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Poverty, Place, and Parental Education: Drivers of Childhood Undernutrition Inequality in Ethiopia

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Abstract

Childhood undernutrition remains a major public health challenge worldwide, with the greatest burden borne by low-income and lower-middle-income countries. In Ethiopia, substantial disparities in childhood undernutrition persist across socioeconomic and demographic groups. This study seeks to assess the magnitude and temporal patterns of key socioeconomic inequalities in childhood undernutrition in Ethiopia. This cross-sectional analysis utilized pooled data from five rounds of the Ethiopia Demographic and Health Surveys conducted between 2000 and 2019, comprising a total sample of 48,782 children under the age of five. Multilevel binary logistic regression models were employed to identify the socioeconomic factors associated with childhood undernutrition. Furthermore, concentration index measures and decomposition analyses were applied to quantify socioeconomic inequalities and examine their trends over time. Several socioeconomic factors, including place of residence, household economic status (measured using an asset-based wealth index), and maternal educational attainment, were significantly associated with childhood undernutrition ($p < 0.001$). Inequalities were most pronounced among children living in rural settings, those from economically disadvantaged households, and those whose mothers lacked formal education. Over the study period from 2000 to 2019, absolute socioeconomic inequality in the prevalence of childhood undernutrition declined by 9.72 percentage points. Childhood undernutrition in Ethiopia remains unevenly distributed, disproportionately affecting children from socioeconomically disadvantaged backgrounds. The study highlights key socioeconomic drivers contributing to these inequalities, offering valuable evidence to guide targeted interventions and context-specific communication strategies aimed at improving child nutritional outcomes. The findings emphasize the importance of strengthening poverty alleviation efforts that directly address food insecurity and undernutrition among low-income population groups in Ethiopia.

Keywords: Childhood undernutrition, Public health, The socioeconomic factors, Poverty alleviation

Introduction

Childhood undernutrition—encompassing stunting, wasting, and underweight [1]—is a critical public health measure for assessing child health, growth, and survival outcomes [2]. It remains a major concern in low- and middle-income settings [3] and is strongly linked to elevated child mortality, accounting for nearly half of all deaths among children under five years of age worldwide [4, 5]. Beyond its immediate survival implications, undernutrition during early childhood negatively affects physical growth and cognitive development [6], leading to long-term consequences such as reduced educational attainment and diminished human capital later in life [7]. At the global level, an estimated 149.2 million children under five years of age were stunted, 45.4 million were wasted, and 85 million were underweight in 2020 [8, 9]. Although there has been a general decline in the prevalence of childhood undernutrition since 2000 [10], substantial disparities persist across regions and subregions [11]. The burden of childhood undernutrition is disproportionately concentrated in low-income and lower-middle-income countries [12]. In 2020, almost two-thirds of children affected by stunting and approximately three-quarters of those suffering from

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wasting resided in lower-middle-income countries [8]. More than half of undernourished children globally lived in Asia, while over one-quarter were in Africa [8, 9]. Notably, despite global progress in reducing stunting, the number of stunted children in Africa increased from 54.4 million in 2000 to 61.4 million in 2020 [8].

In Sub-Saharan Africa, data from 31 countries—including Ethiopia—indicate that 26% of children under five were stunted, 21% were underweight, and 6% were wasted [4]. In Ethiopia specifically, the prevalence of stunting, underweight, and wasting among under-five children was reported at 37%, 21%, and 7%, respectively [13]. Although these figures reflect a gradual reduction over the past two decades, substantial variation in undernutrition persists across population subgroups. Socioeconomic and demographic disparities play a major role in shaping these differences, with household wealth and parental education frequently identified as key sources of inequality [14-17].

Despite observable declines in overall undernutrition prevalence based on Demographic and Health Survey estimates [13, 14], socioeconomic disparities in childhood undernutrition remain pronounced. A large proportion of Ethiopian children live in poor or poorest households, and nearly 85% reside in rural areas where access to essential services is limited, potentially exacerbating existing inequalities. This context underscores the need for robust, evidence-based analyses to better understand the magnitude and distribution of socioeconomic inequalities in childhood undernutrition. Examining both the levels and trends of inequality by key socioeconomic factors is essential for tracking progress and identifying populations at greatest risk. Such analyses also provide valuable insights for policymakers and program implementers to evaluate and refine population-level and socioeconomic policies from a public health perspective.

Although numerous studies have examined inequalities in childhood undernutrition globally [11, 12, 15-20], most have relied on single anthropometric indicators and have not applied both multilevel and decomposition analytical approaches to comprehensively assess inequality. Furthermore, several studies conducted in developing countries, including Ethiopia [21-27], have not explored temporal trends in childhood undernutrition. Evidence on long-term trends in socioeconomic inequalities in childhood undernutrition in Ethiopia remains particularly limited due to the lack of large-scale analyses [17, 18, 20, 28, 29]. Existing studies often focus on individual indicators such as stunting or underweight and are constrained by limited analytical scope, failing to adequately account for the hierarchical structure of survey data or the combined influence of individual-, household-, and community-level factors. Moreover, investigations that assess socioeconomic inequalities using the composite index of anthropometric failure (CIAF) in conjunction with multilevel and decomposition methods are scarce in the Ethiopian context. Therefore, this study seeks to address the question: what are the levels and trends of socioeconomic inequalities in childhood undernutrition in Ethiopia over the past two decades? The primary objective is to examine the magnitude and evolution of key socioeconomic inequalities in childhood undernutrition in Ethiopia, with a focus on identifying the main socioeconomic drivers underlying these disparities.

Materials and Methods

Study context

Ethiopia exhibits pronounced geographic and climatic heterogeneity, ranging from highland plateaus to arid lowlands [30]. Despite recent socioeconomic changes, approximately four out of five Ethiopians continue to live in rural areas, where employment options, infrastructure, and access to basic services remain limited. Educational participation is notably low, with secondary-level schooling attained by only a small proportion of the population—around 12% of women and 15% of men [31]. These structural challenges contribute to Ethiopia's status as one of the world's lowest-income countries [32], with persistent and widespread food insecurity affecting large segments of the population [33].

National efforts to combat childhood undernutrition have been embedded within Ethiopia's broader health and development agenda for several decades. A formal policy commitment was established in 1993 through the adoption of a national health policy that emphasized the prevention of nutrition-related diseases [34]. This policy direction was operationalized through four successive Health Sector Development Programs implemented between 1998 and 2015, each prioritizing maternal and child health interventions, including nutrition-specific actions [35]. In parallel with global initiatives, Ethiopia committed in 2000 to the Millennium Development Goals, including the goal of eliminating extreme poverty and hunger (MDG 1) [36]. To improve equity in primary healthcare delivery, the Health Extension Program was

launched nationwide in 2003 [37]. Complementing health-sector interventions, the Productive Safety Net Program was initiated in 2005 to mitigate chronic food insecurity in drought-prone rural regions and has since progressed through four implementation phases [38]. Ethiopia further strengthened its nutrition policy framework with the introduction of the National Nutrition Strategy in 2008, followed by the first National Nutrition Program (2008–2015) [39] and the second National Nutrition Program (2016–2020), which incorporated the Seqota Declaration—an ambitious commitment to end childhood undernutrition by 2030 [40]. More recently, a comprehensive Food and Nutrition Policy was enacted in 2018 to promote optimal nutritional outcomes across the population. The country has also aligned its development agenda with Sustainable Development Goal 2, which aims to end hunger and all forms of malnutrition by 2030. Notwithstanding these sustained policy efforts and improvements in health service delivery and multisectoral coordination over the past two decades [35], childhood undernutrition continues to represent a major public health concern in Ethiopia.

Data source

The analysis drew on pooled data from five nationally representative rounds of the Ethiopia Demographic and Health Surveys conducted between 2000 and 2019, employing a cross-sectional study design. The EDHS surveys utilized a stratified two-stage cluster sampling methodology, whereby enumeration areas were selected in the first stage, followed by systematic selection of households within each cluster [13, 14]. Although surveys were initially scheduled at five-year intervals (2000, 2005, and 2011), the fourth round was conducted after a six-year interval in 2016. To capture more recent dynamics and extend the temporal assessment of socioeconomic inequalities in childhood undernutrition, the 2019 mini-EDHS—based on a reduced sample size—was also incorporated into the pooled dataset.

Across all survey waves, detailed information on household, socioeconomic, demographic, and health characteristics was collected through structured interviews with women aged 15–49 years. Standardized anthropometric measurements were obtained for all children under five years of age in each survey round. For this study, children's recode (KR) files from all five EDHS rounds, including the 2019 mini-EDHS, were merged to create a combined analytical sample of 48,782 under-five children. These datasets provide comprehensive indicators related to child health, nutrition, and maternal characteristics, enabling a consistent assessment across survey years.

Study variables

- *Outcome variable*

Childhood undernutrition was the main dependent variable examined in this study. It was operationalized using the Composite Index of Anthropometric Failure (CIAF), which combines information from the three standard anthropometric indicators—stunting, wasting, and underweight—to identify children experiencing any form of nutritional deficit. The CIAF was used as an alternative summary measure to capture the total prevalence of undernutrition among under-five children within a population. Unlike conventional indicators that describe separate biological manifestations of growth failure, the CIAF aggregates these conditions into a single measure, making it particularly useful for population-level monitoring and policy planning [41]. This approach allows for a more complete estimation of the overall burden of childhood undernutrition [42].

Based on Z-score classifications, children were grouped into seven mutually exclusive categories following the CIAF framework [41]: children with no anthropometric failure; children with wasting only; children with both wasting and underweight; children with concurrent wasting, stunting, and underweight; children with stunting and underweight; children with stunting only; and children with underweight only. For analytical purposes, these categories were further collapsed into a binary outcome variable. Children who exhibited at least one form of anthropometric failure, either alone or in combination, were coded as undernourished (value = 1), whereas children with no failure were coded as not undernourished (value = 0).

- *Explanatory variables*

Independent variables were classified into exposure variables and control covariates. Three variables were selected as the primary exposures because of their established role in shaping socioeconomic inequalities in childhood undernutrition: place of residence, household economic status, and maternal education [43, 44]. Place of residence was measured at the community level and categorized as urban or rural according to EDHS classifications. Household wealth status was obtained

from the children's recode files for all survey rounds except the 2000 EDHS. For the 2000 survey, a wealth index was generated using principal component analysis (PCA) based on household asset ownership and housing characteristics. Households were initially ranked into five wealth quintiles (poorest, poorer, middle, richer, and richest), which were subsequently reclassified into two broader categories: poor (poorest and poorer) and non-poor (middle, richer, and richest). Maternal education was grouped into three categories: no formal education, primary education, and secondary education or higher.

The selection of covariates was guided by the UNICEF conceptual framework for child malnutrition [29, 45], and variables were organized according to their level of influence. Community-level covariates included regional classification. Ethiopia's former eleven administrative regions were regrouped into three categories: emerging regions (Afar, Somali, Benishangul-Gumuz, and Gambella), established regions (Amhara, Oromia, Harari, Southern Nations, Nationalities and Peoples' Region (SNNPR), and Tigray), and predominantly urban regions (Addis Ababa and Dire Dawa City Administrations) [46].

Household-level variables included sex of the household head (male or female) and household size, categorized as fewer than six members or six or more members. Individual-level covariates consisted of child sex (male/female); maternal assessment of child size at birth (small, average, or large); birth order (first, second to fourth, or fifth and above); timing of initiation of breastfeeding (immediate or delayed); duration of breastfeeding (less than 12 months or 12 months and above); maternal employment status (yes/no); maternal age at the time of childbirth calculated from birth dates (less than 19 years or 19 years and above); total number of children ever born (fewer than five or five and above); number of antenatal care visits (fewer than four or four and above); place of delivery (home or health facility); and survey period, grouped as 2000–2011 and 2016–2019.

Statistical methods

Children with incomplete anthropometric data or missing responses for key variables were excluded prior to analysis. Descriptive analyses were conducted to summarize the characteristics of the study population. Multicollinearity among explanatory variables was evaluated using variance inflation factors, with a cutoff point of 2.5 [47], alongside inspection of correlation matrices [48]. Birth order was excluded from the regression models due to its strong correlation with total number of children ever born ($r = 0.8686$) [48] and a variance inflation factor of 5.17, which exceeded the predefined threshold [47]. Outlier detection was performed using the Blocked Adaptive Computational Efficient Outlier Nominators method, and no influential outliers were identified when applying a 15th percentile threshold [49].

Initial bivariate analyses were carried out to examine unadjusted relationships between explanatory variables and childhood undernutrition. These analyses also informed the selection of variables for inclusion in the multilevel regression models.

Given the hierarchical nature of the EDHS data, multilevel logistic regression models were estimated using mixed-effects procedures in STATA [50]. The analysis followed a three-level structure, with children nested within households and households nested within communities. An intercept-only model was first fitted to assess the extent of between-cluster variation and justify the use of multilevel modeling. In the first adjusted model, community-level variables, including regional classification and place of residence, were introduced while controlling for lower-level factors. Household-level variables were added in the second model. The final model incorporated community-, household-, and individual-level variables simultaneously to evaluate socioeconomic associations with childhood undernutrition. Model performance and fit were assessed using the intraclass correlation coefficient, likelihood ratio tests, and information criteria (AIC and BIC) [51].

Socioeconomic inequality in childhood undernutrition was quantified using the concentration index, focusing on disparities related to place of residence, household wealth status, and maternal education [52]. To examine changes over time, interaction terms between survey period and each exposure variable were included. Trends in inequality were further assessed using decomposition rate analysis [53, 54]. All analyses were conducted using STATA version 17.0 (College Station, Texas 77845, USA).

Results and Discussion

Background characteristics of the study participants

The descriptive characteristics of the study sample are summarized in **Table 1**. Of the total 48,782 under-five children included in the analysis, approximately two-

thirds were drawn from surveys conducted between 2000 and 2011, while the remaining one-third came from the more recent survey rounds spanning 2016 to 2019. Slightly over half of the children (52.69%) resided in established regions, whereas close to one-tenth were from the two chartered city administrations classified as urban regions. The majority of children lived in rural areas (82.87%), with a much smaller share residing in urban settings (17.13%).

With regard to household economic status, children were almost evenly distributed between poor households (50.61%) and non-poor households (49.39%). More than half of the children (55.31%) belonged to households with six or more members. The sex distribution showed a marginal predominance of female children compared with male children. In terms of maternal education, nearly three in ten children (29.30%) were born to mothers with no formal schooling, while the majority (70.70%) had mothers who attained at least primary education.

Maternal reports of child size at birth indicated that similar proportions of children were classified as small (30.10%) and large (30.60%). About half of the children were breastfed for a duration exceeding one year, although a small but notable proportion (5.08%) had never been breastfed. Initiation of breastfeeding occurred immediately after birth for most children (69.53%), whereas approximately one-third (30.47%) experienced delayed initiation.

A large proportion of children (74.87%) were born to mothers who had limited antenatal care utilization, defined as three or fewer visits during pregnancy. More children were born to mothers who had given birth to four or fewer children (58.88%) compared with those whose mothers had five or more births (41.02%). Children born to adolescent mothers constituted around 10% of the sample. In addition, more than half of the children (54.94%) were born to mothers who were not engaged in employment at the time of the survey.

Table 1. Presents the detailed background characteristics of the study participants.

Variable category	Response	Variable	%	N
Community-level factors	Established regions	Regional category	52.69	25,704
	Emerging regions		37.75	18,417
	Urban regions		9.55	4,661
	Rural	Place of residence	82.87	40,424
	Urban		17.13	8,358
Survey timing	2000–2011	Survey period	66.39	32,388
	2016–2019		33.61	16,394
Individual-level factors	Male	Sex of child	48.76	23,784
	Female		51.24	24,998
	Large	Child size at birth	30.60	13,084
	Average		39.30	16,802
	Small		30.10	12,870
	No	Maternal education	29.30	14,295
	Yes		70.70	34,487
	No (< 4 visits)	Antenatal care visit	74.87	24,403
	Yes (≥ 4 visits)		25.13	8,190
	No	Duration of breastfeeding	5.08	2,464
	Yes (< 12 months)		45.48	22,057
	Yes (≥ 12 months)		49.44	23,972
	No (< 19 years)	Maternal age at childbirth	10.11	4,933
	Yes (≥ 19 years)		89.89	43,849
	No (< 5)	Total children ever born	58.98	28,774
	Yes (≥ 5)		41.02	20,008
	No	Maternal employment	54.76	23,558
	Yes		45.24	19,464

Household-level factors	Poor	Household wealth status	50.61	24,503
	Non-poor		49.39	23,908
	< 6 members	Household size	44.51	21,713
	≥ 6 members		55.49	27,069

Bivariate analysis results

The results of the bivariate analysis examining the relationship between socioeconomic factors and childhood undernutrition are presented in **Table 2.** Statistically significant associations ($p < 0.001$) were observed between childhood undernutrition and several key socioeconomic and demographic characteristics. Higher levels of undernutrition were found among children residing in established regions and rural settings, as well as among those living in economically disadvantaged and larger households. Significant associations were also identified for maternal factors, including lack of formal education and limited use of antenatal care services during pregnancy. In addition, children delivered at home and those reported to be small in size at birth exhibited a higher prevalence of undernutrition.

Overall, more than half of the children included in the bivariate analysis (50.71%) were classified as undernourished at the time of the survey, and this prevalence was statistically significant ($p < 0.001$) **(Table 2).**

Table 2. Presents the detailed bivariate associations between the explanatory variables and childhood undernutrition among under-five children in Ethiopia between 2000 and 2019.

Explanatory Variables	Chi-square	Nourished (%)	Nourished (N)	Undernourished (%)	Undernourished (N)
Household Level Drivers					
Household Size	33.48[a]				
6 +		47.92	9788	52.08	10637
< 6		51.10	7906	48.90	7567
Wealth Status	569.24[a]				
Non-poor		55.76	9750	44.24	7737
Poor		43.12	7845	56.88	10347
Community Level Drivers					
Place of Residence	885.14[a]				
Rural		45.70	13561	54.30	16116
Urban		66.44	41133	33.56	2088
Regional Category	490.63[a]				
Emerging		50.11	6660	49.89	6632
Established		45.67	8719	54.33	10373
Urban		65.88	2315	34.12	1199
Individual Level Drivers					
Place of Delivery	922.56[a]				
Health Facility		64.48	5031	35.52	2771
Home		45.03	12499	54.97	15261
Sex of Child	25.37[a]				
Female		47.98	8746	52.02	9482
Male		50.64	8948	49.36	8722
Child Size at Birth	309.06[a]				
Large		52.96	4869	47.04	4324
Average		49.66	6050	50.34	6132
Small		40.60	3789	59.40	5544
Maternal Education	758.75[a]				
Primary +		60.20	6642	39.80	4391
No Education		44.45	11052	55.55	13813

Antenatal Care Visits	479.87[a]				
< 4		46.65	8472	53.35	9689
4 +		62.37	4133	37.63	2494
Duration of Breastfeeding	124.02[a]				
Never Breastfed		52.12	430	47.88	395
12 + Months		46.41	8365	53.59	9661
< 12 Months		52.30	8859	47.70	8080
Age at Childbirth	5.07[b]				
19 +		49.48	16147	50.52	16488
< 19		47.41	1547	52.59	1716
Total Children Ever Born	151.02[a]				
5 +		45.40	6679	54.60	8033
< 5		51.99	11015	48.01	10171
Survey Period	323.61[a]				
2000–2011		45.53	10051	54.47	12023
2016–2019		55.29	7643	44.71	6181
Employment	43.87[a]				
No		49.75	8018	50.25	8098
Yes		45.98	6770	54.02	7954
Total		49.29	17694	50.71	18204

[a]p < .01
[b]p < .05
[c]p < .1

Multilevel analysis results

The findings from the multilevel logistic regression analysis identifying major predictors of childhood undernutrition are summarized in **Table 3**. Results from the empty (null) model were statistically significant, indicating the presence of meaningful variation across clusters and confirming the suitability of applying a multilevel analytical approach.

After adjusting for individual- and household-level factors, regional disparities remained evident. Children living in established regions and in fully urban administrative areas had a significantly lower likelihood of experiencing undernutrition compared with those residing in emerging regions ($p < 0.001$). Similarly, place of residence showed a strong association with nutritional status, as children from urban communities were substantially less likely to be undernourished than their rural counterparts ($p < 0.001$).

Table 3. Presents the detailed estimates from the multilevel regression models assessing childhood undernutrition among under-five children in Ethiopia using EDHS data from 2000 to 2019.

Explanatory variables		Model III Coef. [CI]	Model II Coef. [CI]	Model I Coef. [CI]	Model 0 Coef. [CI]
Household-level attributes					
Wealth status: poor (ref)	Non-poor	−0.061 [−0.074, −0.048][a]	−0.077 [−0.090, −0.064][a]		
Household size: (<6) (ref)	Six and above	−0.007 [−0.021, 0.006]	0.015 [0.003, 0.027][b]		
Community-level attributes					
	Urban		−0.081 [−0.103, −0.058][a]	−0.086 [−0.110, −0.062][a]	−0.085 [−0.109, −0.061][a]
Place of residence: rural (ref)	Urban		−0.097 [−0.116, −0.079][a]	−0.144 [−0.163, −0.124][a]	−0.187 [−0.205, −0.168][a]

Region: emerging (ref)	Established		−0.033 [−0.047, −0.020][a]	−0.041 [−0.055, −0.028][a]	−0.030 [−0.043, −0.017][a]
Individual-level attributes					
Child sex: Male (ref)	Female	0.032 [0.021, 0.043]^[a]			
Size at birth: large (ref)	Average	0.039 [0.026, 0.043]^[a]			
	Small	0.113 [0.099, 0.127]^[a]			
Duration of breastfeeding: never (ref)	Less than 12 months	−0.021 [−0.061, 0.019]			
	12 and above months	0.045 [0.006, 0.085][b]			
Total children ever born: (<5) (ref)	Five and above	0.027 [0.013, 0.041][a]			
Age at first birth: (<19) (ref)	19 and above	−0.028 [−0.049, −0.008][a]			
Education: primary+ (ref)	No education	0.078 [0.066, 0.092][a]			
Survey period: 2000–2011 (ref)	2016–2019	−0.070 [−0.084, −0.058][a]			
Employment: no (ref)	Yes	0.030 [0.018, 0.042][a]			
Constant		0.491 [0.442, 0.540][a]	0.608 [0.590, 0.626][a]	0.570 [0.560, 0.579][a]	0.517 [0.509, 0.525][a]
Random effects					
LR test (Chi^2)		316.9[a]	326.03[a]	343.9[a]	427.32[a]
ICC community		0.011	0.012	0.014	0.019
ICC household		0.159	0.155	0.158	0.171
Community level variance		0.003 [0.002, 0.004]	0.003 [0.002, 0.004]	0.003 [0.002, 0.004]	0.005 [0.004, 0.006]
Household level variance		0.035 [0.030, 0.040]	0.034 [0.030, 0.040]	0.035 [0.031, 0.040]	0.038 [0.033, 0.043]
AIC		41676.89	42405.97	42543.88	43268.07
BIC		41843.15	42489.11	42602.07	43301.32

[a]p < .01
[b]p < .05
[c]p < .1

In Model II, marked geographic and socioeconomic differences in childhood undernutrition were observed. Children residing in established regions, fully urban administrative areas, and urban settings had a significantly lower probability of being undernourished compared with those living in emerging regions and rural communities ($p < 0.001$). Household characteristics also played an important role: children from households with more than six members were more likely to experience undernutrition than those from smaller households ($p < 0.05$). In addition, belonging to a non-poor household was associated with a substantially reduced likelihood of undernutrition when compared with children from poor households ($p < 0.001$).

Results from the fully adjusted model (Model III) indicated that regional and residential disparities persisted even after accounting for individual- and household-level factors. Children living in emerging regions and rural areas faced significantly higher odds of undernutrition than those in established regions and urban locations ($p < 0.001$). Birth characteristics were also influential, as children reported to be small or

average in size at birth were more likely to be undernourished than those born large ($p < 0.001$). Maternal characteristics showed strong associations with child nutritional status: undernutrition was significantly more common among children born to mothers with no formal education, mothers younger than 19 years at childbirth, and mothers who were unemployed ($p < 0.001$). Furthermore, undernutrition prevalence was significantly higher during the earlier survey period (2000–2011) compared with the more recent surveys conducted between 2016 and 2019 ($p < 0.001$).

As indicated in **Table 3**, the addition of individual-level variables led to a modest reduction in community-level variance, decreasing from 0.019 in the null model to 0.011. This reduction suggests that part of the variability across regions and urban–rural settings can be explained by individual characteristics. Similarly, household-level variance declined from 0.171 in Model 0 to 0.159, implying that differences in childhood undernutrition remained across communities despite adjustment for household factors.

Model comparison statistics further confirmed the adequacy of the final model. Model III yielded the lowest Akaike Information Criterion (AIC = 41,676.89) and Bayesi[a]n Information Criterion (BIC = 41,843.15) values relative to the other models, indicating superior model fit. Likelihood ratio tests also demonstrated that the multilevel models provided statistically significant improvements over simpler specifications.

Concentration index analysis results

The concentration curve illustrating childhood undernutrition by socioeconomic status is shown in **Figure 1** The curve lies above the 45-degree line of equality, indicating that undernutrition was disproportionately concentrated among children from economically disadvantaged households in Ethiopia throughout the study period. The calculated concentration index was −0.141 ($p < 0.001$), confirming the presence of socioeconomic inequality in childhood undernutrition, with the burden falling more heavily on poorer population groups **(Figure 1).**

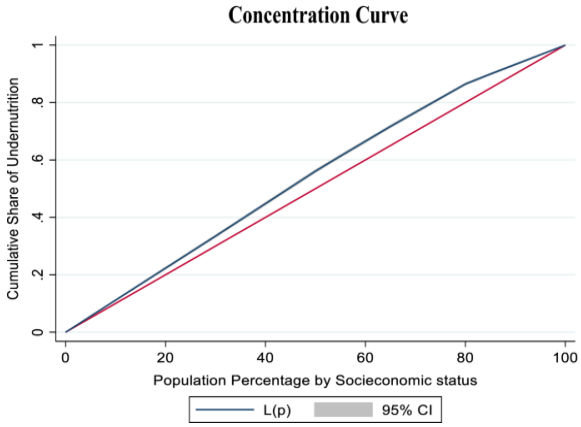

Figure 1. Illustrates the concentration curve for childhood undernutrition in Ethiopia from 2000 to 2019**. Table 4** presents the distribution of wealth-related inequalities in childhood undernutrition according to place of residence and maternal education. The concentration index calculated using the overall wealth index was statistically significant (CI = −0.14124, $p < 0.001$), confirming the presence of socioeconomic inequality in childhood undernutrition.

As shown in **Table 4,** childhood undernutrition was significantly concentrated across both rural and urban populations, as well as among non-poor and poor households and children of mothers with and without formal education ($p < 0.001$). However, the magnitude of inequality varied across these groups. The estimated concentration indices indicate that disparities were most pronounced among children living in rural areas, those from poor households, and those born to mothers without formal education. In contrast, the degree of inequality was comparatively lower among children residing in urban settings, those from non-poor households, and those whose mothers had attained some level of education **(Table 4).**

Table 4. Summarizes the extent of socioeconomic inequality in childhood undernutrition by major contributing factors in Ethiopia during the period 2000–2019.

Inequality drivers		Robust std. error	Concentration index	P-value
Place of residence				
	Difference	0.0262	−0.0255	0.000
	Urban	0.0091	−0.0876	0.000
	Rural	0.0245	−0.1131	0.000

Household wealth status				
	Difference	0.0118	−0.01402	0.237
	Non-poor	0.0130	−0.12287	0.000
	Poor	0.0096	−0.14124	0.000
		0.0176	−0.01088	0.000
Maternal education				
	Difference	0.0200	−0.12286	0.000
	Primary+	0.0064	−0.06813	0.000
	Uneducated	0.0170	−0.19099	0.000

Patterns of socioeconomic disparities in childhood undernutrition over time

Table 5 summarizes the evolution of socioeconomic disparities in childhood undernutrition, broken down by major contributing factors. The decomposition of changes in the concentration index reveals that absolute inequality in undernutrition dropped by 9.72 points between 2000 and 2019. More than the entire observed reduction (approximately 164%) was driven by the progressive closing of the education gap among mothers during this timeframe. On the other hand, growing divides in geographic residence (rural vs. urban) and household economic status partially offset these improvements by pushing inequality higher **(Table 5).**

Table 5. Evolution of socioeconomic disparities in childhood undernutrition linked to primary factors in Ethiopia, 2000–2019.

Explanatory variables	**Survey periods**	**2000–2005**		**2000–2011**		**2000–2016**		**2000–2019**	
		Da	%	Da	%	Da	%	Da	%
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

This study examined the magnitude, trends, and socioeconomic inequalities of undernutrition among children under five years of age in Ethiopia. The overall prevalence of undernutrition was estimated at 50.71%, which remains higher than the reported prevalence in Nigeria (41.9%) in 2018 [55] and is comparable to findings from India (55%) in 2014 [56]. The multilevel analysis indicated that children born to mothers without formal education faced the highest risk of undernutrition, a finding consistent with earlier studies [21-23]. This may be explained by the fact that educated mothers tend to have better knowledge of appropriate child feeding practices and healthcare-seeking behaviors during childhood illness, as well as greater utilization of health services [24]. Additionally, maternal education may enhance women's empowerment, enabling them to marry higher-income partners, secure better employment, reside in improved communities, and make informed household decisions, all of which can directly or indirectly influence child nutritional outcomes [25].

The study also revealed that children from poor households were more likely to be undernourished compared with those from non-poor households, which aligns with findings from previous studies in Ethiopia [21-23]. This association may be attributed to food insecurity among economically disadvantaged households, which directly compromises children's nutritional intake [32]. Furthermore, poor households often lack access to improved water sources, increasing the risk of inadequate dietary intake and dehydration, which may ultimately contribute to childhood undernutrition [26]. Undernutrition is closely linked to poverty, as limited economic resources lead to insufficient food availability in both quantity and quality [25].

Moreover, children living in rural areas were found to have a higher likelihood of being undernourished than those residing in urban areas, consistent with other studies conducted in Ethiopia [30, 53]. This disparity may stem from better living conditions, food availability, and access to services in urban settings [21]. In contrast, rural households frequently rely on unimproved water sources, which may lead to unsafe feeding practices and dehydration, thereby increasing the risk of undernutrition among children [26].

The decomposition analysis further demonstrated that socioeconomic inequality in undernutrition was most pronounced among children from rural areas, poor households, and uneducated mothers, whereas inequalities were minimal among children from urban areas, non-poor households, and educated mothers. Consistent with these findings, childhood undernutrition was disproportionately concentrated among economically disadvantaged population groups. This pattern may be explained by improved access to healthcare services and safe water among urban populations, which supports healthier feeding practices [26]. Additionally, food insecurity among poor households continues to play a significant role in elevating the risk of undernutrition [32]. Children born to educated mothers are also more likely to benefit from improved feeding practices and healthcare utilization [24]. Furthermore, wealthier households can afford diverse and nutritious foods and are better positioned to access healthcare services, which may remain inaccessible to poorer population groups [21].

Trend analysis indicated that absolute socioeconomic inequality in childhood undernutrition declined by 9.72 points between 2000 and 2019. This reduction may reflect sustained government commitment to nutrition and health policies implemented in Ethiopia since 2000. These findings highlight the importance of maintaining national nutrition policy efforts and expanding maternal education, while also implementing strategies aimed at reducing rural–urban disparities and household socioeconomic inequalities at national, sub-national, community, and household levels. A substantial portion of the reduction in undernutrition may be attributed to a narrowing educational gap, as improvements in maternal education over the past two decades have been recognized as a critical factor in enhancing child health and nutritional outcomes [27]. However, widening disparities by place of residence and household wealth status contributed to increased undernutrition, likely due to persistent inequalities in socioeconomic conditions and access to essential services such as healthcare, housing, water, and sanitation between rural and urban areas and across wealth groups.

The major strength of this study lies in the application of robust statistical methods using nationally representative data spanning two decades. The large sample size enhances the reliability of the findings and supports their use for monitoring and evaluating nutrition programs in Ethiopia. Nevertheless, the study did not include all potential determinants of childhood undernutrition, such as household food security and maternal nutritional status, which may substantially influence child nutrition outcomes. In addition, conventional anthropometric indices were not considered, as the analysis focused primarily on the Composite Index of Anthropometric Failure (CIAF). Finally, although associations were identified using repeated retrospective cross-sectional data from the EDHS, causal relationships could not be established.

Conclusion

In summary, childhood undernutrition in Ethiopia remains unequally distributed among under-five children and is predominantly concentrated among populations with lower socioeconomic status. Enhancing women's access to basic education is crucial for improving child feeding practices, healthcare utilization, and overall nutritional status. Efforts should also focus on reducing disparities related to place of residence and household wealth through tailored communication strategies and nutrition education programs that promote positive health behaviors across different population groups. Strengthening and expanding food security and healthcare interventions, including the Productive Safety Net Program (PSNP) and targeted supplementary feeding initiatives, in both rural and urban areas is essential. Furthermore, the study emphasizes the need for comprehensive poverty reduction strategies that directly address food insecurity and childhood undernutrition among low-income population groups in Ethiopia.

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