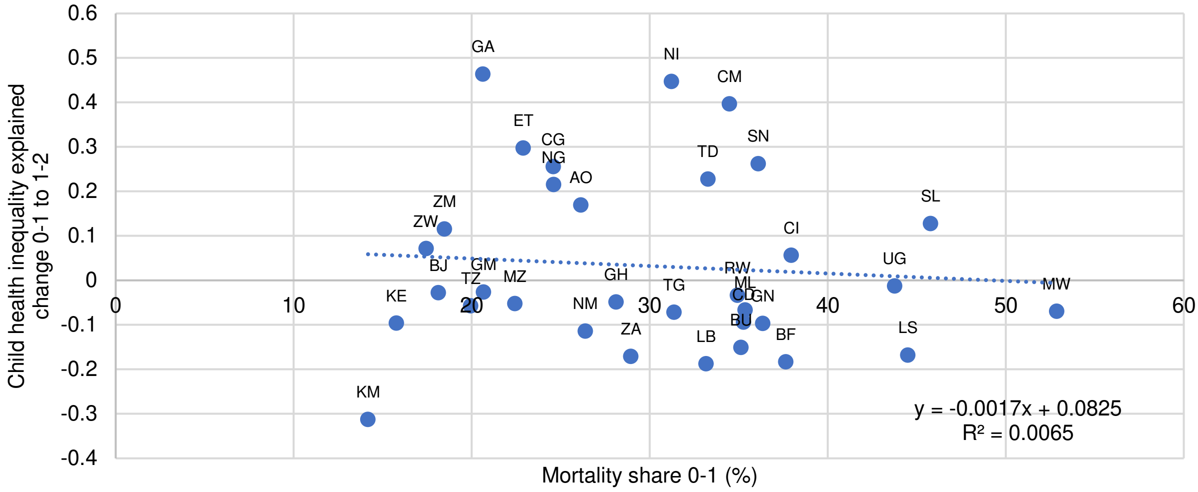
d) Children with 3-4 vs. 4-5 years old



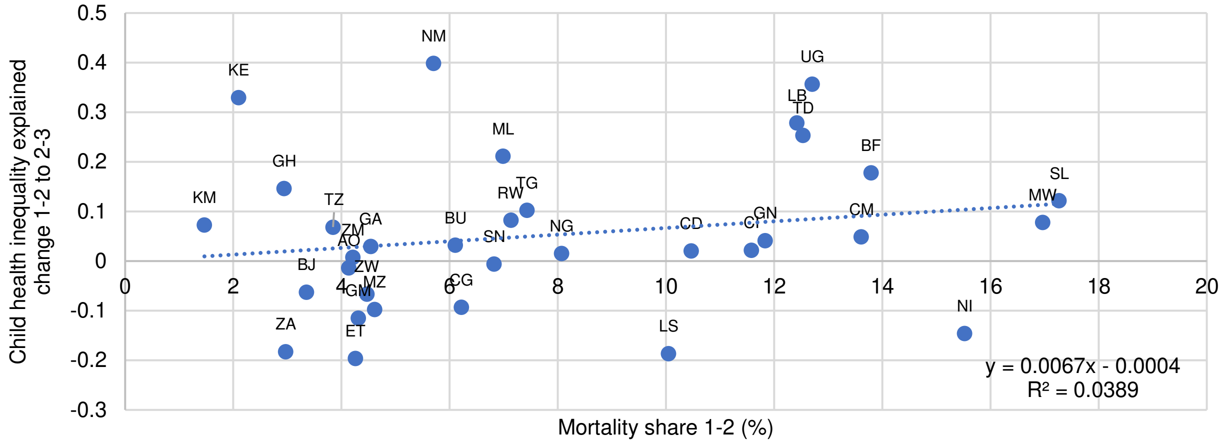
Note: Construct by the authors using data from the DHS databases (2009-2016).

Figure A3. Mortality shares and changes in explained child health inequality among the age groups in SSA

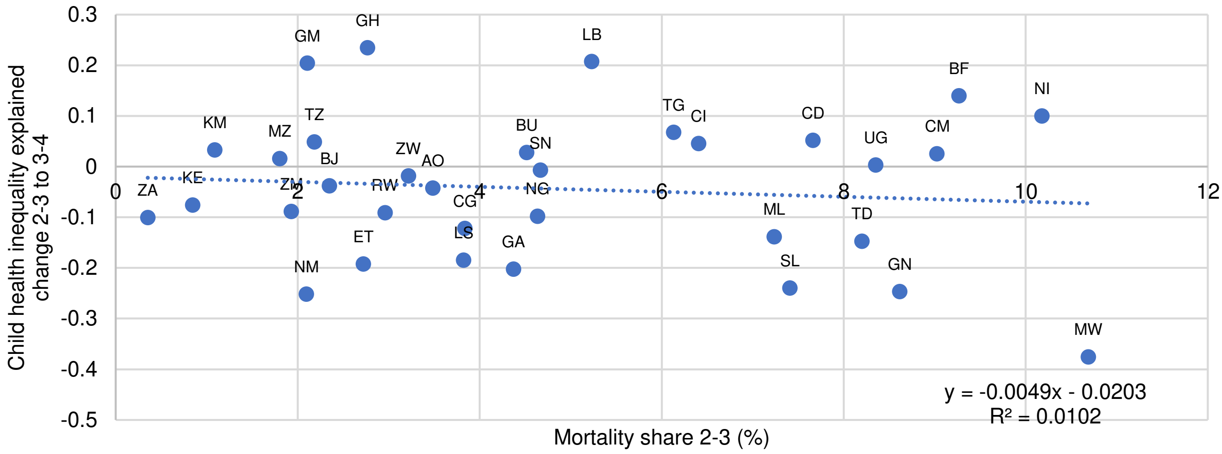
a) Children with 0-1 vs. 1-2 years old



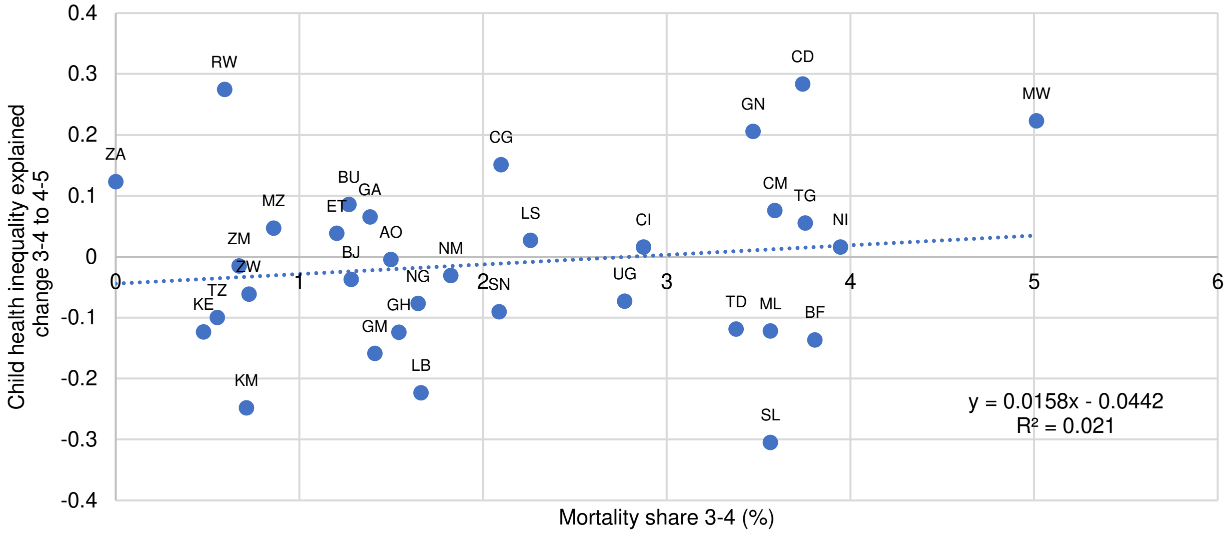
b) Children with 1-2 vs. 2-3 years old



c) Children with 2-3 vs. 3-4 years old



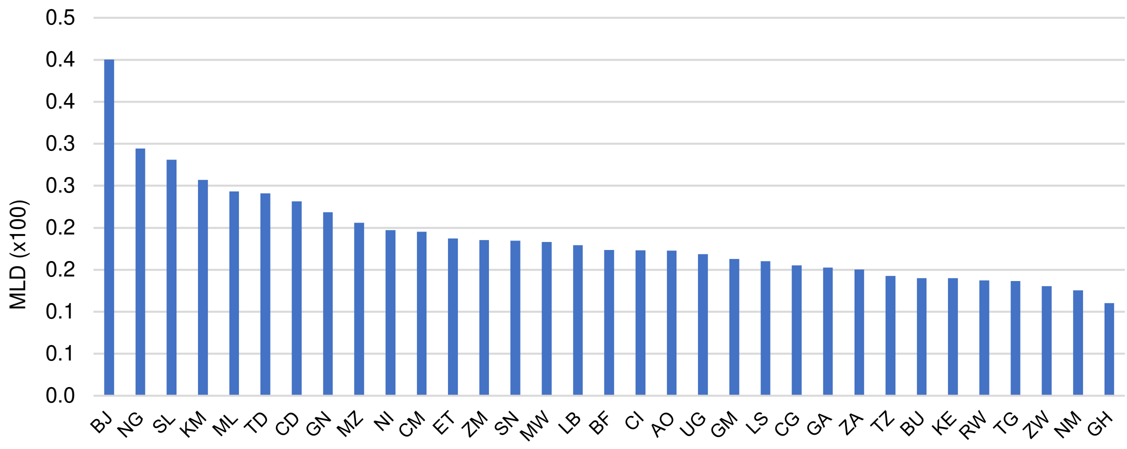
d) Children with 3-4 vs. 4-5 years old



Note: Construct by the authors using data from the DHS databases (2009-2016).

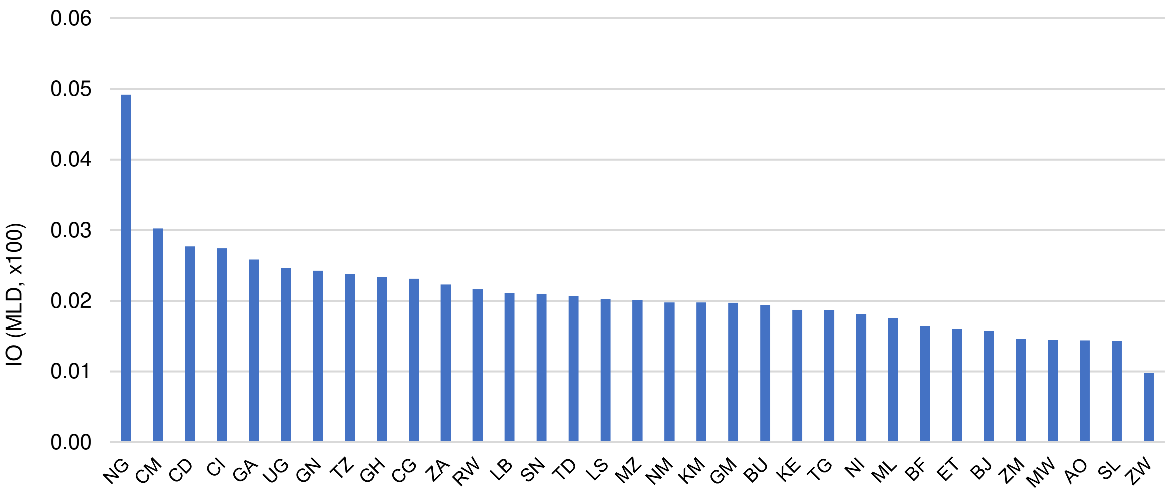
B. On-line Appendix. Figures for the Mean-Log-Deviation (MLD)

Figure B1. Child health inequality in SSA (MLD, x100)



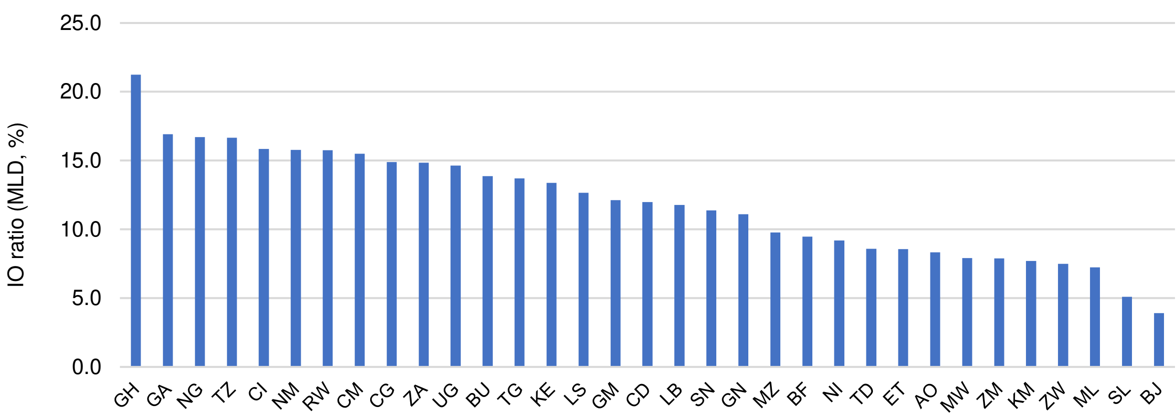
Note: Construct by the authors using data from the DHS databases (2009-2016). See note in Figure 1.

Figure B2. Child health inequality explained by the set of factors in SSA (Gini, x100)



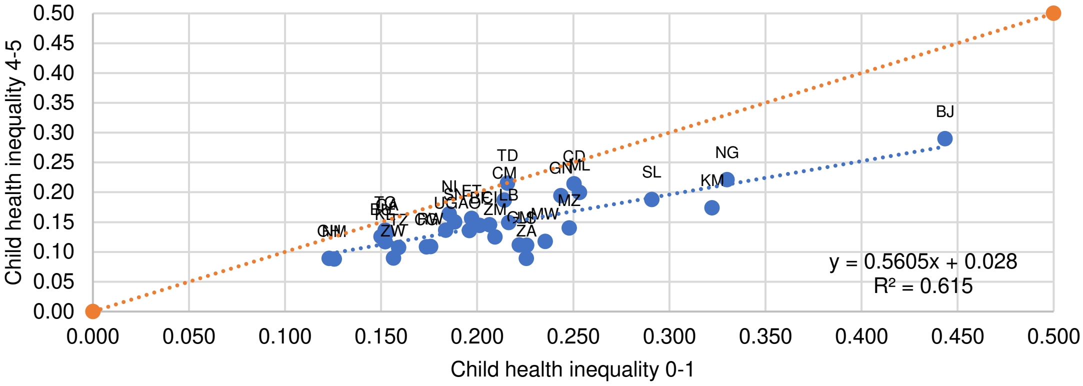
Note: Construct by the authors using data from the DHS databases (2009-2016). See note in Figure 1.

Figure B3. Child health I-ratio in SSA (MLD, %)



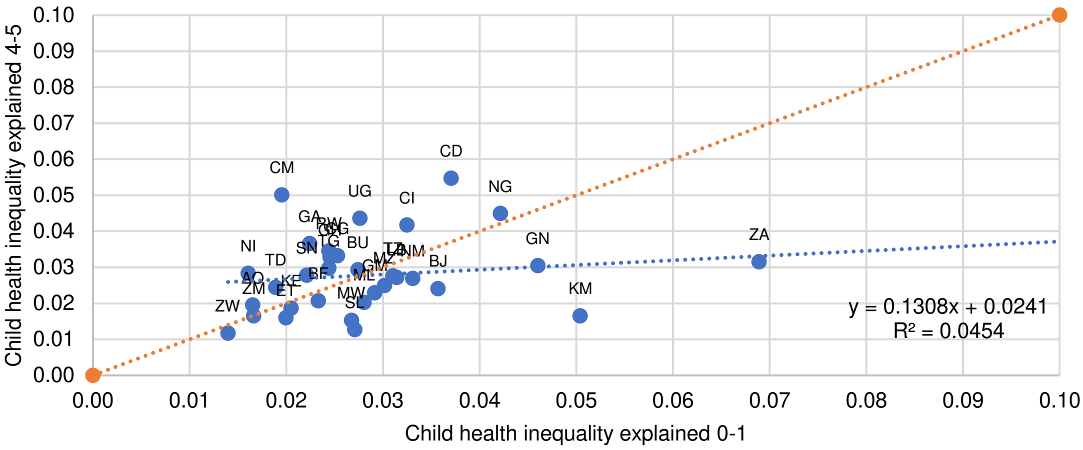
Note: Construct by the authors using data from the DHS databases (2009-2016). See note in Figure 1.

Figure B4. Correlation between child health inequality 0-1 and 4-5 years in SSA (MLD, x100)



Note: Construct by the authors using data from the DHS databases (2009-2016).

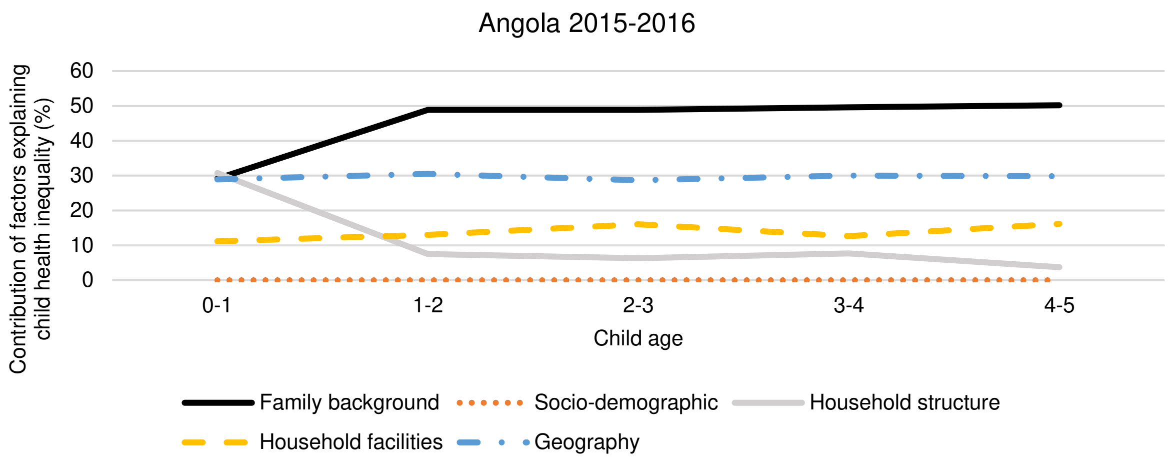
Figure B5. Correlation between child health inequality explained 0-1 and 4-5 years in SSA (MLD, x100)

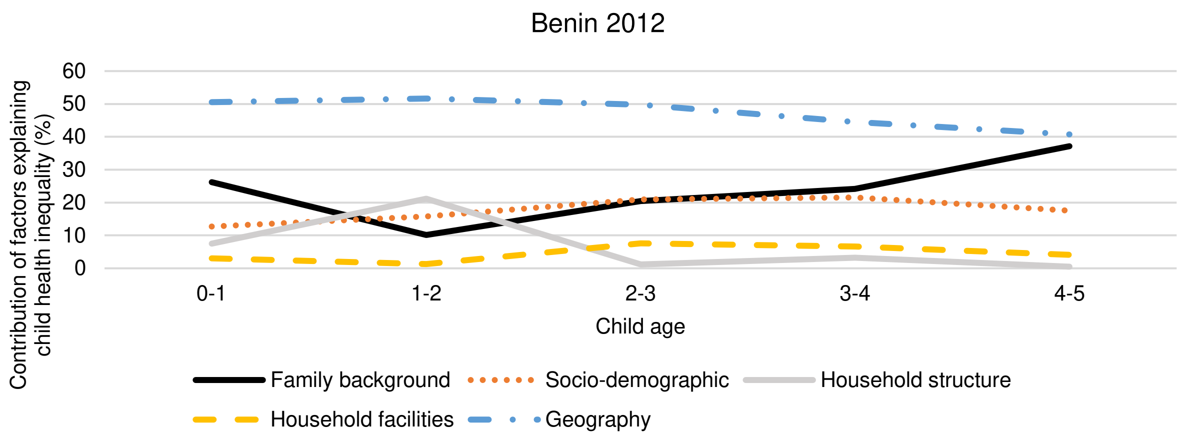


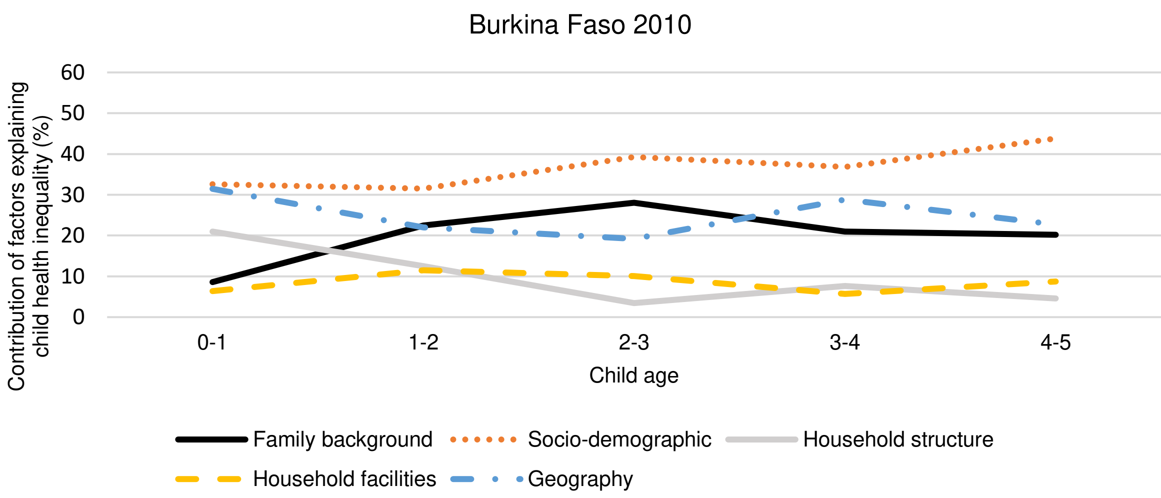
Note: Construct by the authors using data from the DHS databases (2009-2016).

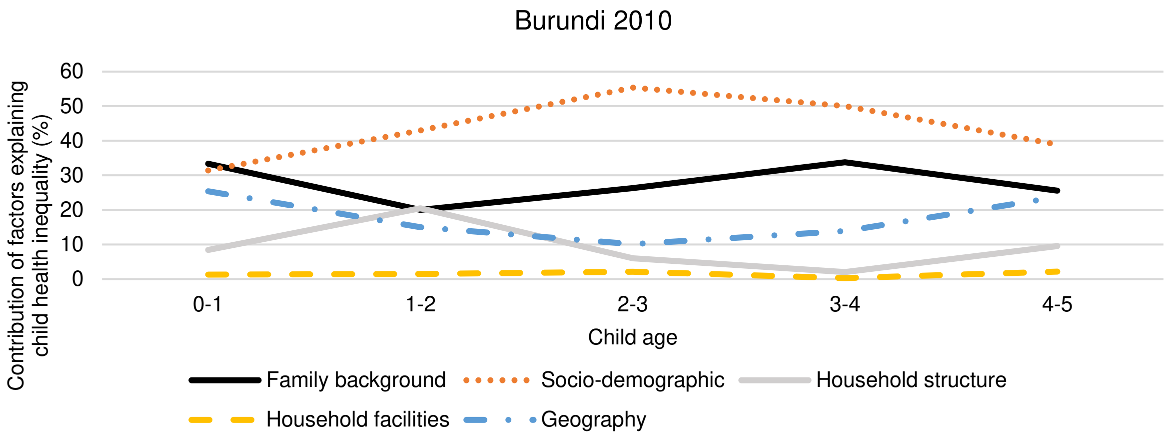
C. On-line Appendix.

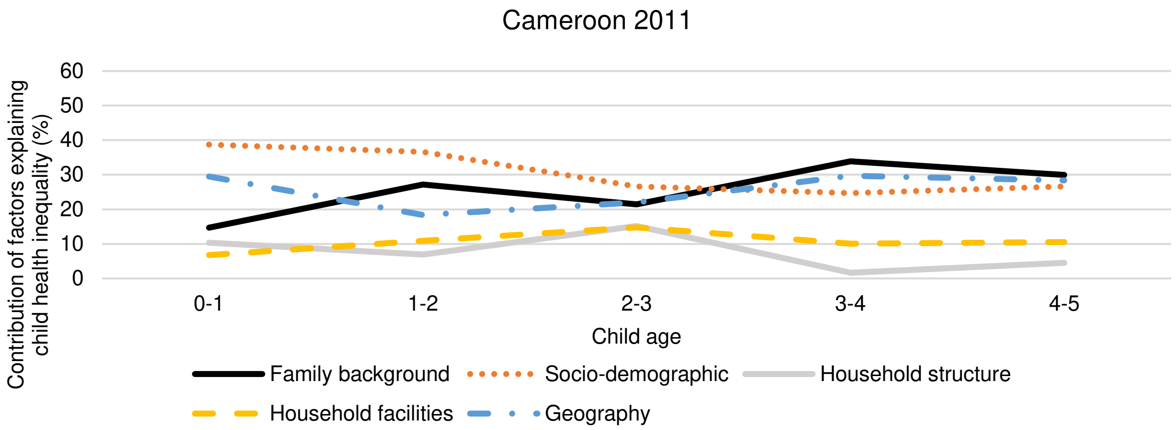
Figure C1. Evolution of the average contribution of factors explaining child health inequality along the age distribution in SSA countries (%)

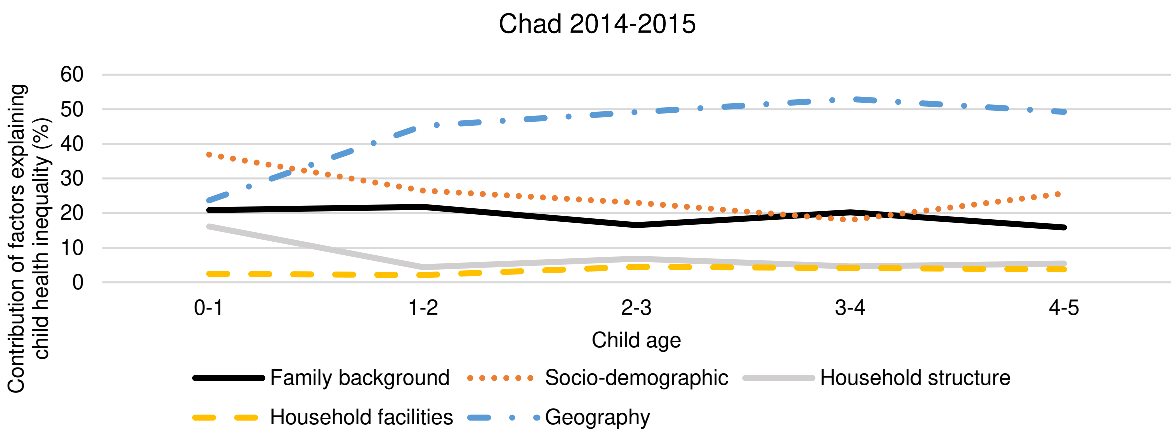


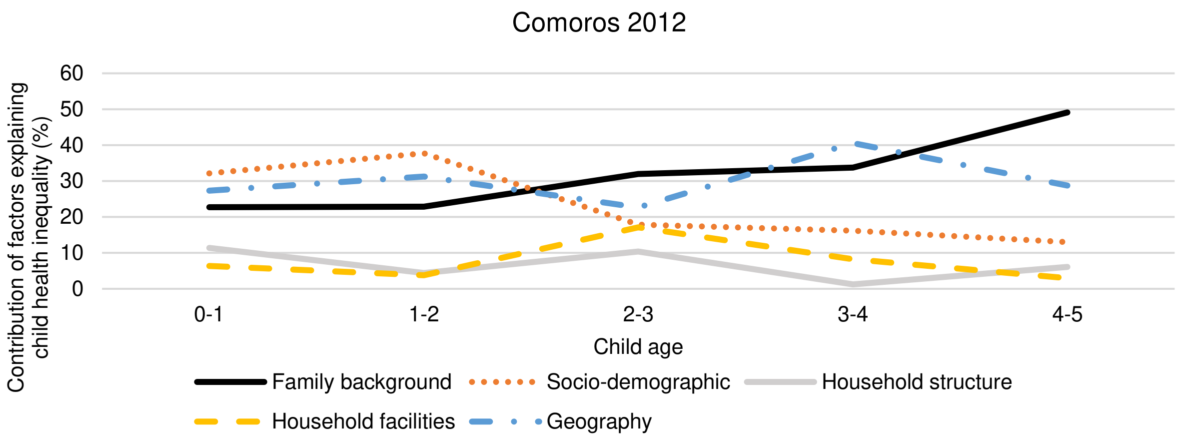


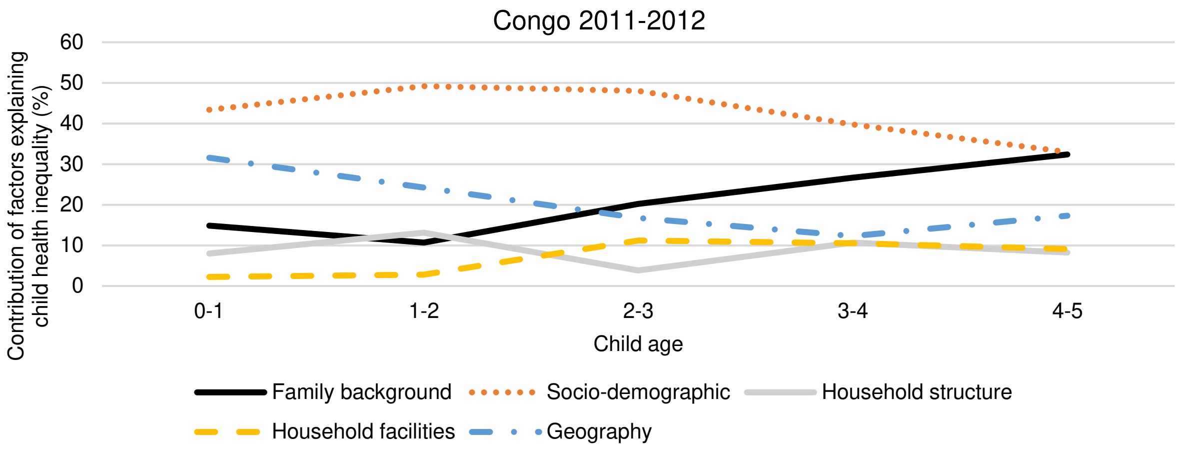


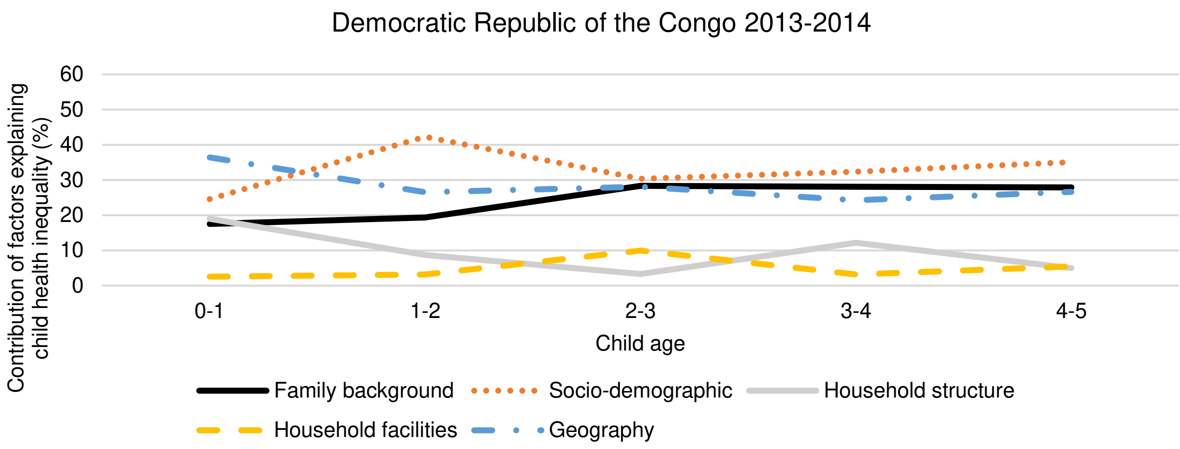

Burundi 2010
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

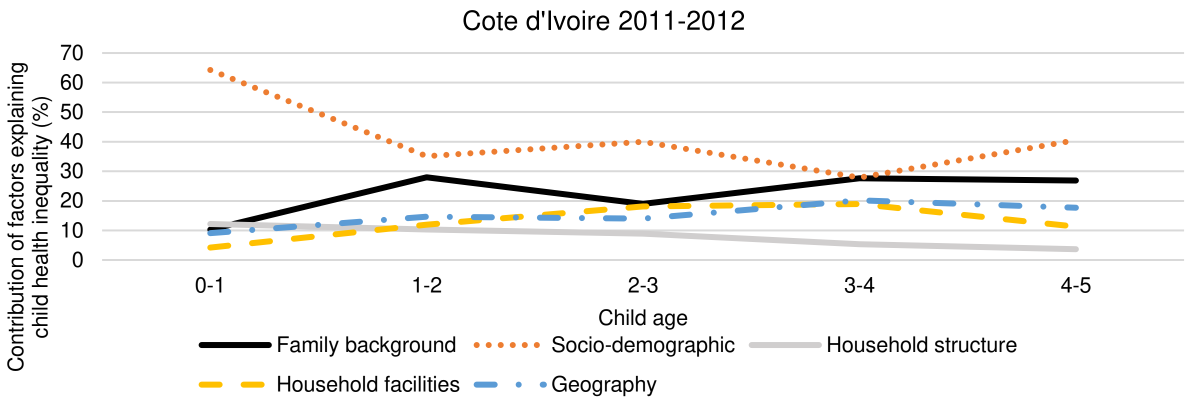

Cameroon 2011
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

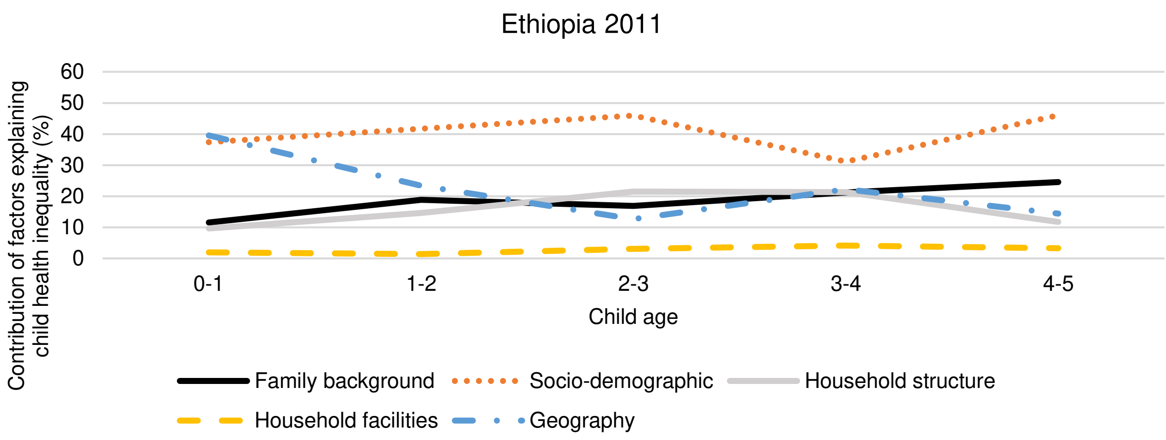

Chad 2014-2015
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

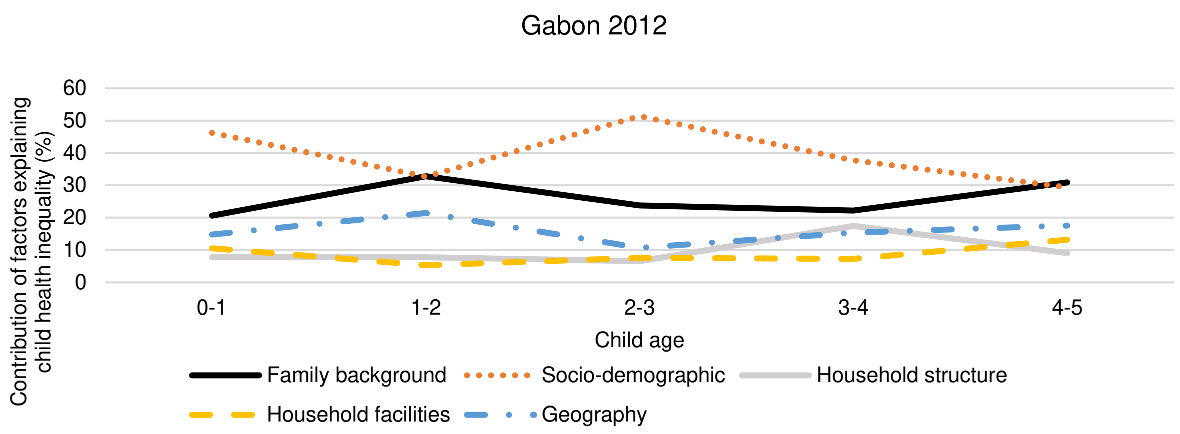

Comoros 2012
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

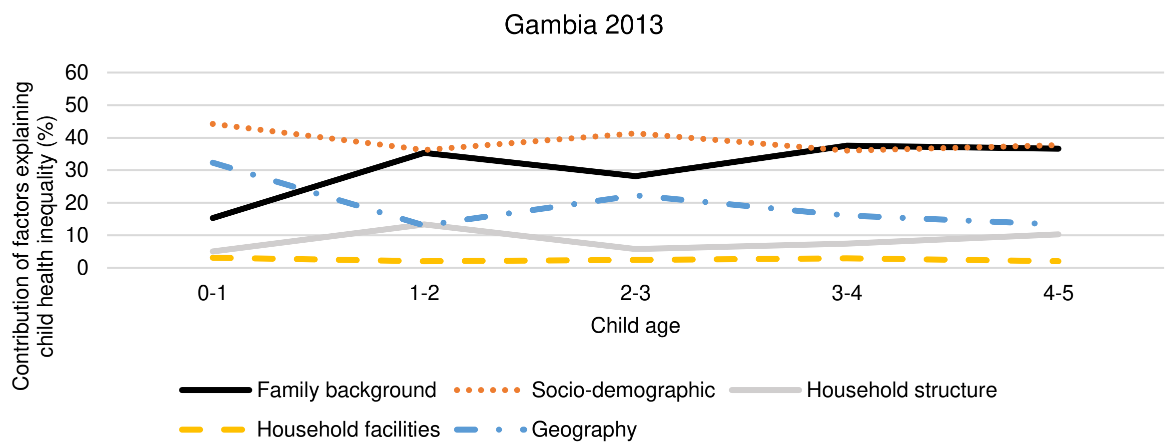

Congo 2011-2012
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Democratic Republic of the Congo 2013-2014
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Cote d'Ivoire 2011-2012
Contribution of factors explaining child health inequality (%)
70
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Ethiopia 2011
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Gabon 2012
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Gambia 2013
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
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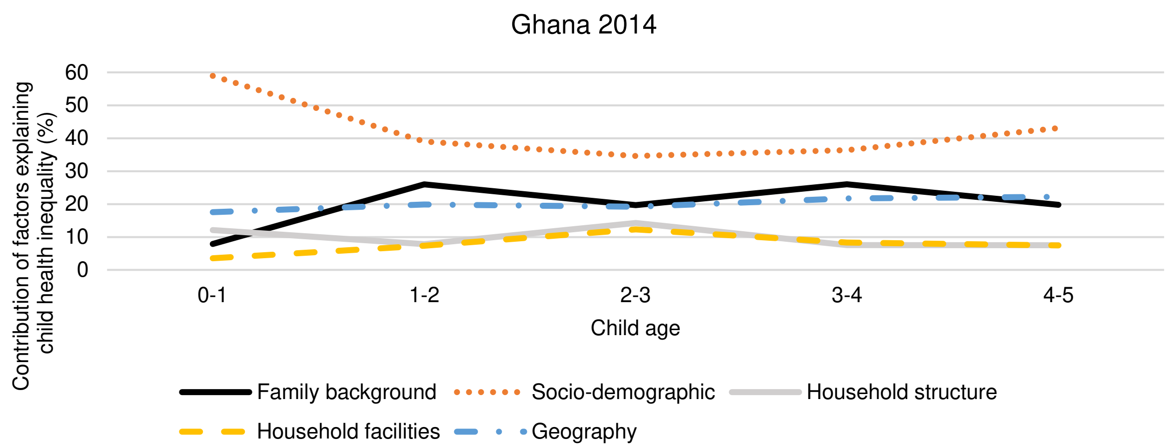
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Ghana 2014
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
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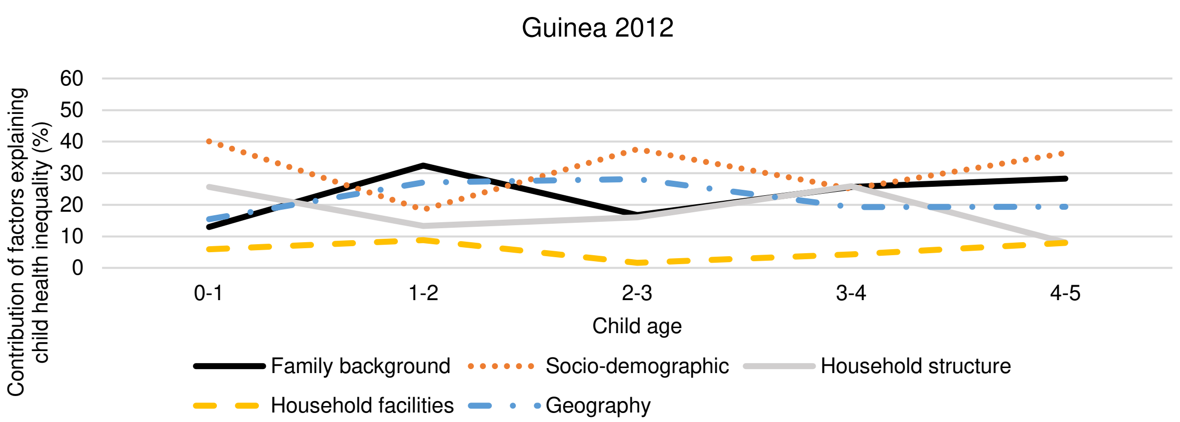
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Guinea 2012
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
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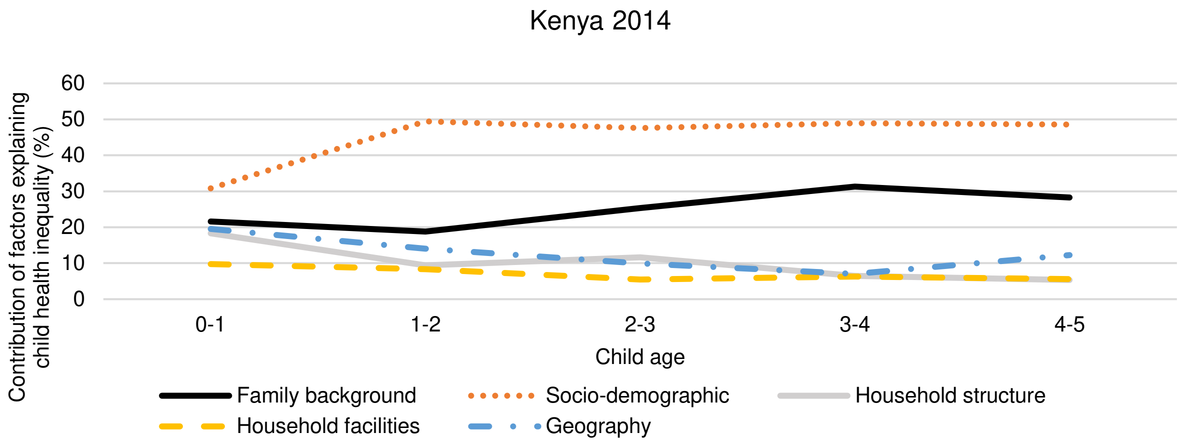
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Kenya 2014
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
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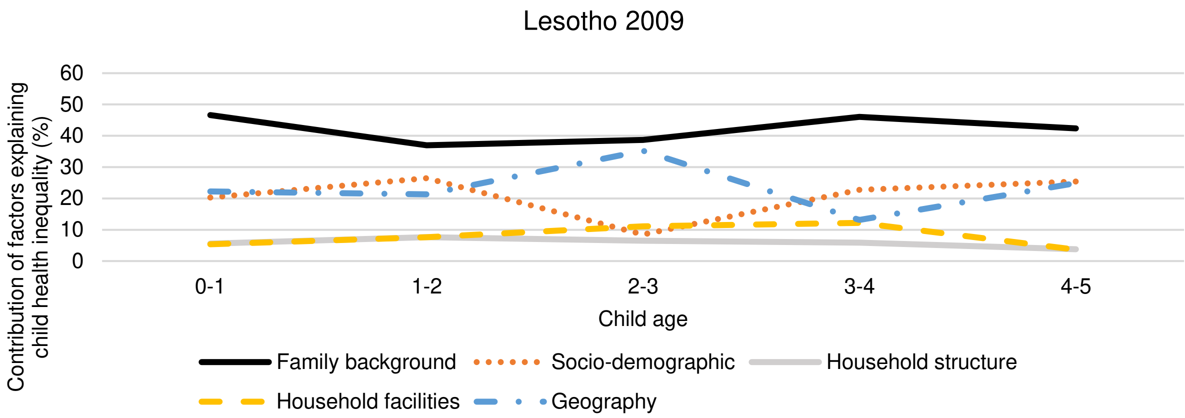
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Lesotho 2009
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
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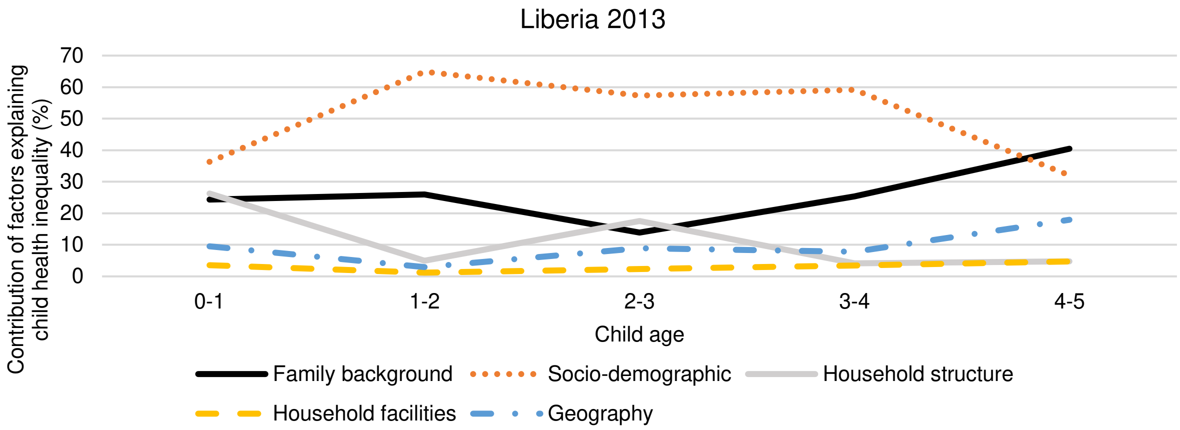
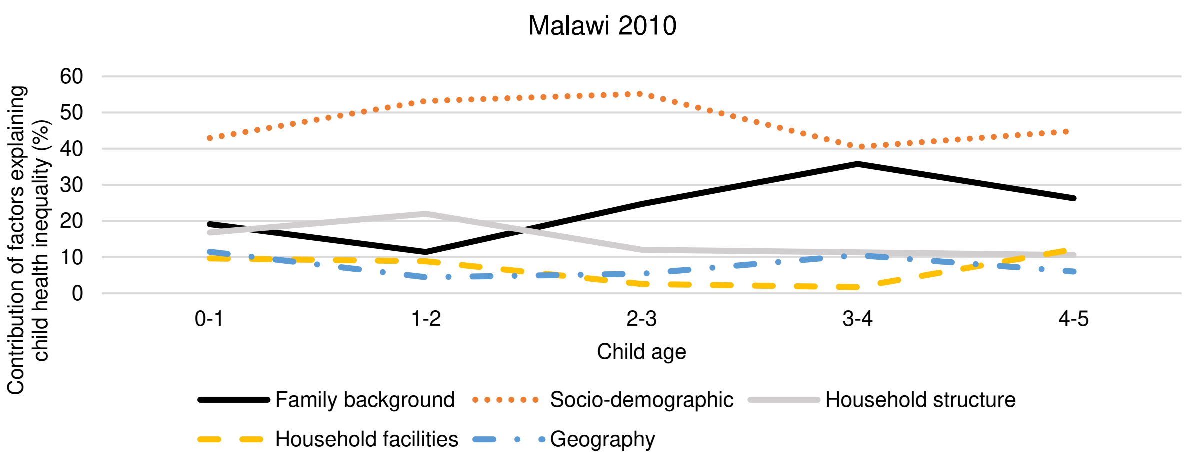
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Liberia 2013
Contribution of factors explaining child health inequality (%)
70
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Malawi 2010
Contribution of factors explaining child health inequality (%)
60
50
40
30
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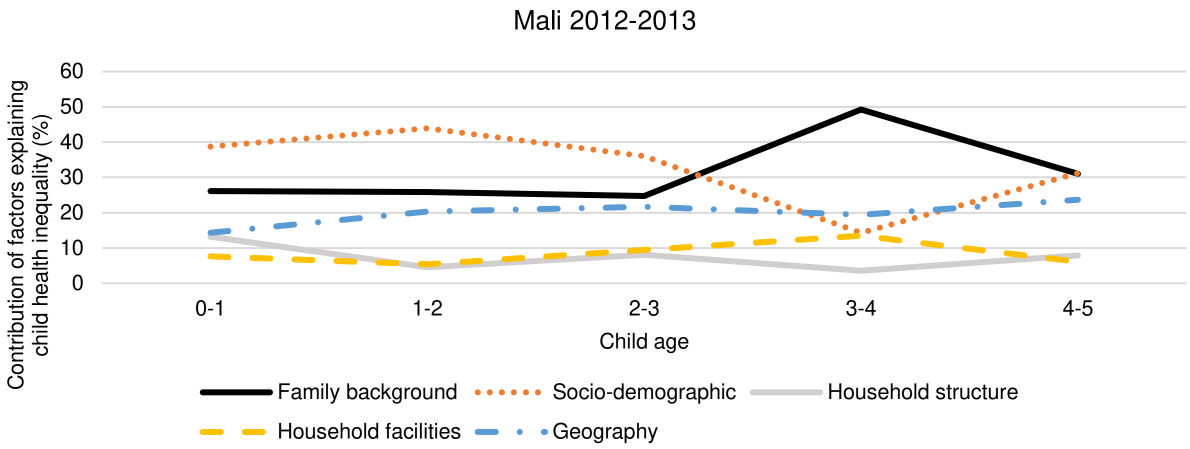
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography



Mali 2012-2013
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
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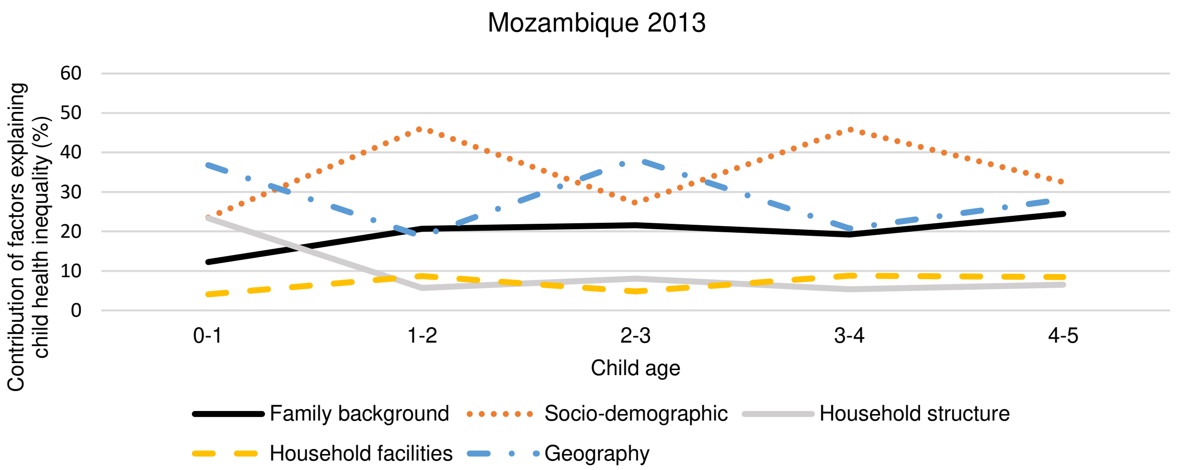
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography



Mozambique 2013
Contribution of factors explaining child health inequality (%)
60
50
40
30
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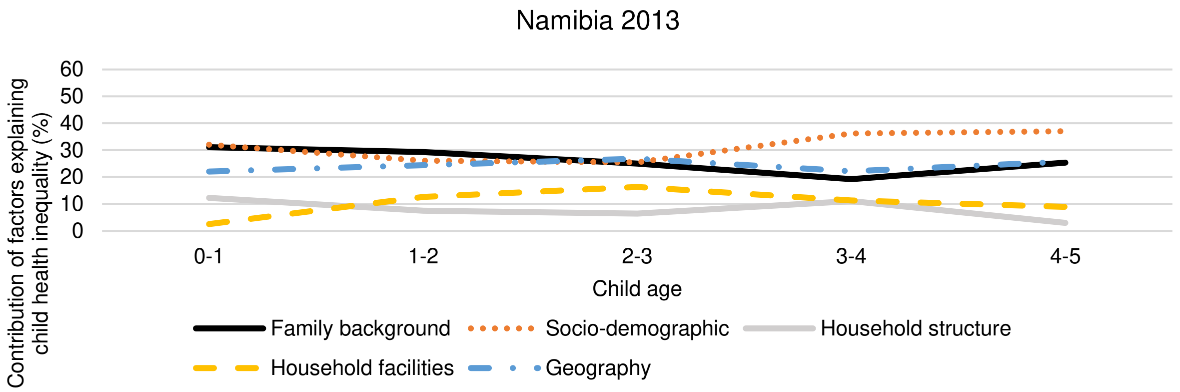
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography



Namibia 2013
Contribution of factors explaining child health inequality (%)
60
50
40
30
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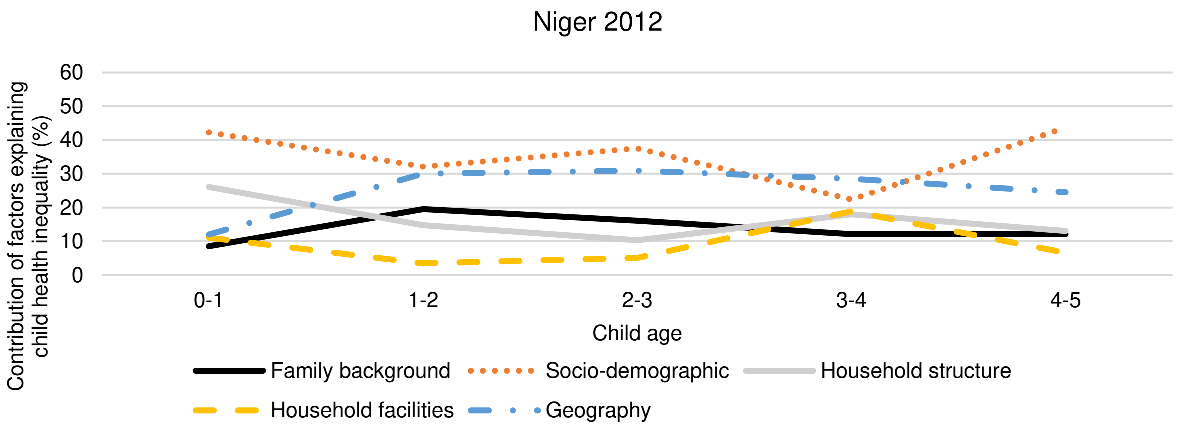
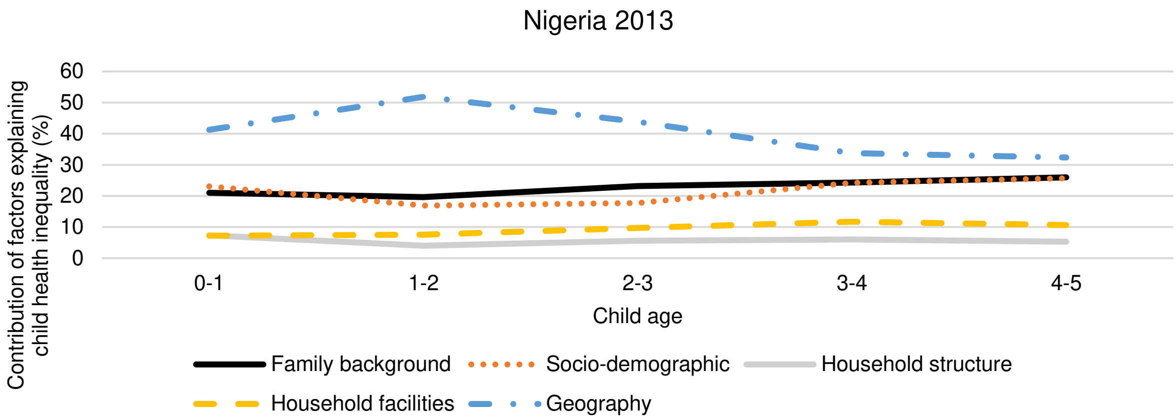
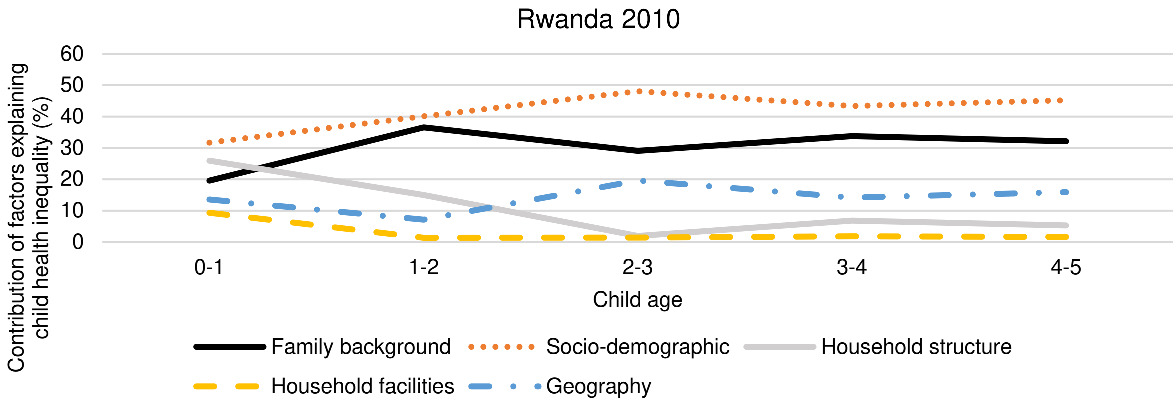
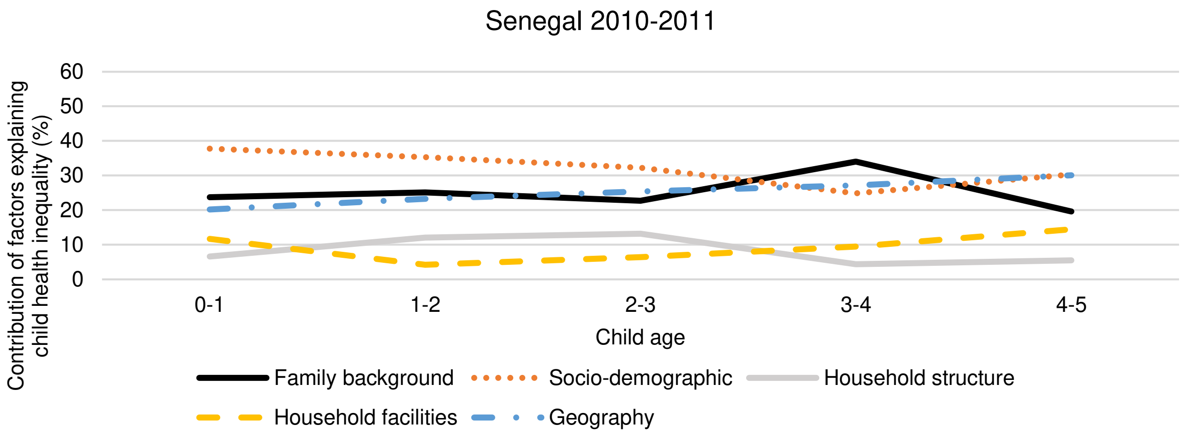
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

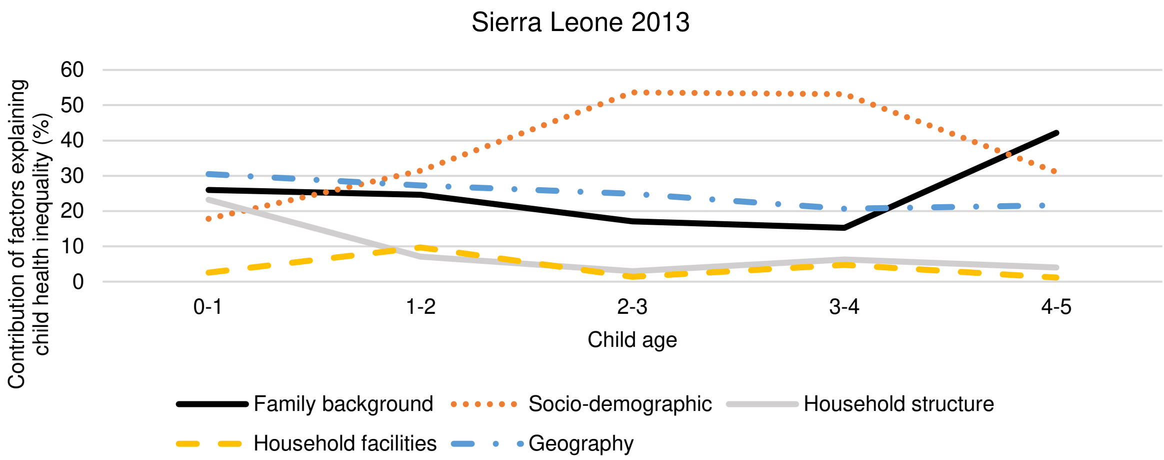


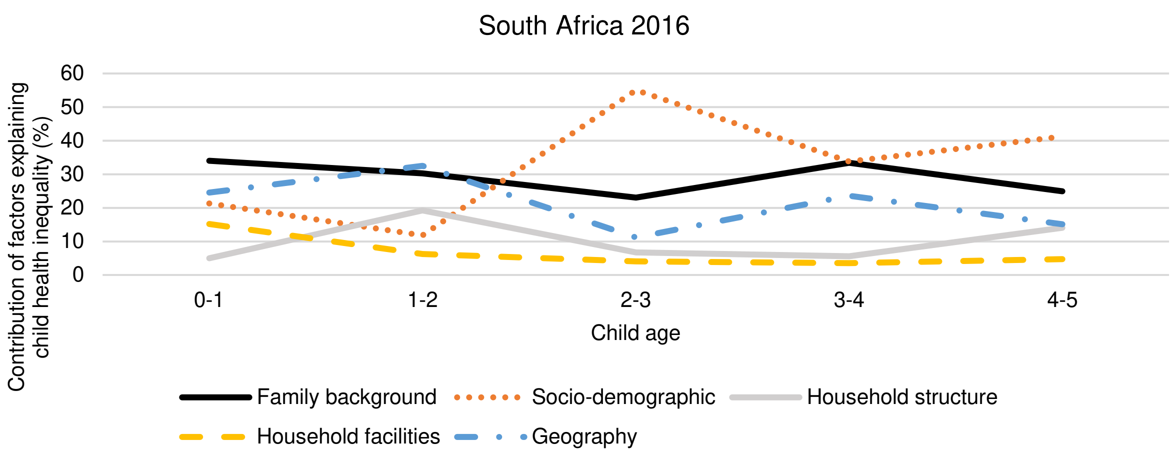
Niger 2012
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

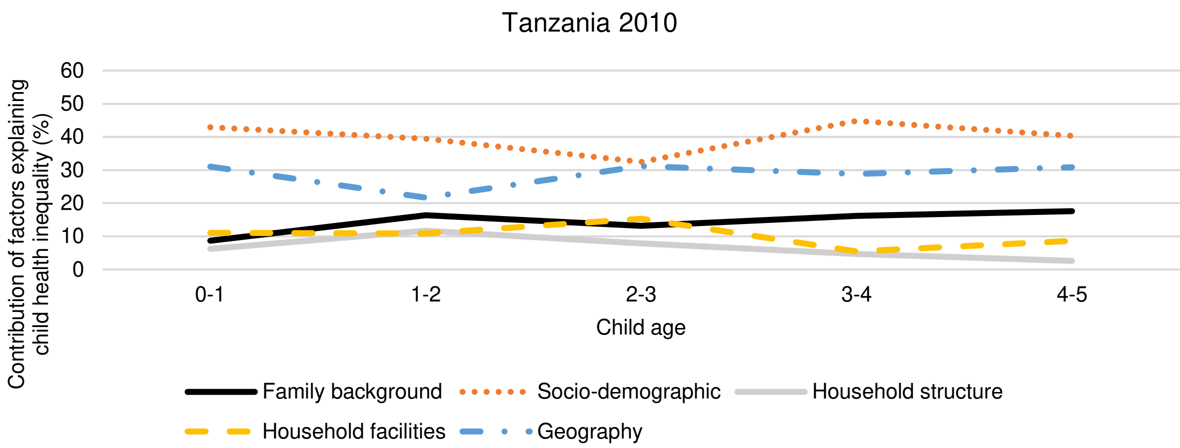

Nigeria 2013
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

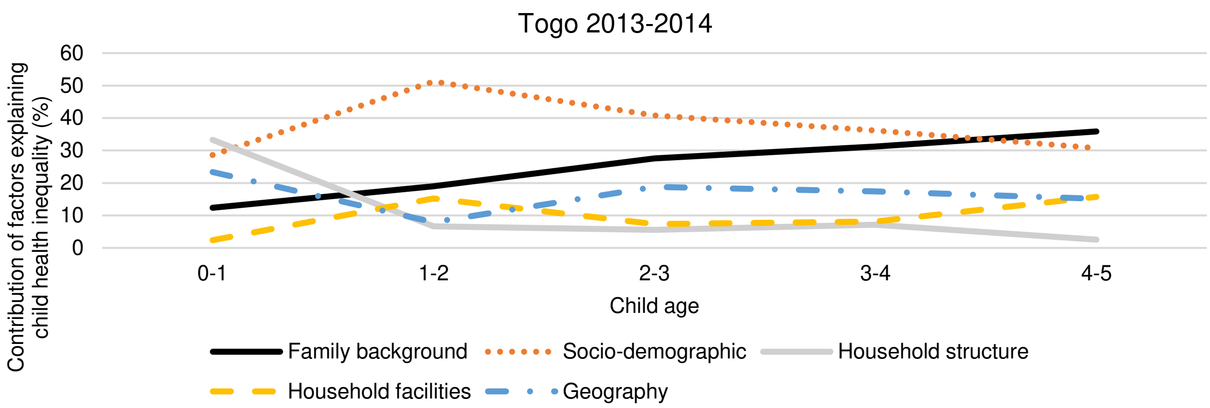

Rwanda 2010
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

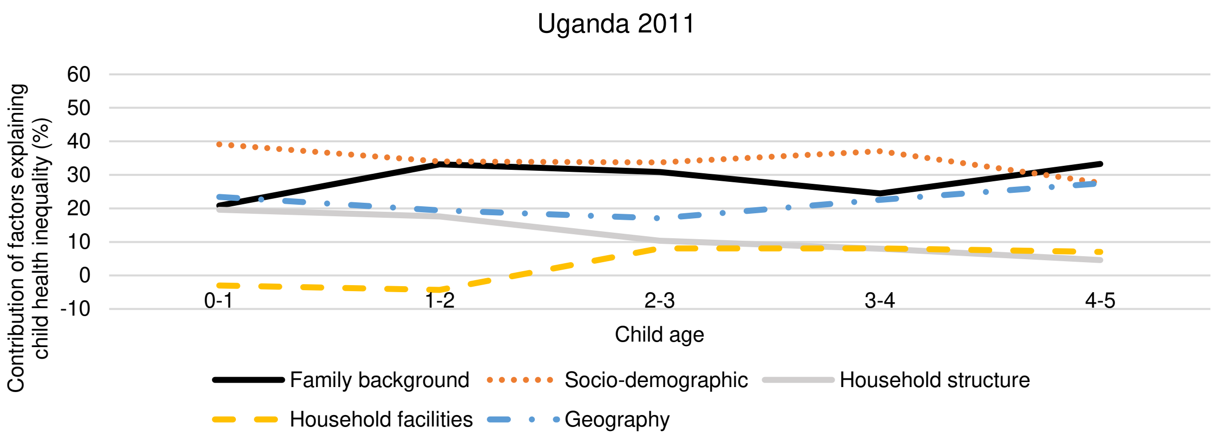

Senegal 2010-2011
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

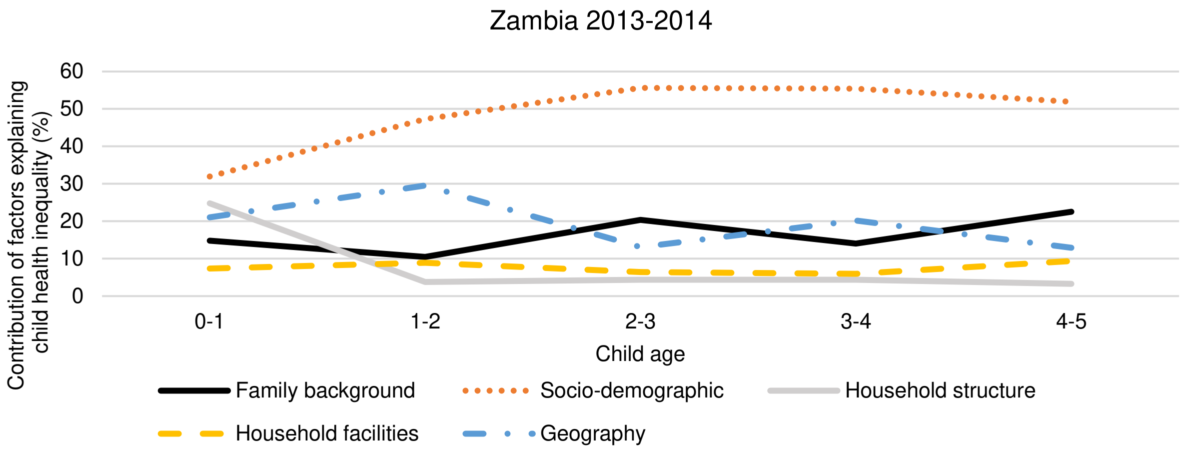

Sierra Leone 2013
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

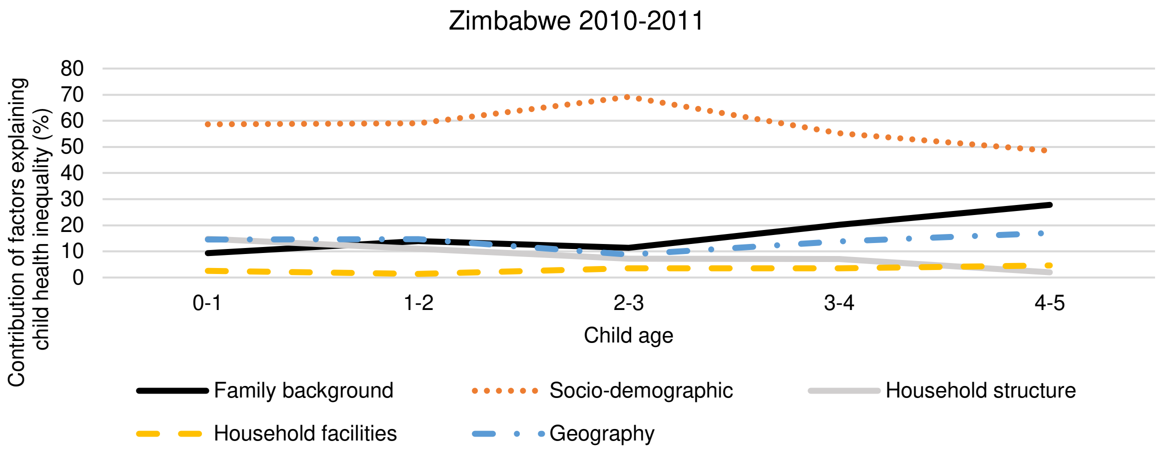

South Africa 2016
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Tanzania 2010
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Togo 2013-2014
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Uganda 2011
Contribution of factors explaining child health inequality (%)
60
50
40
30
20
10
0
-10
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography





Note: Construct by the authors using data from the DHS databases (2009-2016).