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Levels and trends in key socioeconomic inequalities in childhood undernutrition in Ethiopia: evidence from Ethiopia demographic and health surveys 2000-2019

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Abstract

Introduction The global burden of childhood undernutrition is mainly concentrated in low-income and lower-middle-income countries. In Ethiopia, childhood undernutrition varies significantly across different population groups. The present study is aimed at examining the levels and trends in key socioeconomic inequalities in childhood undernutrition in Ethiopia.

Methods This cross-sectional study was based on a total pooled sample of 48,782 under-five children drawn from five rounds of the Ethiopia Demographic and Health Surveys (2000–2019). We used multilevel binary logistic regression analysis to determine the key socioeconomic determinants of undernutrition among under five children. In addition, we applied concentration index and decomposition rate analysis techniques to explore the levels and trends in key socioeconomic inequalities in childhood undernutrition.

Results Place of residence, household wealth status (approximated by asset-based wealth index), and maternal education, among others, were the key socioeconomic variables significantly associated (p < 0.001) with childhood undernutrition in Ethiopia. The level of inequality was the highest with children from rural areas, poor households and uneducated mothers. Absolute socioeconomic inequality in childhood undernutrition prevalence rate was declined by 9.72 during the study period (2000 to 2019).

Conclusion Childhood undernutrition was unequally distributed among under-five children in Ethiopia, and largely concentrated among low socioeconomic status population groups. The identified key socioeconomic drivers of inequality in childhood undernutrition can be used to inform localized interventions and communication strategies to improve nutritional status of under-five children in Ethiopia. The study underscores development of poverty reduction strategies that directly address the existing challenges of the food insecurity and childhood undernutrition for the low-income population groups in the country.

Keywords Childhood · Levels · Inequalities · Trends · Undernutrition · Ethiopia

Abbreviations

AIC	Akaike's information criteria
BIC	Bayesian information criteria
CSA	Central statistical agency
DHS	Demographic and health survey

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EDHS	Ethiopia demographic and health survey
CIAF	Composite index of anthropometric failure
EPHI	Ethiopian public health institute
ICC	Intraclass correlation coefficient
LR	Likelihood ratio
SDG	Sustainable development goal
U5M	Under-five mortality
UN	United Nations
UNDP	United Nations development program
UNICEF	United Nations children's fund
USAID	United States of agency for international development
WHO	World Health Organization

1 Introduction

Childhood undernutrition, which refers to a combination of stunting, wasting and underweight [1], is an important public health indicator for monitoring child nutritional status and survival [2]. Undernutrition is a public health concern in the developing world [3] and is highly associated with increased childhood deaths [4], where nearly half of all deaths in under-five children are attributed to undernutrition [5]. In addition, childhood undernutrition has adverse consequences to the development of children [6]; and it exposes children to have reduced human capital in later life in terms of education, and cognitive development [7].

Globally, 149.2 million under-five children are stunted (short for their age) and 45.4 million under-five children wasted (thin for their height) [8], and 85 million are underweight (thin for their age) in 2020 alone [9]. The prevalence of child undernutrition has shown improvement since 2000 [10]. While the prevalence of undernutrition showed slight improvement across many developing countries in the past two decades, evidence shows that substantial inequalities in childhood undernutrition still exists at regional and sub-regional levels [11]. The global burden of childhood undernutrition is mainly concentrated in low-income and lower-middle-income countries [12]. In 2020, nearly two-thirds of all under-five children with stunting and three quarter of all children with wasting live in lower-middle income countries [8]. In particular, more than half of all under-five children affected by undernutrition (including stunting, wasting and underweight) lived in Asia and more than one quarter lived in Africa in 2020 alone [8, 9]. In addition, although the number of children with stunting is declining at global level, it increased from 54.4 million in 2000 to 61.4 million in 2020 in Africa [8].

In Sub-Saharan Africa, among under-five children living in 31 Sub-Saharan African countries (including Ethiopia), 26% of them were stunted, 21% underweight and 6% were wasted [4]. In Ethiopia, 37% of under-five children were stunted, 21% underweight and 7% were wasted [13]. While there was a modest decline in the prevalence of undernutrition over the last two decades, the prevalence varies significantly across different population groups. Inequalities in undernutrition among children in Ethiopia occur due to several socioeconomic and demographic factors. Education and income-based inequalities are commonly reported parameters [14–17].

Although the prevalence of childhood undernutrition has shown decrement based on estimates from the Demographic and Health surveys [13, 14], socioeconomic inequalities in childhood undernutrition continues to be a significant problem. Given most children are living in the poorer and poorest households and nearly 85% are living in rural areas with little access to services, the extent of inequality could be significant. Thus, the situation necessitates evidence-based findings about the existing socioeconomic inequalities in undernutrition among under-five children to support the ongoing efforts and intervention programs. Assessing the levels and trends in inequalities in childhood undernutrition by key socioeconomic drivers is instrumental for monitoring the progress and adverse effects on vulnerable group of population. Assessing levels and trends in childhood undernutrition inequalities also allows program implementers and policy makers to review the population and socioeconomic policies and their implementation in accordance with public health perspectives.

Although studies on trends in inequalities in childhood undernutrition are numerous across the world [11, 12, 15–20]; however, most of them focused on conventional indices (single indicators of undernutrition) and did not consider both multilevel and decomposition techniques to understand the inequalities in undernutrition. Other numerous studies [50–56] conducted in developing countries, including Ethiopia did not address the existing trends in childhood undernutrition. In particular, our knowledge of the trends in inequalities in childhood undernutrition in Ethiopia is limited due to absence of large-scale studies [17, 18, 20, 21, 38]. Some of these studies focused on single indicators such as stunting

or underweight and they were limited in scope and did not examine the socioeconomic factors considering robust statistical methods, including multilevel and decomposition techniques. The previous studies conducted in Ethiopia also lack to consider the hierarchal nature of data for assessing the factors associated with childhood undernutrition using multilevel analysis approach to investigate the effects of the individual, household and community level characteristics. To the best of our knowledge, the studies that investigate the levels and trends in socioeconomic inequalities in childhood undernutrition based on composite index of anthropometric failure (CIAF) (alternative indicator) using multilevel and decomposition techniques are not well documented in Ethiopia. Therefore, the present study attempted to answer the question "what is the levels and trends of socioeconomic inequalities in childhood undernutrition in Ethiopia over the last two decades?" The study has primarily aimed at examining the levels and trends in key socioeconomic inequalities in childhood undernutrition in Ethiopia based on key socioeconomic drivers.

2 Methods

2.1 Study context

Ethiopia has a diverse topography with different climate variability [22]. Ethiopia's population is still predominantly (80 percent) living in rural areas where there is limited opportunities and access to basic services. For instance, only 12 percent of women and 15 percent of men having attended secondary education [23]. Ethiopia is one of the poorest [24] and the most food insecure [25] countries in the world.

Government of Ethiopia has long been committed to implement nutrition focused policies and international commitments in reducing childhood undernutrition. In 1993, Ethiopia has endorsed health policy with priority given to control disease related to undernutrition [26]. Following the recognition of the health policy, the country has developed and implemented four rounds of health sector development programs with special attention to maternal and child health, including child undernutrition from 1998 to 2015 [27]. In 2000, Ethiopia aligned with United Nations member countries to eradicate extreme poverty and hunger as part of Millennium Development Goal (MDG1) [28]. To ensure equitable access to essential health services, Health Extension Program (HEP) has been implemented since 2003 in the country [29]. To address the chronic food insecurity in drought prone rural settings of the country, Productive Safety Net Program has been implemented since 2005 [30] in four phases. Ethiopia has also demonstrated a strong policy commitment to nutrition by developing and implementing the National Nutrition Strategy in 2008, and the first National Nutrition Program (2008–2015) [31], and the second National Nutrition Program (2016–2020) in 2016 and included the Seqota declaration to end childhood undernutrition by 2030 [32]. In 2018, the Government of Ethiopia implemented Food and Nutrition Policy to attain optimal nutrition status and address childhood undernutrition as well. The Government of Ethiopia is also committed to the Sustainable Development Goals (SDG 2) to end hunger and all forms of malnutrition by 2030. Despite remarkable government commitments to end hunger and improvement made through health care delivery system and multisectoral support [27] over the past two decades, childhood undernutrition remains a major public health concern in the country.

2.2 Data source

This cross-sectional study was based on a representative sample of under-five children drawn from five rounds of the Ethiopia Demographic and Health Surveys (EDHS) (2000–2019). These surveys employed stratified two-stage cluster sampling design for selecting enumeration areas and households within each enumeration area [13, 14]. Although the first three (2000, 2005 and 2011 EDHSs) surveys were conducted every five years interval as planned, the last survey (2016 EDHS) was conducted in 6 years interval. In addition, we included the 2019 mini EDHS dataset (which was based on smaller sample size) to assess the existing trend in key socioeconomic inequalities in childhood undernutrition in the country. Information on socioeconomic, demographic, and health characteristics of individuals and households was obtained by interviewing women aged 15–49 years. Anthropometry of under-five children were collected in all the five round surveys. Accordingly, we merged data from the five rounds of EDHS (including 2019 mini-EDHS) and a pooled sample of 48,782 under-five children were used for the present study. We used children recode (KR) datasets that provide data for a wide range of demographic and socioeconomic indicators, including health and nutrition status of under-five children and their mothers.

2.3 Study variables

2.3.1 Outcome variable

The outcome variable of the study was childhood undernutrition, and measured by the Composite Index of Anthropometric Failure (CIAF) for under-five children using the three standard anthropometric failure or undernutrition indicators (stunting, wasting and underweight) to produce alternative indicator for all undernourished children. An alternative indicator was constructed to provide a single, aggregated figure of the number of undernourished children in a population. Here, it is good to note that the conventional indices reflect distinct biological processes, but the CIAF merits further consideration as a policy and monitoring tool for planning purposes [33]. In additions, an alternative indicator could help provide a comprehensive picture of the overall burden of undernutrition among young children in a population [34]. In this regard, outcome variable was assessed by CIAF and regrouped using Z-score to categorize under-five children into seven subgroups [33]: no failure, wasting only, wasting and underweight, wasting, stunting and under-weight, stunting and underweight, stunting only, and underweight only. Furthermore, the outcome variable was considered as undernourished and assigned value of 1 if child had any form of anthropometric failure (i.e., either stunted, wasted, underweight or any combination of the three), and 0 if the child had no failure.

2.3.2 Explanatory variables

The explanatory variables of this study were grouped as exposure and covariate variables. Place of residence (community level), household wealth index (household level) and maternal education (individual level) were the three exposure variables identified as key socioeconomic inequality drivers of childhood undernutrition [35, 36]. Place of residence in EDHS datasets was categorized as rural or urban. In EDHS, children recode has household wealth index variable for all surveys, except for the 2000 EDHS. For the 2000 EDHS, we constructed wealth index variable based on household characteristics and assets by applying a principal component analysis (PCA). Observations were classified into five quintiles based on asset index values, and a categorical wealth index (poorest, poorer, medium, richer and richest) exposure variable was regrouped into two groups as poor (which consists of the poorest and poorer quintiles) and non-poor (comprising of medium, richer and richest quintiles) for the study. Maternal education was categorized using levels (no formal education, primary, and secondary and above).

Our selection of the covariates was guided by the UNICEF's conceptual framework for child malnutrition [37, 38]. We regrouped the covariates into community, household and individual level variables. The community-level covariate consisted of administrative regions of Ethiopia and the old eleven administrative regions were recategorized into three regional categories: emerging regions (Afar, Somali, Benishangul-Gumuz, and Gambella), established regions (Amhara, Oromia, Harari, Southern Nations Nationalities, and People's Region (SNNPR) and Tigray) and fully urban (Addis Ababa and Dire Dawa City Administrations) [39].

The household-level covariates included in this study were sex of household head (male/female); and household size (< 6/6 +). The individual-level covariates included in this study were sex of child (male/female); child size at birth as reported subjectively by mothers (small/average/large); birth order (1st/2nd-4th/5+); breastfeeding initiation (immediately/lately); duration of breast feeding (< 12/12 + months); maternal employment status (yes/no); maternal age at child birth computed from mother's and her child birth date (< 19/19 +); total children ever born(< 5/5 +); antenatal care visit(< 4/4 +); place of delivery (home/health facility); and survey period (2000–2011 or 2016–2019).

2.4 Statistical methods

Children with missing weight, height/length and other unknown responses were excluded from statistical analysis. Descriptive statistics were used to describe the background characteristics of the study participants. Variance inflation factor (VIF) with cutoff value of 2.5 [40] and correlation matrix [41] were employed to test multicollinearity effect of the explanatory variables. In this regard, birth order was removed from model due to high and strong collinearity with a total number of children (r = 0.8686) [41] and with VIF value of 5.17 which was greater than 2.5 [40]. The outliers were detected using Blocked Adaptive Computational Efficient Outlier Nominators approach and found that absence of outliers using a threshold of Percentile (15) to separate outliers from non-outliers [42].

Bivariate analysis was performed to examine the strength of the association between the explanatory variables and childhood undernutrition. The bivariate analysis was also used to facilitate the decision for inclusion of explanatory variables into multilevel logistic regression analysis.

Multilevel logistic regression analysis was performed using STATA software for mixed effect model [43] to explore the effect of explanatory variables on childhood undernutrition. We estimated a three-level model with the individual, household and community factors as level 1, level 2 and level 3, respectively. The null model was used as a baseline model to determine whether the use of multilevel modeling is appropriate for the analysis or not. Community-level predictors (regional category and place of residence) were included in Model I by controlling household and individual level variables. Model II was fitted after including household-level predictors into the Model I. The final model (Model III) was fitted with community, household and individual level explanatory variables to assess the relationship between the socioeconomic associations and childhood undernutrition. Intraclass Correlation Coefficient (ICC), Likelihood Ratio (LR) test and criteria information tests (AIC and BIC) were used to select the best model fitted for multilevel analysis [44].

Concentration Index (CI) was used to measure socioeconomic inequality and quantify the degree of place of residence, household wealth, and maternal education related inequalities in childhood undernutrition [45]. We interacted the survey period with the three exposure variables for trend analysis. Further, to assess trends in socioeconomic inequalities in childhood undernutrition we employed decomposition rate [46, 47]. All statistical analyses were performed using STATA version 17.0(College Station, Texas 77845 USA).

3 Results

3.1 Background characteristics of the study participants

Table 1 presents the background characteristics of the study participants. About two-third of the study participants were surveyed during 2000–2011 survey period, relative to one-third from 2016 to 2019. More than half (52.69%) of children were living in the established regions and nearly 10% of children were from two-chartered city administration (urban regional category). There were significantly larger proportion of children in rural (82.87%) than (17.13%) in urban areas. Relatively the same proportion (50.61%) of children were living in the poor households and in non-poor households (49.39%). More than half (55.31%) of children were living in the larger households with more than six household members. The descriptive statistics also showed that there were slightly more female children than male children. About 29.30% of children were born from mothers who did not have any formal education, significantly lower than those whose mothers had at least primary level education (70.70%). Nearly similar proportion of children had small (30.10%) and large (30.60%) size at birth. About 50% of children were breastfed for more than a year while nonnegligible proportion (5.08%) of children never had breastfeeding. Breast feeding was initiated immediately after birth for a considerable proportion (69.53%) of children relative to 30.47% of children lately initiated for breastfeeding. Most (74.87%) of children were born from mothers who had small visits (at most 3 times) of the health facilities during their pregnancy. Relatively higher proportion (58.88%) of children were born from mothers who gave birth for at most four children than those whose mothers gave birth for at least five children (41.02%). About 10% of children were born from young mothers (less than 19 years old). More than half (54.94%) of children were born from unemployed mothers (Table 1).

3.2 Bivariate analysis results

Table 2 shows results of the bivariate analysis of association between socioeconomic characteristics and childhood undernutrition. Childhood undernutrition was significantly associated (p < 0.001) with established regions, and rural communities; poor and larger households; mothers who had no formal education and mothers with lesser pregnancy-related antenatal care visits; and children born at home and who had small-size at birth. More than half (50.71%) of children were significantly (p < 0.001) undernourished at the time of survey (Table 2).

Table 1 Background
characteristics of the study
participants (N = 48,782),
Ethiopia, 2000–2019

Variables	N	%
Survey period		
2000–2011	32388	66.39
2016–2019	16394	33.61
Community level drivers		
Regional category		
Established	25704	52.69
Emerging	18417	37.75
Urban	4661	9.55
Place of residence		
Rural	40424	82.87
Urban	8358	17.13
Household level drivers		
Wealth status		
Poor	24503	50.61
Non-poor	23908	49.39
Household size		
<6	21713	44.51
6+	27069	55.49
Individual level drivers		
Sex of child		
Male	23784	48.76
Female	24998	51.24
Maternal education		
No education	14295	29.30
Primary+	34487	70.70
Child size at birth		
Large	13084	30.60
Average	16802	39.30
Small	12870	30.10
Duration of breastfeeding		
Never breastfed	2464	5.08
<12 months	22057	45.48
12+months	23972	49.44
Antenatal care visit		
<4	24403	74.87
4+	8190	25.13
Total children ever born		
<5	28774	58.98
5+	20008	41.02
Age at child birth		
<19	4933	10.11
19+	43849	89.89
Employment		
No	23558	54.76
Yes	19464	45.24

Table 2 Bivariate analysis of explanatory variables by childhood undernutrition (N = 35,898), Ethiopia, 2000–2019

Explanatory variables	Childhood undernutrition				Chi-square
	Nourished		Undernourished		
	N	%	N	%	
Community level drivers					
Regional category					490.63[a]
Established	8719	45.67	10373	54.33	
Emerging	6660	50.11	6632	49.89	
Urban	2315	65.88	1199	34.12	
Place of residence					885.14[a]
Rural	13561	45.70	16116	54.30	
Urban	41133	66.44	2088	33.56	
Household level drivers					569.24[a]
Wealth status					
Poor	7845	43.12	10347	56.88	
Non-poor	9750	55.76	7737	44.24	
Household size					33.48[a]
<6	7906	51.10	7567	48.90	
6+	9788	47.92	10637	52.08	
Individual level drivers					
Sex of child					25.37[a]
Male	8948	50.64	8722	49.36	
Female	8746	47.98	9482	52.02	
Place of delivery					922.56[a]
Home	12499	45.03	15261	54.97	
Health facility	5031	64.48	2771	35.52	
Maternal education					758.75[a]
No education	11052	44.45	13813	55.55	
Primary+	6642	60.20	4391	39.80	
Child size at birth					309.06[a]
Large	4869	52.96	4324	47.04	
Average	6050	49.66	6132	50.34	
Small	3789	40.60	5544	59.40	
Duration of breastfeeding					124.02[a]
Never breast feed	430	52.12	395	47.88	
<12 months	8859	52.30	8080	47.70	
12+months	8365	46.41	9661	53.59	
Antenatal care visit					479.87[a]
<4	8472	46.65	9689	53.35	
4+	4133	62.37	2494	37.63	
Total children ever born					151.02[a]
<5	11015	51.99	10171	48.01	
5+	6679	45.40	8033	54.60	
Age at child birth					5.07[b]
<19	1547	47.41	1716	52.59	
19+	16147	49.48	16488	50.52	
Employment					43.87[a]
No	8018	49.75	8098	50.25	
Yes	6770	45.98	7954	54.02	
Survey period					323.61[a]
2000–2011	10051	45.53	12023	54.47	
2016–2019	7643	55.29	6181	44.71	
Total	**17694**	**49.29**	**18204**	**50.71**	

[a] $p < .01$

[b] $p < .05$

[c] $p < .1$

3.3 Multilevel analysis results

Table 3 shows the results of the multilevel logistic regression analysis for key determinants of childhood undernutrition. The null model showed statistical significance, suggesting that use of multilevel modeling was appropriate for the analysis. Children from the established and urban regions had statistically (p < 0.001) lower chance of being undernourished

Table 3 Multilevel regression modelling for childhood undernutrition (N = 30,130), Ethiopia, EDHS 2000–2019

Explanatory variables	Model 0 Coef. [CI]	Model I Coef. [CI]	Model II Coef. [CI]	Model III Coef. [CI]
Community-level attributes				
Region: emerging(ref)				
Established		− 0.030[− 0.043, − 0.017][a]	− 0.041[− 0.055, − 0.028][a]	− 0.033[− 0.047, − 0.020)[a]
Urban		− 0.085[− 0.109, − 0.061][a]	− 0.086[− 0.110, − 0.062][a]	− 0.081[-0.103, − 0.058][a]
Place of residence: rural(ref)				
Urban		− 0.187[− 0.205, − 0.168][a]	− 0.144[− 0.163, − 0.124][a]	− 0.097[− 0.116, − 0.079][a]
Household-level attributes				
Household size: (< 6) (ref)				
Six and above			0.015[0.003, 0.027][b]	− 0.007 [− 0.021, 0.006]
Wealth status: poor (ref)				
Non-poor			− 0.077[− 0.09, − 0.064][a]	− 0.061[− 0.074, − 0.048][a]
Individual-level attributes				
Child sex: (Male)				
Female				0.032[0.021, 0.043][a]
Size at birth: large(ref)				
Average				0.039[.026, 0.043][a]
Small				0.113.099, 0.127][a]
Duration of breastfeeding: never(ref)				
Less than 12 months				− 0.021[− 0.061, 0.019]
12 and above months				0.045.006, 085][b]
Total children ever born: (< 5) (ref)				
Five and above				0.027[0.013, 0.041][a]
Education: primary + (ref)				
No education				0.078[0.066, 0.092][a]
Age at first birth (< 19)				
19 and above				− 0.028[− 0.049, − 0.008][a]
Employment: no (ref)				
Yes				0.030[0.018, 0.042][a]
Survey period: 2000–2011(ref)				
2016–2019				− 0.070[− 0.084, − 0.058][a]
Constant	0.517[0.509, 0.525][a]	0.570[.560, 0.579][a]	0.608[0.590, 0.626][a]	0.491[0.442, 0.540][a]
Random effect				
Community level variance	0.005 [0.004, 0.006]	0.003[0.002, 0.004]	0.003[0.002, 0.004]	0.003[0.002, 0.004]
Household level variance	0.038 [0.033, 0.043]	0.035[0.031, 0.040]	0.034[0.030, 0.40]	0.035[0.030, 0.040]
ICC community	0.019	0.014	0.012	0.011
ICC household	0.171	0.158	0.155	0.159
AIC	43268.07	42543.88	42405.97	41676.89
BIC	43301.32	42602.07	42489.11	41843.15
LR test (Chi²)	427.32[a]	343.9[a]	326.03[a]	316.9[a]

[a] p < .01

[b] p < .05

[c] p < .1

than their counterparts in the emerging regions. Children residing in urban areas were significantly (p < 0.001) less likely to be undernourished compared to children living in rural areas.

In Model II, children living in the established and urban regions, and urban areas had significantly (p < 0.001) lower likelihood of being undernourished than those children living in the emerging regions and rural areas. Children living in large households (more than six members) had a significantly (p < 0.05) higher chance of being undernourished compared to those from smaller households (less than six members). Children from non-poor households had significantly lower (p < 0.001) likelihood of undernourishment than their counterparts living in the poor households.

In Model III, children from the emerging regions and rural areas had significantly (p < 0.001) higher likelihood of being undernourished than their counterparts in the established regions and urban areas, respectively. Children born with small and average size at birth had a significantly (p < 0.001) higher chance of being undernourished. Maternal education, age at birth and employment-status had significant effect on childhood undernutrition. Children born from uneducated, young (less than 19 years) and unemployed mothers had significantly (p < 0.001) higher chance of being undernourished than those born from educated, older than 19 years and employed mothers, respectively. Childhood undernutrition was significantly (p < 0.001) higher in 2000–2011 as compared to the recent survey periods (2016–2019).

From Table 3, it was observed that the inclusion of individual level (level 1) covariates into the model slightly decreased the effects of community variation from 0.019 (null model) to 0.011. This indicates the existence of smaller variation between regions and urban rural areas. Table 3 also shows reduction in household variation from 0.171 (in Model 0) to 0.159, suggesting that there is relative variation between communities (regions and urban rural areas) in childhood undernutrition.

As seen from Table 3, AIC = 41676.89 and BIC = 41843.15 of the Model III, were the smallest compared to the other models considered. This suggests that the final model was fitted well compared to the rest of the models. Further LR test showed statistically significant associations for the fitted multilevel models.

3.4 Concentration index analysis results

Figure 1 presents concentration curve for childhood undernutrition by key socioeconomic status. The concentration curve was displayed above the equality line (45 degree) showing that childhood undernutrition was more concentrated among lower economic status population group in Ethiopia during the survey period. Concentration index, the area between equality line and concentration curve, was − 0.141 (p < 0.001) which indicates there was inequalities in distribution of childhood undernutrition, and the inequality disfavored the poor in in the country (Fig. 1).

Table 4 depicts wealth-related childhood undernutrition across place of residence and maternal education. The concentration index estimated from the combined wealth index was statistically significant (CI = − 0.14124, p < 0.001). Table 4 shows a significant concentration of childhood undernutrition in both rural and urban settings, poor and non-poor households, and uneducated and educated mothers (p < 0.001). The point estimates suggest that the level of inequality

Fig. 1 Concentration curve of childhood undernutrition, Ethiopia, 2000–2019
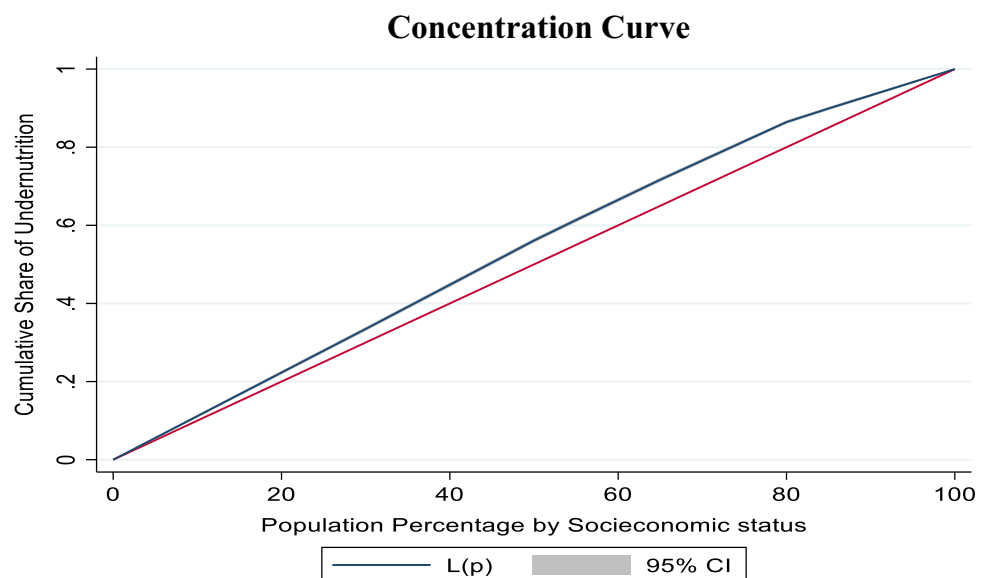
Table 4 Socioeconomic inequality in childhood undernutrition by key drivers, Ethiopia, 2000–2019

Inequality drivers	Concentration index	Robust std. error	P-value
Household wealth status	− 0.14124	0.0096	0.000
Poor	− 0.12287	0.0130	0.000
Non-poor	− 0.01402	0.0118	0.237
Difference	− 0.01088	0.0176	0.000
Place of residence			
Rural	− 0.1131	0.0245	0.000
Urban	− 0.0876	0.0091	0.000
Difference	− 0.0255	0.0262	0.000
Maternal education			
Uneducated	− 0.19099	0.0170	0.000
Primary +	− 0.06813	0.0064	0.000
Difference	− 0.12286	0.0200	0.000

was greatest in children from rural areas, poor households and uneducated mothers, but the inequality with children born in urban areas, non-poor households and educated mothers was relatively small (Table 4).

3.5 Trends of socioeconomic inequalities in childhood undernutrition

Table 5 shows trend analysis results in childhood undernutrition inequality by exposure variables. The decomposition rate analysis result revealed that the overall absolute inequality in childhood undernutrition was declined by 9.72 during the period between 2000 and 2019. About 164% of the decline in childhood undernutrition could be attributed to narrowed gap due to maternal education during the past two decades. However, the widened gap by place of residence and household wealth status contributed to an increase in childhood undernutrition (Table 5).

4 Discussion

This study investigated levels and trends of socioeconomic inequality in undernutrition among under-five children in Ethiopia. The overall prevalence of undernutrition was about 50.71%, which is still higher than 41.9% in Nigeria in 2018 [48] and nearly similar to India (55%) in 2014 [49]. Our multilevel analysis result revealed that under-five children born from uneducated mothers were at most risk of being undernourished, which is consistent with previous studies [50]–[52]. This could be due to established reason that educated mothers are better informed about child feeding and healthcare during illness, utilizing health services [53]. Another possible reason could be that educated women are more empowered to make decision to marry men with higher income, live in better community, get higher paid jobs which directly or indirectly influence their child nutritional status [54]. In addition, the present study revealed that children from poor households were at higher risk of being undernourished as compared to children from non-poor households. This finding was supported by other studies conducted in Ethiopia [50–52]. The reason for this might be due to the fact that the poor households could be affected by food insecurity which directly affect the nutritional status of children [24]. Another

Table 5 Trends in socioeconomic inequalities in undernutrition by key drivers in Ethiopia, 2000–2019. Source: Authors construction using EDHS 2000–2019

Explanatory variables	Survey periods							
	2000–2005		2000–2011		2000–2016		2000–2019	
	D[a]	%	D[a]	%	D[a]	%	D[a]	%
Place of residence	− 1.14	− 46.1	0.793	54.3	1.7	− 20.60	4.48	− 46.2
Household wealth status	5.65	227.5	2.9	49.9	− 0.085	1.02	1.78	− 18.4
Maternal education	− 2.02	− 81.4	− 6.5	34.1	− 9.88	119.58	− 16.0	164.4
Overall	**2.48**	**100.0**	**− 2.8**	**100.0**	**− 8.26**	**100.0**	**− 9.72**	**100.0**

D[a] = Absolute difference in prevalence rate of childhood undernutrition

possible reason might be that the poor households may not have access for improved water which could affect the children's dietary intake and lead to dehydration that results in childhood undernutrition [55]. Additionally, it is worthy to note that undernutrition is a situation that is associated with poverty as it results in hunger and lack of food at right quantity and quality [54]. Moreover, this study showed that under-five children residing in rural areas had higher likelihood of being undernourished compared to those living in urban settings of the country, which is supported by other studies conducted in the country [22, 46]. This might be due to the reason that children residing in urban areas could have better living conditions and access to timely and healthy food [50]. Besides, most of children residing in rural areas may be using unimproved water that leads to unhealthy feeding practice and dehydration that results in undernutrition [55].

Our decomposition analysis also pointed out that the level of inequality was highest with children from the rural areas, poor households and uneducated mothers; however, the inequality with children born form the urban areas, and non-poor households and educated mothers was minimal. In line with this, our finding also showed that the childhood undernutrition was more concentrated among lower economic population groups. This might be due to the reason that children residing in urban areas could have better access to health care service and improved water that leads to better feeding practice [55]. Another reason could be that children residing in the poor households might be affected by food insecurity [24]. Moreover, children from educated mothers could have better access for feeding practice and healthcare, utilizing health services [53]. Furthermore, the wealthiest population groups could afford to purchase various quantities and qualities of food to feed their children and access to health care services that could be limited to lower economic population groups [50].

Furthermore, our trend analysis showed that the overall absolute socioeconomic inequality in childhood undernutrition was declined by 9.72 from 2000 to 2019. The reason behind to such decline could be that the nutritional and health related policy commitment taken by Government of Ethiopia since 2000. Thus, it is good to encourage continuity of the national nutritional policy commitments and maternal education attainment, and further to set policies that could help address rural-urban and household socioeconomic gaps at national, sub-national, community and household levels. Relatively high proportion of the decline in childhood undernutrition could be attributed to narrowed gap due to improvement of maternal education during the past two decades in the country, as maternal education is used as a key to improve child health and nutrition [56]. On the other hand, the widened gap by place of residence and household wealth status contributed to an increase in childhood undernutrition. This can be due to disparities in socioeconomic conditions and access to basic social services such as health care, housing, water, and sanitation services between rural and urban areas, and among the poor and non-poor households.

To this end, application of rigorous statistical methods and analysis techniques using a two-decade nationally representative datasets is the major strength of this study. In addition, the findings of the study were based on large data set which makes it useful for monitoring and evaluation of nutrition programs in the country. However, our study did not consider all potential determinants of childhood undernutrition, including household food security status, maternal nutrition status, among others, that could strongly affect child nutritional status in the country. In addition, the present study did not consider conventional indices as it was mainly focused on CIAF (alternative indicator). Although our study claims the association among the studied variables based on repeated retrospective cross-sectional designs applied by EDHSs, we are not able to demonstrate causality effects in this study.

5 Conclusion

In conclusion, childhood undernutrition was unequally distributed among under-five children in Ethiopia, and largely concentrated among low socioeconomic status population groups. Therefore, it is important to enhance the basic education for women to improve their child feeding practice, utilizing child health care services and child nutritional status. In addition, it is noteworthy to minimize the wide gaps in place of residence and household wealth status through communication strategies and nutrition training packages to promote positive health behaviors that are appropriate to improve child nutritional status at different levels. Moreover, it is instrumental to strengthen and support food security and health care programs, including PSNP along with targeted supplementary feeding practice at both rural and urban settings. Furthermore, the study underscores development of poverty reduction strategies that directly address the existing challenges of the food insecurity and childhood undernutrition for the low-income population groups in the country.

Declarations

Ethics approval and consent to participate For the original conduct of the five rounds of Ethiopia Demographic and Health Surveys (DHSs), ethical approval was obtained from the ethical committee of the ICF. The enumerators obtained informed consent and authorization to anonymously use the data from all survey participants. In our study, we obtained permission to use the data from the DHS program. No further ethical approval was required, as our study solely involved secondary data analysis of publicly available data that does not contain any identifiable information that links to the actual survey participants. The authors also confirm that all methods were carried out by relevant guidelines and regulations.

Competing interests The authors declare that they have no competing interests.

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