IARIW 2021

Monday 23 – Friday 27 August

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Paper prepared for the 36th IARIW Virtual General Conference
August 23-27, 2021
Session 13: Inequalities in Opportunity for Income, Education or Health I
Time: Wednesday, August 25, 2021 [16:30-18:30 CEST]

Child health inequality and opportunities in Sub-Saharan Africa[1]

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September 2020

Abstract:

We estimate child health inequality and the part of inequality caused by measurable factors (*circumstances*), such as family background, the mother socio-demographic and anthropometric factors, household structure, household facilities and the region of residence. For 33 Sub-Saharan countries and using comparable household surveys, we perform this analysis for children below 5 years old, paying special attention to inequality differences by cohorts: from 0-1 up to 4-5 years old. Our measure of child health is the standardized height-for-age z-score corrected by the age (in months) and gender. We show that child health inequality is systematically lesser for the cohort of 4-5 years old than for the younger cohorts, which is consistent with the existence of catch-up. However, the aforementioned set of *circumstances* is impeding a further reduction in child health inequality. Indeed, health inequality caused by these factors (its ratio with respect to total inequality) has risen along the child age distribution in more than 80% of the countries analyzed. We do not find evidences that these results are caused by a mortality-selection bias. Instead, we find that family background, followed by the household facilities and the place of residence of the child, contribute to explaining this evolution of child health inequality in SSA along the age distribution.

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

JEL-Code: I14, I15, O10, P52

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[1] We would like to thank Judit Vall and other participants at the XXVII Meeting on Public Economics in Barcelona for valuable comments and suggestions. The authors acknowledge the financial support of the Ministerio de Economía y Competitividad of Spain through project PID2019-107161GB-C33, and also from Gobierno de Canarias through the R&D project ProID2017010088 (María del Carmen Betancourt y Molina program), co-funded by the Operative Program FEDER 2014-2020. Pérez-Mesa thanks also fundings from Gobierno de Canarias through its FPI program (grant TESIS2019010156). All views, and any remaining errors or omissions are our sole responsibility.

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1-. Introduction

Health is an important channel affecting individual's opportunities. 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). There are solid evidences of the important role that health plays 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). Since health inequality begins at birth, correcting it during infanthood is crucial to improving ongoing opportunities for development and fighting against other forms of inequality.[3] These issues are of special concern in the Sub-Saharan Africa (SSA) region because it is one of the poorest and most unequal regions in the world (Thorbecke, 2013; Alvaredo et al., 2018).

For a set of 33 SSA countries, we use comparable household surveys to estimate child health inequality, and the part of inequality caused by measurable factors, such as family background (e.g., mother's education or wealth of the household), socio-demographic and anthropometric factors 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). We perform this analysis for children below five years old, paying 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. Although we do not have longitudinal information (i.e., information for the same children over time), this analysis by cohorts would provide insights into the following relevant questions: is health inequality existing during the first year of life corrected during the next four years or, on the contrary, are differences maintained or even accentuated? Which factors are behind the changes in child health inequality along the age distribution?

Despite the SSA region having 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). Moreover, recent empirical evidence reveals that inequality of opportunity in consumption (i.e., 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).[4] Regarding health, in spite of a considerable improvement in the region, their current levels of life expectancy or under-five mortality are still much lower

[3] A related literature, which analyzes the social determinants of health (Marmot, 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 a child development, laying the foundation for physical, emotional, and intellectual wellbeing, 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).
[4] This result contrasts with the lower levels obtained in Cogneau and Mesplé-Somps (2008).

and higher, respectively, than in developed countries (WHO, 2018, 2019; Liou et al., 2020).[5] In this context, we find a significant number of papers analyzing child health inequality (of opportunity) in SSA (Zoch, 2015; Hussien and Ayele, 2016; Sanoussi, 2017; Ebaidalla, 2019; Tsawe and Susuman, 2020), 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.[6] Hence, our paper contributes to the existing literature in the understanding of child health inequalities in SSA countries. 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 (circumstances) explaining their changes along the child age distribution.

This attention to equalizing opportunities during early life reinforces and complements the concept of equality of opportunity, which was introduced into economics as a result of Roemer´s (1993, 1998) and Fleurbaey (2008) works, among other authors, and subsequently extended to health by authors such as Rosa Dias (2009) or Trannoy et al. (2009). In this sense, this literature emphasizes that individual's outcomes depend on variables beyond and within the individual's control, called circumstances and effort, respectively. As a result, total inequality can be seen as a combination of inequality caused by different circumstances (inequality of opportunity) and inequality caused by factors more related to preferences of the inherent willingness to exert effort. In this way, 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 health inequality must be considered as inequality of opportunity (Barros et al., 2009; Assaad et al., 2012; Jusot and Tubeuf, 2019). Hence, fighting against child health inequality is a way to equalize opportunities during adulthood and foster posterior economic growth (Marrero and Rodríguez, 2013; 2019). Thus, being aware of this important aspect but, to be consistent with the notation used by aforementioned authors in the health inequality-of-opportunity literature, we refer to our set of measurable factors as circumstances, and to the part of health inequality explained by these factors as Inequality of Opportunity (IO).

We gather information from Demographic and Health Surveys (DHS) VI and VII, covering 33 SSA countries in the 2009-2016 period. Our measure of health is the standardized height-for-age z-score, corrected by age (months of age) and gender. Using a reference gender-age group (i.e., girls at 24 months of age from "the WHO standards"), the standardized measure

[5] Sub-Saharan Africa continues to be the region with the highest under-five mortality rate in the world (78 deaths per 1.000 live births in 2018), 13 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).

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

must be converted into a measure in centimeters in order to use inequality indexes such as the Gini or the Mean Log Deviation, MLD (Pradhan et al., 2003). 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 markets (Katz and Autor, 1999; Kambourov and Manovskii, 2009), for each country, we regress child height (in logs) 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). This adjusted height measure is the one we use in our analysis. Using this adjusted height does not mean that inequality do not change along the age distribution. What we pursue with this adjustment is that our estimations are not caused by the structure of these distributions, i.e., by the composition of gender or children with different ages in a particular country.

To estimate the part of child health inequality explained by the aforementioned set of factors, we follow Ferreira and Gignoux (2011) and estimate an auxiliary regression that relates the (adjusted) child height (in logs) with these factors. Then, we apply the Gini index and the MLD to the fitted part of this regression, thus we calculate the part of inequality explained by these factors, which is our measure of child health IO. We pay special attention to the fraction of inequality that is caused by our set of circumstances IO-ratio (i.e., the fraction of IO with respect to total inequality). We do that for the whole sample and for each age group and show their differences. For each country, we then use a Shapley decomposition approach (Sastre and Trannoy, 2002; Shorrocks, 2013) to measure the fraction of inequality explained by each set of circumstances, for the entire sample and for each age group.[7]

We show that child health inequality is systematically lesser in the cohort of 4-5 years old than in the younger cohorts, which is consistent with the existence of catch-up (Leroy et al., 2015; Desmond and Casale, 2017). For a cross-section analysis, we find a non-significant correlation between the child mortality ratio within each age group and changes in health inequality in posterior age groups, which is an indicative that a mortality-selection bias (Moradi and Baten, 2005; Victora et al., 2010) is not generating this result. However, a more detailed analysis of our results reveals that the aforementioned set of circumstances is impeding a further reduction of child health inequality in most SSA countries. We find that health inequality caused by these factors increases along the child age distribution in more than 50% of the countries analyzed, and its relative importance (its ratio with respect to total inequality) rises in more than 80%. More concretely, using the Shapley approach to decompose health inequality, we

[7] Our estimations take into account 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).

show that family background, followed by the household facilities and the place of residence of the child, are the factors that are contributing more in explaining this result in most of the countries analyzed.

The rest of the paper is structured as follows. In Section 2, we describe the dataset used and shows 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 or measurable factors, including family background, the mother socio-demographic and anthropometric factors, household structure, household facilities and the region of residence. 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 circumstances behind the trends observed in health inequality. Finally, we conclude with Section 6.

2-. Data

We collect data from the Demographic and Health Surveys (DHS) - waves VI and VII - for 33 different SSA countries. Data are referred to years between 2009 and 2016, depending on the country. The countries are (in parenthesis, the year of the survey): Angola (2015-2016), Benin (2012), Burkina Faso (2010), Burundi (2010), Cameroon (2011), Chad (2014-2015), Comoros (2012), Congo (2011-2012), Democratic Republic of the Congo (2013-2014), Cote d'Ivoire (2011-2012), Ethiopia (2011), Gabon (2012), Gambia (2013), Ghana (2014), Guinea (2012), Kenya (2014), Lesotho (2009), Liberia (2013), Malawi (2010), Mali (2012-2013), Mozambique (2011), Namibia (2013), Niger (2012), Nigeria (2013), Rwanda (2010), Senegal (2010-2011), Sierra Leone (2013), South Africa (2016), Tanzania (2010), Togo (2013-2014), Uganda (2011), Zambia (2013-2014) and Zimbabwe (2010-2011). This set of countries represents about 90% of total population in SSA in the 2013-2018 period (World Bank, 2019).[8]

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 (departments, states) and residence level (urban-rural). To achieve this degree of

[8] In general, all results obtained throughout the paper are not affected by the year of the surveys (analysis are available upon request).

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, wages 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).[9]

Table 1 shows general information about the set of DHS surveys used: 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.[10] The table also summarizes information on child height: the average and the standard deviation of the child height-for-age z-score. 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).

[9] 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).

[10] 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-score 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 region	Number of strata	Number of cluster	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. Thus, 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 circumstances: 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 use an inequality-of-opportunity approach to characterize the effect of these factors on child health. In this literature, an individual's outcome (in our case, child height) is a function of factors beyond the individual's control (circumstances) and within the individual's responsibility (the willingness to exert effort). However, as already commented in the introduction, overall health inequality in children should be considered as inequality of opportunity, since a child (below 5 years old) is not responsible for their results (Barros et al., 2009; Assaad et al., 2012; Jusot and Tubeuf, 2019). Hence, heeding this warning, and following these authors, we use the same notation (for comparability and illustrative purposes), and inequality of opportunity (IO) will be that inequality which is due to our observable set of circumstances.

We classify the set of circumstances in five categories: family background, including mother's education, wealth index and mother's occupation; socio-demographic and anthropometric factors 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.

This set of circumstances is available for almost all countries, hence our analysis allows for better comparability (see Table A1 in Appendix A for details).[11] Table 2 shows the descriptive statistics of main circumstances. In our 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

[11] 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.

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.[12] 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.

Table 2. Descriptive statistics of main circumstances

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).

[12] 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).

The average height of the mother is between 155 and 162 centimeters in our set of countries, and the average age of the mother when they have the child is about 26 years old. On average, the mothers have three offspring under 5 years old. 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.[13]

3-. Methodology: child health inequality and inequality of opportunity

3.1-. Measuring 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, using a fixed age/sex reference group (i.e., girls at 24 months of age). The height of children in our sample is transformed to a standardized height using the distribution of heights, by age and sex, of the WHO standards reference population. 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. In principle, this transformation allows the comparability of standardized heights of children at different ages and gender. 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.

[13] Regarding the other circumstances, 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, on average it is the third, while on average around 97% of births are single birth in our set of countries. Finally, the average of households that use solid cooking fuel is 88%.

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 a strong correlation with child age and gender (results are available upon request). Thus, 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., 2019 uses this approach to adjust individual's wealth). 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 set of regional fixed effects (recall from Table 1 that the number of regions is different for each country).

For most countries, the estimated OLS coefficients are significant and with the expected sign (results are available upon request). First, the boy's dummy is positive and significant; second, the estimated sequence of parameters β_j, j=1,2,3, shows a positive correlation between height and age; third, the significance of the squared and even the cubic terms in some countries indicate that the height-age structure is non-linear; fourth, 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, $\widehat{H}$, (a within-group – in age and gender – child height measure) is calculated as follows (the "hat" indicates OLS estimations):

$$\widehat{H}_{ic} = \exp\,[\ln(W_i) - \widehat{\delta_c} D_{ic} - \sum_{j=1}^{3} \widehat{\beta_{jc}} (A_{ic})^j - \sum_{j=1}^{3} \widehat{\gamma_{jc}} D_{ic} (A_{ci})^j]. \quad (2)$$

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 (Gini and MLD) are based on the distribution of $\widehat{H}_{ic}$.

3.2-. Child health inequality of opportunity

To estimate the importance of the aforementioned set of circumstances in child health, we adopt a strategy based on the measurement of inequality of opportunity, IO (Roemer, 1998; Fleurbaey, 2008; Roemer and Trannoy, 2015). Among the existing methods to estimate IO (Roemer and Trannoy, 2015; Ramos and Van de Gaer, 2020), we use the ex-ante parametric approach proposed by Ferreira and Guignoux (2011).[15] This approach permits to take full advantage of the high number of circumstances in our database (14 circumstances, with more than 2000 possible combinations), but it also allows us to analyse the significance that each group of circumstances has in explaining health inequality.

The ex-ante parametric method is based on the estimation of the following reduced form that, in our case, relates the child adjusted height (in logs) and the set of circumstances:

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

where $\widehat{H}_{ic}$ is the adjusted height obtained in (2), and C_1, C_2, C_3, C_4 and C_5 corresponds to the five sets of circumstances 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 circumstances, 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 (all child below 5 years old) and for each child 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 in Section 2.

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 health IO is computed by applying a particular inequality index, I, such as the Gini or the MLD, to the 'smoothed distribution', i.e., IO= $I(\hat{\mu}_{ic})$.

[14] We could also consider gender as an additional circumstance in the estimation of IO 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.

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, and the between-group component can be used as a proxy of IO.[16] 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 share of IO to total inequality 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, although results for the MLD (for the majority of our analysis) are shown in Appendix B. Qualitatively, results are strongly robust to the use of the Gini or the MLD.

4-. Results

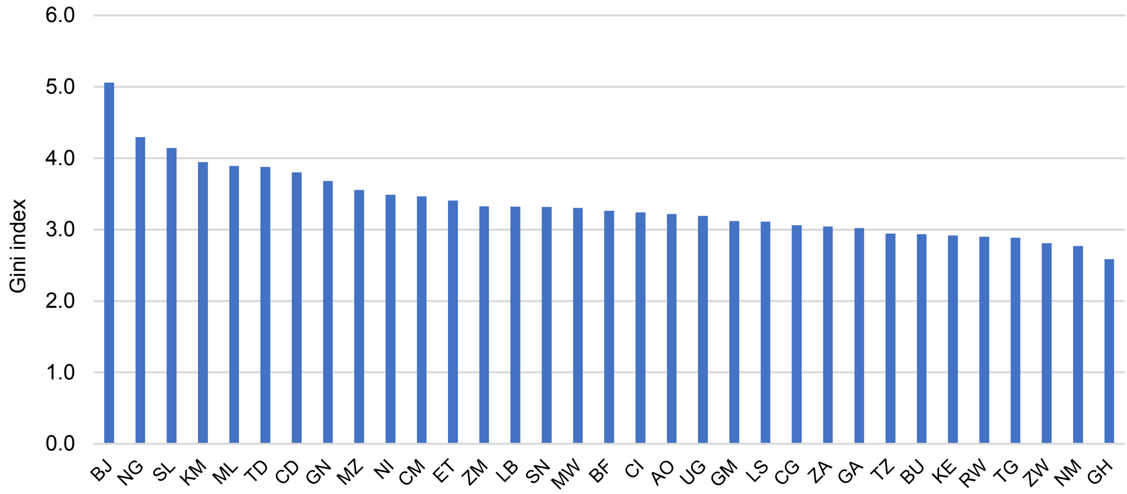
In this section, we first provide health inequality estimates for the whole sample of children under five years old. Second, we show child health IO estimates and analyze main determinants affecting health inequality. Finally, we analyze these inequality measures along the age distribution in our set of 33 SSA countries.

4.1-. Child health inequality

Figure 1 shows child health inequality estimates (using the Gini index) for the whole sample of children below 5 years old and the 33 SSA countries analyzed. Countries are sorted from the highest to the lowest Gini estimates. Figure B1 in Appendix B shows these results for the MLD. Both inequality measures present a similar ranking, with Benin, Nigeria, Sierra Leone, Comoros and Mali the countries with the highest levels of inequality, while Rwanda, Togo, Zimbabwe, Namibia and Ghana experience 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; Kraft, 2015; Hussien and Ayele, 2016).

[16] Given that we are not considering the total number of circumstances affecting child health, the estimated IO is a lower bound. Among the different inequality indexes, the MLD is the only additively decomposable index whose decomposition is path-independent (Foster and Shneyerov, 2000). This latter property of the MLD allows total inequality to be exactly decomposable into a between-group inequality (IO) and a within-group inequality (residual inequality or inequality of effort, as referred in the literature). However, the within-group inequality component contains non-observed circumstances, such as luck and other measurement errors, which prevents consideration of the within-group estimate as a reliable measure of inequality due to individual effort. For that reason, we just look at total inequality and the IO (the between-group) estimates.

Figure 1. Child health inequality (adjusted-height) in SSA countries (Gini, x100)



Notes: Construct by the authors using data from the DHS databases (2009-2016). 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 in Appendix A. In general terms, coefficients have the expected sign. Next, we comment most relevant and robust results in all countries. Regarding the first group of circumstances (family background), mother's education is highly significant in most countries, and it is positively correlated with children's height. With respect to the omitted category (mothers without education), having secondary or tertiary education is associated with about 0.68% and 1.93% more height on average, respectively. In countries such as Angola, Ethiopia, Rwanda or Senegal, this percentage could even rise to 4.45%.[17] 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 1.27% 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 that the mother does not have a job), for given levels of her education and the wealth index of the household, tends to be positively correlated with child height, but it is only significant in four countries (Benin, Chad, Cote d'Ivoire and Kenya).

In the second group of circumstances (socio-demographic factors), mother's height is strongly correlated with children's height in all countries. This correlation reflects – at least partially -

[17] 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 in favoring child health.

the intergenerational transmission of height between parents and children (Subramanian et al., 2009; Venkataramani, 2010; Bhalotra and Rawlings, 2011). Taking the average of all estimated coefficients for this variable (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). This is a measure of intergenerational health transmission. Hence, mothers with differences in height of 10% is translated to differences in the – adjusted - height of their children of about 2.8%. For 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. With respect to the Body Mass Index of the mother, its relationship with child height is similar: an under- or over-weight mother is bad for child height.

Regarding the third group of circumstances (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 partial coefficients, our interpretation of this 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 households, hence more resources can be devoted to, for example, their child health care.

For the fourth group of circumstances (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. For instance, the estimated coefficient of "having an improved source of drinking water" (with respect to an unimproved source of drinking water) is positive most cases but only significant in Mali. In general, households with toilet facilities are positively related to their child's 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. The reduced number of significant coefficients is because this set of variables are positively correlated with the wealth index and other circumstances already included in the first and second group.[18]

In the fifth set of circumstances, living in an urban residence is rarely significant (taking a rural residence as the reference group), and 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 is 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.

4.2-. Child health inequality of opportunity

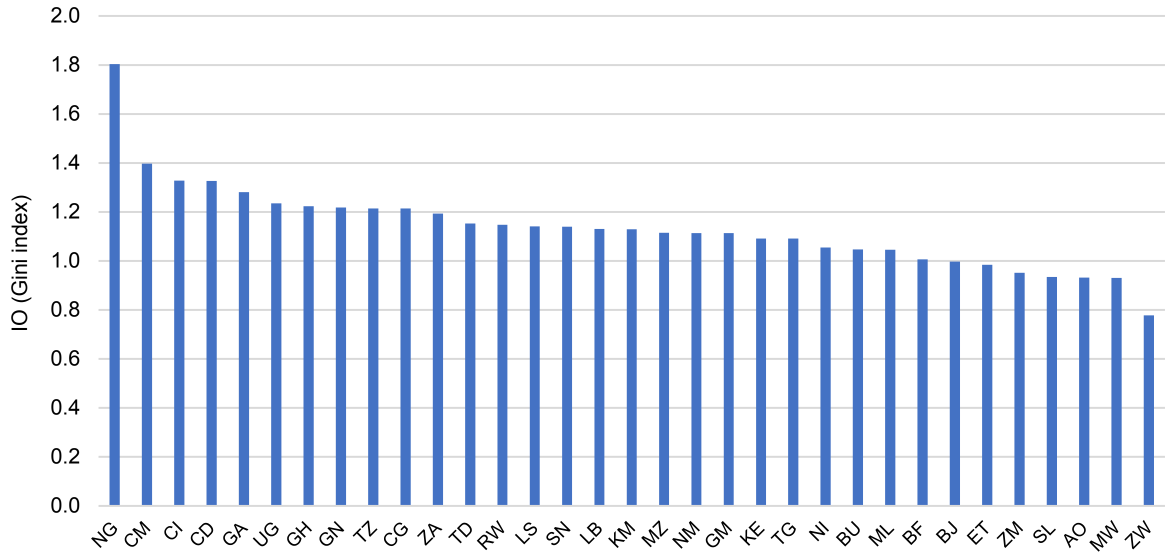
Figure 2 shows estimated child health IO for our set of SSA countries using the Gini index (Figure B2 in the Appendix B shows the result for the MLD). When we compare these estimates with those for total inequality (Figure 1), we have a set of countries that stand out for its high levels of total inequality but also for high levels of health IO. These countries are Nigeria, Democratic Republic of the Congo and Guinea. Meanwhile, Cameroon and Uganda show high levels of heath IO, while moderate levels of total inequality. Zambia, Sierra Leone, Angola, Malawi and Zimbabwe show the lowest levels of child health IO.

It is informative to compare the levels of total inequality and IO with its ratio (i.e., the IO-ratio), which measures the share of total child health inequality that is explained by the set of circumstances described above. This set of circumstances, of which some of them are also used to measure income or wealth inequality of opportunity, are measurable factors that can be tracked and followed over certain groups of individuals (i.e., over age groups) and over time. Thus, measuring and understanding this ratio is relevant to implementing policies that correct the origin of this type of inequality. In the following section, using a Shapley decomposition approach, we show which set of circumstances contribute more to explain child health IO. For remaining inequality (the fraction non-explained by this set of circumstances), we know that it can be associated with other non-observed circumstances, luck or unexpected shocks. Probably, part of this inequality disappears over time, but, since these factors cannot be measured, direct interventions are difficult to implement.

[18] For instance, if we omit the wealth index from the regression, the variables drinking water, toilet facilities and/or cooking fuel becomes significant (and with the expected sign) in several countries, such as in Cameroon, Congo, Liberia, Mozambique, Niger, Nigeria or Rwanda. Moreover, in general, although they are maybe not significant individually, they tend to be joint significant.

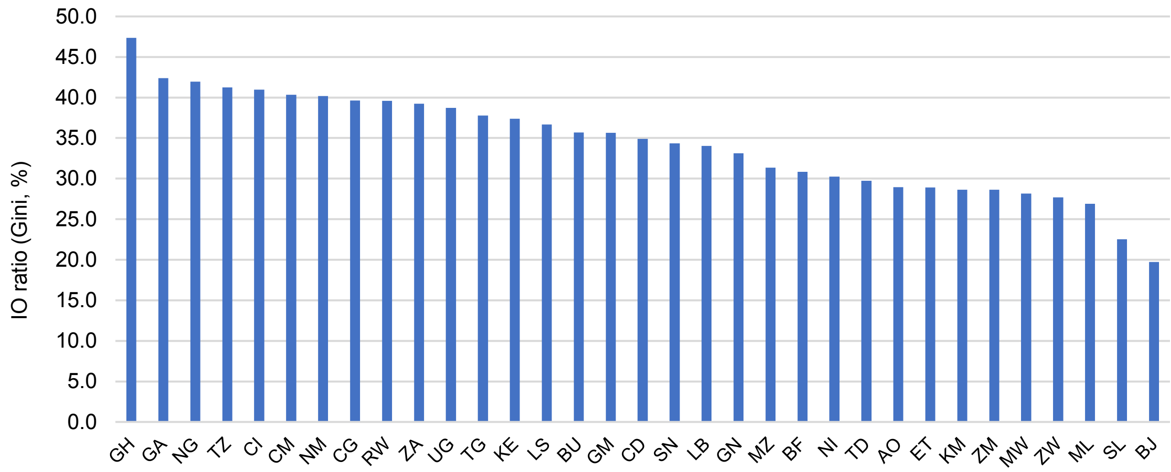
Figure 3 shows the ranking of the IO-ratio for the Gini (Figure B3 in Appendix B shows the result for the MLD). Ghana, Gabon, Nigeria, Tanzania and Cote d'Ivoire now show the highest shares of IO with respect to total inequality (about 41%-47% for the Gini), while Malawi, Zimbabwe, Mali, Sierra Leone and Benin experience the lowest shares (about 20-28% for the Gini).

Figure 2. Child health IO (adjusted-height) in SSA countries (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 inequality of opportunity ratio in SSA countries (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, IO and IO-ratio). The table shows the division of our sample of countries according to its position, in terms of percentiles, in the ranking of the three measures of child health inequality. It classifies countries below p25 (low-inequality), between p25 and p75 (mid-inequality) and above p75 (high-inequality). Additionally, the countries in bold shows an IO-ratio above the 75th percentile (p75, high IO-ratio) and countries underlined are those with an IO ratio below the 25th percentile (p25, low IO-ratio). All other countries have an intermediate level of the IO-ratio (between percentiles 25 and 75).

Thus, for example, Zimbabwe is below p25 both in total inequality and in IO, 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 IO, 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 levels of IO present also the lowest levels of the IO-ratio. Conversely, the countries with the highest levels of IO are the countries with the highest levels of the IO-ratio. However, some countries, such as Namibia, Tanzania and Congo, show intermediate levels of IO and are above p75 in the IO-ratio. Meanwhile, Comoros and Mali also belong to the intermediate levels of IO but present low levels of the IO-ratio. Of course, these situations depend on the comparison between IO and total inequality (results for the MLD estimates are similar, and they are available upon request).

Table 3. Low, mid and high child health inequality, IO and its ratio in SSA countries

	Low inequality of opportunity (<p25)	***Mid inequality of opportunity (p25-p75)***	***High inequality of opportunity (>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 of opportunity. 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 IO ratio (low IO-ratio), while countries in bold letter are those above p75 in this measure (high IO-ratio).

4.3-. 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 (between one and five years old). The evidence provided in this section is based on comparing inequality (total and IO) at different age groups for each country.

We estimate total child health inequality and IO 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. For the child health IO, we estimate equation (3) for each country and age group, and then apply the inequality index to the resultant fitted child height distribution. Estimation results for each child age and country are available upon request. Results of these estimations show, in general, the expected sign, and the most significant circumstances are similar to those found for the overall sample. However, it is worth noting that the significance and the magnitude of the coefficients change with the age group, which could imply differences depending on the child age in the contribution of each set of circumstances on child health (Section 5 performs this analysis).[19]

Figure A4 in Appendix A shows child health inequality and health IO (for the Gini) at different age groups for each of the 33 SSA countries analyzed (results for the MLD are similar and available upon request). To focus on their differences, their values are equal to one for the 0-1 age group. We also show the IO-ratio for each age group. There is a factor common to all countries: total child health inequality shows a downward slope with respect to child age (the exception is Chad, where overall inequality remains at the same level). This result is consistent with the existence of some evidence of catch-up in health in our sample.[20] However, for IO, results are mixed, and we find that, with respect to the 0-1 year old group, child health IO is lower for the 5 years old group for 18 countries (55% of the sample), while it is higher for 15 countries (45% of the sample). We will come back to this result later.

Figures 4 and 5 summarize the above findings in a more compact way. They confront child health inequality and child health IO (using the Gini), respectively, for the one year (x-axis) and the five years old group (y-axis) for the 33 SSA countries (Figures B4 and B5 in the Appendix B replicate this analysis for the MLD). Coming below the 45-degree line indicates that health inequality is lesser for the 4-5 years old group than for the 0-1 group. In our case, all countries

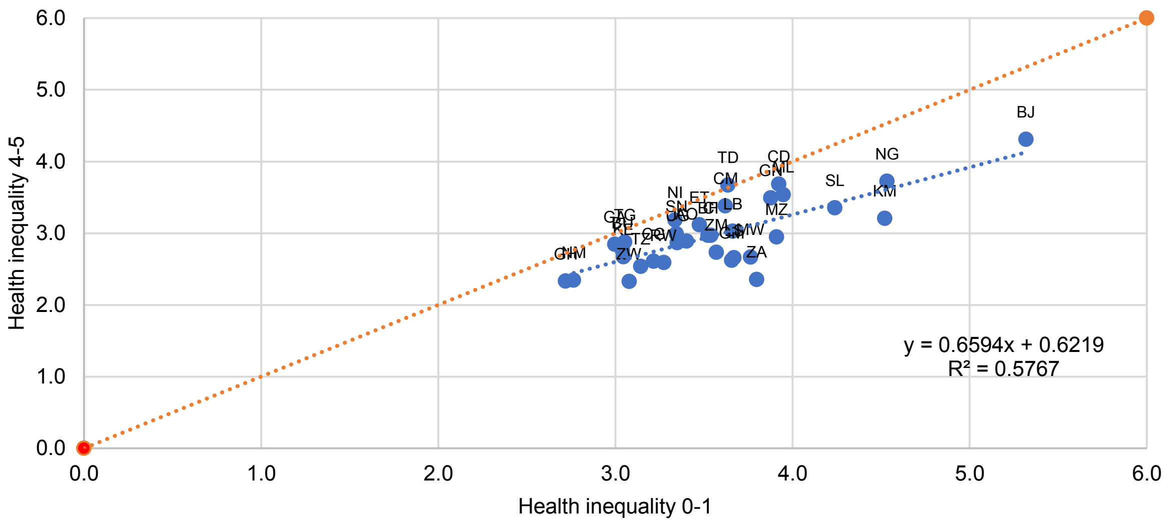
[19] We find that mother's education and the wealth index remain the most important variables within the family background group, and mother's job remains rarely significant. Regarding the socio-demographic group, mother's height is highly significant in almost all countries, while mother's age and mother's 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.

[20] 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 indicative of catch up in child health.

are below this line for overall inequality, while almost half are below and half over the line for health IO.

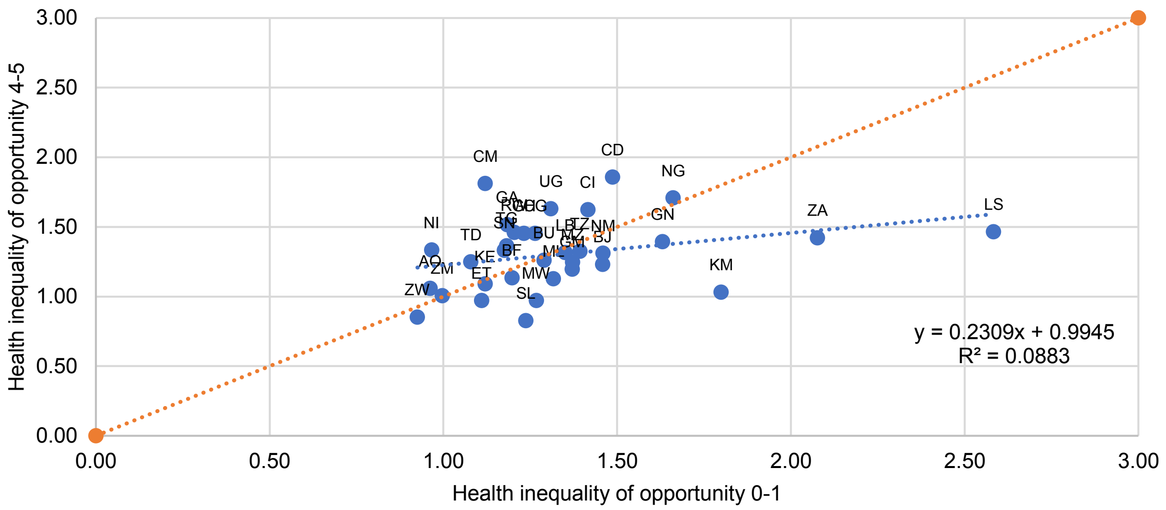
It is worth noting that a mortality-selection bias could be behind the evidence of this reduction in child health inequality along the age distribution (Moradi and Baten, 2005; Victora et al., 2010). Higher mortality in children with the worst health during their first year of life can make countries with high health inequality within this group reduce health inequality faster in posterior groups. We analyze this possibility for our sample in Figures A2 and A3 in Appendix A. To this purpose, we construct a mortality share series for each country and each age group (data come from the same database, the DHS children-recode module for each country).[21] Then, for each age group and for a cross-country analysis, we compare these shares with the changes in health inequality and health IO in posterior age groups. The absence of a significant correlation between these series would be an indicative that the mortality-selection bias is not an important concern in our results. Thus, the reduction of overall health inequality along the age distribution could be due to improvements in the way that certain circumstances 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 most 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)



[21] 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 IO 0-1 and 4-5 years in SSA (Gini, x100)



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, IO or the IO-ratio. Table 4 summarizes results. A first group (11 countries) is characterized by a reduction in total inequality, an increase in health IO and an implied large increase in the IO-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 health IO increases or decreases slightly and, in all cases, the IO-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 IO than in total inequality, so the IO-ratio decreases, is formed by 4 countries: Ethiopia, Guinea, Mali and Sierra Leone. Finally, a fourth group composed by Comoros and Lesotho, where health IO falls much more than total health inequality, and hence it makes IO ratio drop much more than in group 3 (a reduction greater than 20%). Summing up, 27 countries increase their IO-ratio between 0-1 and 4-5 years old, while only 6 countries reduce this ratio along the age distribution.

In general, we cannot detect a significant association between this classification of countries and their geography, since we find countries that belong to different regions of the SSA (West, Central, East, South) in each group.[22] However, it is noteworthy that, between the 8 countries above the 75th percentile of IO in Table 4 for the overall sample of children, 6 of them –

[22] A further cross-section analysis including other macroeconomic variables requires a large sample of countries or regions and/or different years (to construct a panel database), which goes beyond the scope of this paper.

Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Gabon, Ghana, Uganda – show a large increase in the IO-ratio between the 0-1 and the 4-5 age groups.

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

	IO (4-5) << IO (0-1)	**IO (4-5) <=> IO (0-1)**
IO-ratio (4-5) < IO-ratio (0-1)	Comoros and Lesotho. *(Large decrease of IO ratio)*	Ethiopia, Guinea, Mali and Sierra Leone. *(Moderate decrease IO-ratio)*
IO-ratio (4-5) > IO-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 IO-ratio)*	Angola, Cameroon, Congo, Democratic Republic of the Congo, Cote d'Ivoire, Gabon, Ghana, Niger, Rwanda, Uganda and Zambia *(Large increase of IO-ratio)*

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

In summary, we have shown that total child health inequality decreases along the age distribution in almost all SSA countries, while child health IO has increased in some countries but has decreased in some others. However, the child health IO-ratio has increased with the age distribution in most countries. These results indicate that, in most SSA countries, the child health inequality explained by our set of circumstances is becoming more important as children become older. Hence, a further reduction of inequality in children's health inevitably involves levelling the circumstances of children's departure (i.e., equality of opportunity policies) or, failing that, minimizing the impact that these factors have on health by implementing compensatory policies. In the next section, among the five sets of circumstances considered, we analyse which ones are more correlated with changes in child health IO along the age distribution in a cross-country analysis.

5-. Decomposing child health inequality

In this section, we perform a Shapley decomposition (Sastre and Trannoy, 2002; Chantreuil and Trannoy, 2013; Shorrocks, 2013) to determine the impact of the different groups of circumstances to explain child health IO (overall and along the age distribution). We follow Israeli (2007) and apply the Shapley decomposition to the R2 resultant from the linear regression estimated in equation (3).[23] The decomposition determines which fraction of the variability of the child height (in logs) is attributed to each set of circumstances (we consider the five sets of circumstances described in Section 2).[24]

For the whole sample of children under-5 years old, Table 5 summarizes this decomposition for all countries analyzed.[25] On average, we find that "socio-demographic" factors, which include factors such as mother's height, mother's age and mother's body mass index, is the most important group of circumstances in almost all countries in the sample. This group explains, on average, 44% of the variability of child health IO. "Family background", with an average share of 20.7%, and "geography", with an average share of 20.6%, are the second and third more relevant groups. "Household structure" and "household facilities" are the least important, representing on average about 9% and 6% of the variability of child health IO in SSA, respectively. However, as we will show below, results might change when we look at the set of circumstance that can help explain changes of inequality along the age distribution.

We also find relevant differences in the contribution of these sets of circumstances if we look at each country. For example, socio-demographic factors explain 78% of the child health variability in Zimbabwe and just 20.6% in Benin, or 42% in Mozambique. 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" group is the most important set of circumstances 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 in the sample (12.4% is the maximum in Cote d'Ivoire).

[23] 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 circumstances. 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, as we explain in more details in the following footnote, in our case, the R^2 of the log-linear regression is strongly correlated with the estimated IO-ratio for the Gini and the MLD. Hence, our decomposition can be seen as a decomposition of the IO-ratios estimated in Section 3, which is what we are looking for.

[24] The R^2 of the regression is similar to the IO-ratio estimated in Section 3, since both measures capture the variability or dispersion of the dependent variable (child height) that is explained by our set of circumstances. Therefore, variations and differentials in R^2 are like variations and differentials in the IO-ratio. For instance, for our set of countries, the cross-country correlation between the R^2 and the IO-ratio is 0.986 for the Gini and 0.999 for the MLD. These correlations are above 0.95 if we look at any child age in the age distribution.

[25] We show the results of Angola for illustrative purposes. Since Angola does not have data information about "socio-demographic factors", we do not use it for a comparative analysis in this section. Their results are not comparable with those of the other countries.

Table 5. Contribution of circumstances to child health IO in SSA countries (%)

ISO code	Country	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	Democratic Republic of the 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.

In the second part of this section, we look at this decomposition in different child age groups. Table 6 and Figure 6 show the average values for the Shapley decomposition for these different groups. In general, we observe a similar order in the contribution of the set of circumstances explaining child health IO for each child age cohort: first socio-demographic factors, followed by family background and geography, and finally household structure and household facilities.

However, we need to look at the changes along the age distribution to connect these results with the changes in child health IO characterized in the previous section. Indeed, we find that some of these contributions change significantly along the age distribution, and these changes are not uniform across countries. Table 6 and Figure 6 summarize these evolutions (the average levels) along the age distribution. For instance, on average, the group of circumstances related to “family background” shows a clear growth 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 percentage points). The “household facilities” group, in spite of showing one of the smallest percentages (on average) in Table 5, shows a growth trend with the age of children, although less pronounced than the family background group: it represents 5.8% for the 0-1 age group and 7.4% for the 4-5 group (a change of 1.6 percentage points). On the contrary, the contribution of the “geography” and the “household structure” groups decrease throughout the child age distribution. For instance, the “household structure” group reduces its contribution from 15.5% for the 0-1 age group to 6.1% for the 4-5 group (9.4 percentage points), which basically compensates the increase of the “family background” group. Meanwhile, “geography” reduces its contribution from 24.4% for the 0-1 to 22.8% to the 4-5 group (1.6 percentage points), which compensates the increases in the weight of the “household facilities” group. Finally, the “socio-demographic” group, which recall that is, on average, the most important among all sets of circumstances (Table 5), shows a stable trend. Hence, its contribution to child health IO is almost constant around 34.5% along the entire age distribution of the children.

Our analysis corresponds to an average overview in our set of SSA countries. However, a closer look at data finds relevant differences in these trends. Figure C1 in Appendix C collects the set of figures for this decomposition for each country in the sample. For instance, we find that the family background group reduces its contribution to explain health IO in countries such as Chad, Namibia or Senegal. Also, the importance of the “socio-demographic” group increases its importance in countries such as Burkina Faso, Lesotho or Rwanda, and decreases in others such as Gabon, Liberia or Uganda. Or, for example, we find also that the household structure group shows an upward trend along the age distribution in Burundi, Ethiopia or Gambia.

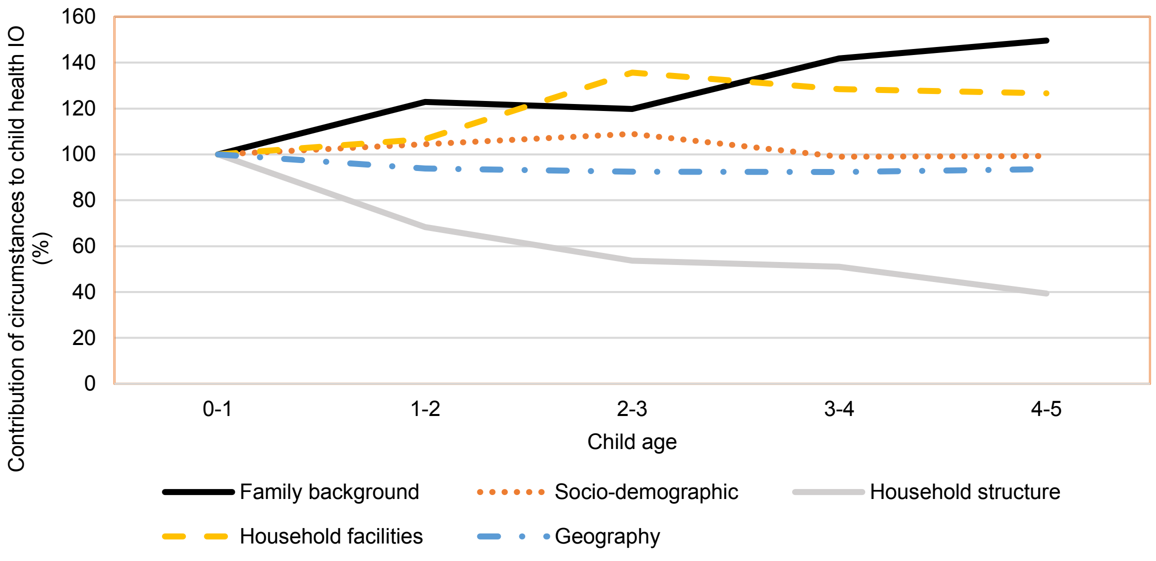
As commented above, total child heath inequality reduces with the age distribution in all countries, but health IO does not. Hence, in most SSA countries, the inequality that is explained by the selected group of circumstances gains importance with the age distribution. Are the different cross-country patterns of circumstances correlated with the different trends observed for health IO along the age distribution in Section 4? In this sense, a cross-country analysis can shed some light on understanding what group of circumstances must be intervened to correct the IO as children become older in SSA countries. Nevertheless, in no case should the results of this exercise be interpreted as policy recommendations.

Table 6. Evolution of the average contribution of circumstances to child health IO by age 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 circumstances explaining child health inequality of opportunity; in columns, the age groups. Standard deviation in parenthesis.

Figure 6. Evolution of the average contribution of circumstances in child health IO by age in SSA (%)

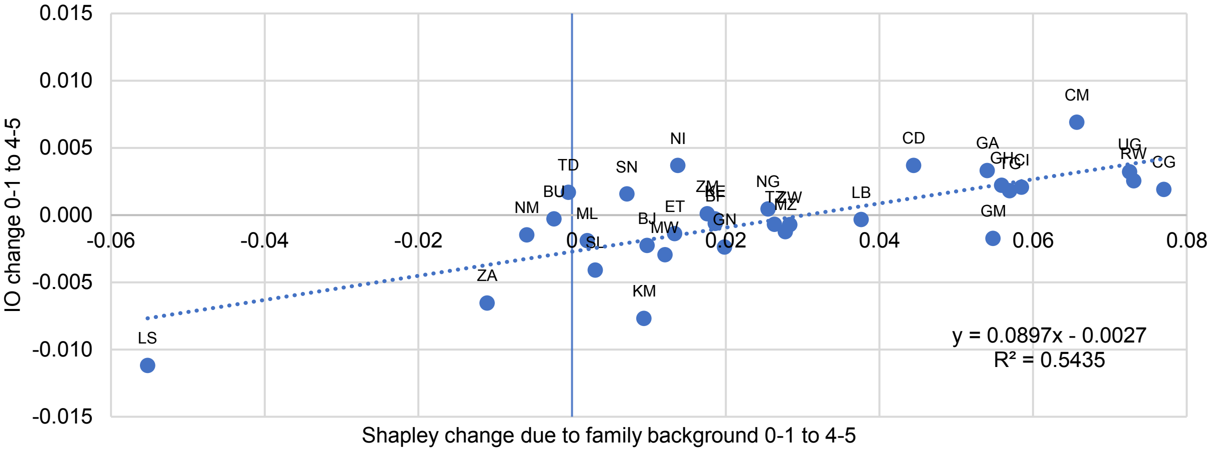


Note: Construct by the authors using data from the DHS databases (2009-2016).

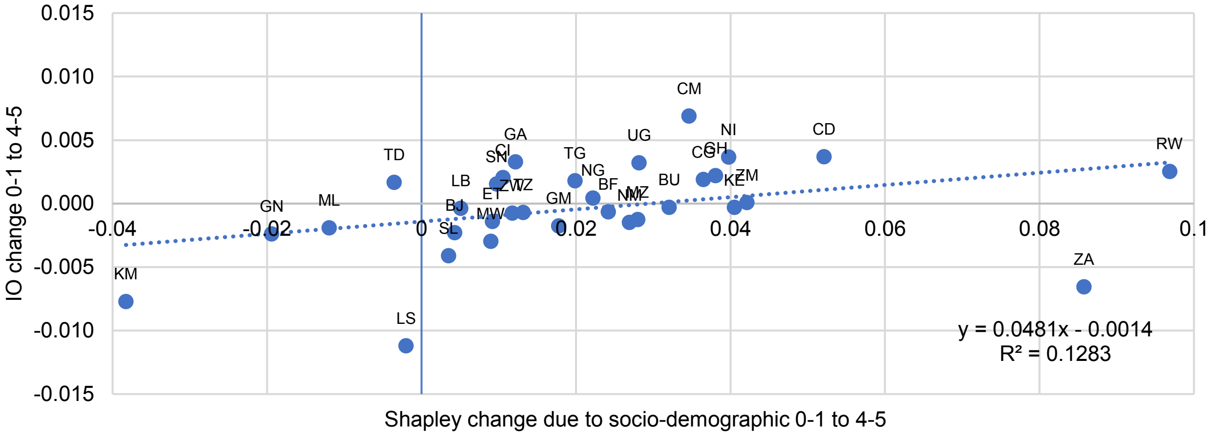
Figure 7(a-e) shows the cross-country correlation between the changes in the Shapley value of each group of circumstances between the 0-1 and the 4-5 age group and the changes in health IO in both age groups. To isolate the correlation over health IO, we compare the changes in IO and the changes in IO explained by each group of circumstances (obtained from the Shapley decomposition). We find a positive and highly significant cross-country correlation between the changes along the age distribution in child health IO and the changes in the Shapley value of three groups: family background, household facilities and geography. On the contrary, for the household structure group, the cross-country correlation is null, while for socio-demographic factors the correlation is positive but very small and hardly significant.

Figure 7(a-e). Correlation between changes in Shapley values of circumstances and changes in child health IO between 0-1 and 4-5 years in SSA countries

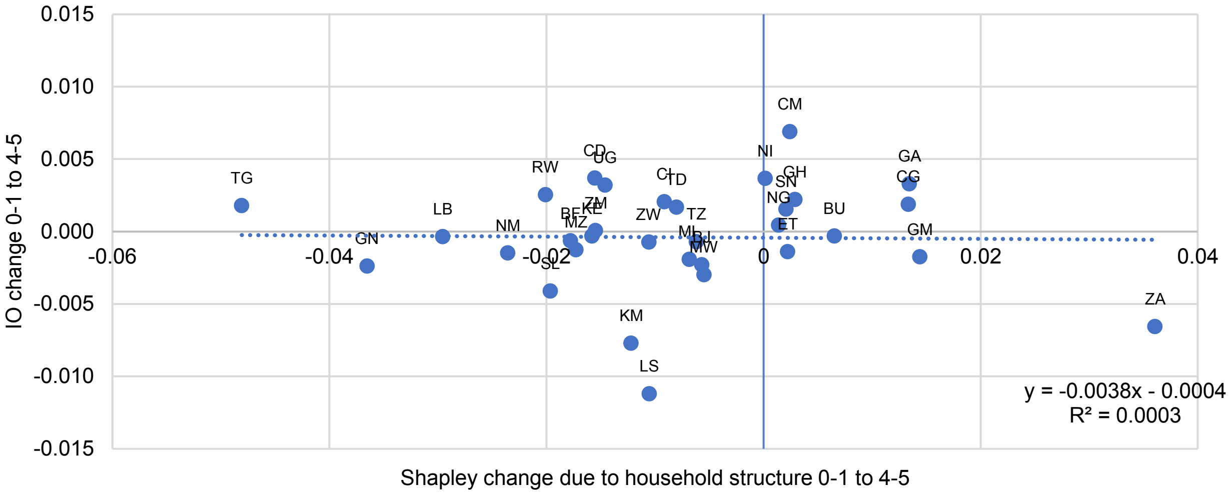
a) Family background



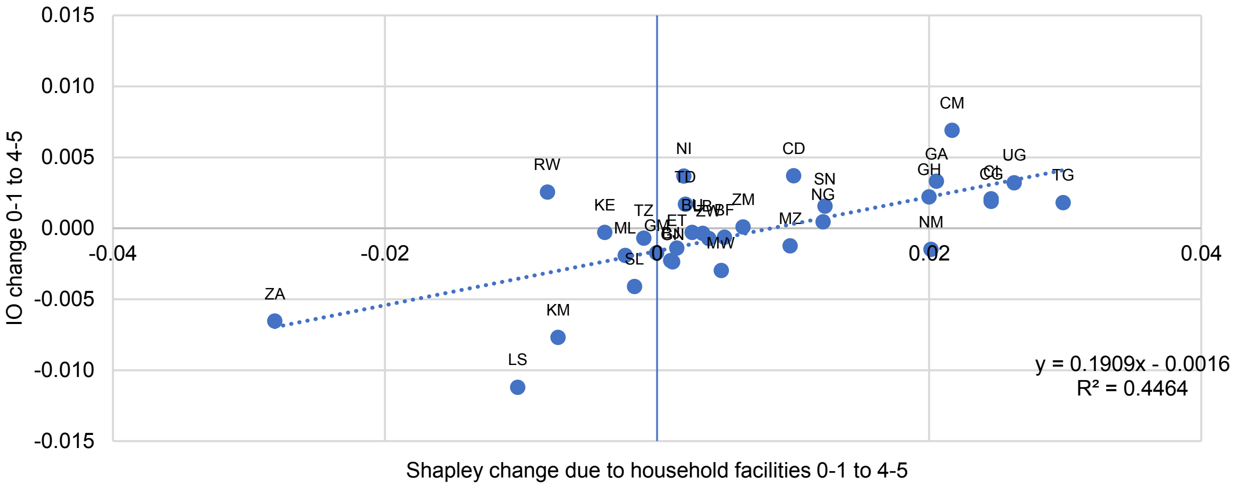
b) Socio-demographic factors of the mother



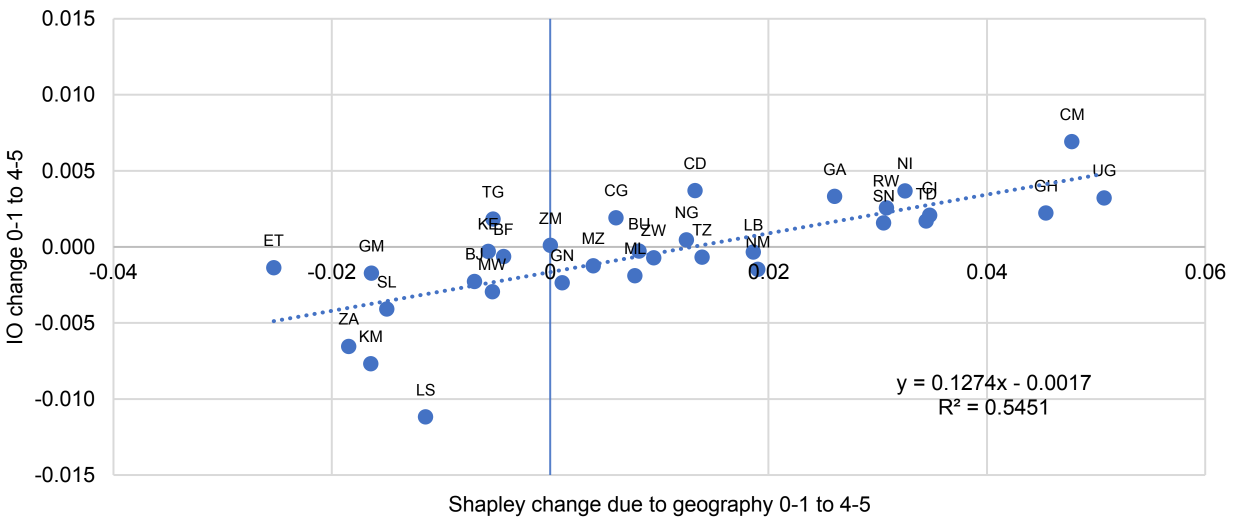
c) Household structure



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 during adulthood. This paper contributes to the understanding of child health inequalities and health inequality of opportunities (IO) in Sub-Saharan countries. Our measure of health is the standardized height-for-age z-score corrected by age (in months) and gender. The set of factors used to calculate the IO are related to parental socioeconomic status, socio-demographic factors, household structure, facilities at home and other exogenous factors such as the region or living in urban or rural areas. We collect data from the Demographic and Health Survey (DHS) VI and VII, covering a total of 33 SSA countries in the 2009-2016 period. For each country, we characterize how child health inequality and IO evolves with child age (between one and five years old), so we can analyze when the initial levels of health inequality (for children below 1 year) are corrected with age or, on the contrary, health differences are maintained or even accentuated. Moreover, through a Shapley decomposition approach, we can characterize the circumstances behind the changes observed in the child health IO along the age distribution.

First, our results show that both for the overall sample and for each age group, mother's education, wealth index, mother's height and type of childbirth are the most important circumstances affecting child height. Second, we classify our sample of countries into low-inequality, mid-inequality and high-inequality, according to their position in terms of percentiles in the ranking of the three measures of child health inequality. Thus, Democratic Republic of the Congo, Guinea and Nigeria are above percentile 75 in total inequality and in IO, while just Zimbabwe is below percentile 25 in both measures. Moreover, we find, in general, countries with the lowest levels of IO also present the lowest levels of the IO-ratio, and the countries with the highest levels of IO are the countries with the highest levels of the IO-ratio.

Third, the only common factor to all countries is that total child health inequality decreases along the age distribution in almost all the countries in our sample, which is consistent with the existence of some evidence of catch-up in health, while child health IO in some countries increases (i.e., Cameroon, Ghana and Uganda) but in others decreases (i.e., Comoros, Malawi and South Africa). However, child health IO-ratio increases in most countries. These results show that, in most SSA countries, the child health inequality explained by our set of circumstances is becoming more important as children become older.

Fourth, although we find relevant differences in the contribution of these sets of circumstances if we look at each country, socio-demographic factors are the most important group of circumstances in almost all countries in the sample, followed by family background and geography. Household structure and household facilities are the least important set of circumstances. We observe a similar order in the contribution of the set of circumstances explaining child health IO in both the overall sample and in each child age cohort. However, we find that some of these contributions change significantly along the age distribution, and these changes are not uniform across countries. On average, family background and household facilities show a growth trend in their contributions to child health IO along the age distribution, while the contribution of the geography and the household structure groups decreases throughout the child age distribution. Socio-demographic factors show a stable trend, where their contribution to child health IO is almost constant.

Finally, in a cross-country analysis, we find that the groups of family background, household facilities and geography are correlated with the increase of health IO along the age distribution. On the contrary, demographic factors and household structure do not significantly correlate with child health inequality changes along the age distribution.

Our results are descriptive and based on simple correlation analysis. Therefore, the policy conclusions that we can draw from our results should be seen simply as potential lines of exploration and action, and not as policy recommendations. That said, our results indicate that a further reduction of inequality in children's health inevitably involves levelling the circumstances of children's departure through equality of opportunity policies or, failing that, minimizing the impact that these factors might have on health by implementing compensatory policies. In this sense, the evidence shows the importance of early-life interventions as a window of opportunity to prevent the loss of the developmental potential of children affected by growth failure. Thus, any comprehensive strategy for resolving the problem of child malnutrition must include an integrated and intersectoral approach taking into account the actions to address the structural factors (the set of circumstances) that influence child development in SSA countries at different stages of a child's life (Smith and Haddad, 2000; UNICEF, 2012). Education is a key factor that can change the cycle of disadvantage, so mother´s education is one of the most important variables which can correct child health inequality during childhood (Smith and Haddad, 2000, 2002; Harttegen, Klasen and Vollmer 2013; Headey, 2013). Besides, policies related to enhancing health environment quality and access to health services are relevant to improvements in child health, so they can also contribute to reducing the effect of the place of residence.

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Appendix A

Table A1. Description of the circumstances

Circumstances	***Definition***	***Categories***
Mother's education	Mother's highest education level attended	No education (omitted) Primary Secondary Higher
Wealth index	Composite measure 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; 500-2500 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; 10-49 years
Offspring	Total number of sons and daughters living at home	Not categories; 0-20 children
Birth order	Order number in which the children were born	Not categories; 0-20
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 circumstances: 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 circumstances: 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 circumstances: 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 circumstances: OLS estimates for overall sample by country (continued)

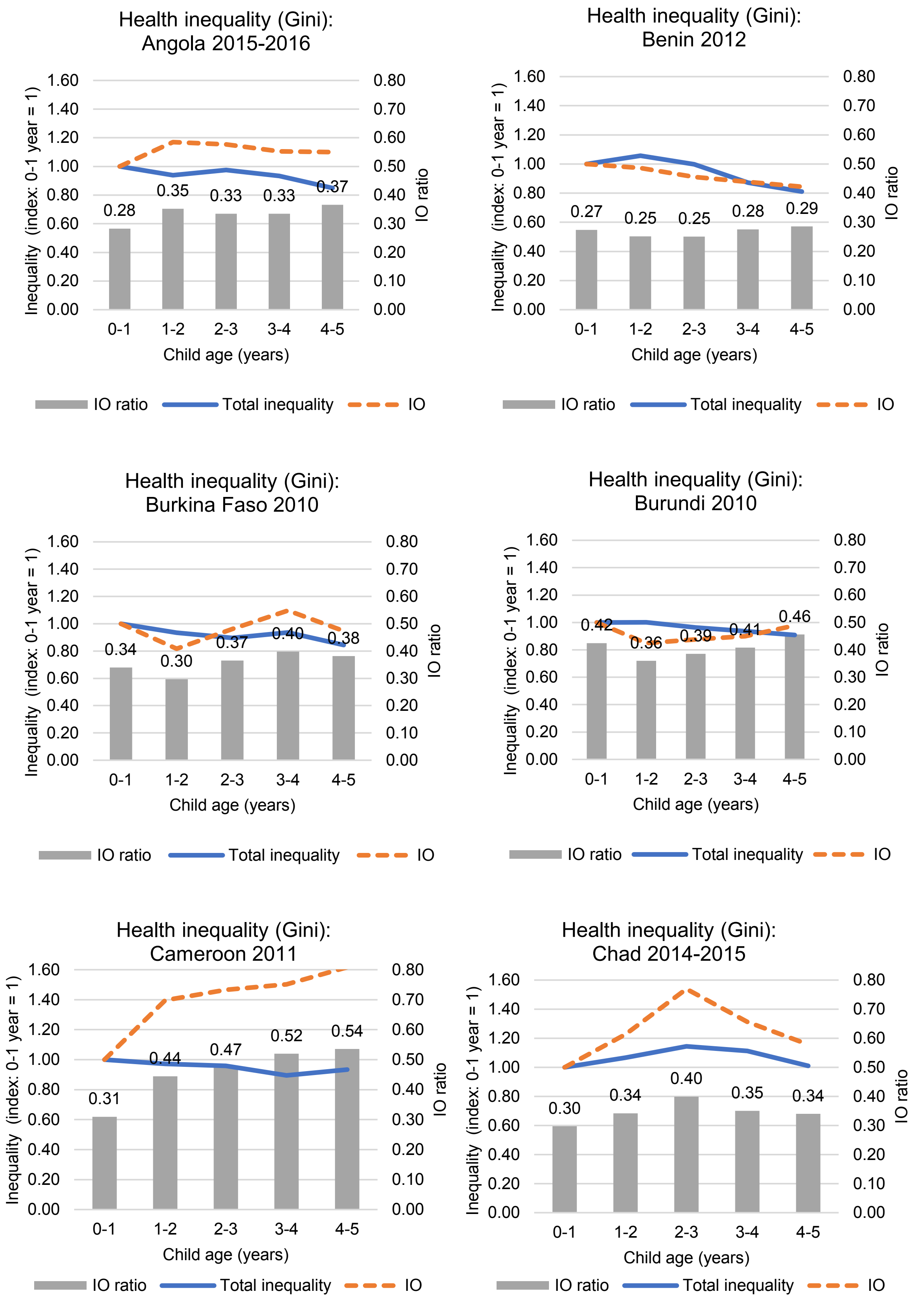
Variable/Country	NI	NM	RW	SL	SN	TD	TG
primary	-0.00493	-0.000735	0.00127	-0.00463	0.00587	0.00211	0.00133
	(0.00360)	(0.00488)	(0.00227)	(0.00403)	(0.00364)	(0.00241)	(0.00250)
secondary	0.00829	-0.00132	0.0110***	-0.00206	0.0171***	0.00987**	0.00315
	(0.00548)	(0.00518)	(0.00416)	(0.00428)	(0.00572)	(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

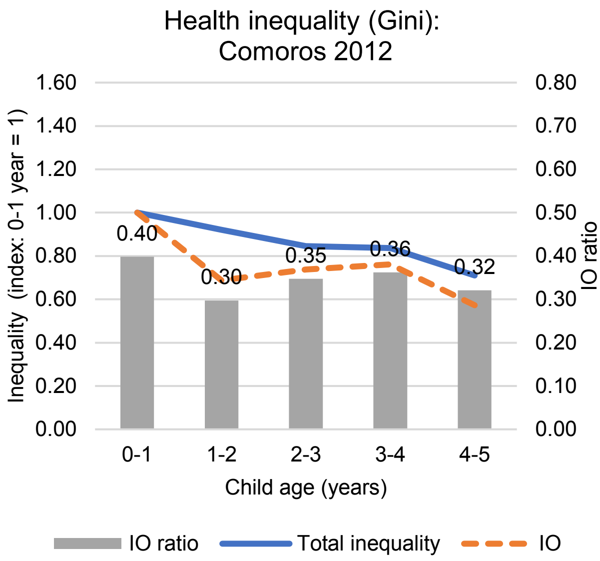
Table A2. Child height and circumstances: OLS estimates for overall sample by country (continued)

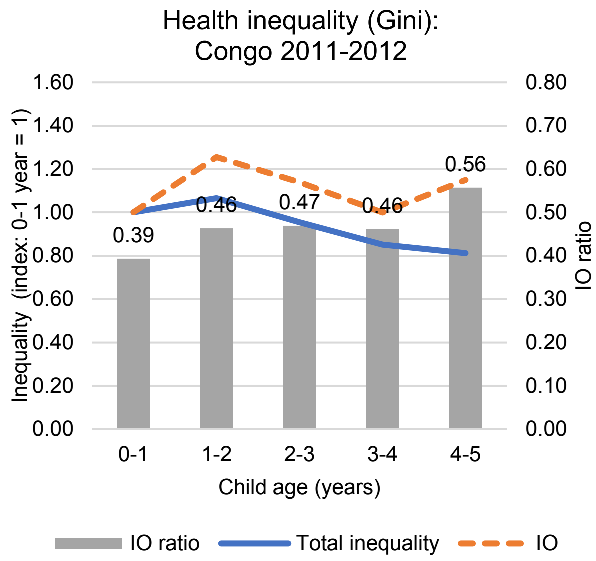
Variable/Country	TZ	UG	ZA	ZM	ZW
primary	0.0000363	0.00355	-0.00269	0.00259	0.00630
	(0.00258)	(0.00524)	(0.0121)	(0.00245)	(0.00627)
secondary	0.00690*	0.00450	-0.000738	0.00410	0.00758
	(0.00414)	(0.00710)	(0.0117)	(0.00272)	(0.00646)
higher	0.0397***	0.0277*	0.0121	0.0107*	0.0170*
	(0.0122)	(0.0148)	(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

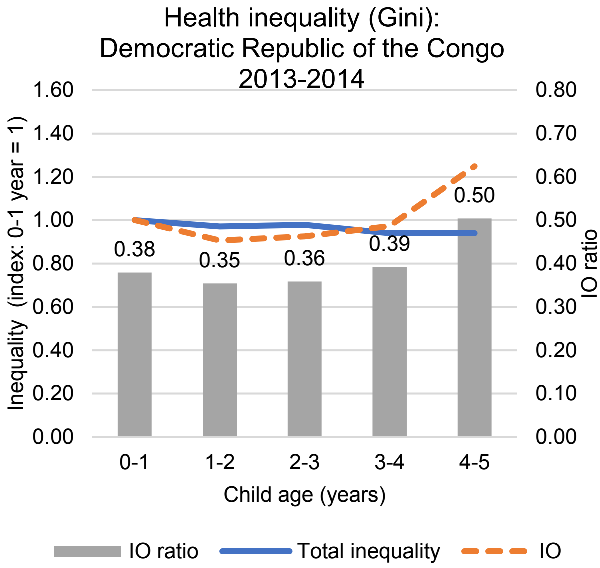
Note: Construct by the authors using data from the DHS databases (2009-2016).
The estimates of dummy regions mentioned in the table 1 are not shown for reasons of space.
Standard errors in parentheses. * $p<0.05$, ** $p<0.01$, *** $p<0.001$

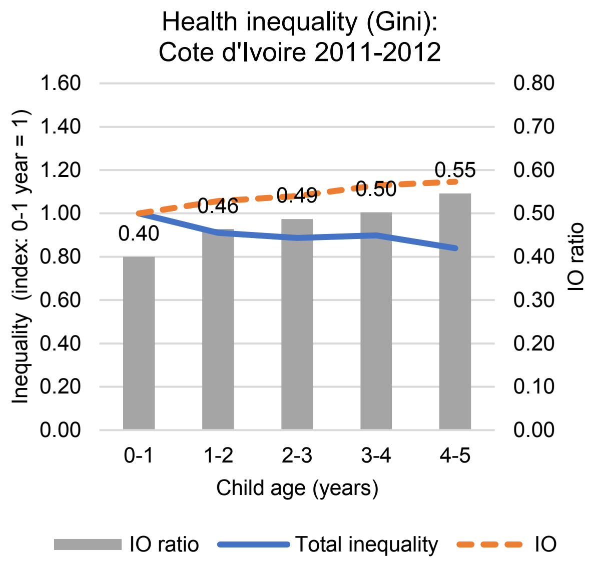
Figure A1. Child health inequality, inequality of opportunity and inequality of opportunity ratio along the age distribution in SSA countries

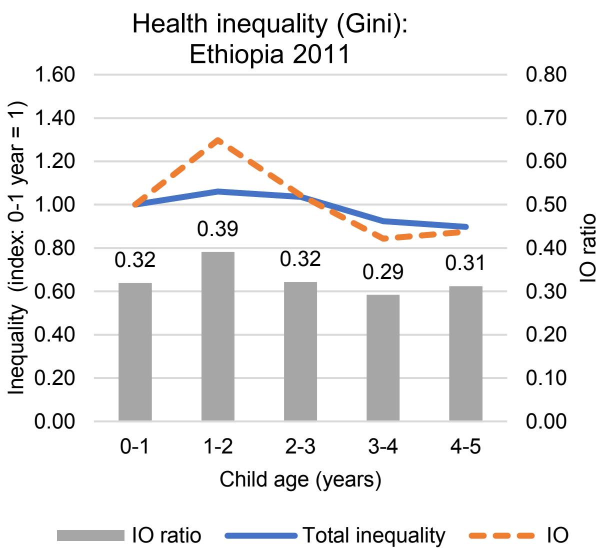


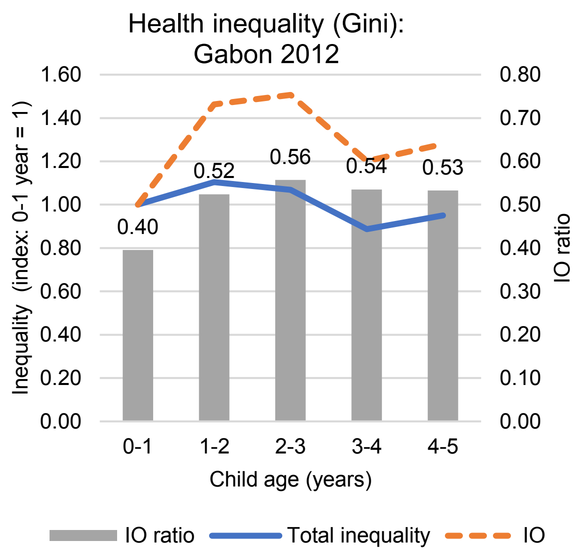

Health inequality (Gini):
Comoros 2012
Inequality (index: 0-1 year = 1)
IO ratio
Child age (years)
0-1
1-2
2-3
3-4
4-5
0.40
0.30
0.35
0.36
0.32
IO ratio
Total inequality
IO

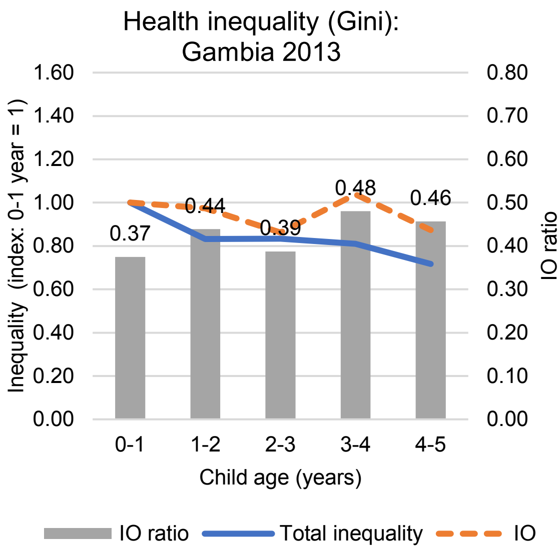

Health inequality (Gini):
Congo 2011-2012
Inequality (index: 0-1 year = 1)
IO ratio
Child age (years)
0-1
1-2
2-3
3-4
4-5
0.39
0.46
0.47
0.46
0.56
IO ratio
Total inequality
IO

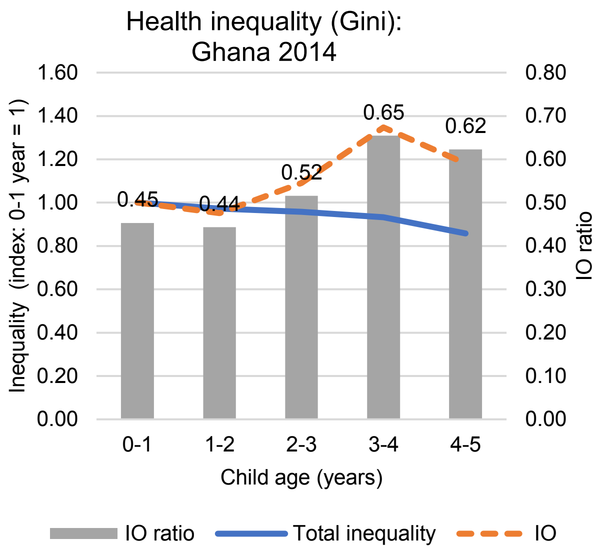

Health inequality (Gini):
Democratic Republic of the Congo
2013-2014
Inequality (index: 0-1 year = 1)
IO ratio
Child age (years)
0-1
1-2
2-3
3-4
4-5
0.38
0.35
0.36
0.39
0.50
IO ratio
Total inequality
IO

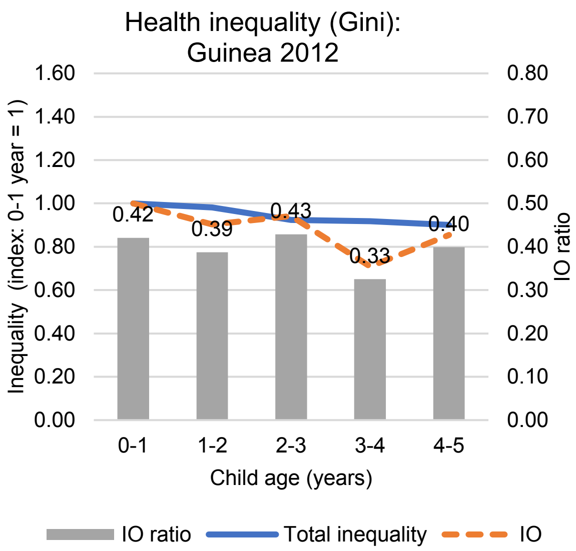

Health inequality (Gini):
Cote d'Ivoire 2011-2012
Inequality (index: 0-1 year = 1)
IO ratio
Child age (years)
0-1
1-2
2-3
3-4
4-5
0.40
0.46
0.49
0.50
0.55
IO ratio
Total inequality
IO

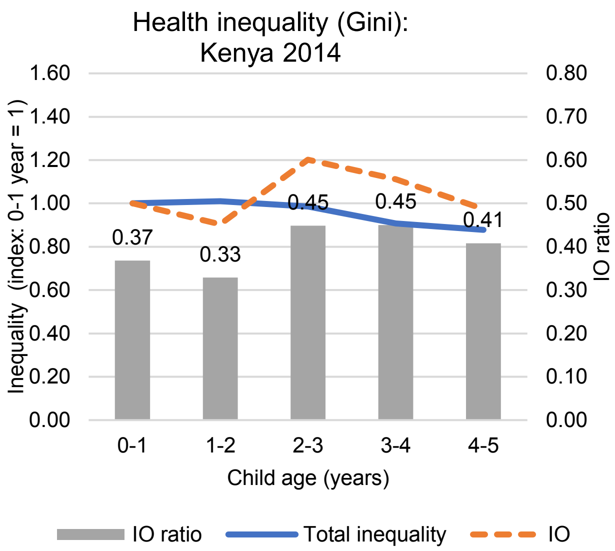

Health inequality (Gini):
Ethiopia 2011
Inequality (index: 0-1 year = 1)
IO ratio
Child age (years)
0-1
1-2
2-3
3-4
4-5
0.32
0.39
0.32
0.29
0.31
IO ratio
Total inequality
IO

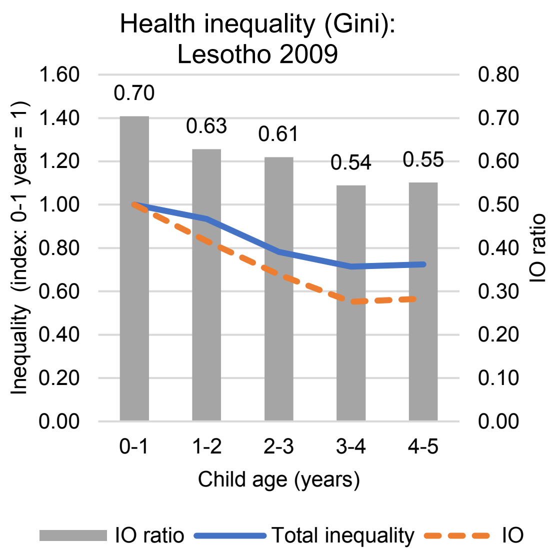

Health inequality (Gini):
Gabon 2012
Inequality (index: 0-1 year = 1)
IO ratio
Child age (years)
0-1
1-2
2-3
3-4
4-5
0.40
0.52
0.56
0.54
0.53
IO ratio
Total inequality
IO

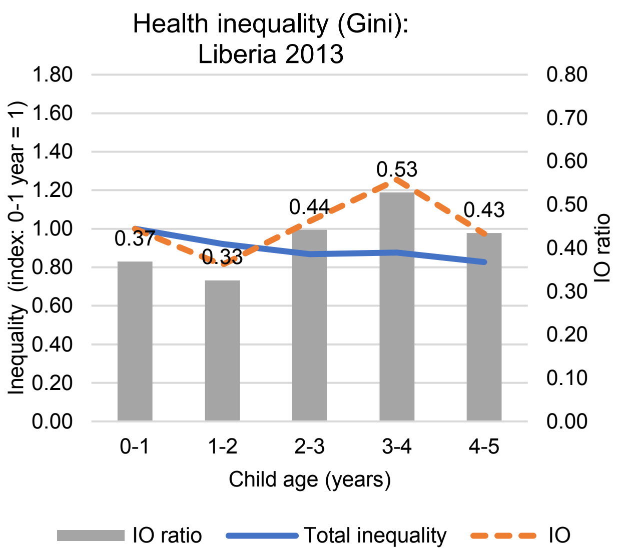

Health inequality (Gini):
Gambia 2013
Inequality (index: 0-1 year = 1)
IO ratio
0.37
0.44
0.39
0.48
0.46
Child age (years)
0-1
1-2
2-3
3-4
4-5
IO ratio
Total inequality
IO

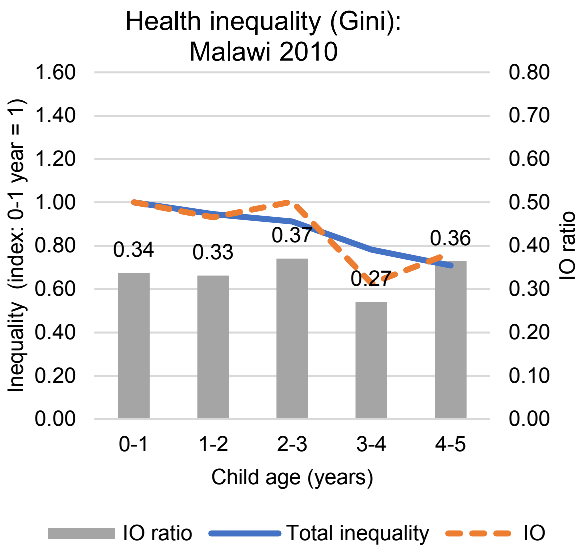

Health inequality (Gini):
Ghana 2014
Inequality (index: 0-1 year = 1)
IO ratio
0.45
0.44
0.52
0.65
0.62
Child age (years)
0-1
1-2
2-3
3-4
4-5
IO ratio
Total inequality
IO

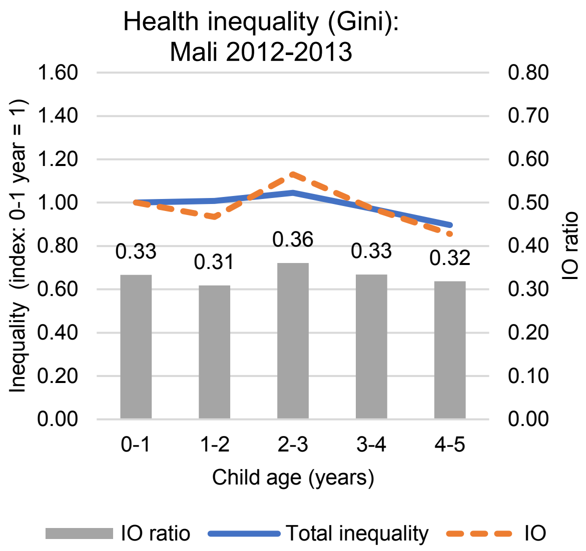

Health inequality (Gini):
Guinea 2012
Inequality (index: 0-1 year = 1)
IO ratio
0.42
0.39
0.43
0.33
0.40
Child age (years)
0-1
1-2
2-3
3-4
4-5
IO ratio
Total inequality
IO

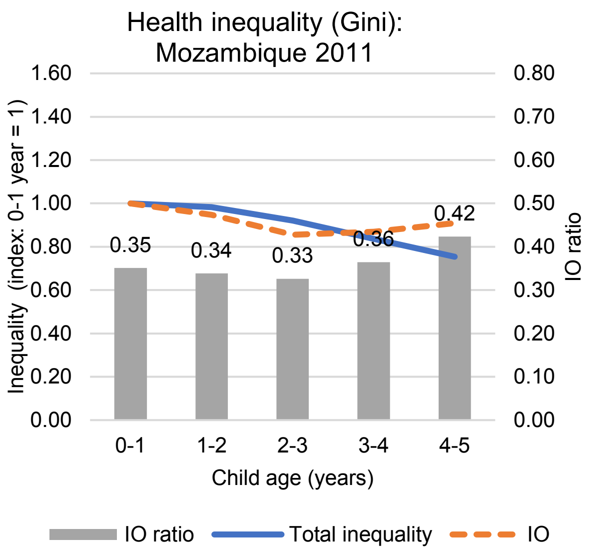

Health inequality (Gini):
Kenya 2014
Inequality (index: 0-1 year = 1)
IO ratio
0.37
0.33
0.45
0.45
0.41
Child age (years)
0-1
1-2
2-3
3-4
4-5
IO ratio
Total inequality
IO

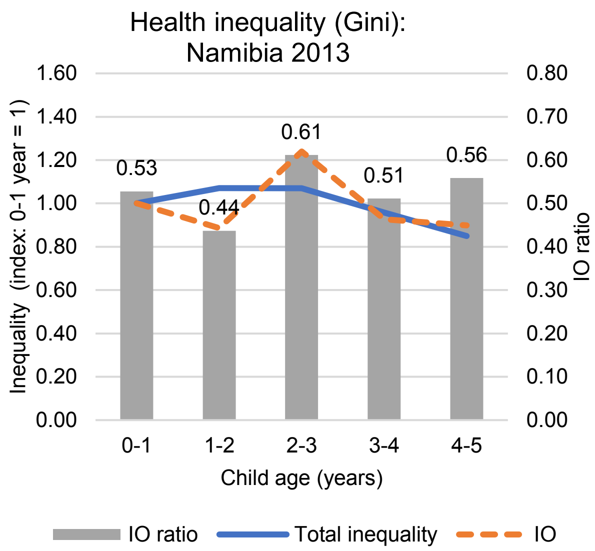

Health inequality (Gini):
Lesotho 2009
Inequality (index: 0-1 year = 1)
IO ratio
0.70
0.63
0.61
0.54
0.55
Child age (years)
0-1
1-2
2-3
3-4
4-5
IO ratio
Total inequality
IO

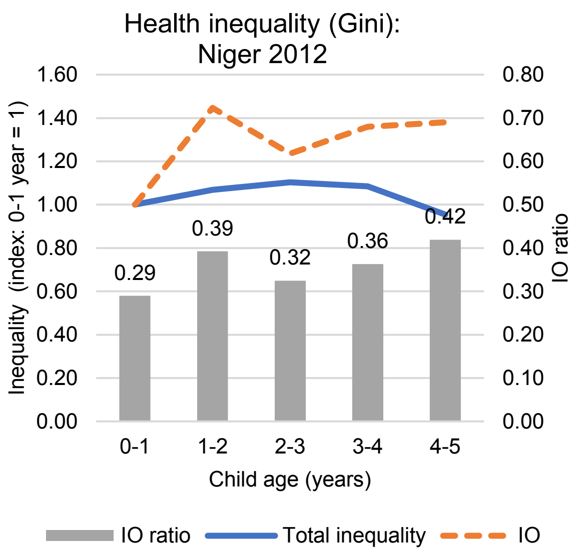

Health inequality (Gini):
Liberia 2013
Inequality (index: 0-1 year = 1)
IO ratio
0.37
0.33
0.44
0.53
0.43
Child age (years)
0-1
1-2
2-3
3-4
4-5
IO ratio
Total inequality
IO

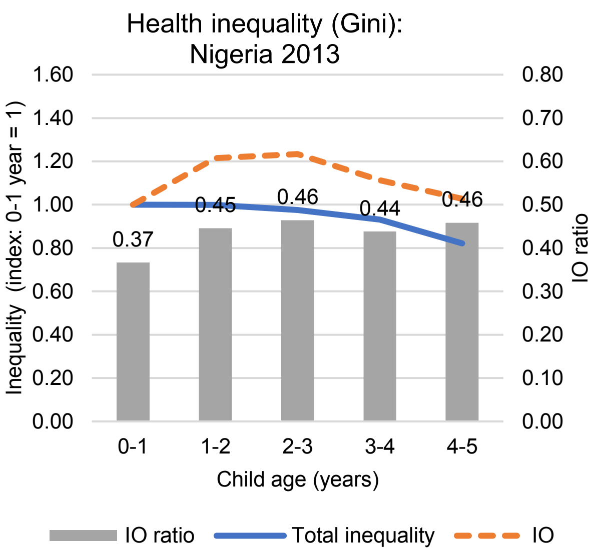

Health inequality (Gini):
Malawi 2010
Inequality (index: 0-1 year = 1)
IO ratio
0.34
0.33
0.37
0.27
0.36
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
IO

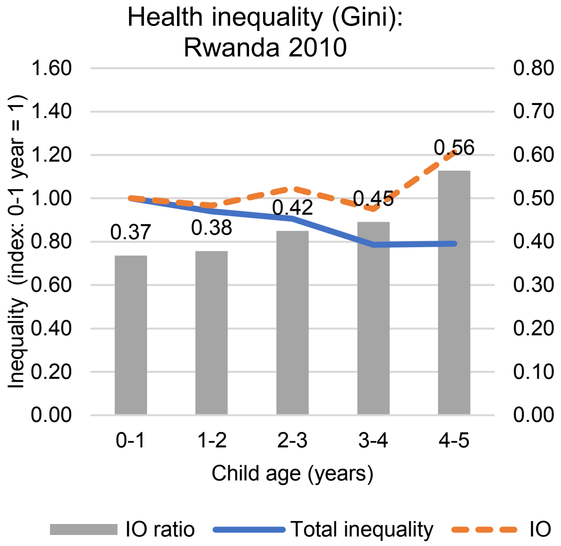

Health inequality (Gini):
Mali 2012-2013
Inequality (index: 0-1 year = 1)
IO ratio
0.33
0.31
0.36
0.33
0.32
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
IO

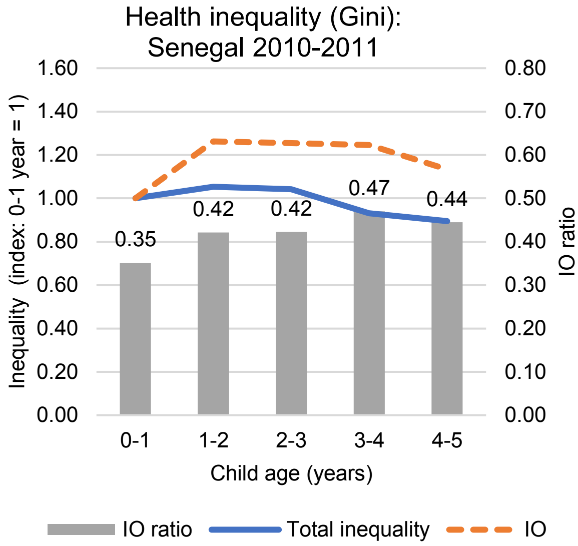

Health inequality (Gini):
Mozambique 2011
Inequality (index: 0-1 year = 1)
IO ratio
0.35
0.34
0.33
0.36
0.42
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
IO

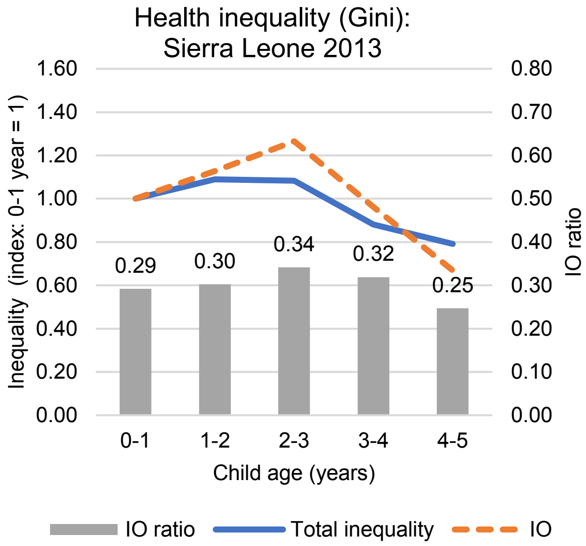

Health inequality (Gini):
Namibia 2013
Inequality (index: 0-1 year = 1)
IO ratio
0.53
0.44
0.61
0.51
0.56
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
IO

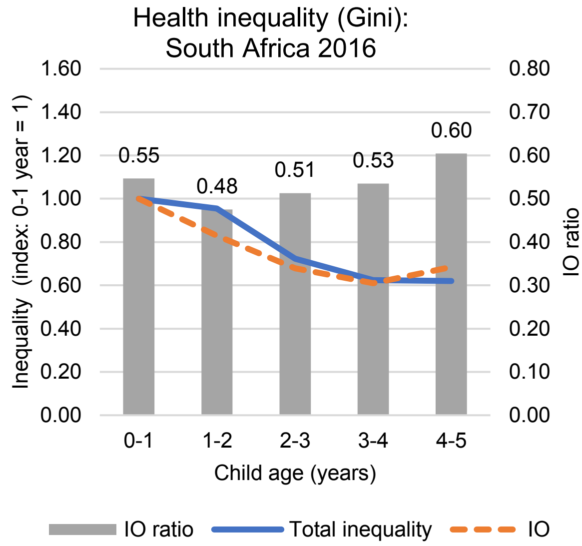

Health inequality (Gini):
Niger 2012
Inequality (index: 0-1 year = 1)
IO ratio
0.29
0.39
0.32
0.36
0.42
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
IO

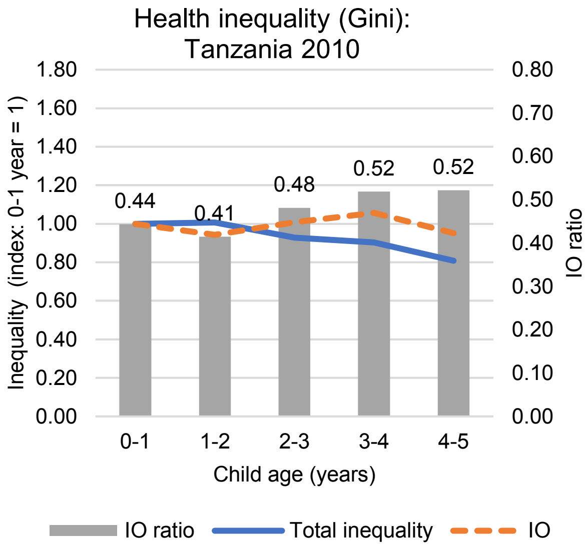

Health inequality (Gini):
Nigeria 2013
Inequality (index: 0-1 year = 1)
IO ratio
0.37
0.45
0.46
0.44
0.46
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
IO

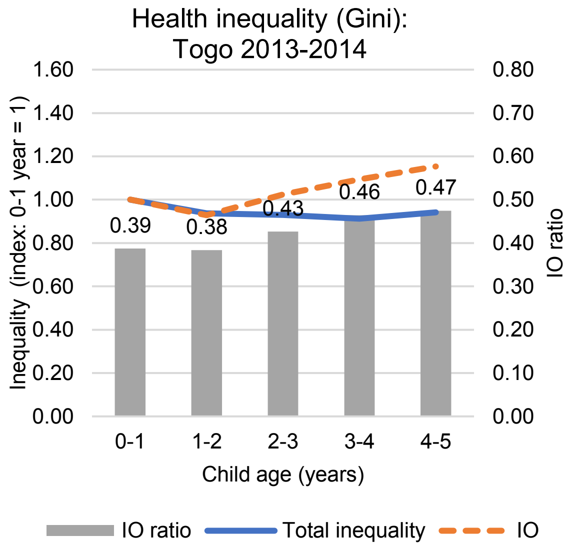

Health inequality (Gini):
Rwanda 2010
Inequality (index: 0-1 year = 1)
IO ratio
0.37
0.38
0.42
0.45
0.56
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
IO

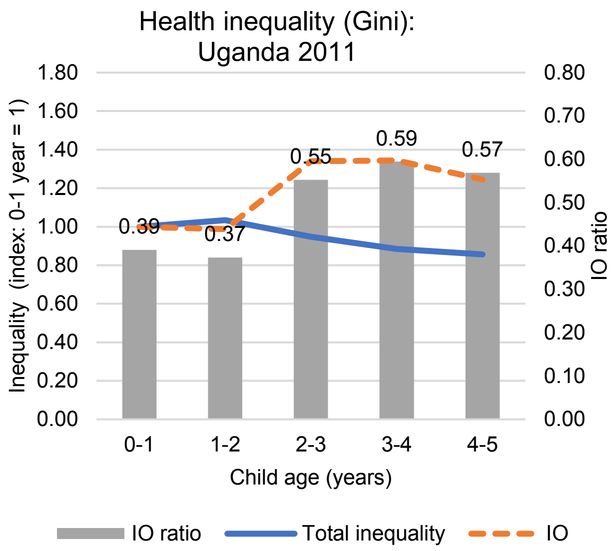

Health inequality (Gini):
Senegal 2010-2011
Inequality (index: 0-1 year = 1)
IO ratio
0.35
0.42
0.42
0.47
0.44
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
IO

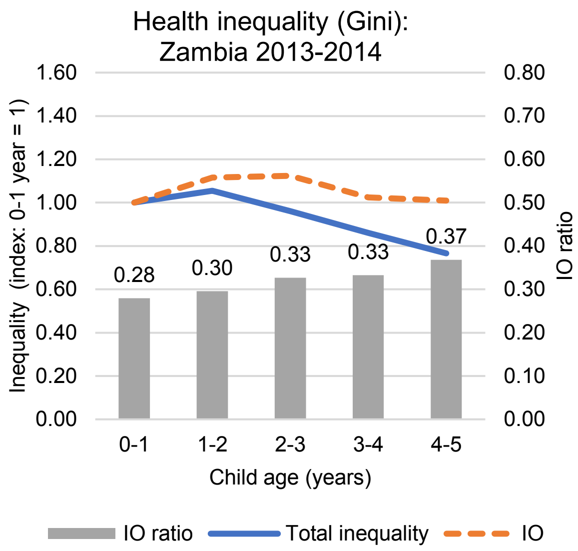

Health inequality (Gini):
Sierra Leone 2013
Inequality (index: 0-1 year = 1)
IO ratio
0.29
0.30
0.34
0.32
0.25
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
IO

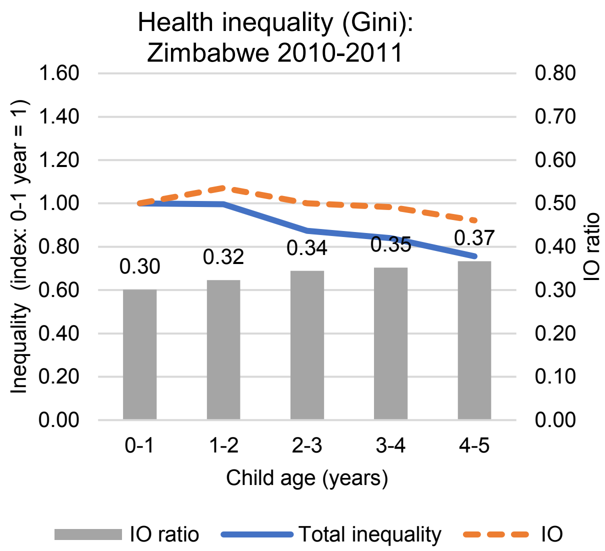

Health inequality (Gini):
South Africa 2016
Inequality (index: 0-1 year = 1)
IO ratio
0.55
0.48
0.51
0.53
0.60
0-1
1-2
2-3
3-4
4-5
Child age (years)
IO ratio
Total inequality
IO


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


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



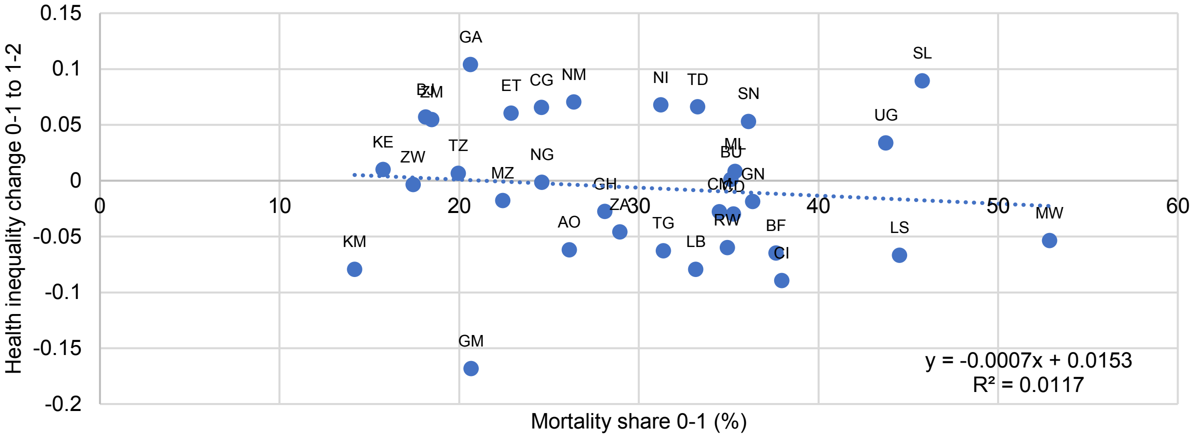




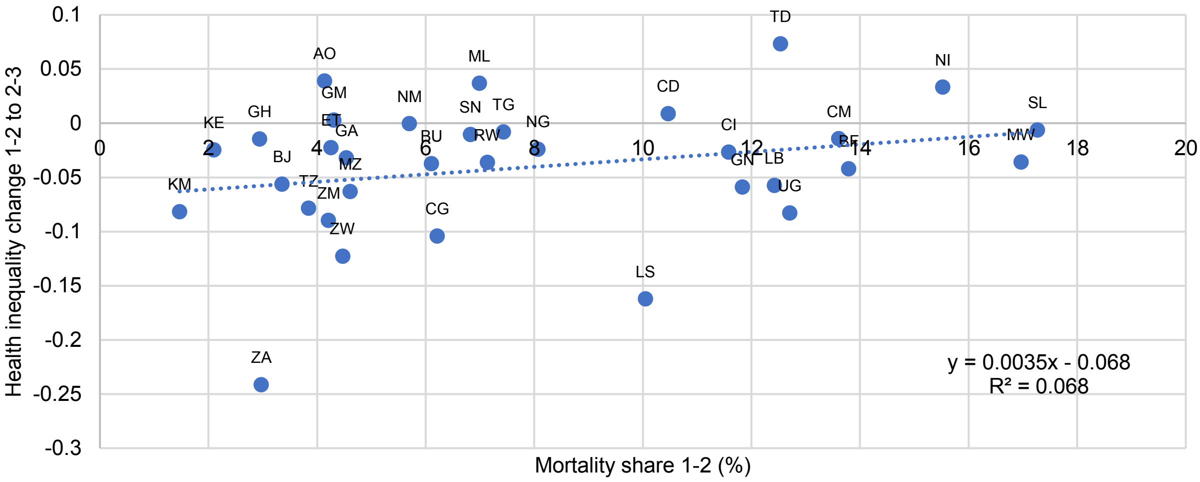
Note: Construct by the authors using data from the DHS databases (2009-2016).

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

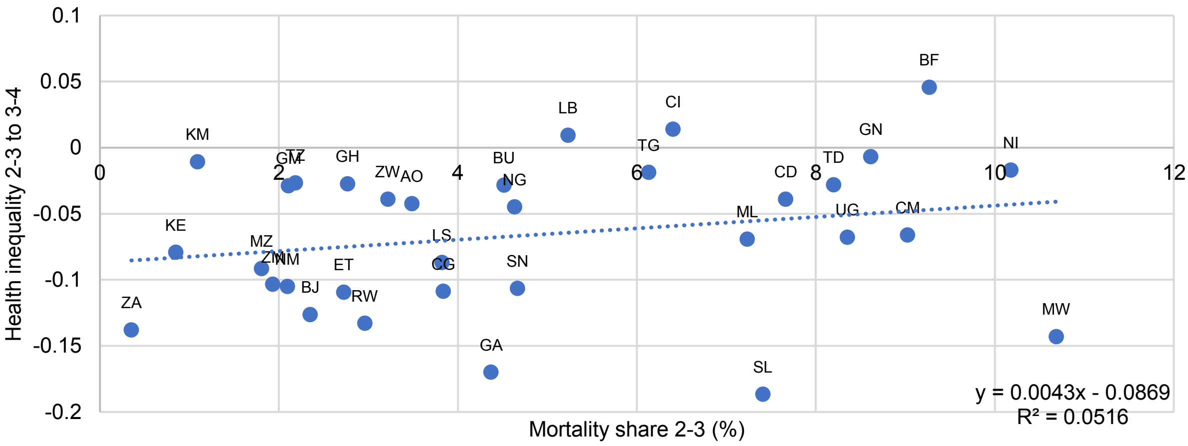
a) Children with 0-1 vs. 1-2 years old



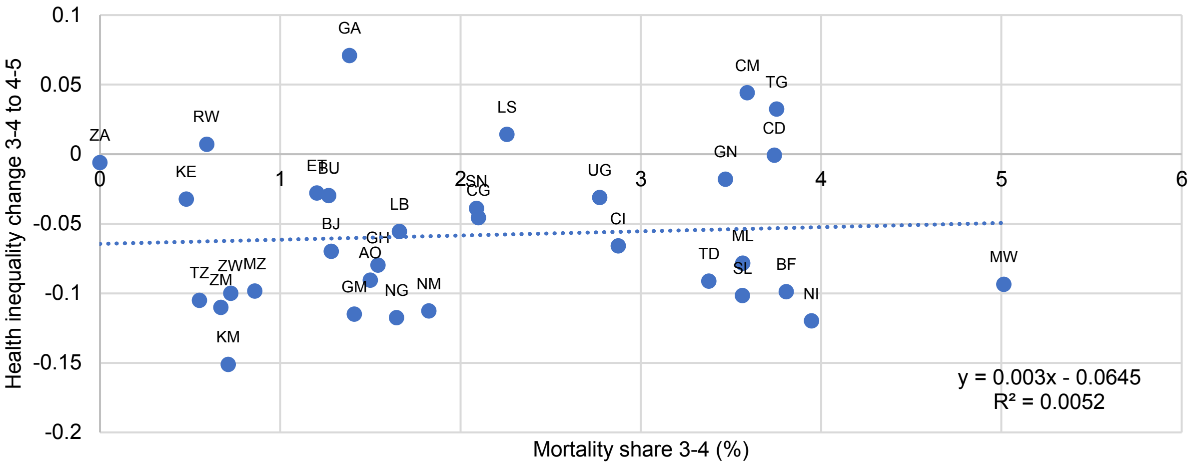
b) Children with 1-2 vs. 2-3 years old



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



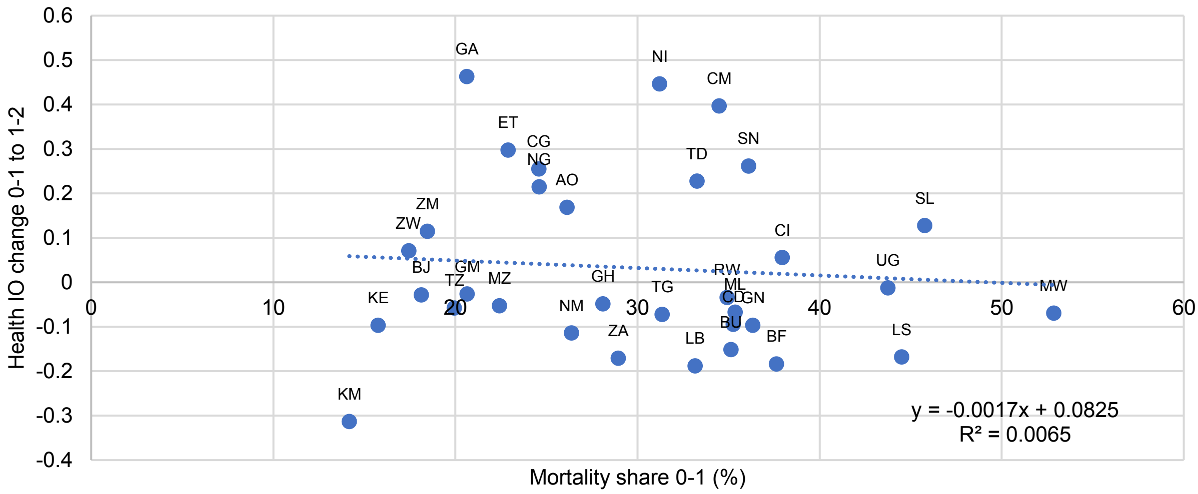
d) Children with 3-4 vs. 4-5 years old



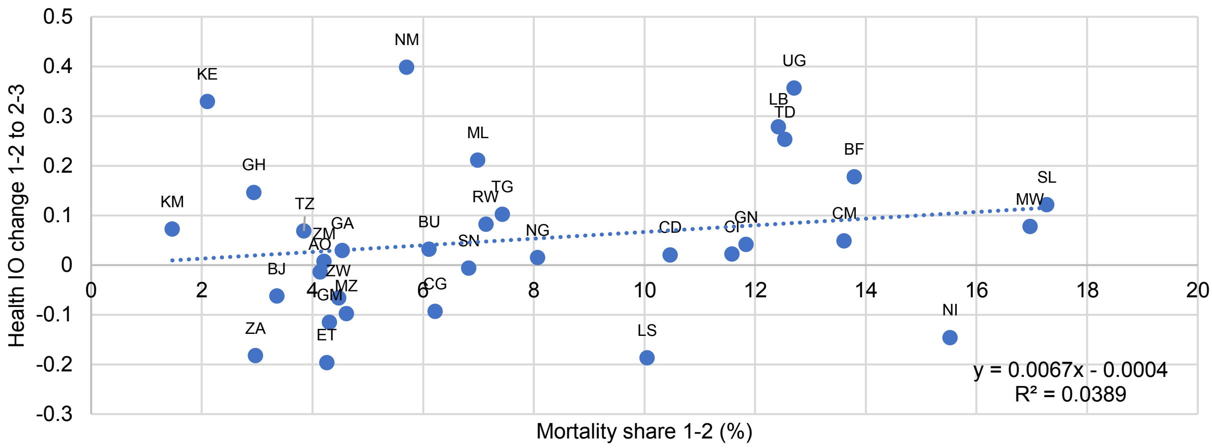
Note: Construct by the authors using data from the DHS databases (2009-2016).

Figure A3. Mortality shares and changes child health IO among age groups in SSA

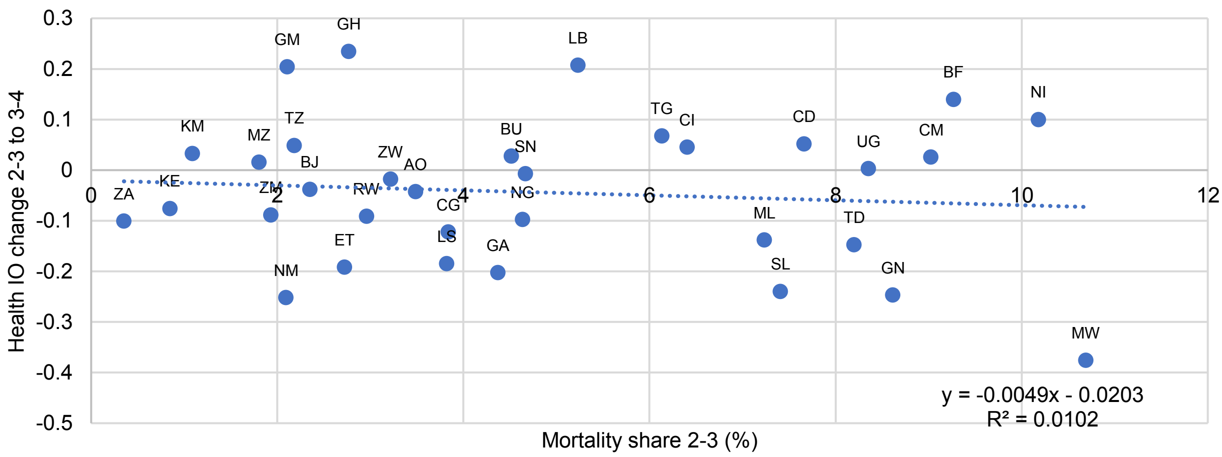
a) Children with 0-1 vs. 1-2 years old



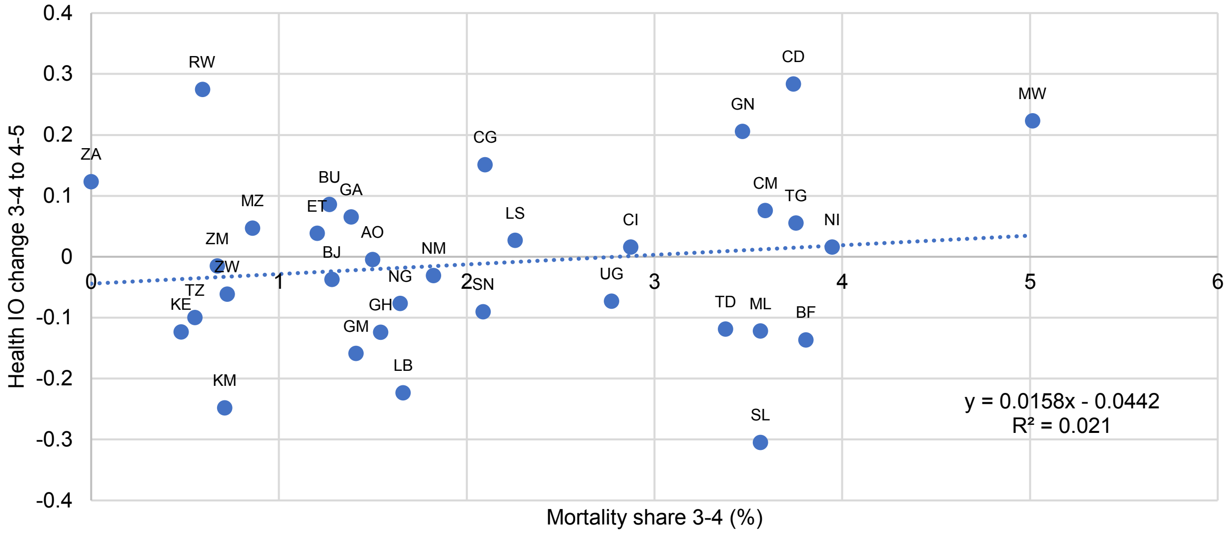
b) Children with 1-2 vs. 2-3 years old



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



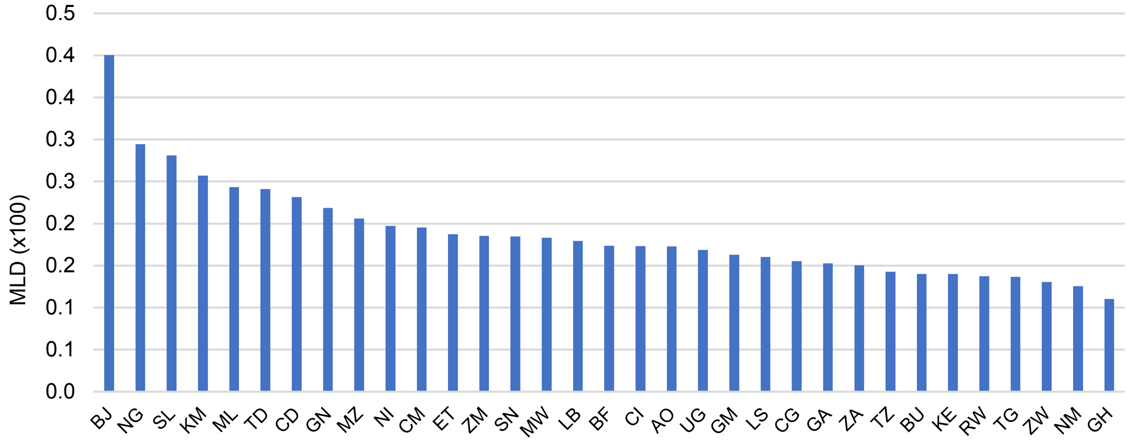
d) Children with 3-4 vs. 4-5 years old



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

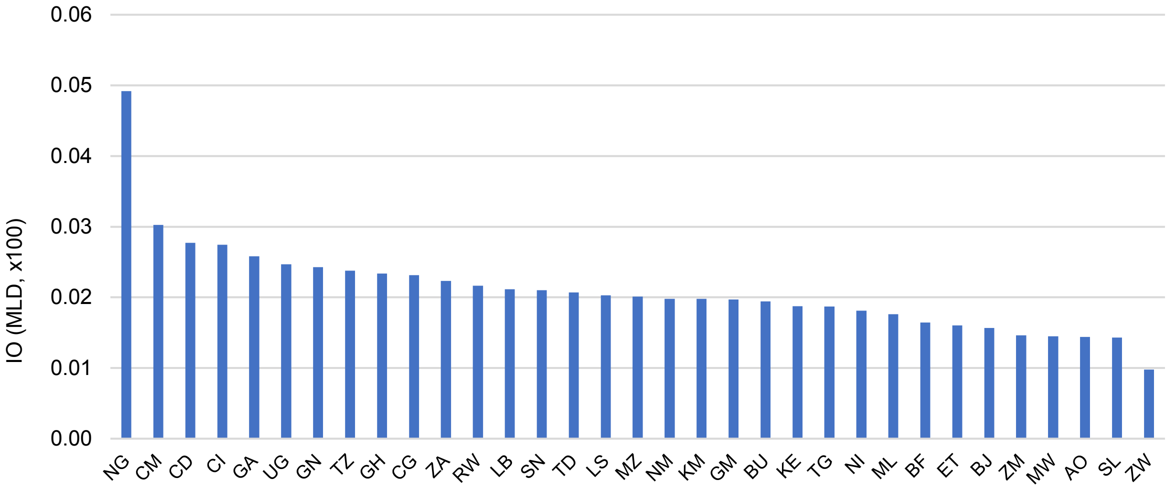
B. On-line Appendix. Figures for the Mean-Log-Deviation (MLD)

Figure B1. Child health inequality (adjusted-height) in SSA countries (MLD, x100)



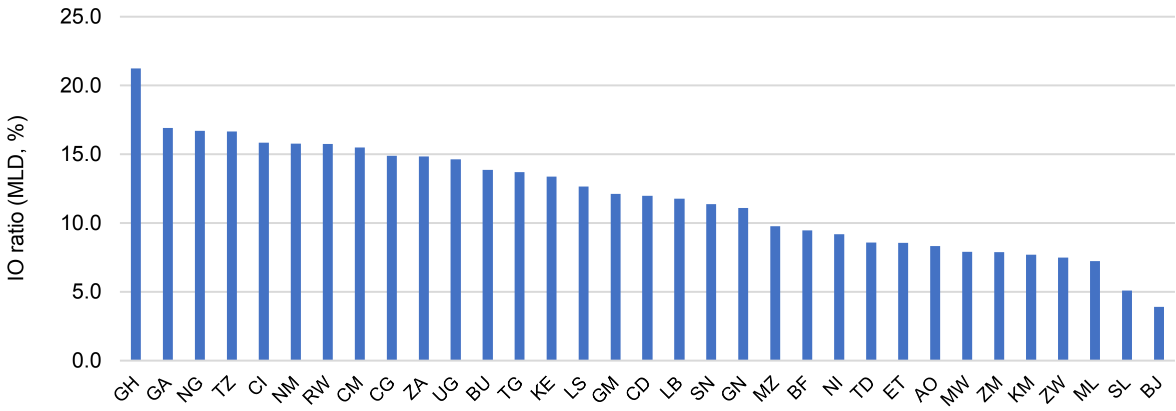
Note: Construct by the authors using data from the DHS databases (2009-2016). See note in Figure 1.

Figure B2. Child health inequality of opportunity (adjusted-height) in SSA countries (MLD, x100)



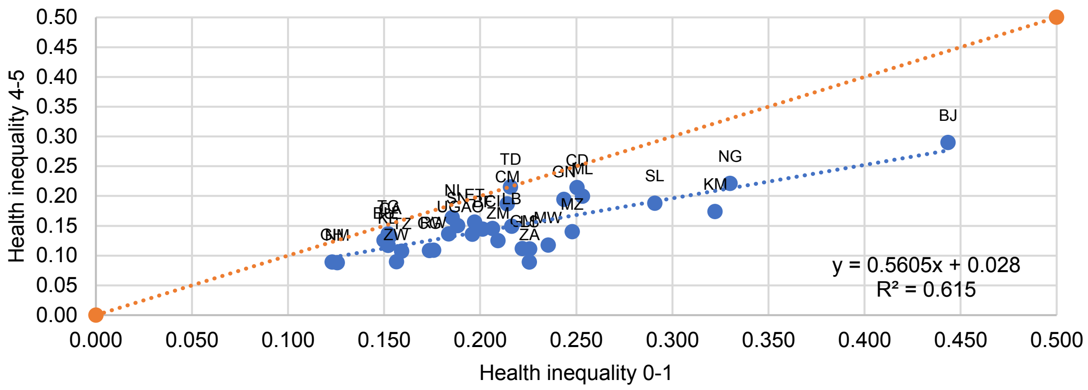
Note: Construct by the authors using data from the DHS databases (2009-2016). See note in Figure 1.

Figure B3. Child health inequality of opportunity ratio in SSA countries (MLD, %)



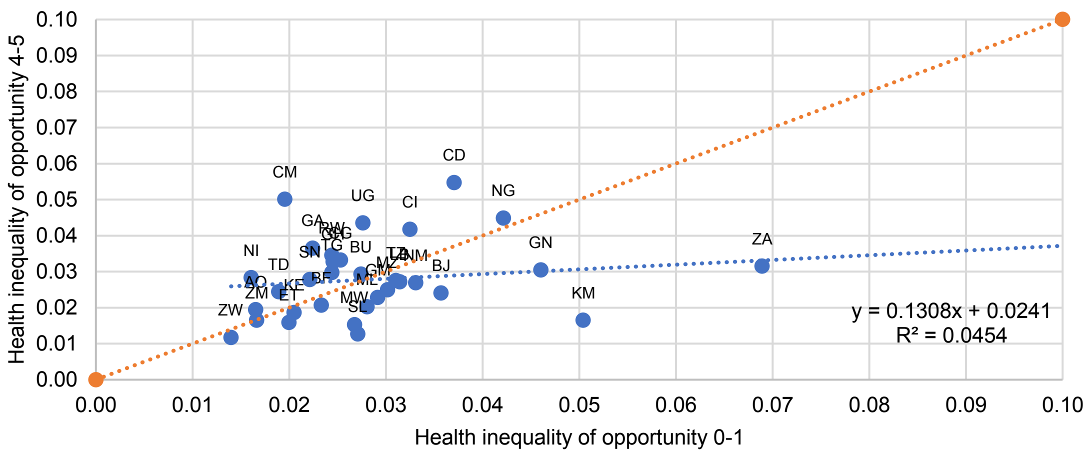
Note: Construct by the authors using data from the DHS databases (2009-2016). See note in Figure 1.

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).

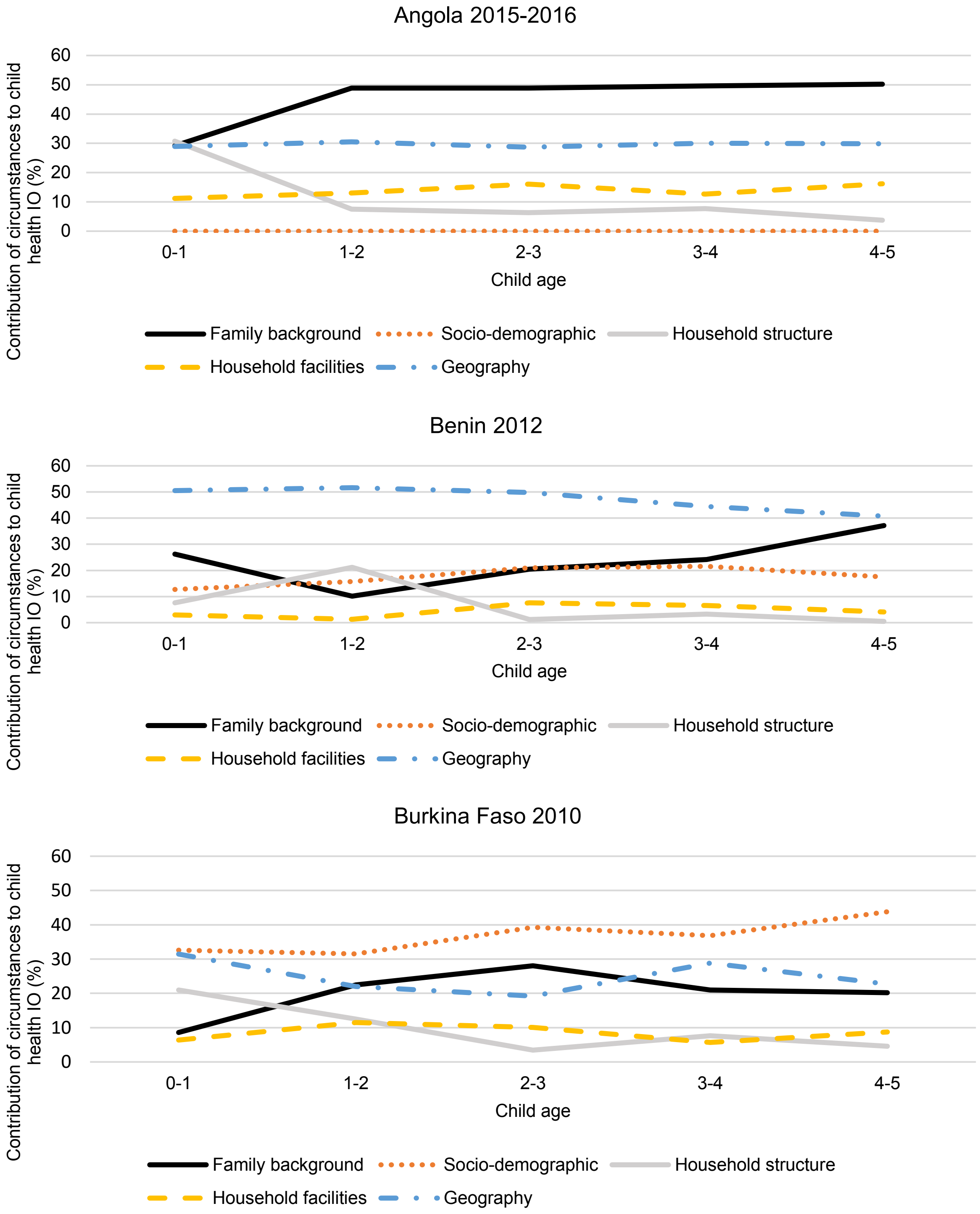
Figure B5. Correlation between child health IO 0-1 and 4-5 years in SSA (MLD, x100)

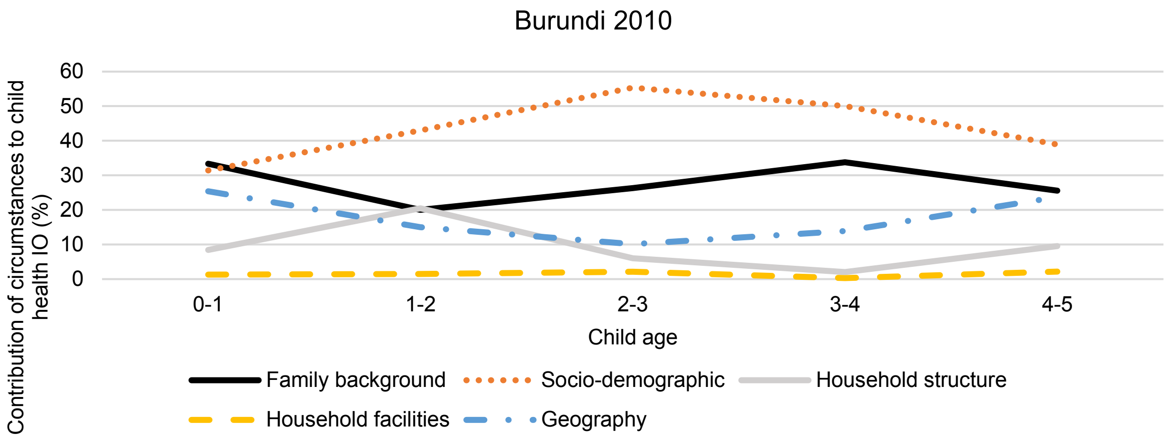


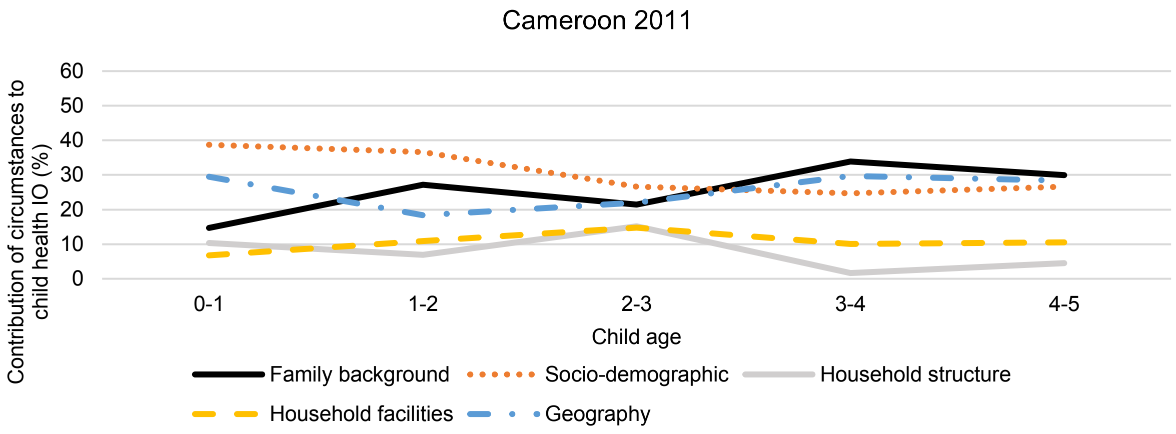
Note: Construct by the authors using data from the DHS databases (2009-2016).

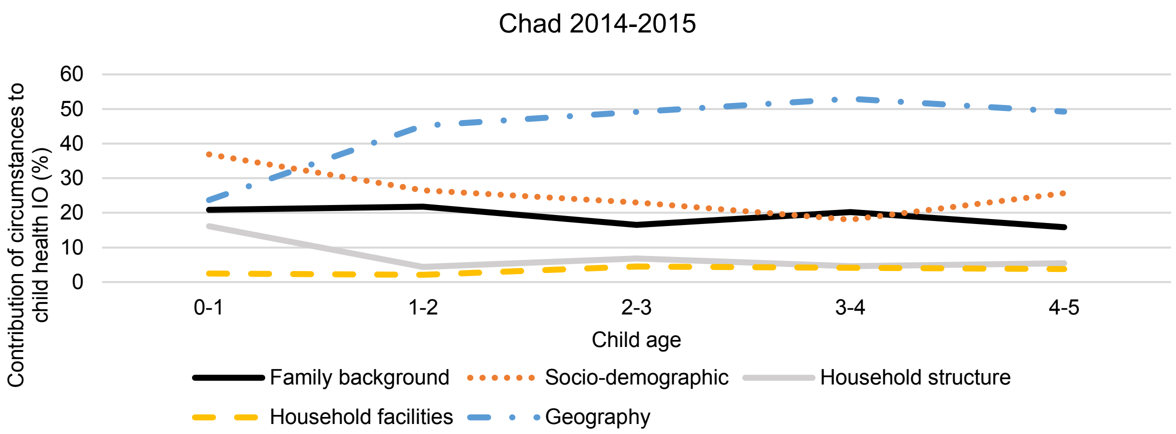
C. On-line Appendix.

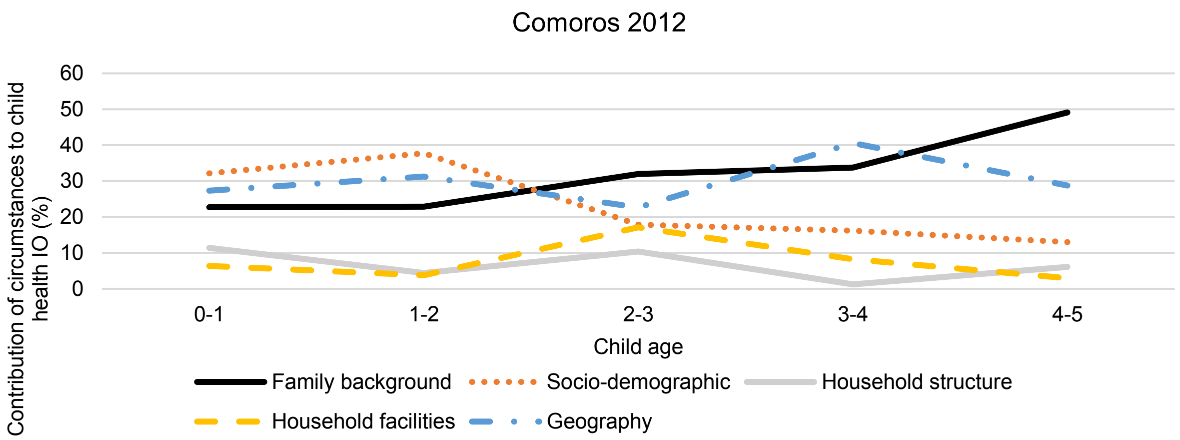
Figure C1. Evolution of the average contribution of circumstances in child health inequality of opportunity by age in SSA countries (%)

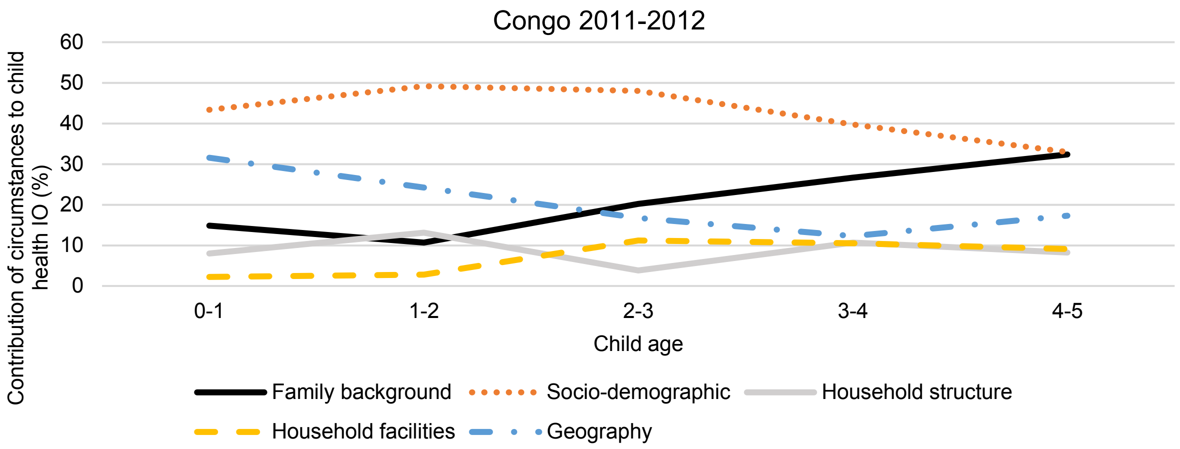


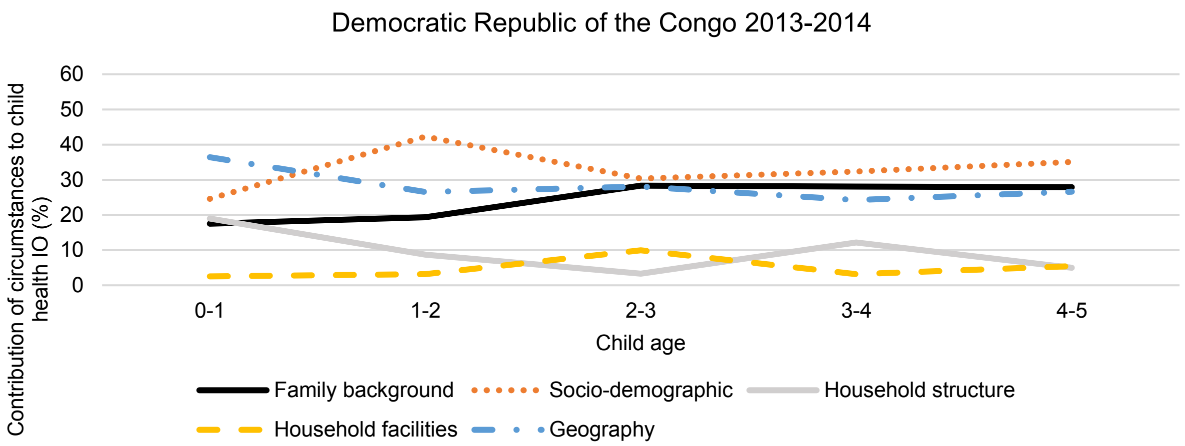

Burundi 2010
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

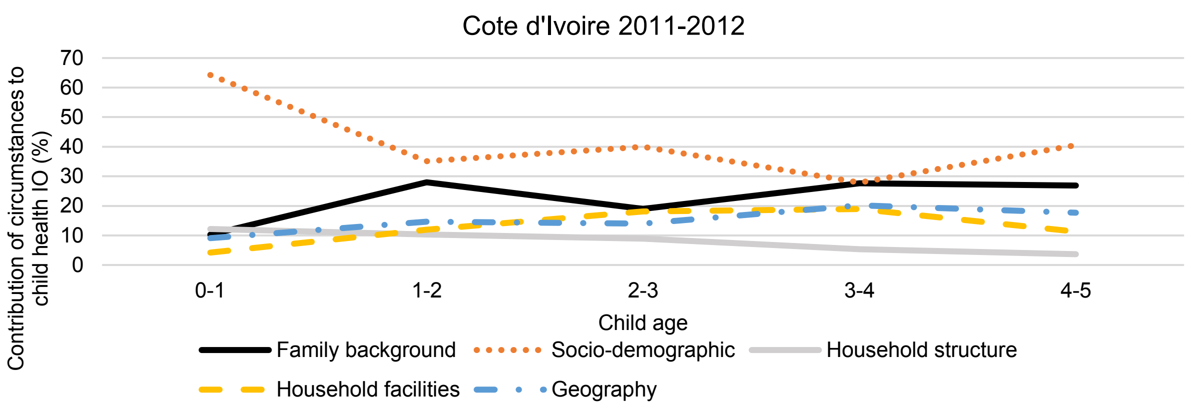

Cameroon 2011
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

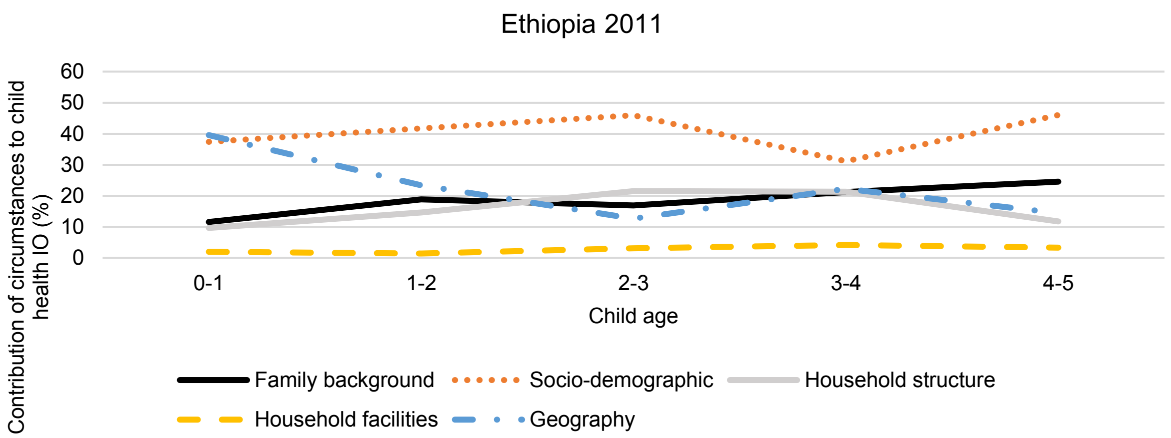

Chad 2014-2015
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

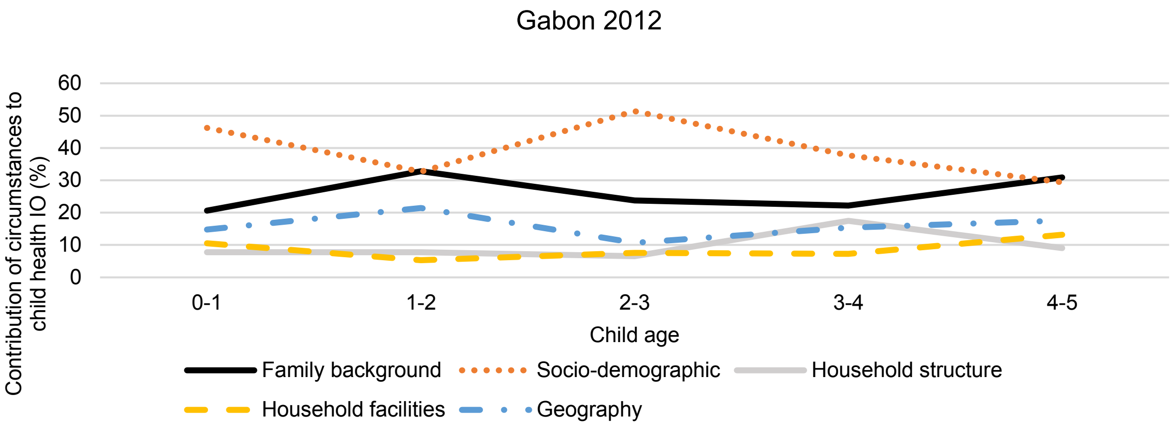

Comoros 2012
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

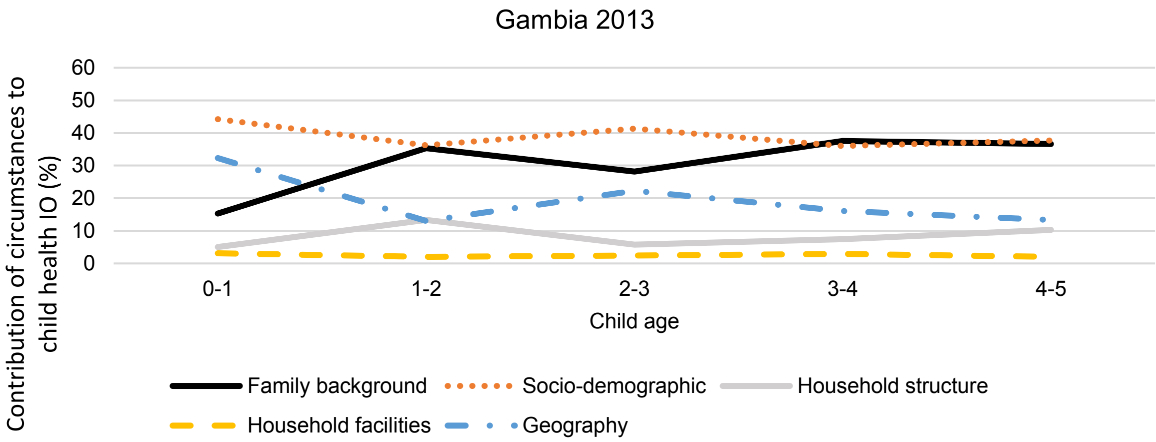

Congo 2011-2012
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

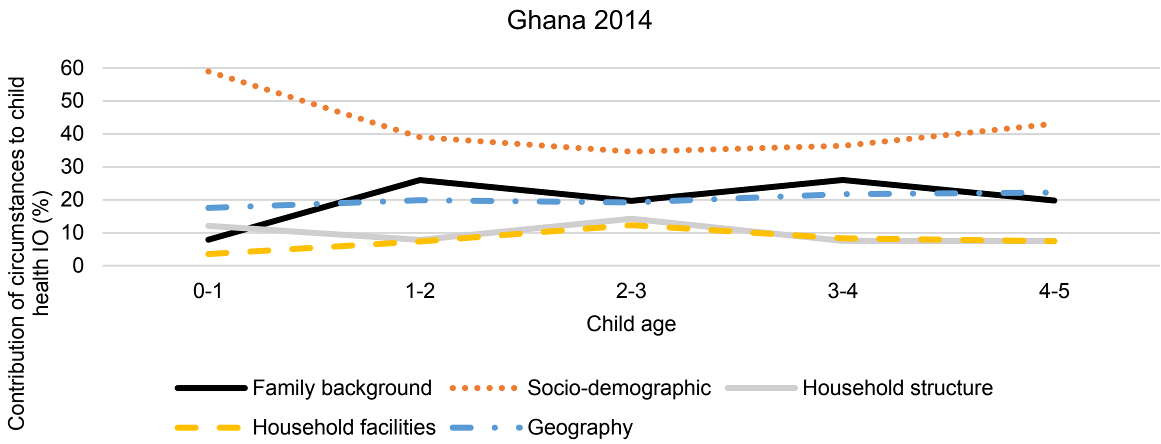

Democratic Republic of the Congo 2013-2014
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

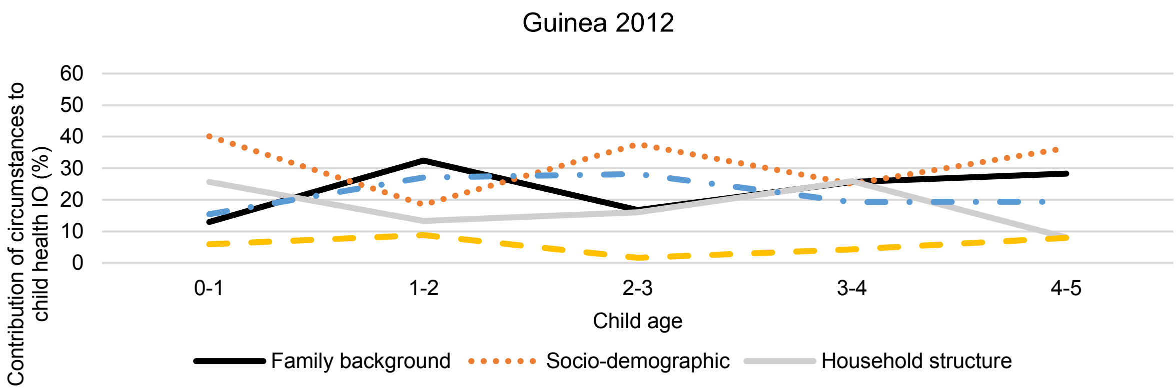

Cote d'Ivoire 2011-2012
Contribution of circumstances to child health IO (%)
70
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

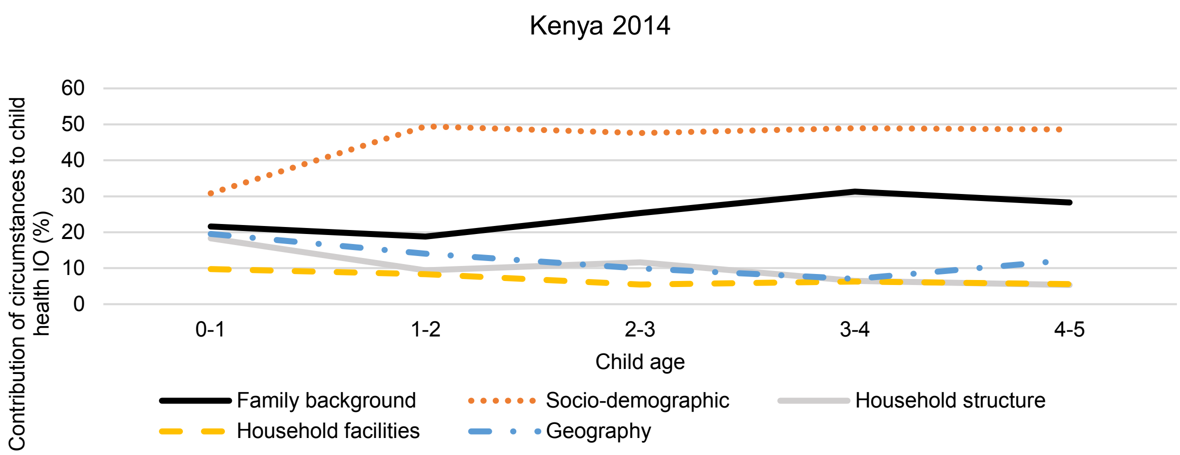

Ethiopia 2011
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

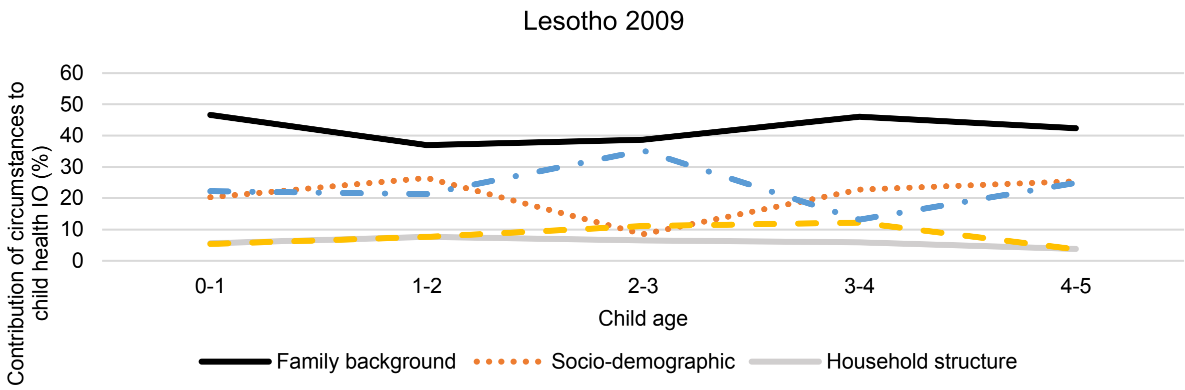

Gabon 2012
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

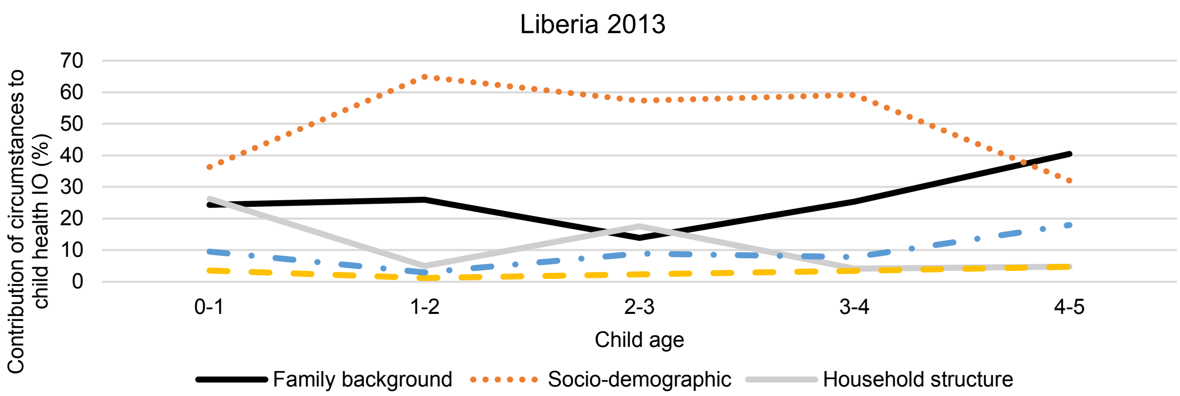

Gambia 2013
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

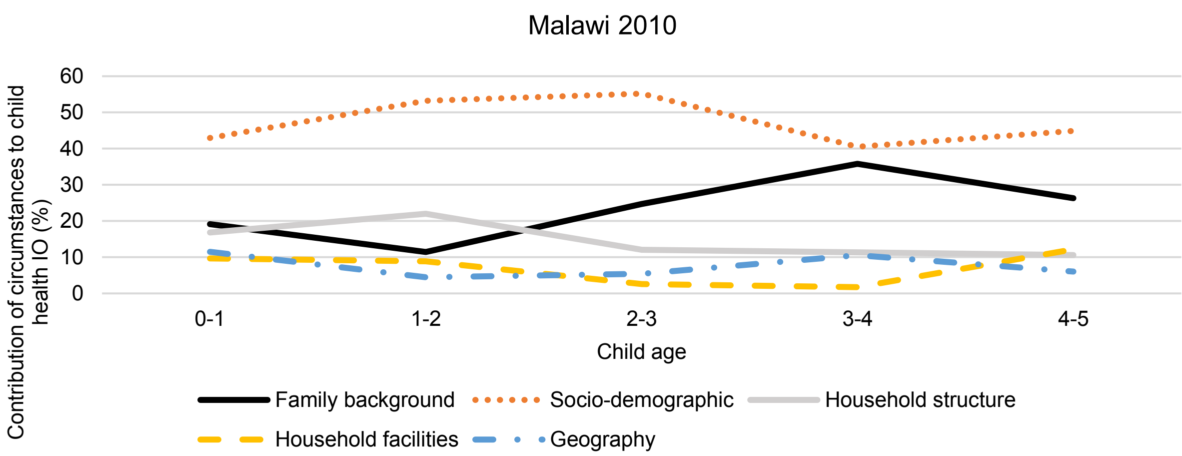

Ghana 2014
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

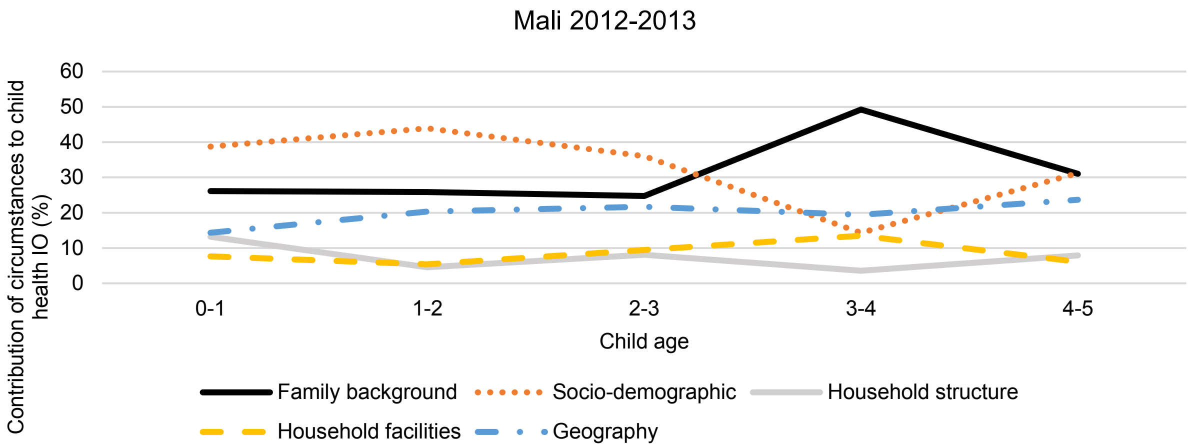

Guinea 2012
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

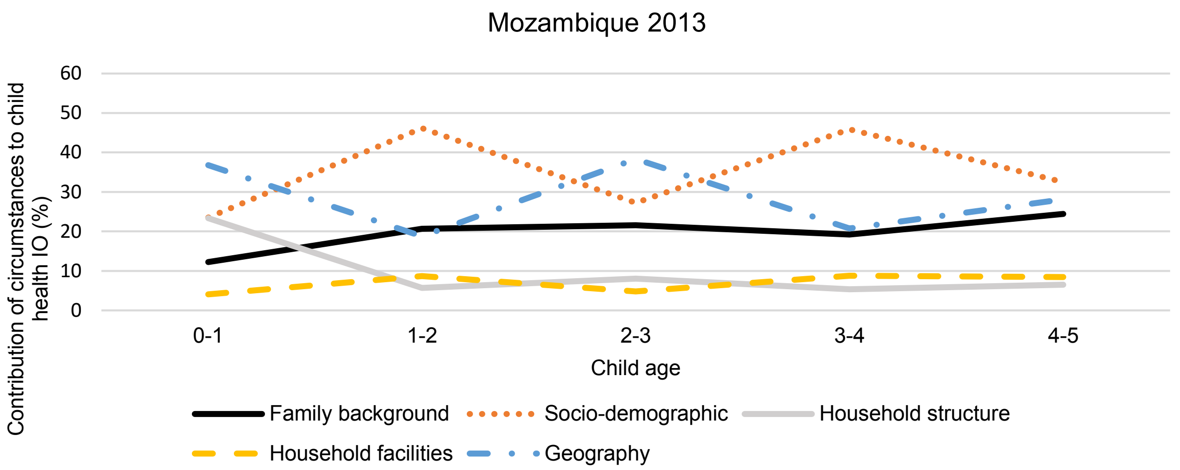

Kenya 2014
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

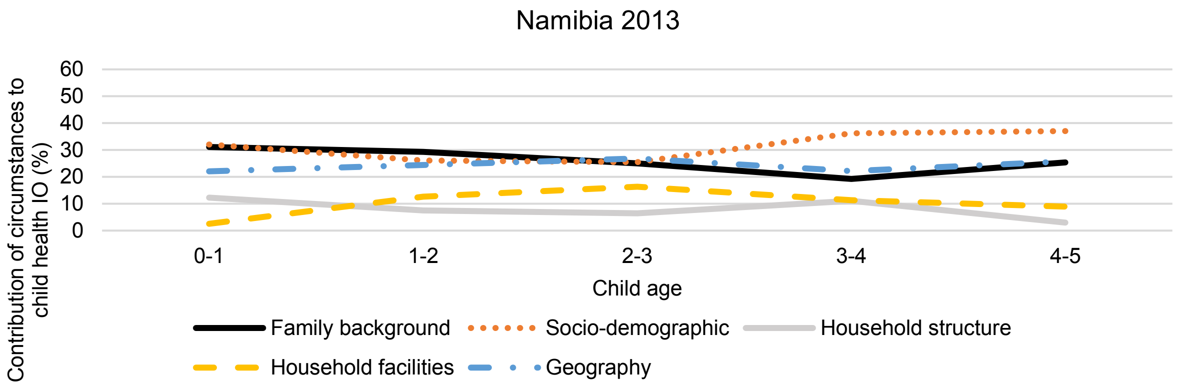

Lesotho 2009
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

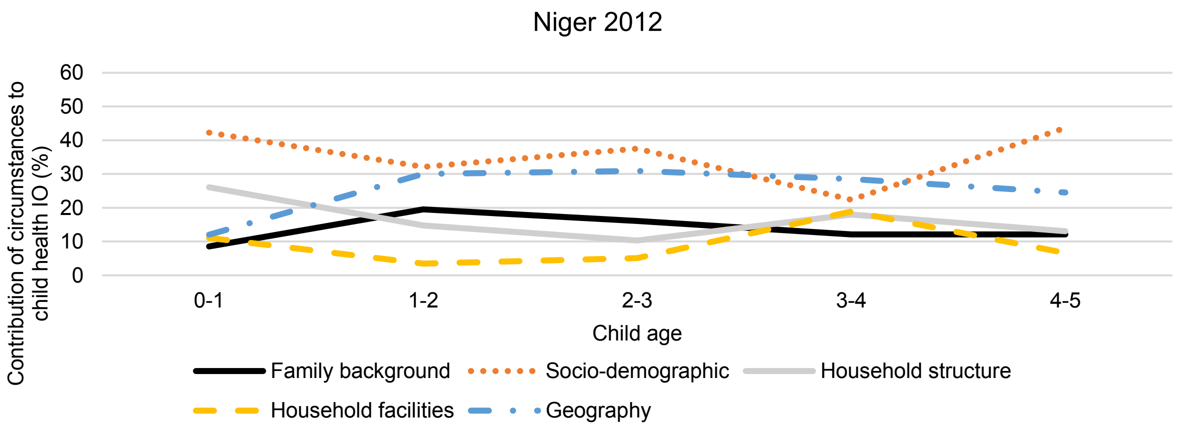

Liberia 2013
Contribution of circumstances to child health IO (%)
70
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

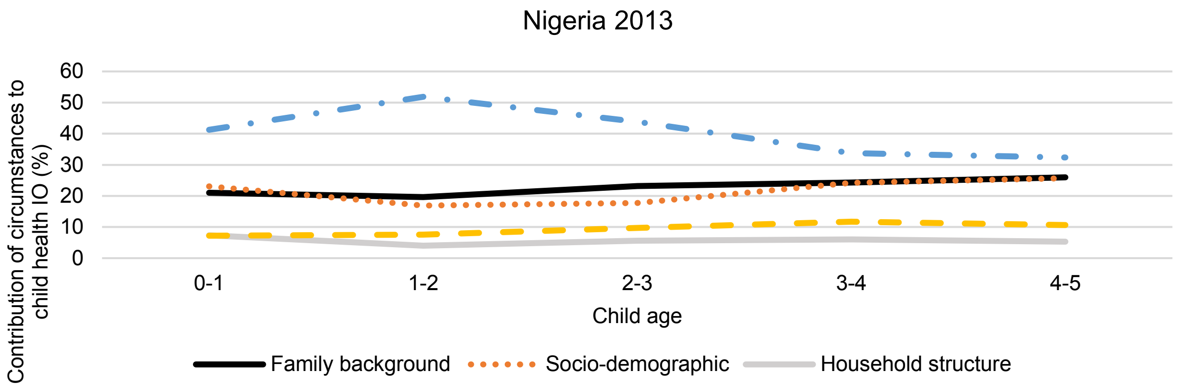

Malawi 2010
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

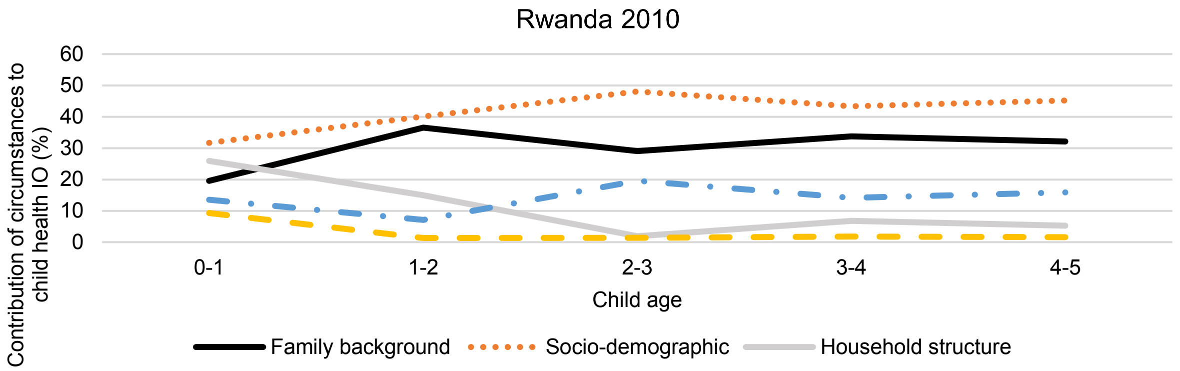

Mali 2012-2013
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

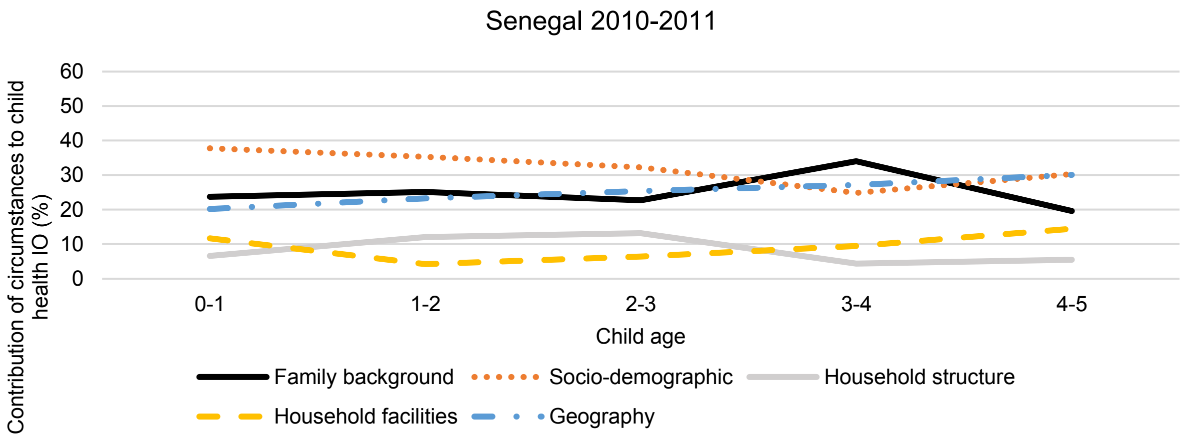

Mozambique 2013
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

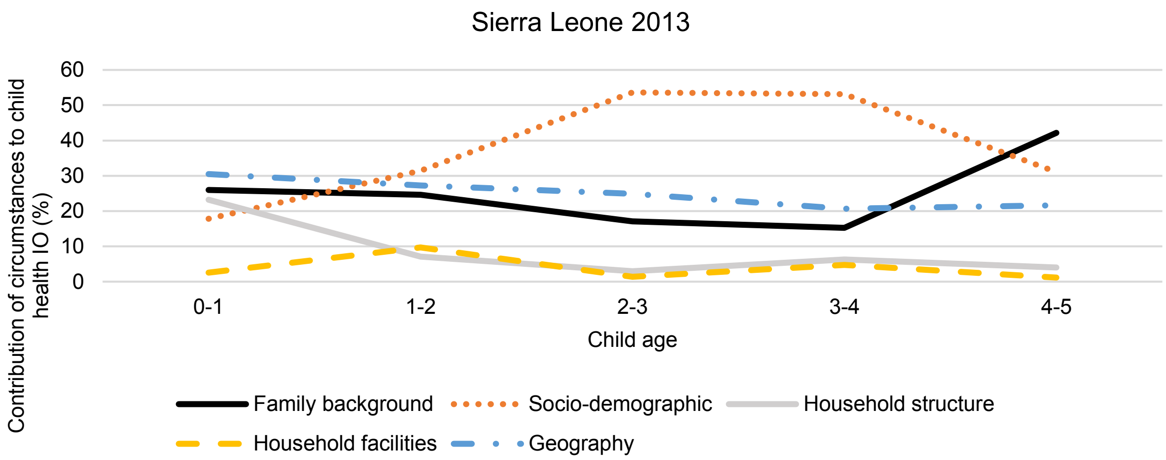

Namibia 2013
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

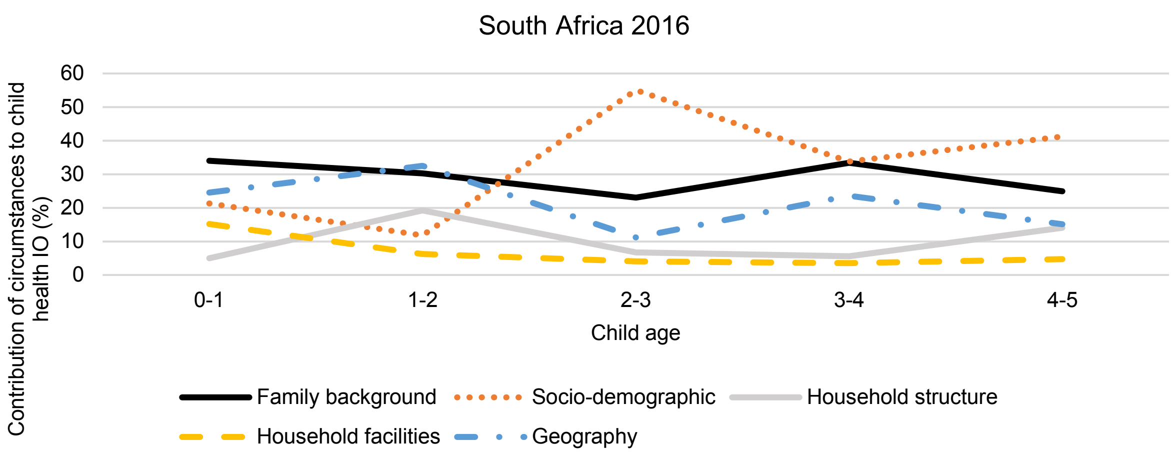

Niger 2012
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

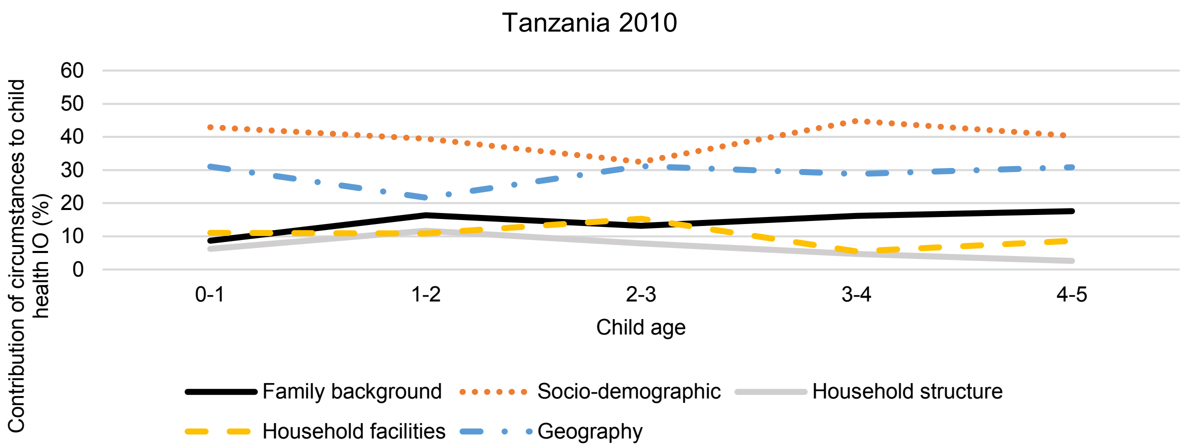

Nigeria 2013
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

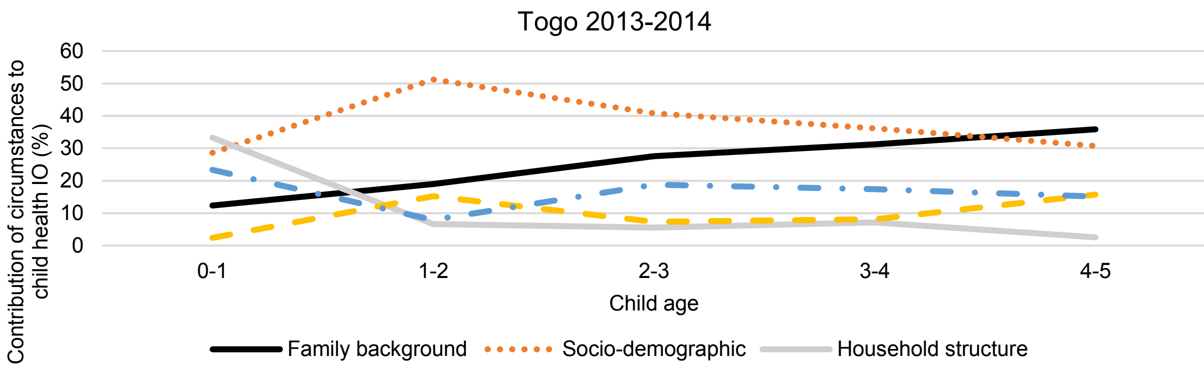

Rwanda 2010
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

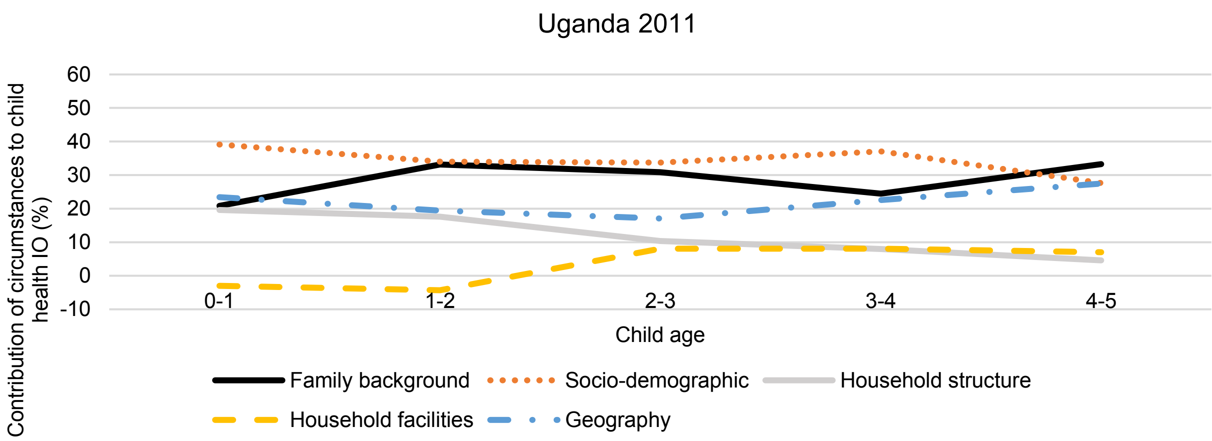

Senegal 2010-2011
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

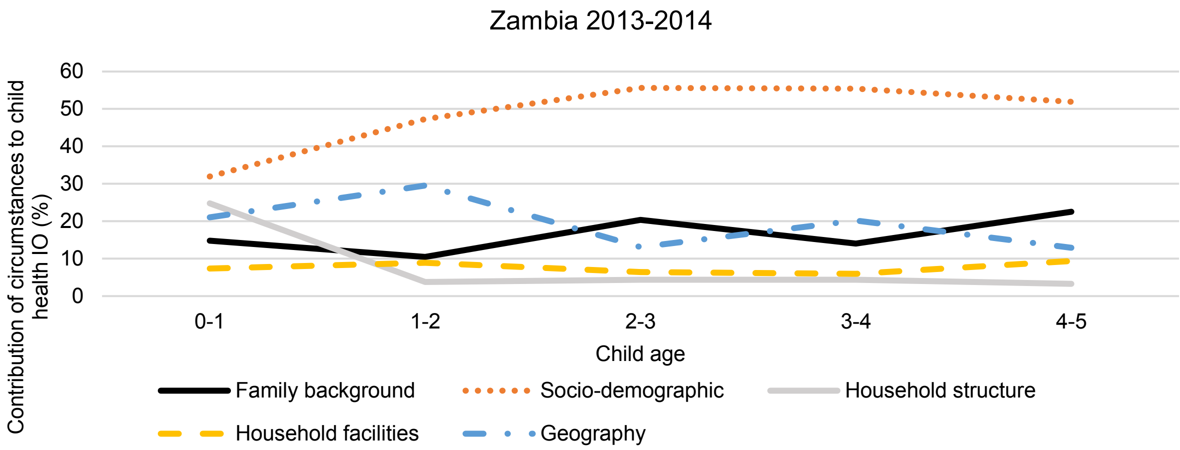

Sierra Leone 2013
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography

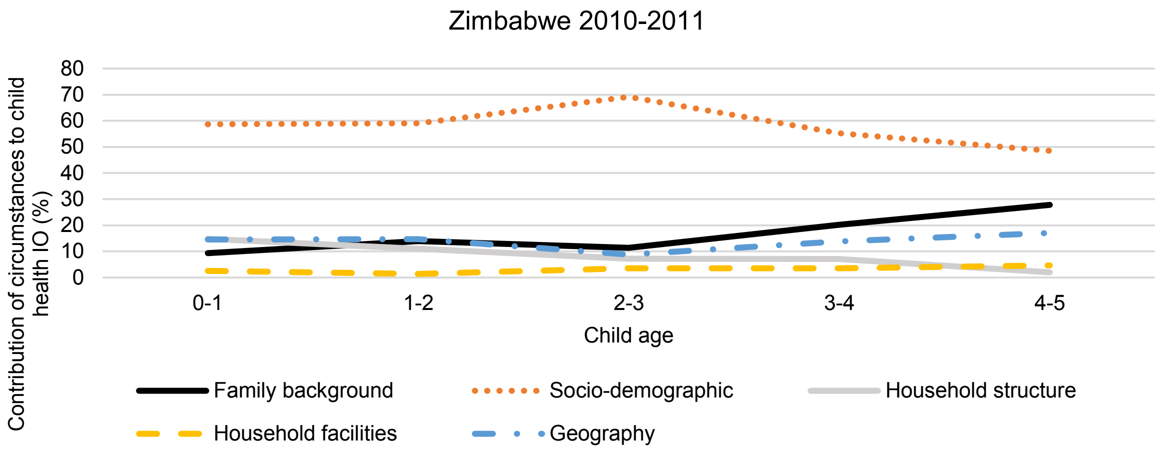

South Africa 2016
Contribution of circumstances to child health IO (%)
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
Child age
Family background
Socio-demographic
Household structure
Household facilities
Geography


Tanzania 2010
Contribution of circumstances to child health IO (%)
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 circumstances to child health IO (%)
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 circumstances to child health IO (%)
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).