RURAL PLANNING JOURNAL
Website: https://journals.irdp.ac.tz/index.php/rpj

DOI: https://doi.org/10.59557/rpj.27.1.2025.164

Determinants of Inequality in Stunting among Children Aged Between 0-23 Months in Tanzania

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ARTICLE INFO

Keywords
Stunting
Malnutrition
Socioeconomic factors
Maternal education
Concentration curve

ABSTRACT

Globally, approximately 149 million children suffer from stunting, a condition linked to long-term health, economic, and cognitive disadvantages. In Tanzania, despite a 4% reduction in stunting rates between 2015 and 2022, disparities persist, particularly among socioeconomically disadvantaged groups. This study explores the determinants of stunting inequality among those aged 0-23 months using data from the 2022 Tanzania Demographic and Health Survey (TDHS). A secondary analysis of 2,158 children revealed a concentration index of -0.0348 (95% CI: -0.0573, -0.0123), indicating stunting disproportionately affects the poor. Decomposition analysis, using concentration curves, highlighted key factors: children aged 18-23 months were 2.40 times more likely to be stunted than those aged 0-5 months, while second-to-fourth-born children were 37% less likely than firstborns. Maternal primary education increased stunting odds by 39% compared to no education, and unimproved toilet facilities raised the risk by 51%. Protective factors included normal birth weight (25.76% contribution), breastfeeding (-7.78%), and vaccination (2.19%). These findings underscore the need for targeted interventions addressing sanitation, maternal education, and early nutrition to reduce stunting disparities.

1. Introduction

Globally, approximately 149 million children under five suffer from stunting, defined as height-for-age below -2 standard deviations from the WHO growth standards, leading to long-term health, economic, and cognitive disadvantages (WHO, 2024; Chanyarungrojn et al., 2023). In sub-Saharan Africa, stunting prevalence remains high at 29%, with Tanzania reporting a national rate of 30% among children under five in 2022, down from 34% in 2015 (UNICEF, 2022; Ministry of Health [Tanzania], 2022). This decline reflects multisectoral interventions like the National Multisectoral Nutrition Action Plan (2016-2021), yet socioeconomic disparities persist, with poorer households bearing a disproportionate burden (Musheiguza et al., 2021). Globally, stunting is driven by malnutrition, poor sanitation, and limited healthcare access, while in Tanzania, regional variations, maternal education, and household wealth are key contributors (Bhutta et al., 2020; Kassim and Mwanri, 2018). Stunting reflects early-life conditions, particularly between 6-24 months, when inadequate nutrition, infections, and lack of stimulation impair growth (Stewart et al., 2013). From a health equity perspective, stunting embodies socioeconomic inequalities, as poorer children face higher risks due to systemic barriers in access to resources, aligning with the capability approach which links health outcomes to social opportunities (Sen, 1999).

The literature highlights multiple determinants of stunting. Maternal factors, such as education and nutritional knowledge, significantly influence child nutrition outcomes (Amaha and Woldeamanuel, 2021; Fadare et al., 2019). Birth spacing and order also matter, with short intervals exacerbating stunting risks for higher-order children (Dhingra and Pingali, 2021; Howell et al., 2016). Environmental factors, including unimproved sanitation and food insecurity, increase stunting prevalence by exposing children to infections (Khan et al., 2021; Islam et al., 2022; Gusnedi et al., 2023). In Tanzania, 30% of under-five children are stunted, with rural areas and poorer households most affected, indicating the importance of targeted interventions (Musheiguza et al., 2021).

This study is motivated by several factors. First, the high stunting prevalence in Tanzania demands a deeper understanding of its determinants. Second, socioeconomic factors like household wealth, maternal education, and childcare practices play critical roles (Headey et al., 2019). Third, regional disease burden variations necessitate context-specific interventions (Mboya and Mahande, 2015). Fourth, addressing stunting disparities aligns with Sustainable Development Goal 2.2 to end malnutrition by 2030 (UN, 2015). Finally, using decomposition analysis and concentration curves can help to identify the causes of stunting inequality, guiding equitable policy interventions (Wagstaff et al., 2003). Our objectives are to investigate determinants like wealth, maternal education, and rural-urban differences, and to decompose their contributions to stunting inequality, providing evidence for policies promoting health equity.

Theoretical and Empirical Literature Review

Child stunting is a complex public health issue shaped by socioeconomic, biological, and environmental factors, necessitating a robust theoretical framework to understand its inequalities. The capability approach, proposed by Sen (1999), posits that health outcomes like stunting reflect individuals' opportunities to achieve well-being, constrained by social and economic factors such as poverty and education. This framework underscores the link between socioeconomic disparities and stunting, as poorer households have fewer resources to secure adequate nutrition and healthcare. Similarly, Grossman's (1972) health capital theory views health as an investment, where maternal education and household wealth enhance child health through better nutrition and sanitation practices. These theories provide a foundation for analyzing stunting inequality, emphasizing the role of structural determinants.

Empirically, maternal education is a consistent predictor of child stunting. Amaha and Woldeamanuel (2021) found that Ethiopian mothers with secondary education reduced stunting odds by 30% compared to those with no education, due to improved nutritional knowledge. In Nigeria, Fadare et al. (2019) reported that maternal nutrition knowledge mediated the effect of education on child growth. However, studies in Tanzania suggest primary education alone may not suffice, highlighting a context-specific gap (Kassim and Mwanri, 2018). Birth order and spacing also influence stunting. Dhingra and Pingali (2021) showed that short birth intervals in India increased stunting risks for higher-order children, while Howell et al. (2016) noted similar trends in African countries. Contrarily, some Tanzanian studies suggest later-born children may benefit from maternal experience, warranting further exploration (Musheiguza et al., 2021).

Environmental factors, particularly sanitation, are critical. Khan et al. (2021) and Islam et al. (2022) linked unimproved toilet facilities in Pakistan and Bangladesh to a 50-60% higher stunting risk due to increased infections. Gusnedi et al.'s (2023) meta-analysis in Indonesia confirmed sanitation's role, alongside food insecurity. In Tanzania, rural households with poor sanitation face higher stunting prevalence, yet few studies quantify its contribution to inequality (Mboya and Mahande, 2015). Socioeconomic inequality in stunting is well-documented globally, with concentration indices showing a pro-poor burden (Prakash and Jain, 2016; Kien et al., 2016). However, decomposition analyses in Tanzania are limited, particularly those fully exploring determinants like sanitation and birth order.

The research gap lies in the limited application of comprehensive decomposition techniques to Tanzanian data. While Musheiguza et al. (2021) analyzed stunting disparities, they did not fully decompose determinants like sanitation and birth order. This study fills this gap by using concentration curves and decomposition analysis, based on the capability approach and health capital theory, to quantify the contributions of socioeconomic, maternal, and environmental factors to stunting inequality, offering actionable insights for rural development and health equity.

2. Materials and Methods

2.1. Data Sources

The study analyzed secondary data from the 2022 Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS), conducted by the Tanzania National Bureau of Statistics in collaboration with other government agencies. The survey used a multi-stage sampling design, selecting 629 clusters (418 rural, 211 urban) from enumeration areas of the 2012 Population and Housing Census. In the second stage, 26 households per cluster were systematically selected, totalling 16,354 households. The study included 4,935 mothers/caregivers and their children aged 0-59 months but focused on 2,158 children aged 0-23 months with weight anthropometric data collected using a SECA Uni scale (100 g precision) by trained enumerators.

2.2. Measuring Stunting

Stunting was measured using the height-for-age z-score, based on WHO growth standards (WHO, 2006). Children with z-scores below -2 were classified as stunted.

2.3. Measurement of Socioeconomic Status

Household socioeconomic status was assessed using a wealth index derived from principal component analysis of assets (e.g., water source, toilet type, electricity, appliances), categorized into quintiles: poorest, poor, middle, richer, and richest.

2.4. Measurement of Variables

Stunting, the dependent variable, is a binary outcome (stunted/not stunted) based on height-for-age z-scores below -2 per WHO standards (WHO, 2006). Independent variables include child characteristics (sex, age, birth weight, size at birth, fever/diarrhea history, breastfeeding, vaccination, birth order), maternal characteristics (age, education, marital status, employment, ANC visits), and household characteristics (head's sex, residence, wealth index, toilet facility, water source, electricity). The wealth index, a proxy for socioeconomic status, is derived via principal component analysis of household assets, categorized into quintiles (poorest to richest). All variables align with TDHS-MIS 2022 definitions, ensuring comparability with prior studies (Ministry of Health [Tanzania], 2022).

2.5. Inequality Analysis

The degree of socioeconomic disparity in child stunting (CI) was measured using the concentration index. The CI formula was proposed by Kakwani et al., (1997) as follows:

$$c = \frac{2}{n.\mu}\left[\sum_{i=1}^{n} y_i R_i\right] - 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots.(i)$$

where n is the sample size, μ is the mean of stunting, y_i is the value of each of the indexes of stunting in the i^{th} child, and Ri shows the rank of socio-economic status of the i^{th} child. In this study. The Kakwani CI was chosen for its ability to quantify health inequality relative to socioeconomic status, offering a standardized measure comparable across studies (Kakwani et al., 1997). Its negative value indicates a pro-poor concentration of stunting. Concentration curves were used to visualize the socioeconomic distribution of stunting, providing a robust measure of inequality (O'Donnell et al., 2008).

2.6. Decomposition of the Concentration Index

The CI was decomposed following Wagstaff et al. (2003):

$$y_i = \alpha + \sum_k B_k x_k \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(ii)$$

where the error term is denoted by α and each independent variable's coefficient is represented by B_k. Should (y_i) in equation (i) be substituted with its corresponding quantity in equation (ii), the concentration index for (y_i) will be

$$c = \sum_k \left(\frac{B_k \bar{X}_k}{\mu}\right) c_k + \frac{cG_\varepsilon}{\mu} = c_{\hat{y}} + \frac{cG_\varepsilon}{\mu} \ldots\ldots.(iii)$$

Where $\bar{X}_k$ is the mean of xk, c_k is a concentration index for xk, and cG_ε is the generalized CI for the error term (ε). is the residual.

For binary outcomes like stunting, a generalized linear model (GLM) with a binomial distribution and identity link function was used, as it accounts for non-linearity while maintaining interpretability (Van Doorslaer et al., 2004). Logit estimates were derived as follows:

$$\mathrm{logit}(\mathrm{p}(\mathrm{y_i} = 1)) = \alpha + \sum_{\mathrm{k}} \mathrm{B_k x_k} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(\mathrm{iv})$$

where

$p(y_i = 1)$is the probability of stunting, and B_k coefficients were estimated using R Studio's 'rineq' package, ensuring robust standard errors (McCullagh, 2019).

Justification for Concentration Curves and Indices: Concentration curves plot the cumulative share of stunting against the cumulative share of the population ranked by wealth, revealing whether stunting is disproportionately borne by the poor. The CI quantifies this disparity, with a negative value indicating pro-poor inequality. This approach ensures a comprehensive measurement of socioeconomic inequality in stunting (O'Donnell et al., 2008).

3. Results

Figure 1 presents the trend of stunting among children under five in Tanzania (1999-2022), showing a decline from 48% to 30% (Source: TDHS-MIS, 2022). Table 1: Descriptive Statistics (n=2158) (Source: TDHS-MIS, 2022). Of the 2,158 children aged 0-23 months, 50.51% were male, 26.37% were aged 0-5 months, 6.63% had low birth weight (<2501 g), and 62.31% were average size at birth. Health conditions included 11.96% with recent fever and 13.04% with diarrhea. Breastfeeding was prevalent (78.13% still breastfeeding), and 72.81% were vaccinated. Maternal characteristics showed 34.94% of mothers were under 25 years, 50.65% had primary education, 84.01% were married, and 64.5% had ≥4 antenatal care (ANC) visits. Household characteristics indicated 73.4% rural residence, 47.05% with improved toilets, and 31.91% with electricity access.

Table 1: Descriptive Statistics (*n=2158*)

Variable	Frequency	Percentage
Child's characteristics		
Sex		
Male	1090	50.51
Female	1068	49.49
Age		
0-5 months	569	26.37
6-11 months	528	24.47
12-17 months	525	24.33
18-23 months	536	24.84
Birth weight		
<2501 Small	143	6.63
2501-4000 Normal	1520	70.44
>4000 Large	495	22.94
Size of the child at birth		
Small	147	7.22
Average	1268	62.31
Large	620	30.47
Had fever 2 weeks before the survey		
No	1899	88.04
Yes	258	11.96
Had diarrhea 2 weeks before the survey		
No	1874	86.96
Yes	281	13.04
Breastfeeding status		
Ever, not currently	407	18.86
Never Breastfeeding	65	3.01
Still Breastfeeding	1686	78.13
Ever received vaccination?		
No	121	27.19
Yes	324	72.81
Birth order		
1st born	495	22.94
2-4 order	1102	51.07
5+ order	561	26
Mother's characteristics		
Age		
<25 years	754	34.94
25-29 years	525	24.33
30-34 years	399	18.49
35-49 years	480	22.24
Highest education level		
No education	450	20.85
Primary	1093	50.65
Secondary+	615	28.5
Marital status		
Single	170	7.88
Married	1813	1813
Divorced/Separated/Widow	175	8.11
Working status		
No	949	43.98
Yes	1209	56.02
Number of ANC visit		
< 4 visits	766	35.5
>=4 visits	1392	64.5
Household characteristics		
Sex of the Household head		
Male	1646	76.27
Female	512	23.73
Age of household Head		

Variable	Frequency	Percentage
below 25 years	123	5.7
25-49 years	1442	66.82
above 50 years	593	27.48
Place of residence		
Urban	574	26.6
Rural	1584	73.4
Wealth index		
Poor	889	41.2
Middle	447	20.71
Rich	822	38.09
Type of toilet facility		
Improved	973	47.05
Unimproved	851	41.15
Open defecation	244	11.8
Source of drinking water		
Improved	1451	70.16
Unimproved	617	29.84
Access to electricity		
No	1408	68.09
Yes	660	31.91

Source: TDHS-MIS,2022

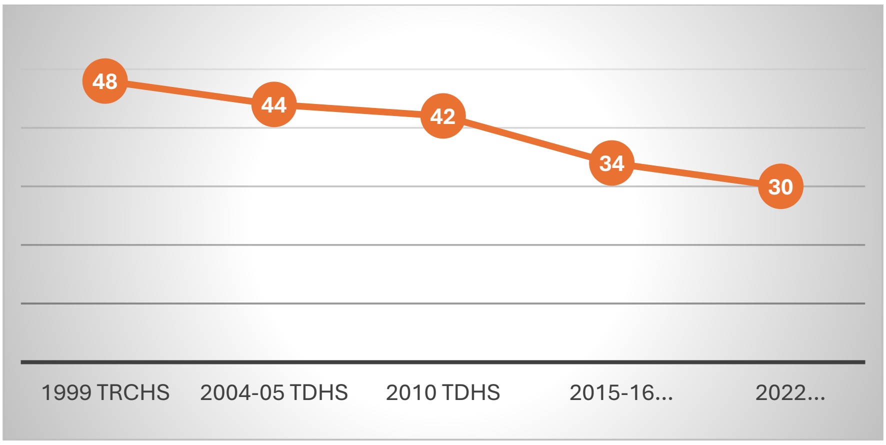

Figure 1: Percent of children under 5 who are Stunted

Concentration Curve and Index:
Figure 2 shows the concentration curve. The fact that the CC was above the equality curve suggests that the most disadvantaged individuals accounted for a disproportionate share of the poorest outcomes. This result is consistent with findings from Table 2, where the overall concentration index is -0.0348094 (95% CI-0.0572692, -0.0123496).

Determinants and Decomposition of Stunting:
Table 2 presents logistic regression results, identifying significant determinants of stunting. Children aged 18-23 months had 2.40 times higher odds of stunting (OR=2.40, p<0.00001) compared to those aged 0-5 months, and those aged 12-17 months had 1.62 times higher odds (OR=1.62, p=0.015). Second-to-fourth-born children were 37% less likely to be stunted (OR=0.63, p<0.05) compared to firstborns. Mothers with primary education had 39% higher odds of their children being stunted (OR=1.39, p<0.05) compared to those with no education. Households with unimproved toilet facilities had 51% higher odds of stunting (OR=1.51, p<0.05) compared to those with improved facilities. Other factors, such as breastfeeding (OR=0.73, p=0.09), normal birth weight (OR=1.59, p=0.08), and rural residence (OR=0.91, p=0.29), showed non-significant associations but contributed to the model's explanatory power.
Table 3 shows decomposition results, quantifying contributions to stunting inequality. Normal birth weight (2501-4000 g) contributed 25.76% to reducing inequality, while still breastfeeding contributed -7.78%, reflecting protective effects. Unimproved toilet facilities were the largest contributor to inequality (77.21%), driven by their concentration among poorer households (CI=-0.2562). Other notable contributors included rural residence (-23.89%) and access to electricity (59.42%), highlighting socioeconomic disparities.

Table 2: Logistic Regression Results for Stunting Determinants

Variable	Categories	Odds Ratio (OR)	p-Value
	Child's Characteristics		
Sex	Male	Ref	
	Female	0.81	0.12
Age	0-5 months	Ref	
	6-11 months	0.9	0.32
	12-17 months	1.62*	0.015
	18-23 months	2.4***	<0.00001
Birth Weight	<2501 g (Small)	Ref	
	2501-4000 g (Normal)	1.59	0.08
	>4000 g (Large)	1.25	0.22
Size at Birth	Small	Ref	
	Average	1.01	0.89
	Large	1.01	0.92
Fever (2 weeks prior)	No	Ref	
	Yes	1.21	0.19
Diarrhea (2 weeks prior)	No	Ref	
	Yes	1.63	0.06
Breastfeeding Status	Ever, not currently	Ref	
	Never Breastfeeding	0.82	0.34
	Still Breastfeeding	0.73	0.09
Vaccination	No	Ref	
	Yes	0.79	0.11
Birth Order	1st born	Ref	
	2-4 order	**0.63***	*<0.05*
	5+ order	1.14	0.41
	Mother's Characteristics		
Age	<25 years	Ref	
	25-29 years	1.22	0.18
	30-34 years	1.09	0.55
	35-49 years	0.94	0.62
Education Level	No education	Ref	
	Primary	**1.39***	*<0.05*
	Secondary+	1.05	0.71
Marital Status	Single	Ref	
	Married	0.78	0.15
	Divorced/Separated/Widow	1.24	0.33
Working Status	No	Ref	
	Yes	0.83	0.13
ANC Visits	<4 visits	Ref	
	≥4 visits	0.98	0.85
	Household Characteristics		
Sex of Household Head	Male	Ref	
	Female	0.82	0.16
Place of Residence	Urban	Ref	
	Rural	0.91	0.29
Toilet Facility	Improved	Ref	
	Unimproved	**1.51***	<0.05
	Open defecation	1.18	0.37
Source of Drinking Water	Improved	Ref	
	Unimproved	1.03	0.79
Age of Household Head	Continuous (per year)	1	0.91
Access to Electricity	No	Ref	
	Yes	0.84	0.17

Notes: Statistical significance: *p<0.05, **p<0.001, ***p<0.00001. Coefficients estimated using R Studio's 'rineq' package with a GLM (binomial distribution, identity link). Ref = Reference category.

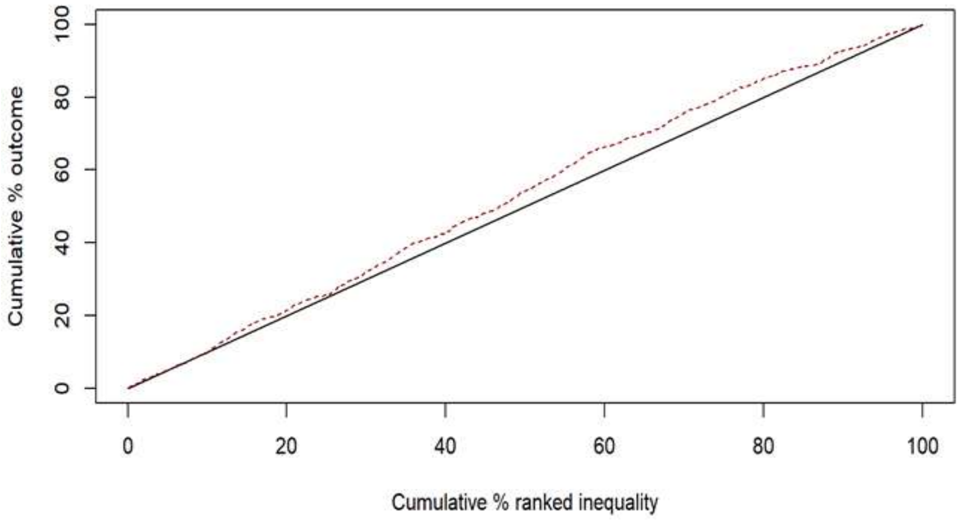

Figure 2: The concentration curve of Outcome (stunting) vs ranked inequality (wealth index)

Table 3: Decomposition Results of Stunting Inequality

Variable	Categories	Contribution (%)	Contribution (Abs)	Elasticity	Concentration Index	coefficients
Overall CI: -0.0348094	**95% confidence interval:(** -0.0572692, -0.0123496)					
Child's characteristics						
Sex	Male	**Reference**				
	Female	3.337	-0.001	-0.065	0.017	-0.193
Age	0-5 months					
	6-11 months	1.577	-0.0005	-0.012	0.0452	-0.100
	12-17 months	6.191	-0.002	0.065	-0.0330214	**0.484** *
	18-23 months	-12.006718	0.0041795	0.132	0.0316246	**0.9024***
Birth weight	<2501 Small	**Reference**				
	2501-4000 Normal	-61.003628	0.021235	0.199	0.1065849	0.464144
	>4000 Large	25.7553954	-0.0089653	0.038	-0.2339037	0.227701
Size of the child at birth	Small	**Reference**				
	Average	-0.1000976	0.0000348	0.005	0.0060972	0.014205
	Large	-0.1089996	0.0000379	0.0016	0.0229437	0.009356
Had fever 2 weeks before the survey	No	**Reference**				
	Yes	-1.596285	0.0005557	0.00785	0.0706952	0.186773
Had diarrhea 2 weeks before the survey	No	**Reference**				
	Yes	-7.7446577	0.0026959	0.0213	0.1262855	0.487763
Breastfeeding status	Ever, not currently	**Reference**				
	Never Breastfeeding	-1.5348997	0.0005343	-0.0029	-0.1815211	-0.19429
	Still Breastfeeding	-7.7831329	0.0027093	-0.15384	-0.0176102	-0.31516
Ever received a vaccination?	No	**Reference**				
	Yes	2.192836	-0.0007633	-0.1102	0.006921	-0.23653
Birth order	1st born					
	2-4 order	7.3286863	-0.0025511	-0.1448	0.0176072	-**0.457836**.
	5+ order	6.5716516	-0.0022876	0.02275	-0.100538	0.135173
Mother's characteristics						
Age	<25 years	**Reference**				
	25-29 years	-7.715021	0.0026856	0.02821	0.0951936	0.201922

	30-34 years	-2.2465139	0.000782	0.00961	0.0813149	0.084016
	35-49 years	0.8686955	-0.0003024	-0.00993	0.0304332	-0.06632
Highest education level	No education	**Reference**				
	Primary	4.7806487	-0.0016641	0.09718	-0.017131	**0.335514.**
	Secondary+	-9.2467603	0.0032187	0.0072	0.4420484	0.047018
Marital status	Single	**Reference**				
	Married	-2.984704	0.001039	-0.1270	-0.0081787	-0.24662
	Divorced/Separated/Widow	-5.1688016	0.0017992	0.01289	0.139725	0.218565
Working status	No					
	Yes	4.381143	-0.001525	-0.06161	0.0247569	-0.18961
Number of ANC visit	< 4 visits	**Reference**				
	>=4 visits	2.0923085	-0.0007283	-0.0081	0.08964	-0.02224
Household characteristics						
Sex of the Household head	Male	**Reference**				
	Female	2.9085514	-0.0010124	-0.0346	0.0292575	-0.19767
Place of residence	Urban	**Reference**				
	Rural	-23.894592	0.0083176	-0.0456	-0.1820119	-0.09836
Type of toilet facility	Improved	**Reference**				
	Unimproved	77.20707	-0.0268753	0.10481	-0.256221	**0.415417***
	Open defecation	27.90300	-0.009729	0.0191	-0.4864	0.167068
Source of drinking water	Improved	**Reference**				
	Unimproved	6.2084927	-0.00216	0.00653	-0.33139	0.0314
Age of household Head		4.4132239	-0.00153	0.06829	-0.02249	0.002531
Access to electricity	No	**Reference**				
	Yes	59.4171	-0.0206	-0.03193	0.647504	-0.1757

Notes: Overall CI: -0.0348 (95% CI: -0.0573, -0.0123). Statistical significance: *p<0.05, **p<0.001, ***p<0.00001. Ref = Reference category

4. Discussion of the Results

The study aimed at exploring determinants of inequality in stunting among children, overall, the study found that the trend of stunting continues to decline, and inequality in stunting is a burden among the poor. This finding is consistent with a study conducted in Tanzania by Musheiguza et al. (2021), where stunting rates among the poor have decreased despite socioeconomic disparities still being a burden. The reduced trend is because of projects like the Addressing Stunting in Tanzania Early (ASTUTE) program and the Njombe Region Acceleration Stunting Reduction Roadmap 2023–2030, which emphasize multisectoral approaches, including communities, and acknowledge the importance of the first 1,000 days of life. Additionally, approximately 40% more food is produced than is needed in areas like Mbeya, Rukwa, and Ruvuma due to the flourishing food production in these areas (UNICEF, 2019; UNICEF, 2016; FAO, n.d; Global Nutrition Report, n.d).

The study also found that children aged 12-17 months with normal birth weights had a positive contribution in reducing stunting; this finding is consistent with studies carried out by Haque et al. (2023) and Sartika et al. (2021), who found the protective effect of normal birth weights aligns with the positive contribution observed in reducing the risk of stunting. This may indicate that during this critical growth phase, the nutritional needs of children with normal birth are being met, while larger birth weights and average or large size at birth negatively contribute to reducing stunting. Moreover, breastfeeding is essential for a child's nutritional needs due to the inverse relationship, which implies that breastfeeding may protect against stunting. This finding is similar to the study conducted by Susianto et al. (2022), who found that early breastfeeding initiation can lower stunting risk in children. Vaccinated children exhibit a slight protective effect against stunting; hence, immunization programs likely contribute to overall health and well-being (Qadri et al., 2013).

The results of decomposition in our study suggested that children aged 12-23 months, specifically those aged 18-23, had higher odds of being stunted as compared to those with 0-5 months. This finding is similar to studies conducted in Burundi, Rwanda, Ethiopia, and Indonesia, where they found that children aged 12-17 months and 18-23 months had a higher risk of stunting (Nkurunziza et al., 2017;

Nshimyiryo et al., 2019; Tadele et al., 2022; Gusnedi et al., 2023). The plausible explanation is that for 12-23-month-olds, complementary foods are being introduced instead of exclusive breastfeeding; hence, inappropriate or inadequate complementary feeding practices might contribute to stunting.

Additionally, the study discovered that, in terms of birth order, second through fourth-born children had a lower risk of stunting than first-born children. This result contradicts research findings carried out by Howell et al. (2016) and Dhingra and Pingali (2021), who found that higher birth order children are more likely to be stunted, have low weight, consume fewer food groups, and eat fruits and vegetables less often. This variation might be because mothers often gain greater experience with subsequent pregnancies and births. Hence, they could understand nutrition, hygiene, and childcare practices.

In comparison to mothers who have no education, the study specified that mothers with only a primary education have an increased probability of their children being stunted. This result differs from the research by Fadare et al. (2019), Amaha and Woldeamanuel (2021), Amaha and Woldeamanuel(2021), and Luzingu et al. (2022), where they discovered a substantial, positive correlation between child height-for-age (HAZ) and weight-for-height (WHZ) scores and higher mother education, typically above primary level. This difference may be because, while mothers with only a primary education may have had some exposure to health education, it may not have been enough to fully comprehend and apply healthy eating and lifestyle habits for their children. Stunting may ensue from this lack of thorough understanding, which might lead to poor feeding procedures and care. Stunting might arise from poor feeding methods and care due to a lack of thorough information.

Furthermore, decomposition analysis also revealed that households with unimproved toilet facilities had a higher risk of stunting. This finding is similar to the studies conducted by the World Health Organization (2024), Islam et al. (2022), and Khan et al. (2021), who revealed that children living in food-insecure families with unimproved toilet facilities had 5.88 times greater chances of morbidity than children living in food-secure households with improved toilet facilities. This correlation can be explained by the fact that households with unimproved toilet facilities are frequently linked with inadequate sanitation and hygiene practices within households. This may lead to a higher prevalence of fecal contamination in the living environment, which increases the risk of diarrheal diseases and other infections that may contribute to stunting in children.

5. Conclusion

Stunting in Tanzania has declined to 30% by 2022, yet socioeconomic disparities persist, disproportionately affecting poorer households (CI=-0.0348). Concentration curves confirm the pro-poor distribution of stunting, underscoring structural barriers. Early breastfeeding, normal birth weight, and vaccination reduce stunting risk, while older infants (18-23 months), maternal primary education, and unimproved sanitation increase it. Higher birth orders offer unexpected protection, likely due to maternal experience. To advance health equity, we recommend scaling the National Sanitation Campaign with affordable latrines in rural areas; expanding secondary education with nutrition modules via community platforms; targeting 12-23-month-olds with micronutrient-rich food subsidies; and creating a national stunting dashboard integrating TDHS data for real-time monitoring. These interventions align with SDG 2.2, addressing sanitation, education, and nutrition gaps to reduce stunting disparities.

References

African Union Commission. (2020). *Africa regional overview of food security and nutrition 2019: Containing the damage of economic slowdowns and downturns to food security in Africa* (Vol. 1). Food and Agriculture Organization of the United Nations. https://www.fao.org/documents/card/en/c/ca7343en

Amaha, N. D., and Woldeamanuel, B. T. (2021). Maternal factors associated with moderate and severe stunting in Ethiopian children: Analysis of some environmental factors based on 2016 Demographic Health Survey. *Nutrition Journal, 20*(1), 1–9. https://doi.org/10.1186/s12937-021-00677-6

Bhutta, Z. A., Akseer, N., Keats, E. C., Vaivada, T., Baker, S., Horton, S. E., ... and Black, R. E. (2020). How countries can reduce child stunting at scale: Lessons from exemplar countries. *The American Journal of Clinical Nutrition, 112*(Supplement_2), 894S–904S. https://doi.org/10.1093/ajcn/nqaa153

Chanyarungrojn, P. A., Lelijveld, N., Crampin, A., Nkhwazi, L., Geis, S., Nyirenda, M., and Kerac, M. (2023). Tools for assessing child and adolescent stunting: Lookup tables, growth charts and a novel appropriate-technology "MEIRU" wallchart—a diagnostic accuracy study. *PLOS Global Public Health, 3*(7), e0001592.

https://doi.org/10.1371/journal.pgph.0001592

Dhingra, S., and Pingali, P. L. (2021). Effects of short birth spacing on birth-order differences in child stunting: Evidence from India. *Proceedings of the National Academy of Sciences, 118*(8), e2017834118. https://doi.org/10.1073/pnas.2017834118

EAA, F. (2021). *Africa regional overview of food security and nutrition 2021: Statistics and trends*. Food and Agriculture Organization of the United Nations. https://www.fao.org/documents/card/en/c/cb7498en

Fadare, O., Amare, M., Mavrotas, G., Akerele, D., and Ogunniyi, A. (2019). Mother's nutrition-related knowledge and child nutrition outcomes: Empirical evidence from Nigeria. *PLoS ONE, 14*(2), e0212775. https://doi.org/10.1371/journal.pone.0212775

FAO in Tanzania. (n.d.). *Ending malnutrition is within our hands*. Food and Agriculture Organization of the United Nations. https://www.fao.org/tanzania/news/detail-events/en/c/1330037/

Global Nutrition Report. (n.d.). *Tanzania nutrition profile*. https://globalnutritionreport.org/resources/nutrition-profiles/africa/eastern-africa/united-republic-tanzania/

Grossman, M. (1972). On the concept of health capital and the demand for health. Journal of Political Economy, 80(2), 223–255. https://doi.org/10.1086/259880

Gusnedi, G., Nindrea, R. D., Purnakarya, I., Umar, H. B., Susilowati, A., and Lipoeto, N. I. (2023). Risk factors associated with childhood stunting in Indonesia: A systematic review and meta-analysis. *Asia Pacific Journal of Clinical Nutrition, 32*(2), 184–195. https://doi.org/10.6133/apjcn.202306_32(2).0001

Haque, M. A., Choudhury, N., Wahid, B. Z., Ahmed, S. T., Farzana, F. D., Ali, M., ... and Ahmed, T. (2023). A predictive modelling approach to illustrate factors correlating with stunting among children aged 12–23 months: A cluster randomised pre-post study. *BMJ Open, 13*(4), e067961. https://doi.org/10.1136/bmjopen-2022-067961

Headey, D., Heckert, J., Ndiaye, B., Brero, M., Assey, V., and Palloni, G. (2019). *Accounting for the rapid reduction of child stunting in Tanzania over 2005–2016* (Vol. 1874). International Food Policy Research Institute. https://www.ifpri.org/publication/accounting-rapid-reduction-child-stunting-tanzania-over-2005-2016

Howell, E. M., Holla, N., and Waidmann, T. (2016). Being the younger child in a large African family: A study of birth order as a risk factor for poor health using the demographic and health surveys for 18 countries. *BMC Nutrition, 2*(1), 1–12. https://doi.org/10.1186/s40795-016-0100-7

Islam, M. A., Rahman, M., Uddin, M. F., Tariqujjaman, M., Karmakar, G., Rahman, M. A., and Sarma, H. (2022). Household food insecurity and unimproved toilet facilities associate with child morbidity: Evidence from a cross-sectional study in Bangladesh. *BMC Public Health, 22*(1), 1075. https://doi.org/10.1186/s12889-022-13462-7

Kakwani, N., Wagstaff, A., and Van Doorslaer, E. (1997). Socioeconomic inequalities in health: Measurement, computation, and statistical inference. *Journal of Econometrics, 77*(1), 87–103. https://doi.org/10.1016/S0304-4076(96)01807-6

Kassim, N., and Mwanri, A. W. (2018). Social factors contributing to stunting for children under five years in Tanzania. *African Journal of Education, Science and Technology, 4*(1), 1–9.

Khan, A. Y., Fatima, K., and Ali, M. (2021). Sanitation ladder and undernutrition among under-five children in Pakistan. *Environmental Science and Pollution Research, 28*(29), 38749–38763. https://doi.org/10.1007/s11356-021-13439-5

Kia, A. A., Goodarzi, S., Asadi, H., Khosravi, A., and Rezapour, A. (2019). A decomposition analysis of inequality in malnutrition among under-five children in Iran: Findings from multiple indicator demographic and health survey, 2010. *Iranian Journal of Public Health, 48*(4), 748–757.

Kien, V. D., Lee, H. Y., Nam, Y. S., Oh, J., Giang, K. B., and Minh, H. V. (2016). Trends in socioeconomic inequalities in child malnutrition in Vietnam: Findings from the Multiple Indicator Cluster Surveys, 2000–2011. *Global Health Action, 9*(1), 29263. https://doi.org/10.3402/gha.v9.29263

Luzingu, J. K., Stroupe, N., Alaofe, H., Jacobs, E., and Ernst, K. (2022). Risk factors associated with under-five stunting, wasting, and underweight in four provinces of the Democratic Republic of Congo: Analysis of the ASSP project baseline data. *BMC Public Health, 22*(1), 2422. https://doi.org/10.1186/s12889-022-14857-2

Mboya, I. B., and Mahande, M. J. (2015). Prevalence and factors associated with stunting among public primary school children in rural Kilimanjaro, Tanzania. *East African Health Research Journal, 1*(1), 1–8.

McCullagh, P. (2019). *Generalized linear models* (2nd ed.). Routledge. https://doi.org/10.1201/9780203753736

Ministry of Health [Tanzania Mainland], Ministry of Health [Zanzibar], National Bureau of Statistics, Office of the Chief Government Statistician, and ICF. (2022). *Tanzania Demographic and Health Survey and Malaria Indicator Survey 2022 final report*. Dodoma, Tanzania, and Rockville, MD, USA: Ministry of Health, National Bureau of Statistics, Office of the Chief Government Statistician, and ICF. https://dhsprogram.com/pubs/pdf/FR382/FR382.pdf

Musheiguza, E., Mahande, M. J., Malamala, E., Msuya, S. E., Charles, F., Philemon, R., and Mgongo, M. (2021). Inequalities in stunting among under-five children in Tanzania: Decomposing the concentration indexes using Demographic Health Surveys from 2004/5 to 2015/6. *International Journal for Equity in Health, 20*(1), 1–10. https://doi.org/10.1186/s12939-021-01491-5

Nations, U. (2015). *Transforming our world: The 2030 agenda for sustainable development*. United Nations, Department of Economic and Social Affairs. https://sdgs.un.org/2030agenda

Nkurunziza, S., Meessen, B., Van Geertruyden, J. P., and Korachais, C. (2017). Determinants of stunting and severe stunting among Burundian children aged 6–23 months: Evidence from a national cross-sectional household survey, 2014. *BMC Pediatrics, 17*(1), 1–14. https://doi.org/10.1186/s12887-017-0929-2

Nshimyiryo, A., Hedt-Gauthier, B., Mutaganzwa, C., Kirk, C. M., Beck, K., Ndayisaba, A., ... and El-Khatib, Z. (2019). Risk factors for stunting among children under five years: A cross-sectional population-based study in Rwanda using the 2015 Demographic and Health Survey. *BMC Public Health, 19*(1), 1–10. https://doi.org/10.1186/s12889-019-6504-z

O'Donnell, O., Van Doorslaer, E., Wagstaff, A., and Lindelow, M. (2008). Analyzing health equity using household survey data: A guide to techniques and their implementation. World Bank. https://openknowledge.worldbank.org/handle/10986/6896

Prakash, M., and Jain, K. (2016). Inequalities among malnourished children in India: A decomposition analysis from 1992–2006. *International Journal of Social Economics, 43*(6), 643–659. https://doi.org/10.1108/IJSE-01-2014-0009

Qadri, F., Bhuiyan, T. R., Sack, D. A., and Svennerholm, A. M. (2013). Immune responses and protection in children in developing countries induced by oral vaccines. *Vaccine, 31*(3), 452–460. https://doi.org/10.1016/j.vaccine.2012.11.012

Rueda-Guevara, P., Botero-Tovar, N., Trujillo, K. M., and Ramírez, A. (2021). Worldwide evidence about infant stunting from a public health perspective: A systematic review. *Biomedica, 41*(3), 541–554. https://doi.org/10.7705/biomedica.5687

Sartika, A. N., Khoirunnisa, M., Meiyetriani, E., Ermayani, E., Pramesthi, I. L., and Nur Ananda, A. J. (2021). Prenatal and postnatal determinants of stunting at age 0–11 months: A cross-sectional study in Indonesia. *PLoS ONE, 16*(7), e0254662. https://doi.org/10.1371/journal.pone.0254662

Sen, A. (1999). Development as freedom. Oxford University Press.

Stewart, C. P., Iannotti, L., Dewey, K. G., Michaelsen, K. F., and Onyango, A. W. (2013). Contextualising complementary feeding in a broader framework for stunting prevention. *Maternal and Child Nutrition, 9*(S2), 27–45. https://doi.org/10.1111/mcn.12088

Susianto, S. C., Suprobo, N. R., and Maharani, M. (2022). Early breastfeeding initiation effect in stunting: A systematic review. *Asian Journal of Health Research, 1*(1), 1–6. https://doi.org/10.55561/ajhr.v1i1.11

Tadele, T. T., Gebremedhin, C. C., Markos, M. U., and Fitsum, E. L. (2022). Stunting and associated factors among 6–23 month old children in drought vulnerable kebeles of Demba Gofa district, southern Ethiopia. *BMC Nutrition, 8*(1), 9. https://doi.org/10.1186/s40795-022-00502-4

UNICEF. (2016). *National Multisectoral Nutrition Action Plan 2016–2021*. https://www.unicef.org/tanzania/reports/national-multisectoral-nutrition-action-plan-2016-2021

UNICEF. (2019). *Tanzania National Nutrition Survey 2018*. https://www.unicef.org/tanzania/media/2141/file/Tanzania%20National%20Nutrition%20Survey%202018.pdf

UNICEF. (2022). State of the world's children 2022. https://www.unicef.org/reports/state-worlds-children-2022

Van de Poel, E., O'Donnell, O., and Van Doorslaer, E. (2009). Urbanization and the spread of diseases of affluence in China. *Economics and Human Biology, 7*(2), 200–216. https://doi.org/10.1016/j.ehb.2009.05.004

Van Doorslaer, E., Koolman, X., and Jones, A. M. (2004). Explaining income-related inequalities in doctor utilisation in Europe. *Health Economics, 13*(7), 629–647. https://doi.org/10.1002/hec.919

Wagstaff, A., Van Doorslaer, E., and Watanabe, N. (2003). On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam. *Journal of Econometrics, 112*(1), 207–223. https://doi.org/10.1016/S0304-4076(02)00161-6

WHO Multicentre Growth Reference Study Group, and de Onis, M. (2006). WHO child growth standards based on length/height, weight and age. *Acta Paediatrica, 95*(S450), 76–85. https://doi.org/10.1111/j.1651-2227.2006.tb02378.x

WHO Working Group. (1986). Use and interpretation of anthropometric indicators of nutritional status. *Bulletin of the World Health Organization, 64*(6), 929–941. https://pubmed.ncbi.nlm.nih.gov/3493862

Wirth, J. P., Rohner, F., Petry, N., Onyango, A. W., Matji, J., Bailes, A., ... and Woodruff, B. A. (2017). Assessment of the WHO Stunting Framework using Ethiopia as a case study. *Maternal and Child Nutrition, 13*(2), e12310. https://doi.org/10.1111/mcn.12310

World Health Organization. (2002). *The world health report 2002: Reducing risks, promoting healthy life*. World Health Organization. https://www.who.int/publications/i/item/9241562072

World Health Organization. (2024, March 22). *Sanitation: An emerging water, sanitation, and hygiene issue*. https://www.who.int/news-room/fact-sheets/detail/sanitation