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An evolution of inequality of opportunity in the nutritional outcomes of under-five children in Malawi

Pemphero Norah Mphamba *, Gowokani Chijere Chirwa, Jacob Mazalale

University of Malawi, P.O. Box 280, Zomba, Malawi

A R T I C L E I N F O

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A B S T R A C T

Background: Malnutrition among children is a significant public health and development issue, especially in low- and middle-income countries, Malawi inclusive, which contributes to preventable diseases and deaths. Significant socioeconomic disparities persist, which affect access to and equal distribution of basic nutrition. This study analyzed the extent and trends of Inequality of Opportunity (IOP) in the nutritional outcomes of children aged 0–59 months.

Methods: The study used nationally representative data from the 2006, 2013–14, and 2019-20 Malawi Multiple Indicator Cluster Survey. In terms of method, we examined IOP in stunting, wasting, and underweight indicators, using the Human Opportunity Index and the Dissimilarity Index in 55,723 children. The Shapley-value technique decomposed the relative IOP.

Results: We find the largest share of circumstance-driven inequality in stunting (8.96 percent), followed by underweight (1.91 percent), and then wasting (0.90 percent). The Shapley-value decomposition results indicate the child's age (29.15 percent for stunting, 12.42 percent for underweight, and 52.36 percent for wasting) and gender (8.28 percent, 18.36 percent and 8.87 percent), wealth (6.36 percent, 22.87 percent and 8.54 percent), and mother's education (6.28 percent, 11.29 percent and 5.51 percent) as the dominant contributors to IOP for all three nutritional outcome indicators; stunting, underweight and wasting, respectively.

Conclusion: The findings suggest that policies aimed at narrowing the wealth and education inequality gap could help equalize nutrition opportunities for children in Malawi.

1. Introduction

Existing research recognizes the critical role of early childhood nutrition in health and well-being later in life (Human Early Learning Partnership & Commission on Social Determinants of Health, 2007). Poor nutrition during pregnancy and early childhood can be detrimental to brain development and have significant long-term effects, as failure to maximize early brain development results in lasting developmental defects (Nurliyana et al., 2016).

Malnutrition in early life affects adult cognitive abilities (Mwene-Batu et al., 2020), educational attainment (Glewwe & Miguel, 2007; Osei & Lambon-Quayefio, 2022), health (De & Chattopadhyay, 2019), overall labour productivity, and lifetime earnings (Black et al., 2007). Malnutrition also accounts for 45 percent of deaths in children under five globally (Vassilakou, 2021). Where prevalent, these individual setbacks impede human capital development and negatively impact socioeconomic development (Nandi et al., 2017).

Child malnutrition is a severe health problem worldwide. In 2020, 149.2 million children under five were stunted, 45.4 million children under five were wasted (UNICEF/WHO/The World Bank, 2021), and 85.4 million children under five were underweight (WHO, 2021). However, child malnutrition is more common in low-and middle-income countries, as these are the groups most at risk of malnutrition owing to scarce public resources and the need for international development assistance (FAO IFAD UNICEF WFP and WHO, 2022). Stunting rates are particularly high in Sub-Saharan Africa (32.3 percent), in Asia, specifically Central and Southern Asia (29.8 percent), and Oceania (41.4 percent), with the exception of New Zealand and Australia (UNICEF/WHO/The World Bank, 2021). Wasting prevalence is highest in Central and Southern Asia (13.6 percent), Oceania, excluding New Zealand and Australia (9 percent), and Sub-Saharan Africa (5.9 percent) (UNICEF/WHO/The World Bank, 2021). Underweight is more common in South Asia (27.4 percent) and sub-Saharan Africa (16.9 percent) (The World Bank, 2021). A large and growing body of evidence (Akombi et al., 2017;

* Corresponding author.
E-mail addresses: pempheromphamba@gmail.com (P.N. Mphamba), gchirwa@unima.ac.mw (G.C. Chirwa), jmazalale@unima.ac.mw (J. Mazalale).

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Asmare & Agmas, 2022; Case et al., 2002; Chirwa & Ngalawa, 2008; Dhamija et al., 2023) suggests that health-related disparities are highly attributable to socio-economic-related disparities.

This study investigates inequality of opportunity in nutritional outcomes among children under five in the Malawian context to determine priority areas to be targeted by policymakers to curb undernutrition. Undertaking this study is important as it speaks to the various policy goals. Reducing health-related inequalities is at the core of Malawi 2063 (National Planning Commission, 2020), a government goal emphasizing human capital development as a priority area, and the Sustainable Development Goals (SDGs). Specifically outlined in the United Nations (UN) Agenda 2030, SDG Goal 3 aims to "Ensure healthy lives and promote well-being for all at all ages"; Goal 2 strives to "End hunger, achieve food security, improve nutrition, and promote sustainable agriculture, with Goal 2.2 seeking to "Reduce the prevalence of stunting among children under five by 40 percent between 2012 and 2025, as well as reduce wasting to less than 5 percent and have no increase in overweight over the same period", and Goal 10 emphasizes the imperative to "Reduce inequality within and among countries" (United Nations, 2015). Examining the disparities in nutritional outcomes thus requires understanding their underlying factors for better policy formulation. It is, therefore, important to understand IOP to reduce the lifetime consequences of predetermined factors.

Malawi's nutrition situation makes an interesting case for examining IOP for three reasons. First, Malawi has seen an improvement in nutritional outcome indicators in the last decade. However, progress has been slow, leaving stunting and underweight prevalence still high; 35 percent and 12.8 percent, respectively, in 2020 (WFP, 2022); both higher than the global average prevalence (22 percent for stunting, 12.6 percent for underweight), and the prevailing wasting rates, though low (2.6 percent). Second, current progression shows that the alluded factors still pose a public health concern, thus undermining the achievement of SDGs 2 and 3 by 2030. The current levels are still higher than expected. Thirdly, there are worsening inequalities in Malawi. For example, inequalities in wealth (Gini = 0.564), consumption (Gini = 0.450), and other socioeconomic indicators that affect health access, such as education, have worsened over the last decade (Mussa & Masanjala, 2015). Lastly, the poverty situation remains critical in the country, which affects food security. Over 50 percent of Malawi's 17.6 million residents live below the international poverty line of $1.90 per day (National Statistical Office Ministry of Finance and Economic Affairs UNDP &OPHI, 2022), and 61.7 percent of the population is multidimensionally poor (Government of Malawi UNDP OPHI, 2021). This poverty situation may have heightened the IOP through the income effect that is transmitted through the food insecurity channel (WFP, 2022).

There is a gap in understanding IOP even though numerous studies examining child health disparities in developing nations identify various socioeconomic-related factors such as education (Ersado & Aran, 2014; Makoka & Masibo, 2015), household wealth (Aizawa, 2019; Ashley-Cooper et al., 2019; Dhamija et al., 2023; Ebaidalla, & UNU-WIDER, 2019; Ghosh, 2023), age (Mkupete et al., 2022), gender (Chilora & Duchoslav, 2020; Mussa, 2015), water and sanitation (Mkupete et al., 2022), region of residence (Liu et al., 2022; Pérez-Mesa et al., 2022), price volatility (Mkupete et al., 2022). All these studies have resulted in mixed findings.

In Malawi, existing literature on nutrition-related disparities (Chikhungu, 2022; Chilora & Duchoslav, 2020; Claffey et al., 2020; Machira & Chirwa, 2020; Makoka & Masibo, 2015; Mussa, 2015; Pérez-Mesa et al., 2022) made no distinction between legitimate and illegitimate sources of child nutritional inequalities except in the study of Pérez-Mesa et al. (2022), who examined IOP in child height inequality in 33 SSA countries using DHS from 2009 to 2016, Malawi (2010 DHS) inclusive.

Roemer (1998, 2002) defines legitimate sources of inequalities as factors that are beyond an individual's control, such as gender and family background, also known as circumstances, and defines illegitimate sources, also called effort, as factors that an individual can be held responsible for. The former represents a type of inequality known as Inequality of Opportunity. Equality of opportunity, according to Roemer, entails a situation where the distribution of outcomes is independent of inherent exogenous factors beyond the control of an individual (Roemer, 1998, 2002; Roemer & Trannoy, 2013).

Given that no factors are within the control of children under five, Roemer's framework would imply that all observed inequalities in outcomes would be attributed to IOP. It would, however, yield a measure of equality of opportunity that is unrealistic because equality of outcome would imply that all children of the same age and sex have the same height and weight (Krafft, 2015). Therefore, adaptation is required, as done by Assaad et al. (2012). Therefore, observable characteristics measure inequality of opportunity in child health. In contrast, luck and genetic variations attributable to parental characteristics are considered morally justifiable and, therefore, included in the residual inequality and are not attributable to inequality in opportunities (Assaad et al., 2012).

Pérez-Mesa et al. (2022), in examining Malawi's child health inequality, use data that is old and preceded by new events, which warrants another investigation. Thus, this presents a gap that ought to be studied in the context of IOP. Furthermore, a gap still exists in IOP for wasting and underweight in Malawi, and an evolution of IOP in nutritional outcomes over the years 2006–2020. Thus, this study provides some relevant value addition using the most recent data. The study has two objectives. First, it measures the extent of IOP in the nutrition outcomes of children in Malawi. Then, a decomposition analysis of the IOP is conducted to identify and quantify the impact of each examined circumstance in explaining inequalities.

This study contributes to the existing literature in two ways. First, to the best of our knowledge, this is the first study to examine the inequality of opportunity in the Malawian context for wasting and underweight. Second, the study utilizes data from 2006 to 2019–20, thus providing a better understanding of the trend of IOP and changes in the contributions of various circumstances to IOP over the years.

2. Methods

2.1. Data

This paper uses data from the Multiple Indicator Cluster Surveys (MICS) for 2006, 2013–14 and 2019–20, collected by the Malawi National Statistical Office. The MICS is a global survey program developed by the United Nations Children's Fund (UNICEF) to provide good quality and reliable statistical and internationally comparable data on the situation of children and women for monitoring progress towards national goals and Sustainable Development Goals. It collects information on children under five, women and men aged 15–49 years in every third household selected. Information on child anthropometrics was collected, which is the interest of this paper as it focuses on child stunting, underweight, and wasting.

The MICS is one of Malawi's most extensive nationally representative household surveys, tackling one of Malawi's challenges; the need for sub-national data. The surveys were conducted in 26 districts in 2006 (July–November), 27 districts in 2013–14 (December 2013–April 2014), and all 28 districts in Malawi in 2019–20 (December 2019–August 2020), using a two-stage sampling method based on the Malawi Population and Housing Census (PHC). In the initial stage, a specified number of clusters were systematically selected in each district. In the second stage, a household listing was conducted within the selected clusters, and a systematic sample of households was selected within each cluster. A total of 31,200 households in 1040 clusters in 2006, 28,479 in 1140 clusters in 2013–14, and 26,882 households in 1111 clusters in 2019–20 were selected. The total sample of under-five children was 22,994 in 2006, 18,981 in 2013–14, and 15,457 in 2019–20. After data cleaning to address missing variables in anthropometrics, the final sample sizes were 22,266 for 2006, 18,574 for 2013–2014, and 14,883 for 2019–2020.

2.2. Child health outcome

Anthropometric measures, height-for-age (stunting), weight-for-age (underweight), and weight-for-height (wasting) z-scores were generated. Height is a preferred indicator because it is a good measure of general health status as it signifies the accumulation of poor nutrition and illnesses (Pradhan et al., 2003). Weight is the other measure of interest, and more weight for a given height does not always indicate being healthier, but it is a measure that is more sensitive to short-term variations in nutrition (Pradhan et al., 2003).

It is well-established that children's height and weight rise with age and differ depending on the gender of the child (Assaad et al., 2012; Pradhan et al., 2003). Thus, to abstract the standard variability in height and weight across age and gender, we used a reference distribution for healthy children developed by the World Health Organization (WHO, 2006) as most empirical evidence on child health inequalities (Assaad et al., 2012; Krafft, 2015; Pradhan et al., 2003).

We calculated three continuous variables, namely height for age Z-score (HAZ), weight for age Z-score (WAZ), and weight for height Z-score (WHZ). Based on these continuous variables, two dummy variables were constructed accordingly for the outcome indicators stunting, underweight, and wasting. According to the World Health Organization (WHO, 2006), a child is defined to be stunted, wasted, or underweight if their z-score is two standard deviations below the benchmark (-2sd). The outcome measure is generated as: stunted (0 = No if HAZ ≥ -2 and 1 = Yes if HAZ < - 2), wasted (0 = No if WHZ $\geq -$ 2sd and 1 = Yes if WHZ < $-$ 2sd), underweight (0 = No if WAZ $\geq -$ 2 and 1 = Yes if WAZ < $-$ 2sd).

2.3. Circumstances

This paper used fourteen types of circumstances variables grouped into individual and household, all of which are beyond the control of the individual. For individual factors, we have age (Liu et al., 2022), gender (Liu et al., 2022; Sanoussi, 2017; Sanoussi et al., 2020), birth order (Assaad et al., 2012; Liu et al., 2022), and breastfeeding status (Katoch, 2022; Mkupete et al., 2022). For household factors, we have the number of under-five children in the household (Sanoussi et al., 2020), residence area (Pérez-Mesa et al., 2022), region (Assaad et al., 2012; Liu et al., 2022), wealth (Aizawa, 2019; Assaad et al., 2012; Singh, 2011), mother's and father's education (El-Kogali et al., 2016; Liu et al., 2022; Pérez-Mesa et al., 2022), water and sanitation (Mkupete et al., 2022), media exposure (Aizawa, 2019), and mother's age at birth (Assaad et al., 2012; Paul & Saha, 2022).

2.3.1. Individual factors

Existing literature (Fledderjohann & Channon, 2022; Haq et al., 2021; Samuel et al., 2022) has examined age and gender disparities in child development. Research suggests gender differences in parents' human capital investment, but the results are mixed and country-specific. This might suggest that cultural factors influence parents' decision-making. With the increase in age, a child's risk of malnutrition rises, which is attributable to the supplementation of foods with poor nutritional value being introduced later than necessary (Kassie & Workie, 2020). Age and gender have, therefore, been included in the analysis.

Following the literature on the tradeoff between quality and quantity for children within a family setting, child health is related to the birth order and the number of young siblings in the family (Becker, 1991). Breastfeeding also affects the risk of malnutrition (Katoch, 2022; Machira & Chirwa, 2020) and has been included. Breastfeeding boosts a child's defensedefences against infectious illnesses and lowers their risk of malnutrition.

2.3.2. Household factors

To account for the vast variations in regions and areas of residence across Malawi, we include regions with north, central and south categories, and areas of residence with rural and urban categories. Child nutrition can be influenced by factors specific to the communities where the children stay.

We add the father's educational attainment and the mother's educational attainment. This is motivated by empirical evidence on the association between parental background and children's development. Parents with more education are more adept at using health facilities and handling information. According to the bargaining literature on household decisions, bargaining status, which is improved by education (McElroy & Horney, 1990), could also influence those resources that the mother may receive for herself as well as for her child, possibly leading to adverse nutrition consequences (Kulkarni et al., 2020). Higher levels of maternal education in Malawi are associated with a lower risk of child malnutrition (Makoka, 2013; Makoka & Masibo, 2015).

The toilet and water source types are also incorporated to consider household sanitation factors. Children's health is positively correlated with sanitation; access to a suitable toilet facility (Mkupete et al., 2022; Rah et al., 2020). However, the literature on water sources is mixed (Rah et al., 2020; Sahiledengle et al., 2022; van Cooten et al., 2019). It is well-recognized that a family's economic situation strongly influences a child's nutritional state (Amare et al., 2019; Kang & Kim, 2019; Shrestha et al., 2022). Poor people frequently have limited access to food, which is a requirement for food security and access to health care. Therefore, we include the wealth quintile, categorized into poorest, second, middle, fourth, and richest.

The risk of child malnutrition increases with young maternal age (Wemakor et al., 2018), mother's age at birth has been included. Lower maternal age is associated with adverse birth outcomes and low birth weight (Fall et al., 2015). Media exposure has also been included as a circumstance variable. Literature (Adedokun & Yaya, 2021; Ahsan et al., 2017) suggests that mass media exposure significantly affects nutrition. Media exposure in this study entails exposure to radio and television. A detailed description of the circumstance variables is presented in Table 1.

3. Analytical method

3.1. Estimation of the human opportunity index and dissimilarity index

The study adopts the methodological framework of Paes de Barros et al. (2009) of measuring inequality of opportunity within a society, following Roemer's conceptualization. This metric of analysis is known as the human opportunity index (HOI). The HOI measures how far a society is from universal access to a good or service and how equitable the access is across circumstance groups (Molinas Vega et al., 2011). The computation is done by putting together two methods of analyzing access. These are the absolute coverage level of a particular opportunity; the mean coverage level, and the dissimilarity index, also known as the D-index.

The D-index divides the population of children into distinct groups based on their life circumstances, such as the location of a child. It then assesses the weighted differences in groups; average access to an opportunity to the average for all population groups. The D-index is the share of opportunities that must be redistributed among circumstance groups, from better to worse-off groups, to achieve equalized opportunity. Appendix A outlines a comprehensive step-by-step estimation procedure for the HOI and the D-index. Utilizing Shapley decomposition, the D-index is deconstructed to determine the specific contributions of different circumstances to the overall inequality.

3.2. Shapley decomposition

The Shapley decomposition is a method for attributing the

Table 1
Description of circumstance variables.

Individual level variables	
Age	Dummy (1 = 0–11 months, 0 otherwise 1 = 12–23 months, 0 otherwise 1 = 24–35 months, 0 otherwise 1 = 36–47 months, 0 otherwise 1 = 48–59 months, 0 otherwise)
Gender	Dummy (1 for Males, 0 for Females)
Birth order	Dummy (1 = Firstborn, 0 otherwise 1 = Second/Third born, 0 otherwise 1 = Fourth born or higher. 0 otherwise)
Breastfeeding status	Dummy (1 = Yes, 0 No)
Household level variables	
Number of under-five siblings	Dummy (1 = One, 0 otherwise 1 = Two, 0 otherwise 1 = Three or more, 0 otherwise)
Area	Dummy (Urban 1, Rural 0)
Region	Dummy (1 = North, 0 otherwise 1 = Central, 0 otherwise 1 = South, 0 otherwise)
Mother's education and Father's education	Dummy (1 = None, 0 otherwise 1 = Primary, 0 otherwise 2 = Secondary+ (secondary, higher education and any other vocational courses), 0 otherwise)
Type of toilet facility	Dummy (1 = Flush, 0 otherwise 1 = Pit latrine, 0 otherwise 1 = No toilet, 0 otherwise 1 = other facilities (composting toilets, hanging latrines, and the bush), 0 otherwise
Main source of drinking water	Dummy (1 = Piped, 0 otherwise 1 = Borehole, 0 otherwise 1 = Well, 0 otherwise 1 = Spring, 0 otherwise 1 = Other sources (rainwater, tanker trucks, water kiosk, and surface water), 0 otherwise
Wealth quintile	Dummy (1 = Poorest, 0 otherwise 1 = Poorer, 0 otherwise 1 = Middle, 0 otherwise 1 = Fourth, 0 otherwise 1 = Richest, 0 otherwise)
Mother's age at birth	Dummy (1=<20, 0 otherwise 1 = 20–34, 0 otherwise 1 = 34+, 0 otherwise)
Media exposure	Dummy (1 = Exposed, 0 otherwise 1 = Not exposed, 0 otherwise)

contribution of different factors to a particular outcome using the Shapley Value (Shorrocks, 2013). The method originated from cooperative game theory, where a coalition of players receives shares proportionate to their marginal contribution towards a common objective. By averaging over the marginal contributions of each factor, the Shapley decomposition comprehensively allocates the total inequality to the covariates. The basic idea is that the human opportunity index is based on a set of circumstances, and adding more to these increases the value of the dissimilarity index. The effect of adding a circumstance to the measure relies on the initial set or subset of circumstances to which it has been added (Shorrocks, 2013). The unique impact of a circumstance is the mean value of all the changes that occur when a particular circumstance is added to all possible subsets of pre-existing circumstances (Shorrocks, 2013) (See Appendix A).

4. Results

4.1. Summary statistics

The highest prevalence of malnutrition, as shown in Fig. 1, is that of stunting at 50.19 percent, 40.17 and 28.95 percent for all years, then underweight which has been fluctuating over the years, at 14.11 percent in 2006, increased to 15.58 percent in 2013/14 then reduced to 10.78 percent in 2019/20. The lowest prevalence is of wasting at 4.23 percent, 4.09 percent, and 2.97 percent for 2006, 2013/14, and 2019/20,

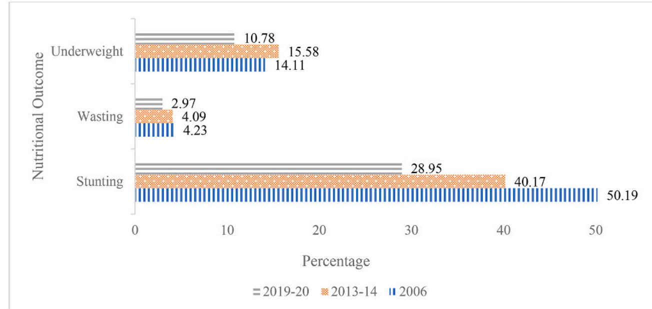

Fig. 1. Prevalence rates of malnutrition in Malawi.

indicating a reduction over the years.

Table 2 presents the descriptive statistics for the pooled, 2006, 2013–14, and 2019-20 samples following a univariate analysis.

In the pooled sample, there were more females than males (50.29 percent females, 49.71 percent males). Most individuals reside in the rural areas (88.77 percent) and the Southern region (45.96 percent). A majority of the mothers (68.70 percent) and fathers (45.18 percent) have primary education compared to those with no education and secondary education. Most of the individuals in the sample use boreholes for water (59.74 percent) and pit latrines for sanitation (88.16 percent) and belong to the poorest wealth quintile (22.72 percent). Media exposure is high at 51.48 percent. Most of the children in the samples are of high birth orders; four and higher (39.46 percent), and have ever been breastfed (99.07 percent). Most of the households in the pooled data sample had one under-five child (52.78 percent).

Table 3 shows the percentage distribution of socioeconomic and demographic characteristics for stunted, wasted, and underweight children following a bivariate analysis conducted along with the Chi-Square test for independence to determine whether there is a significant relationship between the dependent variables and the categorical independent variables.

Overall, the results show that the trajectory of malnutrition has been the same for many indicators over the years. Stunting and underweight are more prevalent in higher age groups than wasting, which is more prevalent in lower age groups and more common among males. Most malnourished children have parents with no education. A large population of stunted, wasted, and underweight children are based in rural areas compared to urban areas and belong to the poorest wealth quintile.

For the pooled sample, the cross-tabulated frequencies, at 5 percent significance indicate that the majority of the stunted, wasted, and underweight population are male (44.1 percent, 4.4 percent, 15.6 percent), reside in the rural areas (42.1 percent, 3.9 percent, 14.1 percent), have mothers with no education (48.4 percent, 4.8percent, 17.7 percent), and belong to the poorest wealth quintile (46.6 percent, 4.7 percent, 17.6 percent). At 5percent significance, there's a statistically significant relationship between the child's age, region, wealth quintile, birth order, toilet facility, the main source of drinking water, gender, area of residence, mother's education, father's education, number of under-five siblings, and all nutrition indicators. Media exposure had a statistically significant relationship with underweight but not stunting and wasting. Mother's age at birth was significantly related to stunting and underweight but not wasting.

4.2. Inequality of opportunity

Fig. 2 presents the results of the human opportunity index (HOI), the dissimilarity index (D-index), and the coverage rate. The results for the HOI show that for stunting, wasting, and underweight, 54.2 percent, 94.5 percent, and 84.4 percent of basic nutrition are available and equitably distributed, respectively. The D-index shows that the highest

Table 2
Summary statistics (N= Observations, percent = Percentage distribution).

	Pooled		2006		2013–14		2019–20	
Variable	N	Percent	N	Percent	N	Percent	N	Percent
Child's age (months)								
0–11	11,398	20.70	4829	21.93	3470	18.99	3099	20.98
12–23	11,988	21.77	4988	22.65	3841	21.02	3158	21.38
24–35	11,569	21.01	4827	21.92	3676	20.12	3062	20.73
36–47	10,969	19.92	4297	19.51	3848	21.06	2828	19.14
48–59	9141	16.60	3079	13.98	3435	18.80	2624	17.76
Gender								
Male	27,700	49.71	11,035	49.56	9278	49.95	7389	49.65
Female	28,023	50.29	11,231	50.44	9296	50.05	7494	50.35
Residence								
Rural	49,465	88.77	19,970	89.69	16,460	88.62	13,038	87.60
Urban	6258	11.23	2296	10.31	2114	11.38	1845	12.40
North	10,599	19.02	4422	19.86	3219	17.33	2960	19.89
Central	19,514	35.02	8209	36.87	6356	34.22	4949	33.25
South	25,610	45.96	9634	43.27	8999	48.45	7123	47.86
Parents' Education								
Mothers' education: none	8381	15.04	4785	21.49	2259	12.16	1336	08.98
Mothers' education: primary	38,282	68.70	14,985	67.30	13,158	70.84	10,135	68.10
Mothers' education: secondary+	9044	16.23	2489	11.18	3146	16.94	3408	22.90
Father's education: none	3912	07.02	2084	09.36	1118	06.02	710	04.77
Father's education: primary	25,176	45.18	10,923	49.06	8696	46.82	5559	37.35
Father's education: secondary+	10,916	19.59	3897	17.50	4006	21.57	3398	22.83
Wealth Status								
Poorest	12,660	22.72	4983	22.38	4131	22.24	3545	23.82
Second	11,941	21.43	4745	21.31	4058	21.85	3135	21.07
Middle	11,590	20.80	4756	21.36	3917	21.09	2916	19.59
Fourth	10,403	18.67	4251	19.09	3371	18.15	2779	18.67
Richest	8726	15.66	3531	15.86	2792	15.03	2400	16.13
Variable	N	Percent	N	Percent	N	Percent	N	Percent
Water and Sanitation								
Piped water	9372	16.82	3607	16.20	3184	17.14	2581	17.34
Borehole	33,289	59.74	11,805	53.02	11,928	64.22	9553	64.19
Well	9339	16.76	4983	22.38	2535	13.65	1819	12.22
Spring water	780	01.40	285	01.28	193	01.04	301	02.02
Other water sources	2942	05.28	1583	07.11	732	03.94	630	04.23
Flush toilet	797	01.43	309	01.39	271	01.46	214	01.44
Pit latrine	49,125	88.16	18,835	84.59	17,088	92.00	13,200	88.69
No toilet	5517	09.90	3046	13.68	1152	06.20	1319	08.86
Other toilet facilities	334	00.61	73	00.33	61	00.33	150	01.01
Maternal age								
Mother's age at birth: <20	9571	17.98	3365	15.38	3224	18.50	2983	21.42
Mother's age at birth: 20-34	36,685	68.92	15,458	70.65	12,116	69.53	9113	65.45
Mother's age at birth: 34+	6973	13.10	3059	13.98	2086	11.97	1828	13.13
Under-five siblings								
No. of U-5 children in household: 1	29,411	52.78	10,167	45.66	9584	51.60	9659	64.90
No. of U-5 children in household: 2	22,947	41.18	10,541	47.34	7840	42.21	4563	30.66
No. of U-5 children in household: 3+	3338	05.99	1556	06.99	1122	06.04	661	04.44
Birth Order								
Birth order: 1	12,233	23.37	4544	21.64	3694	21.20	3995	28.69
Birth order: 2-3	19,457	37.17	7933	37.78	6249	35.86	5274	37.88
Birth order: 4+	20,656	39.46	8520	40.58	7483	42.94	4655	33.43
Breastfeeding Status								
Ever breastfed	33,751	99.07	14,898	98.99	10,748	98.73	8106	99.68
Not breastfed	136	00.40	66	00.44	44	00.41	26	00.32
Media Saturation								
Have media exposure	28,683	51.48	14,723	66.14	9268	49.90	4690	31.51
No media exposure	27,034	48.52	7537	33.86	9304	50.09	10,193	68.49

IOP is found in stunting. To achieve equality of opportunity, 9 percent. 0.9 percent and 1.9 percent inequality must be redistributed from better to worse off groups for stunting, wasting, and underweight. The coverage rate of basic nutrition is 56.9 percent in regards to stunting, 95.4 percent for wasting, and 86.1 percent for underweight.

The trend of IOP in Fig. 3 shows that from 2006 to 2019–20, there has been a decrease in the IOP in stunting and wasting, from 9.6 percent in 2006 to 6.2 percent in 2013–14, then 5.7 percent in 2019–20 for stunting, and 1.2 percent,1.1 percent, and 0.5 percent for 2006, 2013–4, and 2019–20. For underweight, the IOP that needs to be reallocated for equality to prevail has been increasing, from 1.9 percent in 2006 to 2.0 percent in 2013–14 and 2.2 percent for 2019–20.

The most precise estimation of IOP can be generated by considering all the factors that impact a child's health as well as the most precise measurement of the observable factors. Due to data limitations, one can only, in practice, control a portion of the factors influencing IOP and aggregate some of the factors. Since the measurement of inequality of opportunity in our analysis examines inequalities attributable to observable circumstances, the inequality of opportunity measured will be a lower bound on true inequality of opportunity since not all

Table 3
Cross Tabulation of Socioeconomic and Demographic Characteristics and Child Nutritional Status (Notes: Statistical Significance: *p < 0.1, **p < 0.05, ***p < 0.01).

	Stunted				Wasted				Underweight			
Variable	Pooled	2006	2013	2019	Pooled	2006	2013	2019	Pooled	2006	2013	2019
Child's age (months)												
0–11	24.7***	30.3***	26.0***	14.5***	6.1***	7.8***	6.2***	3.4***	9.7***	10.2***	12.0***	6.4***
12–23	46.3***	57.1***	44.5***	31.6***	5.0***	5.1***	5.7***	4.2***	15.4***	16.1***	17.5***	11.6***
24–35	51.2***	60.3***	49.2***	39.4***	3.1***	3.0***	3.9***	2.3***	16.0***	16.1***	18.4***	13.1***
36–47	46.5***	56.1***	45.1***	34.0***	2.6***	2.3***	2.8***	2.6***	13.9***	14.5***	15.2***	11.4***
48–59	38.8***	50.1***	38.1***	26.3***	2.2***	2.1***	2.2***	2.3***	14.3***	14.4***	15.8***	12.1***
Gender												
Male	44.1***	52.8***	43.2***	32.3***	4.1***	4.4	4.6***	3.1	15.0***	15.6***	16.6***	12***
Female	38.3***	47.7***	37.2***	25.7***	3.6***	4.1	3.5***	2.8	12.5***	12.6***	14.6***	9.6***
Area												
Rural	42.1***	51.3***	40.9***	29***	3.9***	4.3	4.2**	3.1**	14.1***	14.4***	16.1***	11.2***
Urban	33.5***	40.7***	34.5***	23.5***	3.1***	3.8	3.1**	2.1**	10.4***	11.2***	11.8***	7.7***
Region												
North	36.1***	43.6***	37.2***	23.4***	4.4***	5.8***	3.7	3.1***	11.2***	12.6***	12.3***	7.7***
Central	43.5***	52.5***	42***	31.1***	3.5***	3.8***	4.1	2.3***	14.2***	15.2***	15.4***	11***
South	41.5***	51.5***	39.9***	29.8***	3.9***	3.9***	4.2	3.4***	14.4***	13.8***	16.9***	11.9***
Mother's education												
None	48.4***	53.9***	44.7***	35.0***	4.8***	4.8*	5.3***	3.6*	17.7***	17.5***	20.1***	14.5***
Primary	42.1***	50.9***	41.0***	30.4***	3.8***	4.1*	4.1***	3.1*	14.0***	14.1***	15.8***	11.6***
Secondary+	30.6***	38.8***	33.3***	22.2***	3.1***	3.7*	3.4***	2.3*	8.7***	7.7***	11.4***	6.9***
Father's education												
None	47.0***	54.0***	43.6***	31.7***	4.1***	4.5	4.3*	2.7*	16.2***	17.1***	17.5***	11.5***
Primary	43.1***	51.9***	40.9***	29.4***	3.9***	4.3	4.0*	2.9*	14.2***	14.5***	15.8***	11***
Secondary+	34.1***	41.9***	34.4***	22.6***	3.3***	3.6	3.7*	2.4*	9.8***	9.6***	11.8***	7.3***
Wealth Quintile												
Poorest	46.6***	54.5***	47.4***	34.5***	4.7***	4.9***	5.1***	3.9***	17.6***	17.8***	20.1***	14.3***
Second	44.0***	53.1***	42.5***	32.0***	3.8***	3.9***	4.4***	2.9***	14.9***	15.4***	16.5***	12.3***
Middle	42.2***	51.1***	41.4***	28.6***	4.1***	4.6***	4.1***	3.4***	13.9***	14.6***	15.9***	10.2***
Fourth	39.8***	49.1***	38.0***	27.8***	3.2***	3.7***	3.4***	2.3***	11.6***	11.6***	13.5***	9.1***
Richest	31.8***	40.2***	31.4***	19.7***	3.2***	3.8***	3.5***	2.0***	9.4***	9.5***	11.4***	6.8***
Water source												
Piped	35.9***	44.5***	35.5***	24.3***	3.3***	3.8***	3.0***	2.8**	10.7***	10.4***	12.9***	8.6***
Borehole	40.6***	49.8***	40.6***	29.2***	4.0***	4.4***	4.3***	3.0**	13.9***	14.2***	15.8***	11.2***
Well	48.0***	55.8***	43.3***	33.0***	3.6***	3.9***	3.9***	2.4**	15.8***	16.6***	17.7***	11.2***
Spring	43.7***	56.0***	45.6***	30.9***	4.9***	6.0***	4.1***	4.3**	14.5***	14.1***	18.1***	12.6***
Other	42.0***	47.8***	41.8***	31.6***	5.0***	4.8***	5.6***	4.8**	14.0***	14.5***	15.4***	11.1***
Toilet Facility												
Flush	24.0***	30.4***	21.0***	18.6***	2.3***	2.3***	3.0*	1.4	7.3***	5.8***	9.2***	7.0***
Pit latrine	40.7***	50.0***	39.9***	28.6***	3.8***	4.1***	4.1*	3.0	13.4***	13.7***	15.4***	10.5***
No toilet	47.5***	53.3***	48.5***	33.4***	4.5***	5.4***	4.5*	2.5	17.1***	17.2***	20.3***	14.0***
Other	40.1***	56.0***	37.1***	33.3***	5.2***	4.0***	9.7*	4.0	16.0***	17.3***	16.1***	15.3***
Mother's age at birth												
<20	42.9***	52.6**	42.8***	32.1***	4.0*	4.3	4.2	3.6***	14.9***	15.4**	16.7***	12.5***
20–34	41.2***	50.3**	39.7***	27.7***	3.8*	4.3	4.0	2.6***	13.3***	13.9**	15.0***	9.9***
34+	42.9***	51.6**	42.5***	29***	4.3*	4.3	4.9	3.8***	15.0***	14.8**	18.6***	11.3***
No. of under-fives in the household												
1	39.2***	50.2	38.8***	28.1***	3.7***	4.2	3.9***	2.9	12.9***	14.0	14.5***	10.3***
2	43.3***	50.4	41.1***	30.4***	3.9***	4.2	4.0***	3	14.3***	14.2	16.0***	11.4***
3 or more	44.2***	48.6	45.4***	31.8***	5.2***	4.9	6.2***	4.1	17.0***	14.5	22.4***	13.6***
Birth Order												
1	40.7***	51.0**	40.1**	29.6**	4.0***	4.5**	4.5	3.1	13.7***	14.6***	15.5***	10.8***
2–3	40.2***	49.4**	39.5**	27.4**	3.6***	3.9**	3.9	2.7	12.4***	12.6***	14.8***	9.4***
4 or higher	43.1***	51.5**	41.8**	29.7**	4.2***	4.8**	4.2	3.2	15.1***	15.4***	16.7***	11.9***
Media Exposure												
Exposed to media	41.0	48.7***	36.9***	24.7***	3.7*	4.1	3.7***	2.5**	12.7***	13.2***	17.1***	8.7***
Not exposure to media	41.4	53.1***	43.4***	30.9***	4.0*	4.5	4.5***	3.2**	14.7***	15.9***	14.1***	11.8***
Breastfeeding												
Breastfed	39.9**	48.2*	38.8	25.9	4.5	5.0	4.8*	3.4	13.4**	13.7	15.6**	9.8
Not breastfed	50.4**	60.6*	51.1	23.1	4.4	4.5	6.7*	0	19.7**	19.7	26.7**	7.7

circumstances can be observable in survey data (Ferreira & Gignoux, 2011).

The HOI and coverage rates for stunting and wasting have been increasing, as seen in Fig. 4. For underweight, it saw a reduction from 2006 to 2013-14 and then rose again in 2019–20.

The Shapley-value decomposition results in Table 4 indicate that the age (29.15 percent, 52.36 percent, and 12.42 percent), gender (8.28 percent, 8.87 percent, and 18.36 percent), wealth quintile (6.36 percent, 8.54 percent, and 18.36 percent) and mother's education (6.28 percent, 5.51 percent and 11.29 percent) are the dominant contributors of IOP

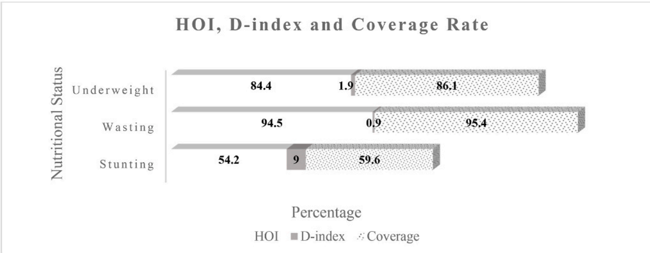

Fig. 2. Extent of IOP.

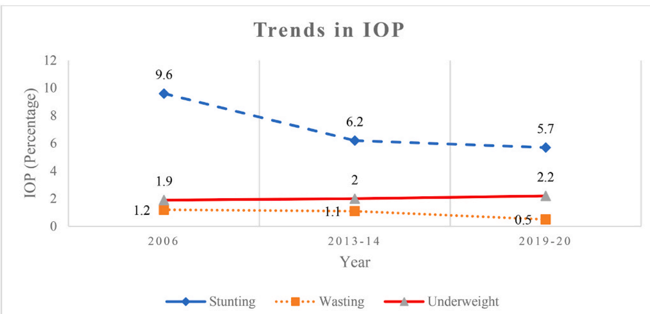

Fig. 3. IOP trends.

for the three nutritional outcomes, stunting, wasting and underweight, respectively. For underweight, birth order (7.10 percent) also contributes significantly. The decomposition results for specific years are provided in Appendix B, Figures 5–7.

5. Discussion

This study analyzed the extent and the trend of inequality of opportunity in the nutritional outcomes, stunting, wasting, and underweight for under-five children in Malawi between 2006 and 2019–20. We discuss the salient findings below.

Firstly, the prevailing inequality of opportunity is higher in stunting (9 percent) than in wasting (0.9 percent) and underweight (1.9 percent). This IOP is lower than that found in some African; Congo DR, Guinea Bissau, Mali (Sanoussi et al., 2020), and Asian developing (Aizawa, 2019) countries. Over the years, IOP has decreased for the opportunities of stunting and wasting but has been increasing for underweight. Regarding the HOI, the results indicate that it is highest for wasting, followed by underweight, and then stunting. The availability and equitable distribution of basic nutrition in Malawi for stunting and wasting increased over time. Overall, these findings indicate the existence of a significant gap in opportunity, thus highlighting the need for sustained efforts to guarantee equitable access.

In terms of the decomposition, differences in age, gender, wealth quintile, and mother's education exhibit significant contributions to IOP in all three nutritional outcomes: stunting, wasting, and underweight for the analysis period. Birth order was found to be a dominant contributor to IOP only in underweight.

For age, stunting and underweight were found to be more pronounced in higher age groups as compared to wasting. These findings corroborate those of Chirwa and Ngalawa (2008). They demonstrated that age and child nutrition portray a U-shaped relationship and that the critical age for stunting and underweight is 30 months, beyond which children are likely to fend supplementary nourishment for themselves within and outside of the household in Malawi, the critical age for wasting was found to be lower. Our result is also validated by other studies that showed that stunting increased with age (Chowdhury et al., 2020; Marriott et al., 2012). Even though this is the case, these findings differ from other countries, such as Bangladesh, which find wasting to be prominent in higher age groups (Chowdhury et al., 2020). The findings of this study are partly similar to those of Liu et al. (2022), who found a significant contribution of age to wasting and underweight but not stunting in China, and Mkupete et al. (2022), who found age as a main contributor to stunting in Tanzania.

Gender is another major contributor to IOP. This can be attributed to biases in feeding and the provision of care between genders. Gender

Table 4
Shapley decomposition (percent of the IOP).

	Stunting	Wasting	Underweight
Age	29.15	52.36	12.42
Gender	8.28	8.87	18.36
Wealth quintile	6.36	8.54	22.82
Mother's education	6.28	5.51	11.29
Father's education	3.01	0.82	1.05
Number of under-five siblings	4.18	1.27	4.42
Area	2.16	2.17	1.86
Region	0.23	0.70	1.67
Birth order	0.79	3.82	7.10
Media exposure	1.47	0.74	3.89
Mother's age at birth	0.29	1.96	1.17
Water source	2.72	0.26	1.94
Toilet facility	1.88	1.79	3.41
Breastfeeding	0.06	0.48	0.29
Year	33.13	10.72	8.31

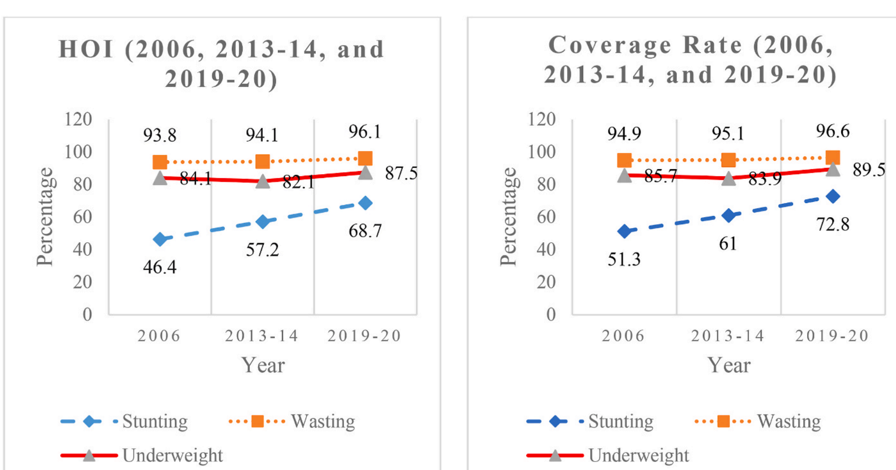

Fig. 4. HOI and coverage rate: 2006, 2013–14, and 2019-20.

differences in child nutrition have been widely assessed in Sub-Saharan Africa (Garg & Morduch, 1998; Kabubo-Mariara et al., 2009; Wamani et al., 2007), which indicates that females are often favored, especially in low socioeconomic statuses, hence having lower malnutrition rates. However, there is also a broad literature (Jayachandran & Kuziemko, 2011; Le & Nguyen, 2022) that has documented son preference in breastfeeding and allocation of time for child care for many countries. Our findings differ from those reported in China (Liu et al., 2022) who found a less significant contribution of gender, and also Sanoussi et al. (2020) in Mali for stunting, but are in line with those in Tanzania (Mkupete et al., 2022), in India (Ghosh et al., 2022) and Hoyos and Narayan (2011) who show that gender influences access to children's opportunities in many developing countries, including Malawi.

Mother's education also significantly contributed to IOP. The impact of a mother's education on a child's health has been widely documented in Malawi and other countries (Abuya et al., 2012; Aizawa, 2019; Currie & Moretti, 2003; Desai & Alva, 1998; Liu et al., 2022; Makoka, 2013; Makoka & Masibo, 2015; Mussa, 2015; Pérez-Mesa et al., 2022). Makoka and Masibo (2015) found that junior and secondary education are the threshold levels of maternal education that reduce malnutrition in under-five children in Malawi. High maternal education is associated with greater female autonomy and better child care and health service utilization. However, the differences can be explained by education inequalities in Malawi which have persisted and are inequitably distributed to the detriment of the poor (Mussa & Masanjala, 2015), thus affecting nutritional knowledge accumulation and health-seeking behavior. Furthermore, the persistent dropout of females in the course of education-especially in the rural areas is a potential explanation for this variation (Chikhungu et al., 2020). It is documented that as females transition from primary to college, many drop out during the secondary education phase. This has the potential to reduce vital child management knowledge that arises with better and higher education.

Another explanation of the result drivers is that of wealth. For wealth, the relationship between socioeconomic status and child health is one of the most robust discussions in economics (Case et al., 2002; Currie & Stabile, 2003). Early life circumstances, such as being born into a poor family, have a bearing on a child's health (Case & Paxson, 2002). Our findings on this aspect can now have an economic explanation. Over the study period, the wealth inequalities have worsened in Malawi. The Gini coefficient for wealth increased from 0.431 in 2004 to 0.564 in 2011, based on household ownership of the following durable assets: radio, television, furniture, sewing machine, fridge, washing machine, bicycle, motorbike, and automobiles (Mussa & Masanjala, 2015). Thus, this feeds back into the Roemer framework, which was explained previously, that circumstances beyond the children's control perpetuate the IOP. Furthermore, our findings can also be attributed to the persistent poverty situation in Malawi, which places Malawi as a nation with low human development (UNDP, 2022). For over 20 years, half of the Malawian population has lived below the poverty line. There has not been any substantial growth in incomes, thereby having no large income effect on consumption. These findings differ from those of Mkupete et al. (2022) in Tanzania but are similar to other studies (Aizawa, 2019; Pérez-Mesa et al., 2022; Saidi & Hamdaoui, 2017).

The effect of birth order on child nutrition is explained by sibling rivalry for resources (Helfrecht & Meehan, 2016), and we find that its role is more pronounced in the composite indicator for malnutrition. These results differ from those of Liu et al. (2022), who find a more dominant role of birth order in stunting than underweight in China.

6. Study limitations

The following limitations should be taken into account in the interpretation of the study findings. Firstly, the study did not incorporate supply-side factors due to insufficient data. Secondly, given the time differences between the surveys, other changes in the healthcare landscape and macroeconomic changes may have taken place, which could affect the findings, and the analysis of these changes was outside the purview of this study. This study's findings provide important policy and future research implications, despite the limitations. Lastly, our data cannot fully explain "why" IoP is higher in stunting than the others-which creates room for further studies.

7. Conclusion

Using the Shapley value, the paper has established that, among others, the biological factor of age contributes a large share of inequality in opportunity. This is pronounced in the variables for stunting and wasting. Nonetheless, the effect of wealth, which is proximate to permanent income, is also greater, especially in the variable of wasting. The role of mothers' education is also critical in contributing to inequality. Furthermore, our study reveals that the confirmed incidence of IOP (Inequality of Opportunity) is decreasing for stunting and wasting but increasing for underweight. Additionally, the Shapley decomposition analysis demonstrates that the effects are diverse. To carter for policy, using this paper as a source of vital information, we recommend that there is a need to include studies that promote non-curricular education on child nutrition using various platforms. For example, the approach of using expert mothers[1] [GC1], as done in some programmes in Malawi. These expert mothers are characterized by similarities in attributes such as age and wealth status. The parental peer effects through networking may affect food choices, child practices and eventually inequalities of opportunity. Furthermore, it may be helpful to reintroduce adult schools, as was the case in the 1990s, but this time with a focus on child nutrition-related aspects. In the past, adult education extended beyond academic subjects and included practical skills such as child care, health improvement, hygiene, sanitation, and financial management. These non-formal, government-funded community schools brought together individuals of similar ages and socioeconomic backgrounds, proving effective for addressing specific areas such as nutrition education. Regarding wealth, given the fact that there is growing inequality in wealth, as an alluded area, it is imperative to come up with programmes that would empower women to improve asset holding. Designing specific programmes for women with children, specifically in rural areas where the poverty situation is rampant, would be ideal.

Furthermore, we recommend enacting a community-based approach by training community members to serve as volunteers in nutrition, antenatal and postnatal care, immunizations, birth spacing, and sanitation, in collaboration with community health workers such as the Health Surveillance Assistants. Each volunteer would be assigned a specific number of households to provide counselling and assistance on health and feeding practices. Additionally, they would conduct regular growth data monitoring for children under five, enhancing both early detection of potential signs of malnutrition and health-seeking behavior. This approach, as demonstrated by the successful implementation in Thailand (Kathuria et al., 2019), may contribute to reducing stunting, which not only reflects long-term nutritional inadequacies but is also associated with higher levels of IOP.

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Ethical statement

Hereby I, Pemphero Norah Mphamba, consciously assure that for the manuscript, An Evolution of Inequality of Opportunity in the Nutritional Outcomes of Under-Five Children in Malawi, the following is fulfilled:

[1] [GC1] https://journals.lww.com/jaids/fulltext/2017/06011/the_roles_of_expert_mothers_engaged_in_prevention.16.aspx.

1.) This material is the authors' own original work, which has not been previously published elsewhere.
2.) The paper is not currently being considered for publication elsewhere.
3.) The paper reflects the authors' own research and analysis in a truthful and complete manner.
4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
5.) The results are appropriately placed in the context of prior and existing research.
6.) All sources used are properly cited.
7.) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

Corresponding author (Pemphero Norah Mphamba) agree with the above statements and declare that this submission follows the policies and guidelines of SSM-Population Health as outlined in the Guide for Authors and in Ethical Publishing.

CRediT authorship contribution statement

Pemphero Norah Mphamba: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Gowokani Chijere Chirwa:** Writing – review & editing, Supervision. **Jacob Mazalale:** Supervision.

Declaration of competing interest

None.

Data availability

The authors do not have permission to share data.

APPENDIX A. METHOD

CONCEPTUAL FRAMEWORK

This study follows the Roemer framework of measuring IOP by partitioning factors that affect individual outcomes into circumstances and efforts (Roemer, 1998, 2002; Roemer & Trannoy, 2013). A general health production function would therefore be specified as:

$$y = f(C, E, \upsilon) \tag{1}$$

where health status, y is a function of individual circumstances, C, E is effort, and υ, residual inequality. For child health, efforts would constitute the unobservable factors; luck and genetics, which would be defined as residual inequality. Equal opportunity would mean that the distribution function of y given C is equal to the distribution of y unconditional on C:

$$f(c) = f(y) \tag{2}$$

Following the literature on the determinants of child malnutrition (Chilora & Duchoslav, 2020; Fagbamigbe et al., 2020; Ijarotimi, 2013; Smith & Haddad, 2000; Tekile et al., 2019), inequalities in child health and IOP (Assaad et al., 2012; Ekholuenetale et al., 2020; Krafft, 2015), and the general health production function theoretical literature (Grossman, 1972; Strauss & Thomas, 1998), this study specifies a generalized health production function as follows:

$$H = h(IN, HH, \varepsilon_h) \tag{3}$$

H is a set of measured health outcomes; height and weight. It is a function of a vector of health inputs, IN, which include child characteristics, breastfeeding, age, gender, and birth order. It is also a function of household and parental characteristics and circumstances, HH; parents' education, demographics, water and sanitation, and household wealth. Included within the random disturbance, ε_h are the elements of random genetic variation, observable and unobservable, and measurement error.

ESTIMATION OF THE HOI AND THE D-INDEX

Step 1: Logistic Regression

A logistic model is constructed to assess the probability that an individual child, i, had access to an opportunity conditional on their n circumstance variables. We define a logistic regression model with binary outcome variable θ_i, which takes 1 if the individual has access to an opportunity and 0 if the individual has no access.

$$\ln\left(\frac{Pr(\theta_i = 1 \mid x_1, x_2, \cdots, x_n)}{1 - Pr(\theta_i = 1 \mid x_1, x_2, \cdots, x_n)}\right) \tag{4}$$

Using the estimated coefficients in equation (4), we obtain the predicted probability of access to opportunity $\widehat{p_i}$ for each child in the sample in consideration based on a vector of their circumstances x_{ki}.

Step 2: Predicted probability of access

$$\widehat{p}_i = \frac{exp\left(\widehat{\beta}_0 + \sum_k^n x_{ki}\widehat{\beta}_k\right)}{1 + \exp\left(\widehat{\beta}_0 + \sum_k^n x_{ki}\widehat{\beta}_k\right)} \tag{5}$$

$\widehat{p_i}$ is the predicted probability of access to an opportunity for a child, $\widehat{\beta_0}$ the estimated intercept, and $\widehat{\beta_k}$ is the estimated coefficient for circumstance k.

Step 3: The overall coverage rate of predicted access and the D-index are generated

$$C = \sum_{i=0}^{n} w_i p_i \tag{6}$$

where $w_i = {}^{1}/_{n}$ or some sampling weights. Using this coverage rate, the D-index is calculated as follows:

$$D = \frac{1}{2C}\left(\sum_{i=1}^{n} w_i |\widehat{p_i} - C|\right), 0 \leq D \leq 1 \tag{7}$$

D measures the degree of opportunity inequality that is attributable to individual circumstances. It ranges from 0 to 1. $D = 0$ implies that every individual in society enjoys the same opportunities, while $D = 1$ implies that only one person enjoys all opportunities.

Step 4: Computing the HOI

We then compute the HOI as follows:

$$HOI = C(1 - D), 0 \leq HOI \leq 1 \tag{8}$$

The HOI on equation (8) ranges from 0 to 1 where 1 means that a society that has achieved one hundred percent coverage of all services and has a perfect equal distribution of opportunities. Therefore, $D = 0 \Rightarrow (1 - D)$ will equal 1 in this case, signifying equality of opportunity.

SHAPLEY DECOMPOSITION

The formula for computing an additional circumstance is:

$$D_A = \sum\nolimits_{s \subseteq N/\{N\}} \frac{|S|!(n - |s| - 1)!}{n!} [D(S \cup \{A\} - D(S)] \tag{9}$$

where D_A is the impact of an additional circumstance A, N is the overall number of circumstances, n is the number of selected circumstances s is the subset of N circumstances without A. $D(S)$ is the dissimilarity index estimated using a set of circumstances S and $D(S \cup \{A\}$ is the dissimilarity index calculated with a set of circumstances S and circumstance A. The application of the shapely decomposition method allows us to capture the contribution of each circumstance variable omitted to the dissimilarity index as follows:

$$\varphi_A = \frac{D_A}{D(N)} \tag{10}$$

where $\sum \varphi_A = 1$ in equation (10); all circumstances amount to 1 (100 percent). In other words, the Shapley value decomposition satisfies a crucial requirement: all circumstances contribute equally to the dissimilarity index, adding up to 100 percent.

APPENDIX B. DECOMPOSITION OF IOP (PERCENTAGE) IN UNDER-FIVE CHILDREN'S NUTRITIONAL OUTCOMES FOR DIFFERENT YEARS

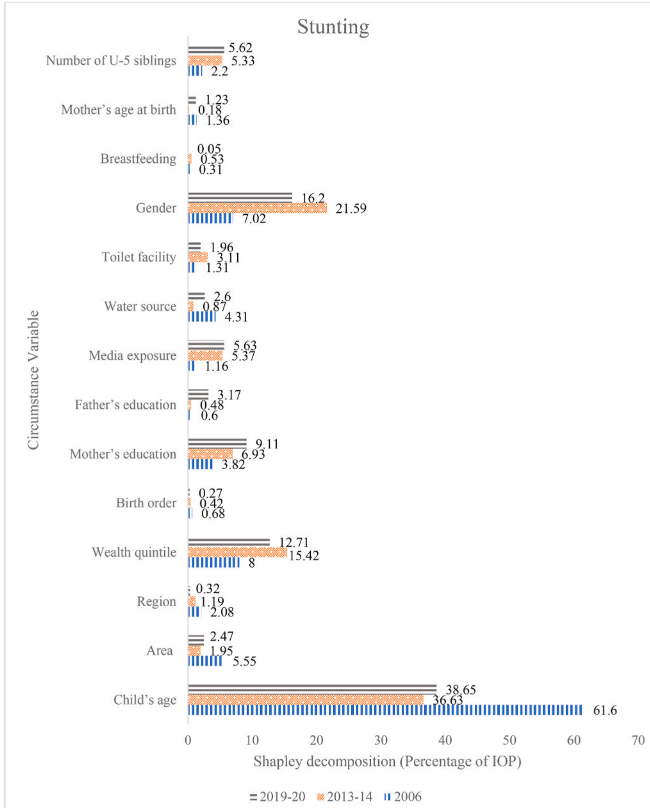

Figure 5. Percentage Contribution of Circumstances to IOP in Stunting (2006, 2013–14 and 2019–20)

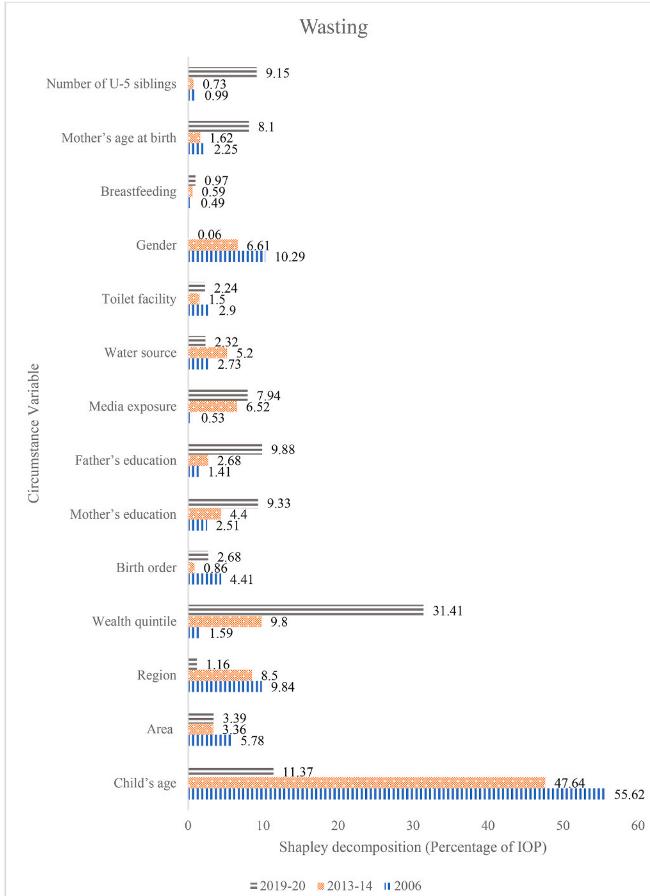

Figure 6. Percentage Contribution of Circumstances to IOP in Wasting (2006, 2013–14 and 2019–20)

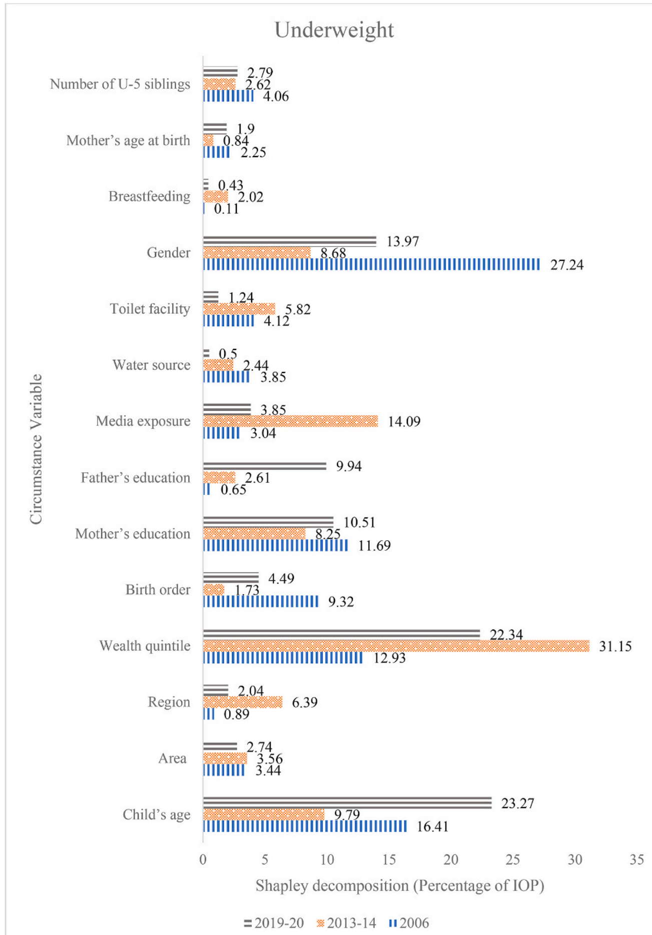

Figure 7. Percentage Contribution of Circumstances to IOP in Underweight (2006, 2013–14 and 2019–20)

References

Abuya, B. A., Ciera, J., & Kimani-Murage, E. (2012). Effect of mother's education on child's nutritional status in the slums of Nairobi. *BMC Pediatrics, 12*(1), 80. https://doi.org/10.1186/1471-2431-12-80

Adedokun, S. T., & Yaya, S. (2021). Factors associated with adverse nutritional status of children in sub-Saharan Africa: Evidence from the Demographic and Health Surveys from 31 countries. *Maternal and Child Nutrition, 17*(3), Article e13198. https://doi.org/10.1111/mcn.13198

Ahsan, K. Z., Arifeen, S. E., Al-Mamun, M. A., Khan, S. H., & Chakraborty, N. (2017). Effects of individual, household and community characteristics on child nutritional status in the slums of urban Bangladesh. *Archives of Public Health, 75*(1), 9. https://doi.org/10.1186/s13690-017-0176-x

Aizawa, T. (2019). Ex-ante inequality of opportunity in child malnutrition: New evidence from ten developing countries in Asia. *Economics and Human Biology, 35*, 144–161. https://doi.org/10.1016/j.ehb.2019.06.003

Akombi, B. J., Agho, K. E., Merom, D., Renzaho, A. M., & Hall, J. J. (2017). Child malnutrition in sub-Saharan Africa: A meta-analysis of demographic and health surveys (2006-2016). *PLoS One, 12*(5), Article e0177338. https://doi.org/10.1371/journal.pone.0177338

Amare, Z. Y., Ahmed, M. E., & Mehari, A. B. (2019). Determinants of nutritional status among children under age 5 in Ethiopia: Further analysis of the 2016 Ethiopia demographic and health survey. *Globalization and Health, 15*(1), 62. https://doi.org/10.1186/s12992-019-0505-7

Ashley-Cooper, M., van Niekerk, L.-J., & Atmore, E. (2019). Early childhood development in South Africa: Inequality and opportunity. In N. Spaull, & J. D. Jansen (Eds.), *South African schooling: The enigma of inequality: A study of the present situation and future possibilities* (pp. 87–108). Springer International Publishing. https://doi.org/10.1007/978-3-030-18811-5_5.

Asmare, A. A., & Agmas, Y. A. (2022). Determinants of coexistence of stunting, wasting, and underweight among children under five years in the Gambia; evidence from 2019/20 Gambian demographic health survey: Application of multivariate binary logistic regression model. *BMC Public Health, 22*(1), 1621. https://doi.org/10.1186/s12889-022-14000-3

Assaad, R., Krafft, C., Hassine, N. B., & Salehi-Isfahani, D. (2012). Inequality of opportunity in child health in the Arab world and Turkey. *Middle East Development Journal, 4*(2). https://doi.org/10.1142/S179381201250006X, 1250006-1-1250006–1250037.

Becker, G. S. (1991). *A treatise on the family* (Enlarged Edition). Harvard University Press.

Black, S. E., Devereux, P. J., & Salvanes, K. G. (2007). From the cradle to the labor market? The effect of birth weight on adult outcomes. *Quarterly Journal of Economics, 122*(1), 409–439. https://doi.org/10.1162/qjec.122.1.409

Case, A., Lubotsky, D., & Paxson, C. (2002). Economic status and health in childhood: The origins of the gradient. *The American Economic Review, 92*(5), 1308–1334. https://doi.org/10.1257/000282802762024520

Case, A., & Paxson, C. (2002). Parental behavior and child health. *Health Affairs, 21*(2), 164–178. https://doi.org/10.1377/hlthaff.21.2.164

Chikhungu, C. L. (2022). Trends and patterns of stunted only and stunted-underweight children in Malawi: A confirmation for child nutrition practitioners to continue focusing on stunting. *Malawi Medical Journal, 34*(2), 111–117. https://doi.org/10.4314/mmj.v34i2.6

Chikhungu, L., Kadzamira, E., Chiwaula, L., & Meke, E. (2020). Tackling girls dropping out of school in Malawi: Is improving household socio-economic status the solution? *International Journal of Educational Research, 103*, Article 101578. https://doi.org/10.1016/j.ijer.2020.101578

Chilora, L. K., & Duchoslav, J. (2020). *Determinants of children's nutritional status in Malawi* (0 ed.). International Food Policy Research Institute. https://doi.org/10.2499/p15738coll2.133799.

Chirwa, E. W., & Ngalawa, H. P. (2008). Determinants of child nutrition in Malawi. *South African Journal of Economics, 76*(4), 628–640. https://doi.org/10.1111/j.1813-6982.2008.00212.x

Chowdhury, T. R., Chakrabarty, S., Rakib, M., Afrin, S., Saltmarsh, S., & Winn, S. (2020). Factors associated with stunting and wasting in children under 2 years in Bangladesh. *Heliyon, 6*(9), Article e04849. https://doi.org/10.1016/j.heliyon.2020.e04849

Claffey, A. J., George, J. C., Thorne, K. A., Zelasko, J. C., Zittel, K. W., & Holmes, D. M. (2020). Impacts of village isolation on childhood nutritional status in rural Malawi. *Journal of Global Health Reports, 4*. https://doi.org/10.29392/001c.14378

Currie, J., & Moretti, E. (2003). Mother's education and the intergenerational transmission of human capital: Evidence from college openings. *Quarterly Journal of Economics, 118*(4), 1495–1532. https://doi.org/10.1162/003355303322552856

Currie, J., & Stabile, M. (2003). Socioeconomic status and child health: Why is the relationship stronger for older children? *The American Economic Review, 93*(5), 1813–1823. https://doi.org/10.1257/000282803322655563

De, P., & Chattopadhyay, N. (2019). Effects of malnutrition on child development: Evidence from a backward district of India. *Clinical Epidemiology and Global Health, 7*(3), 439–445. https://doi.org/10.1016/j.cegh.2019.01.014

Desai, S., & Alva, S. (1998). Maternal education and child health: Is there a strong causal relationship? *Demography, 35*(1), 71–81. https://doi.org/10.2307/3004028

Dhamija, G., Kapoor, M., Kim, R., & Subramanian, S. V. (2023). Explaining the poor-rich gap in anthropometric failure among children in India: An econometric analysis of the NFHS, 2021 and 2016. *SSM - Population Health, 23*, Article 101482. https://doi.org/10.1016/j.ssmph.2023.101482

Ebaidalla, E. M., & UNU-WIDER. (2019). *Inequality of opportunity in child health in Sudan: Across-region study* (86th ed., Vol. 2019). UNU-WIDER. https://doi.org/10.35188/UNU-WIDER/2019/722-4

Ekholuenetale, M., Tudeme, G., Onikan, A., & Ekholuenetale, C. E. (2020). Socioeconomic inequalities in hidden hunger, undernutrition, and overweight among under-five children in 35 sub-Saharan Africa countries. *Journal of the Egyptian Public Health Association, 95*(1), 9. https://doi.org/10.1186/s42506-019-0034-5

El-Kogali, S. E. T., Krafft, C., Abdelkhalek, T., Benkassmi, M., Chavez, M., Bassett, L., & Ejjanoui, F. (2016). *Inequality of opportunity in early childhood development in Morocco over time*. SSRN Scholarly Paper 2779366) https://papers.ssrn.com/abstract=2779366.

Ersado, L., & Aran, M. A. (2014). *Inequality of opportunity among Egyptian children*. SSRN Scholarly Paper 2494015) https://papers.ssrn.com/abstract=2494015.

Fagbamigbe, A. F., Kandala, N. B., & Uthman, A. O. (2020). Demystifying the factors associated with rural–urban gaps in severe acute malnutrition among under-five children in low- and middle-income countries: A decomposition analysis. *Scientific Reports, 10*(1), Article 11172. https://doi.org/10.1038/s41598-020-67570-w

Fall, C. H. D., Sachdev, H. S., Osmond, C., Restrepo-Mendez, M. C., Victora, C., Martorell, R., Stein, A. D., Sinha, S., Tandon, N., Adair, L., Bas, I., Norris, S., & Richter, L. M. (2015). Association between maternal age at childbirth and child and adult outcomes in the offspring: A prospective study in five low-income and middle-income countries (COHORTS collaboration). *Lancet Global Health, 3*(7), e366–e377. https://doi.org/10.1016/S2214-109X(15)00038-8

FAO, IFAD, UNICEF, WFP and WHO. (2022). *The state of food security and nutrition in the world 2022*. FAO. https://doi.org/10.4060/cc0639en

Ferreira, F. H. G., & Gignoux, J. (2011). The measurement of inequality of opportunity: Theory and an application to Latin America. *Review of Income and Wealth, 57*(4), 622–657. https://doi.org/10.1111/j.1475-4991.2011.00467.x

Fledderjohann, J., & Channon, M. (2022). Gender, nutritional disparities, and child survival in Nepal. *BMC Nutrition, 8*(1), 50. https://doi.org/10.1186/s40795-022-00543-6

Garg, A., & Morduch, J. (1998). Sibling rivalry and the gender gap: Evidence from child health outcomes in Ghana. *Journal of Population Economics, 11*(4), 471–493. https://doi.org/10.1007/s001480050080

Ghosh, P. (2023). Undernutrition among the children from different social groups in India: Prevalence, determinants, and transition over time (2005–2006 to 2019–2021). *Journal of Racial and Ethnic Health Disparities*. https://doi.org/10.1007/s40615-023-01796-y

Ghosh, P., Rohatgi, P., & Bose, K. (2022). Determinants of time-trends in exclusivity and continuation of breastfeeding in India: An investigation from the National Family Health Survey. *Social Science & Medicine, 292*, Article 114604. https://doi.org/10.1016/j.socscimed.2021.114604

Glewwe, P., & Miguel, E. A. (2007). The impact of child health and nutrition on education in less developed countries. In *Handbook of development economics* (Vol. 4, pp. 3561–3606). Elsevier. https://doi.org/10.1016/S1573-4471(07)04056-9.

Government of Malawi, UNDP, OPHI. (2021). *Ministry of economic planning and development, & and public sector reforms*. Malawi multidimensional poverty index report. National Statistical Office.

Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy, 80*(2), 223–255.

Haq, I., Hossain, M. I., Parvin, M. M., Saleheen, A. A. S., Habib, M. J., & Chowdhury, I.-A.-Q. (2021). Gender differences in child nutrition status of Bangladesh: A multinomial modeling approach. *Journal of Humanities and Applied Social Sciences, 4*(5), 379–392. https://doi.org/10.1108/JHASS-02-2021-0030

Helfrecht, C., & Meehan, C. L. (2016). Sibling effects on nutritional status: Intersections of cooperation and competition across development. *American Journal of Human Biology: The Official Journal of the Human Biology Council, 28*(2), 159–170. https://doi.org/10.1002/ajhb.22763

Hoyos, A., & Narayan, A. (2011). Inequality of opportunities among children: How much does gender matter? World bank. http://hdl.handle.net/10986/27452.

Human Early Learning Partnership & Commission on Social Determinants of Health. (2007). *Early child development: A powerful equalizer: Final report for the world health organization's commission on the social determinants of health. /Prepared by Arjumand Siddiqi, Lori G. Irwin, Dr. Clyde Hertzman*. WHO IRIS https://apps.who.int/iris/handle/10665/69729.

Ijarotimi, O. S. (2013). Determinants of childhood malnutrition and consequences in developing countries. *Current Nutrition Reports, 2*(3), 129–133. https://doi.org/10.1007/s13668-013-0051-5

Jayachandran, S., & Kuziemko, I. (2011). Why do mothers breastfeed girls less than boys? Evidence and implications for child health in India. *Quarterly Journal of Economics, 126*(3), 1485–1538. https://doi.org/10.1093/qje/qjr029

Kabubo-Mariara, J., Ndenge, G. K., & Mwabu, D. K. (2009). Determinants of children's nutritional status in Kenya: Evidence from demographic and health surveys. *Journal of African Economies, 18*(3), 363–387. https://doi.org/10.1093/jae/ejn024

Kang, Y., & Kim, J. (2019). Risk factors for undernutrition among children 0–59 months of age in Myanmar. *Maternal and Child Nutrition, 15*(4), Article e12821. https://doi.org/10.1111/mcn.12821

Kassie, G. W., & Workie, D. L. (2020). Determinants of under-nutrition among children under five years of age in Ethiopia. *BMC Public Health, 20*(1), 399. https://doi.org/10.1186/s12889-020-08539-2

Kathuria, A., Arur, A., & Digwaleu-Kariko, E. (2019). *Success stories with reducing stunting: Lessons for PNG*. World Bank Group. https://policycommons.net/artifacts/1462680/success-stories-with-reducing-stunting/2106149/.

Katoch, O. R. (2022). Determinants of malnutrition among children: A systematic review. *Nutrition, 96*, Article 111565. https://doi.org/10.1016/j.nut.2021.111565

Krafft, C. (2015). The determinants of inequality in child nutrition status: Evidence from Jordan. *Review of Development Economics, 26*(1), 112–132. https://doi.org/10.1111/rode.12839

Kulkarni, S., Frongillo, E. A., Cunningham, K., Moore, S., & Blake, C. E. (2020). Women's bargaining power and child feeding in Nepal: Linkages through nutrition information. *Maternal and Child Nutrition, 16*(1), Article e12883. https://doi.org/10.1111/mcn.12883

Le, K., & Nguyen, M. (2022). Son preference and health disparities in developing countries. *SSM - Population Health, 17*, Article 101036. https://doi.org/10.1016/j.ssmph.2022.101036

Liu, X., Shi, X., & Chen, K. (2022). Inequality of opportunity in children's nutritional outcomes in China. *Global Food Security, 33*, Article 100635. https://doi.org/10.1016/j.gfs.2022.100635

Machira, K., & Chirwa, T. (2020). Dietary consumption and its effect on nutrition outcome among under-five children in rural Malawi. *PLoS One, 15*(9), Article e0237139. https://doi.org/10.1371/journal.pone.0237139

Makoka, D. (2013). *The impact of maternal education on child nutrition: Evidence from Malawi, Tanzania, and Zimbabwe (DHS working papers No. 84)*. Article DHS Working Papers No. 84 https://dhsprogram.com/publications/publication-wp84-working-papers.cfm.

Makoka, D., & Masibo, P. K. (2015). Is there a threshold level of maternal education sufficient to reduce child undernutrition? Evidence from Malawi, Tanzania and Zimbabwe. *BMC Pediatrics, 15*(1), 96. https://doi.org/10.1186/s12887-015-0406-8

Marriott, B. P., White, A., Hadden, L., Davies, J. C., & Wallingford, J. C. (2012). World Health Organization (WHO) infant and young child feeding indicators: Associations with growth measures in 14 low-income countries. *Maternal and Child Nutrition, 8*(3), 354–370. https://doi.org/10.1111/j.1740-8709.2011.00380.x

McElroy, M. B., & Horney, M. J. (1990). Nash-bargained household decisions: Reply. *International Economic Review, 31*(1), 237–242. https://doi.org/10.2307/2526642

Mkupete, M. J., Von Fintel, D., & Burger, R. (2022). Decomposing inequality of opportunity in child health in Tanzania: The role of access to water and sanitation. *Health Economics, 31*(11), 2465–2480. https://doi.org/10.1002/hec.4591

Molinas Vega, J. R., Paes de Barros, R., Chanduvi, J. S., Giugale, M., Cord, L. J., Pessino, C., & Hasan, A. (2011). *Do our children have a chance?: A human opportunity report for Latin America and the Caribbean*. The World Bank. https://doi.org/10.1596/978-0-8213-8699-6

Mussa, R. (2015). Intrahousehold and interhousehold child nutrition inequality in Malawi. *South African Journal of Economics, 83*(1), 140–153. https://doi.org/10.1111/saje.12060

Mussa, R., & Masanjala, W. (2015). A dangerous divide: The state of inequality in Malawi. *Oxfam International*. https://www-cdn.oxfam.org/s3fs-public/file_attachments/rr-inequality-in-malawi-261115-en.pdf.

Mwene-Batu, P., Bisimwa, G., Baguma, M., Chabwine, J., Bapolisi, A., Chimanuka, C., Molima, C., Dramaix, M., Kashama, N., Macq, J., & Donnen, P. (2020). Long-term effects of severe acute malnutrition during childhood on adult cognitive, academic and behavioural development in African fragile countries: The Lwiro cohort study in Democratic Republic of the Congo. *PLoS One, 15*(12), Article e0244486. https://doi.org/10.1371/journal.pone.0244486

Nandi, A., Bhalotra, S., Deolalikar, A. B., & Laxminarayan, R. (2017). The human capital and productivity benefits of early childhood nutritional interventions. In D. A. P. Bundy, N. de Silva, S. Horton, D. T. Jamison, & G. C. Patton (Eds.), *Child and adolescent health and development* (3rd ed.). The International Bank for Reconstruction and Development/The World Bank http://www.ncbi.nlm.nih.gov/books/NBK525244/.

National Planning Commission. (2020). *Malawi 2063: An inclusively wealthy and self-reliant nation*.

National Statistical Office, Ministry of Finance and Economic Affairs, UNDP, & OPHI. (2022). *The second Malawi multidimensional poverty index report*.

Nurliyana, A. R., Mohd Shariff, Z., Mohd Taib, M. N., Gan, W. Y., & Tan, K.-A. (2016). Early nutrition, growth and cognitive development of infants from birth to 2 years in Malaysia: A study protocol. *BMC Pediatrics, 16*(1), 160. https://doi.org/10.1186/s12887-016-0700-0

Osei, R. D., & Lambon-Quayefio, M. P. (2022). Effects of long-term malnutrition on education outcomes in Ghana: Evidence from a panel study. *European Journal of Development Research, 34*(1), 1–21. https://doi.org/10.1057/s41287-020-00350-4

Paes de Barros, R., Ferreira, F. H. G., Molinas Vega, J. R., & Saavedra Chanduvi, J. (2009). *Measuring inequality of opportunities in Latin America and the Caribbean*. The World Bank. https://doi.org/10.1596/978-0-8213-7745-1

Paul, P., & Saha, R. (2022). Is maternal autonomy associated with child nutritional status? Evidence from a cross-sectional study in India. *PLoS One, 17*(5), Article e0268126. https://doi.org/10.1371/journal.pone.0268126

Pérez-Mesa, D., Marrero, G. A., & Darias-Curvo, S. (2022). Child health inequality in Sub-Saharan Africa. *Economics and Human Biology, 47*, Article 101176. https://doi.org/10.1016/j.ehb.2022.101176

Pradhan, M., Sahn, D. E., & Younger, S. D. (2003). Decomposing world health inequality. *Journal of Health Economics, 22*(2), 271–293. https://doi.org/10.1016/S0167-6296(02)00123-6

Rah, J. H., Sukotjo, S., Badgaiyan, N., Cronin, A. A., & Torlesse, H. (2020). Improved sanitation is associated with reduced child stunting amongst Indonesian children under 3 years of age. *Maternal and Child Nutrition, 16*(S2), Article e12741. https://doi.org/10.1111/mcn.12741

Roemer, J. E. (1998). *Equality of opportunity*. Harvard University Press.

Roemer, J. E. (2002). Equality of opportunity: A progress report. *Social Choice and Welfare, 19*(2), 455–471.

Roemer, J. E., & Trannoy, A. (2013). *Equality of opportunity*.

Sahiledengle, B., Petrucka, P., Kumie, A., Mwanri, L., Beressa, G., Atlaw, D., Tekalegn, Y., Zenbaba, D., Desta, F., & Agho, K. E. (2022). Association between water, sanitation and hygiene (WASH) and child undernutrition in Ethiopia: A hierarchical approach. *BMC Public Health, 22*(1), 1943. https://doi.org/10.1186/s12889-022-14309-z

Saidi, A., & Hamdaoui, M. (2017). On measuring and decomposing inequality of opportunity in access to health services among Tunisian children: A new approach for public policy. *Health and Quality of Life Outcomes, 15*(1), 213. https://doi.org/10.1186/s12955-017-0777-7

Samuel, A., Osendarp, S. J. M., Feskens, E. J. M., Lelisa, A., Adish, A., Kebede, A., & Brouwer, I. D. (2022). Gender differences in nutritional status and determinants among infants (6–11 m): A cross-sectional study in two regions in Ethiopia. *BMC Public Health, 22*(1), 401. https://doi.org/10.1186/s12889-022-12772-2

Sanoussi, Y. (2017). Measurement and analysis of inequality of opportunity in access of maternal and child health care in Togo. *BMC Health Services Research, 17*(2), 699. https://doi.org/10.1186/s12913-017-2647-8

Sanoussi, Y., Ahinkorah, B. O., Banke-Thomas, A., & Yaya, S. (2020). Assessing and decomposing inequality of opportunity in access to child health and nutrition in sub-Saharan Africa: Evidence from three countries with low human development index. *International Journal for Equity in Health, 19*(1), 143. https://doi.org/10.1186/s12939-020-01258-5

Shorrocks, A. F. (2013). Decomposition procedures for distributional analysis: A unified framework based on the Shapley value. *The Journal of Economic Inequality, 11*(1), 99–126. https://doi.org/10.1007/s10888-011-9214-z

Shrestha, M. L., Perry, K. E., Thapa, B., Adhikari, R. P., & Weissman, A. (2022). Malnutrition matters: Association of stunting and underweight with early childhood development indicators in Nepal. *Maternal and Child Nutrition, 18*(2), Article e13321. https://doi.org/10.1111/mcn.13321

Singh, A. (2011). Inequality of opportunity in Indian children: The case of immunization and nutrition. *Population Research and Policy Review, 30*(6), 861–883. https://doi.org/10.1007/s11113-011-9214-5

Smith, L. C., & Haddad, L. J. (2000). *Explaining child malnutrition in developing countries: A cross-country analysis*. International Food Policy Research Institute.

Strauss, J., & Thomas, D. (1998). Health, nutrition, and economic development. *Journal of Economic Literature, 36*(2), 766–817.

Tekile, A. K., Woya, A. A., & Basha, G. W. (2019). Prevalence of malnutrition and associated factors among under-five children in Ethiopia: Evidence from the 2016 Ethiopia Demographic and Health Survey. *BMC Research Notes, 12*(1), 391. https://doi.org/10.1186/s13104-019-4444-4

The World Bank. (2021). *World Bank development indicators*. https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?view=chart.

UNDP. (2022). In *Uncertain times, unsettled lives: Shaping our future in a transforming World*. United Nations Development Programme.

UNICEF/WHO/The World Bank. (2021). *Levels and trends in child malnutrition*. World Health Organization.

United Nations. (2015). *Transforming our world: The 2030 Agenda for sustainable development*.

van Cooten, M. H., Bilal, S. M., Gebremedhin, S., & Spigt, M. (2019). The association between acute malnutrition and water, sanitation, and hygiene among children aged 6–59 months in rural Ethiopia. *Maternal and Child Nutrition, 15*(1), Article e12631. https://doi.org/10.1111/mcn.12631

Vassilakou, T. (2021). Childhood malnutrition: Time for action. *Children, 8*(2), 103. https://doi.org/10.3390/children8020103

Wamani, H., Åstrøm, A. N., Peterson, S., Tumwine, J. K., & Tylleskär, T. (2007). Boys are more stunted than girls in Sub-Saharan Africa: A meta-analysis of 16 demographic and health surveys. *BMC Pediatrics, 7*(1), 17. https://doi.org/10.1186/1471-2431-7-17

Wemakor, A., Garti, H., Azongo, T., Garti, H., & Atosona, A. (2018). Young maternal age is a risk factor for child undernutrition in Tamale Metropolis, Ghana. *BMC Research Notes, 11*(1), 877. https://doi.org/10.1186/s13104-018-3980-7

WFP. (2022). *Malawi IPC chronic food insecurity report (p. 49)*.

WHO. (2006). *WHO child growth standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age*. Methods and Development.

WHO. (2021). *Underweight in children under 5 (JME) (UNICEF-WHO-WB)*. World Health Organization. https://www.who.int/data/gho/data/indicators/indicator-details/GHO/gho-jme-underweight-prevalence.