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Childhood stunting severity level and associated factors among under-five children in Tanzania: a multi-level ordinal logistic regression analysis using 2022 Tanzanian demographic and health survey

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Abstract

Introduction Childhood stunting is a significant public health challenge in Tanzania, affecting over one-third of the children. It has long-term consequences for growth, development, and the overall health status. The high prevalence of stunting in Tanzania necessitates an understanding of its severity levels and determinants. Therefore, this study aimed to explore the varying severity levels of stunting and its associated factors among under-5 children in Tanzania, using data from the Demographic and Health Survey.

Materials and methods A cross-sectional study utilizing secondary data from Tanzanian Demographic and Health Survey (TDHS) 2022 was employed. A weighted sample of 4,866 children under-5 years of age was included in the analysis. A multilevel ordinal logistic regression model was employed to account for the ordinal nature of stunting and hierarchical structure of the TDHS data. The Brant test was used to assess whether the proportional odds assumption was met, with a p-value greater than 0.05 indicating that the assumption was satisfied. The deviance measure was used to compare the fitness of the different models. A multilevel proportional odds model was used to investigate the impact of risk factors contributing to stunting.

Results The prevalence of stunting among Tanzanian under-5 children was 29.66%. Of these, 22.16% were moderately stunted, and 8.67% were severely stunted. Being Male, children aged 6–23 months, those born as part of multiple births, children from low- or middle-income households, those whose mothers have no formal or only primary education, and those living in areas with high poverty rates, children residing in the southern and southwestern highland administrative regions are more likely to experience severe stunting.

Conclusion This study revealed that stunting among under-5 children in Tanzania remains a significant public health concern. By addressing these determinants, such as ensuring access to proper nutrition, improving maternal

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education, and promoting community awareness, Tanzania can make significant strides toward reducing the burden of stunting and improving the health and well-being of children under-5 years of age.

Clinical trial number Not applicable.

Keywords Stunting, Children, Tanzania, TDHS, Multilevel Ordinal Logistic Regression

Introduction

Childhood stunting is a critical public health issue that affects millions of children worldwide. A global estimate indicates that 149.2 million children under the age of five suffer from childhood stunting, which is one of the most significant impediments to human development. The distribution varies by region more than half (53%) of these children live in Asia, and over 41% reside in Africa [1, 2]. Although stunting rates have declined in most regions over the past two decades, Africa and Asia have not shown similar progress [2, 3]. For example, in Tanzania, the 2022 Demographic and Health Survey indicated that 30% of children under-5 are stunted [4]. It remains to be a primary cause of illness and death among children under-5 in developing nations.

Children suffering from this condition are largely irreversible because they lack appropriate nutrition and are repeatedly infected during the first 1000 days of life. The consequences of undernourishment in children under-5 years of age can persist into adulthood and affect health and development [5, 6]. There are long-term impacts of stunting on individuals and societies, such as diminished cognitive and physical development [7, 8], reduced productivity capacity, poor health, and an increased risk of degenerative diseases such as diabetes [9–11].

The factors contributing to stunted growth and development encompass poor socioeconomic conditions, poor maternal health and nutrition, frequent illness, and inappropriate infant and young child feeding and care in early life [1, 12–14]. Previous studies have revealed that several factors are associated with stunting among children, such as the sex and age of the child, wealth status of the household, interval between births, place of residence, and maternal educational status [15–18].

Approximately 45% of deaths among under-5 children are related to malnutrition [3]. The World Health Organization has set a goal of reducing stunting prevalence by 40% by 2025 [19]. Despite a 30% decline in the prevalence stunting in Tanzania over the past 25 years, one in three under-5 children still suffers from stunting [6]. To address this issue, the Tanzanian government and development partners are implementing multisectorial interventions tailored to local needs [20]. Hence, to achieve a world free of all forms of malnutrition, it is crucial to gather evidence on the prevalence of stunted under-5 children [19].

While some studies have explored the factors contributing to stunting in Tanzanian under-5 children [15, 21–23], there is a need for a comprehensive analysis using large-scale national data and complex sampling methods. Previous studies have primarily employed binary logistic regression models (nourished and undernourished) to identify factors affecting stunting in children under-5. However, given that children's nutritional status is classified as well-nourished, moderately malnourished, or severely malnourished, an ordinal regression approach is more appropriate. To address this, we used multilevel ordinal logistic regression to obtain a reliable estimate that accounted for the varying impacts of stunting severity while minimizing information loss. Notably, the factors responsible for mild stunting may not be the same as those responsible for severe stunting. Therefore, the present study aimed to assess the levels of stunting-associated factors among under-5 children in Tanzania using data from the TDHS 2022. These findings have important implications for policymakers and program planners by guiding the development and implementation of evidence-based interventions to address the significant burden of stunting in Tanzania.

Materials and methods

Data source and sampling procedure

This study utilized data from Tanzania's 2022 Demographic and Health Survey (TDHS), which employed a two-stage sample design to provide national, urban, and rural estimates for the Tanzania Mainland and Zanzibar. For indicators such as malnutrition, the survey offers regional estimates for all 31 regions: 26 in Tanzania Mainland and 5 in Zanzibar. The first stage involved selecting sampling points (clusters) from enumeration areas (EAs) defined in the 2012 Tanzania Population and Housing Census using probability proportional to size (PPS) sampling. Regions were grouped into zones, to enhance the precision of the zonal indicators. Tanzania was stratified by geographical region and urban/rural area, selecting 629 clusters (211 urban, 418 rural). In the second stage, 26 households were systematically selected per cluster, totaling 16,354 households.

Individual weights were calculated to adjust for unequal selection probabilities and nonresponse. This study used the kids record (KR) file from the TDHS 2022 dataset. Height and weight measurements were taken from a sub-sample of 5,589 children under-5. The final weighted sample size for analysis was 4,866 under-5 children (unweighted sample size = 4,807) (Fig. 1). Detailed sampling techniques, sample size, data collection instruments, quality control measures, and ethical considerations are documented in the 2022 TDHS report [4].

Study variables and measurements

Dependent variable

The focus of this study was the severity of stunting among under-5 children. Children's stunting levels were categorized into three groups: severely stunted children with a Z-score less than – 3 standard deviation (SD), moderately stunted children with a Z-score between – 3.00 SD and – 2.00 SD, and children with normal growth (not stunted) having a Z-score greater than – 2.00 SD [24].

Additionally, for the mathematical expression:

$$\text{Stunting level} = \begin{cases} \textit{Severely stunted}: \; Z < -3SD \\ \textit{Moderately stunted}: \; -3SD \leq \; Z < -2SD \\ \textit{Normal growth (Not Stunted)}: \; Z \geq \; -2SD \end{cases}$$

Independent variables

To account for the hierarchical nature of DHS data, two sources of independent variables were used in this study (individual and community-level variables). Children's age (< 6 months, 6–23 months, and ≥ 24 months), child sex (male/female), child twin status (single/multiple), maternal age (≤ 24 years, 25–34 years, and ≥ 35 years), sex of the household head, educational status (no education, primary, secondary and above), marital status (married, unmarried, separated and widowed), maternal occupation, family size (≤ 5 and > 5), wealth index (poorest, poor, middle, rich, richest), parity (nulliparous, primiparous, multiparous, and grand multiparous) comprised the individual-level variables. Community-level factors were shared by all women living in the same community (cluster), including residence, administrative zones, poverty, and maternal education. Community-level explanatory variables were created by aggregating the individual characteristics at the community (cluster) level. These aggregate variables were categorized as high or low, based on the distribution of the proportion values calculated for each community. Descriptive statistics were used to assess the distribution of proportion values. For normally distributed aggregate variables, the mean value was used as the cutoff point for categorization; for non-normally distributed variables, the median value was used.

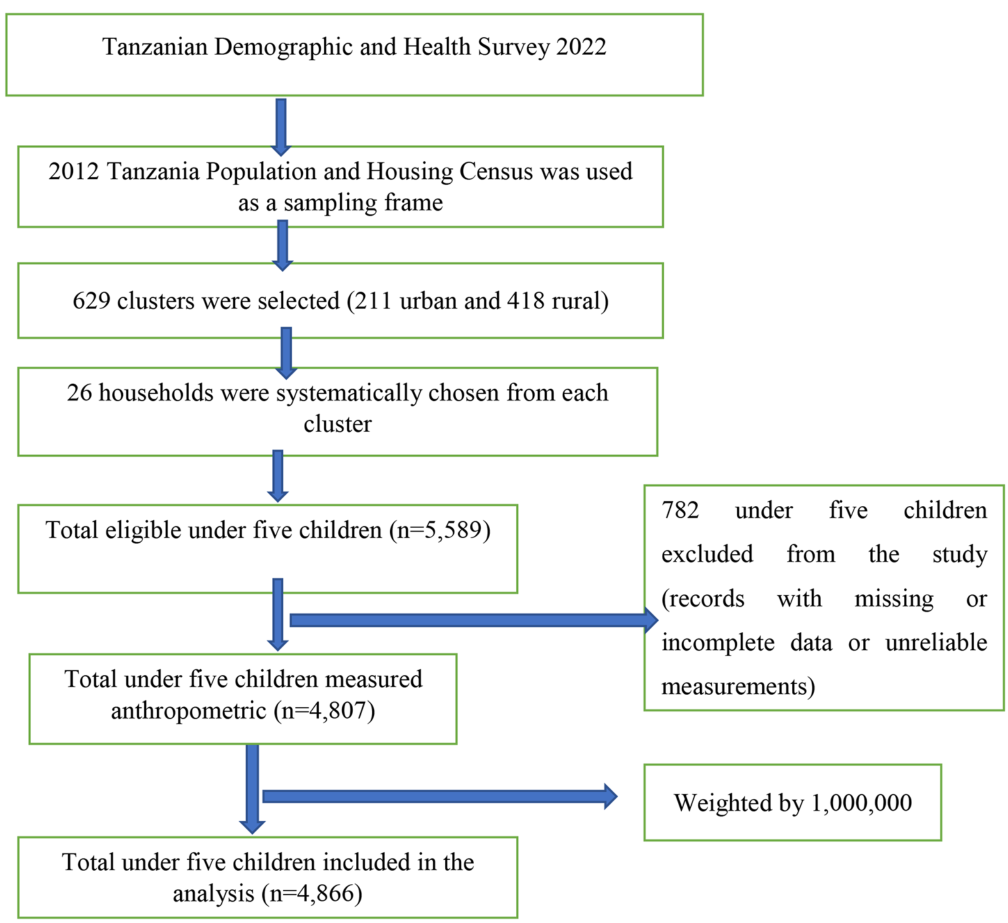

Fig. 1 Sampling scheme of 2022 TDHS

Community poverty was classified as high if the proportion of women from the two lowest wealth quintiles in a given community ranged from 47 to 100% and low if the proportion was 0–46%. On the other hand, community education was categorized as low if the proportion of women with secondary education and above in the community was 0%, and high if the proportion ranged from 1 to 100%.

Statistical tests and models

Before performing any statistical analysis, the data were weighted using sampling weight, primary sampling unit, and stratum. This process ensured the representativeness of the survey and accounted for the sampling design when calculating the standard error, ultimately leading to accurate statistical estimation. Data handling and analysis were conducted using the STATA version 17 statistical software. The study's outcome variables were ordinal and polychotomous, with predictor factors analyzed using an ordinal logistic regression model.

The fundamental assumption of an ordinal logistic regression model is proportional odds. When the data meet this assumption, a proportional odds model can be applied; otherwise, a partial proportional model is necessary. To identify the most suitable ordinal model for the data, we examined the proportional odds model (POM) assumptions, which require the effects of all independent factors to remain constant across the categories of outcome variables. We used Brant's test to confirm the proportional odds assumption after fitting the proportional odds model. The test yielded a p-value of > 0.05, indicating that the proportional odds assumption was met. Consiquentely, we employed a multilevel proportional odds model to assess the independent variables and predictors of stunting levels.

Equation 1:The multilevel ordinal logistic model [25]

$$\log\left[\frac{Pijc}{1-Pijc}\right]=\gamma_c-\left[x_{ij\beta}+v_i\right]$$

The terms in this model are

Pijc: Is the probability that the observation for individual i, group j, and category c falls into a outcome category levels.

Log[Pijc/1-Pijc]: This represents the log-odds of the probability PijcP_{ijc}Pijc, also known as the logit transformation.

: Yc:This is a constant term (intercept) specific to the outcome category c, often interpreted as the baseline log-odds for category c.

x_{ij}: The covariates associated with individual i within group j

β : Slope of the regression slopes, or the effects of the covariates on the outcome

v_i: Effect of a cluster on a subject's outcome, which is known as the cluster effect on individual level i

For the multilevel ordinal logistic regression analysis, we developed four models. The initial model, serving as a null model without explanatory variables, evaluates the extent of clustering at stunting levels. Model I was adjusted for individual-level variables, model II was adjusted for community-level variables, and model III adjusted for both individual- and community-level variables. Because the models were nested, we used deviance (-2log-likelihood ratio) for model comparison, selecting the model with the lowest deviance as the best fit. In the bivariate multilevel proportional odds model, variables with a p-value < 0.2 were considered for the multivariable multilevel proportional odds model. The multivariate multilevel proportional odds model reported adjusted odds ratios (AOR) with 95% confidence intervals (CI), with statistical significance set at a p-value < 0.05.

Ethical consideration

The present investigation was not obliged to seek participant consent or ethical clearance as it involved a secondary analysis of publicly accessible survey data obtained from the MEASURE DHS program. The relevant website (<http://www.dhsprogram.com>) granted us permission to download and employ the data for our research purposes. It is worth noting that the dataset did not include residential addresses or personal names.

Results

Descriptive characteristics

A total of 4,866 under-5 years of age were included in the study. Of these, 55.97% were children aged ≥ 24 years and 50.96% were male. Approximately 44.34% were from parity ≥ 4, and (97.5%) type of births were single. One-fifth of the mothers 21.52% did not attain formal education, and 25.68% were aged ≥ 35 years. Regarding household wealth status, approximately 22.97% children were from the poorest wealth index.

Regarding community-level factors, 73.17% were from rural areas, 37.85% were from the lake administrative zone, 12.25% were from the southern zone, and 2.94% were from the Zanzibar administrative zone. Community maternal education was high in two-third 61.58% of the study participants, and the level of poverty was low in 50.35% of the community.

The overall prevalence of stunting among under-5 children was 29.66%. Of these, 20.99% of under-5 children had moderate stunting and 8.67% had severe stunting (Table 1).

Model comparisions

This study compared a single-level ordinal logistic regression model with a multilevel ordinal logistic regression

Table 1 Individual and community-level characteristics of the study participants in Tanzania

Variables	Category	Weighted frequency ($n = 4,866$)	Percentage (%)
Individual-level factors			
Child's age in months	< 6 months	620	12.94
	6–23 months	1,513	31.09
	≥ 24 months	2,723	55.97
Parity	One	783	16.08
	2–3	1,926	39.57
	≥ 4	2,157	44.34
Sex of child	Male	2,480	50.96
	Female	2,386	49.04
Type of birth	Single	4,745	97.50
	Multiple	121	2.50
Maternal educational status	No education	1,047	21.52
	Primary	2,816	57.85
	Secondary	955	19.64
	Higher	48	0.99
Household wealth status	Poorest	1,118	22.97
	Poorer	966	19.85
	Middle	955	19.62
	Richer	1,016	20.87
	Richest	819	16.68
Sex of household head	Male	3,759	77.24
	Female	1,107	22.76
Number of household members	≤ 5	2,244	46.09
	> 5	2,624	53.91
Maternal age in years	15–24 years	1,382	28.41
	25–34 years	2,234	45.91
	≥ 35 years	1,250	25.68
Marital status	Single/divorced/widowed	760	15.62
	Married/living with partner	4,106	84.38
Community-level factors			
Residence	Urban	1305	26.83
	Rural	3,561	73.17
Administrative zones of Tanzania	Central	514	10.57
	Northern	498	10.24
	Southern	611	12.55
	Southwest highland	186	3.83
	Eastern	253	5.19
	Southern highland	353	7.25
	Western	466	9.58
	Lake	1,842	37.85
	Zanzibar	143	2.94
Community maternal education	Low	1,870	39.42
	High	2,997	61.58
Community poverty	Low	2,450	50.35
	High	2,416	49.65
Childhood stunting	Severe stunting	422	8.67
	Moderate stunting	1,021	20.99
	Not stunted	3,423	70.34

Table 2 Summary statistics of goodness-of-fit measure for multilevel ordinary logistic regression models

Measures	Null model	Model I	Model II	Model III
ICC	0.17	0.16	0.13	0.09
Variance	0.423	0.297	0.217	0.196
Deviance	7377.34	7121.86	7241.23	7055.44
PCV	Reference	-0.031	0.033	0.37
MOR	1.82	1.73	1.67	1.68
AIC	7383.33	7150.811	7269.233	7088.084
BIC	7402.77	7241.501	7359.923	7250.03
-log rikelihood ratio	-3688.667	-3560.925	3620.617	-3527.725
LR-test	LR test vs. logit model: chibar2(01) = 31.07 Prob > = chibar2 < 0.0001			

AIC: Akaike Information Criteria, BIC: Bayesian Information Criteria, LLR: Log-Likelihood Ratio, ICC: Intra-Class Correlation Coefficient, PCV: Proportional Change in Variance, MOR: median odds ratio

model without predictors. Deviance (-2 likelihood ratio test) was employed to assess model appropriateness, yielding a statistically significant result (p-value < 0.05). This result indicates that the multilevel model provided a superior fit.

Four random-effects models were evaluated, with the model exhibiting the lowest deviation being chosen. The models demonstrated varying statistical performances across multiple metrics. The intra-class correlation coefficient (ICC) showed a reduction from 0.17 in the null model to 0.09 in model III, suggesting that individual-level factors increasingly accounting for variance as predictors were introduced. The variance decreased progressively, starting at 0.423 in the null model and reaching 0.196 in model III, indicating an improved variance explanation. Model I exhibited the lowest deviance (7121.86), while Model III achieved the lowest AIC (7088.08), signifying the best overall fit. The proportional change in variance (PCV) improved in model III (0.37), demonstrating that additional predictors explained more variance. The median odds ratio (MOR) showed a slight decrease across the models, indicating a reduced clustering effect. model III also had the lowest -log likelihood ratio and best overall fit, although model I performed well with a simpler structure. model II displayed higher deviance, AIC, and BIC, suggesting that it may have introduced unnecessary complexity without improving the fitness. In conclusion, model III offered best fit compared with the other models. Therefore, all interpretations and reports were based on this model (Table 2).

Assumption of proportional odds

Parallel-line assumption was evaluated using the Brant test. This test's null hypothesis states that the effects of the independent variables do not differ across stunting levels in the proportional odds assumption. The Brant test results showed that the proportional odds

Table 3 Parameter estimates of the multilevel ordinal logistic regression model

Variables	Category	Crude odds ratio (95% CI)	Model I (level I	Model II	Model III
			AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Sex of child	Male	1.35 (1.18–1.53)	1.36 (1.19–1.56)		1.53 (1.35–1.76)
	Female (R)	1	1		1
Child age in months	< 6 months (R)	1	1		1
	6–23 months	2.26 (1.77–2.9)	2.0 (1.60–2.60)		2.07 (1.62–2.63)
	≥ 24 months	2.25 (1.78–2.85)	2.1 (1.63–2.56)		2.10 (1.63–2.59)
Types of birth	Single (R)	1	1		1
	Multiple	6.63 (4.52–9.73)	5.83 (4.07–8.35)		6.15 (4.29–8.79)
Family size	≤ 5 (R)	1	1		1
	> 5	0.97 (0.85–1.12)	0.90 (0.77–1.05)		0.91 (0.78–1.06)
Parity	One (R)	1	1		1
	2–3	0.88 (0.72–1.06)	0.76 (0.63–0.94)		0.76 (0.62–1.93)
	≥ 4	0.93 (0.77–1.13)	1.68 (0.55–2.85)		0.69 (0.56–1.86)
Household wealth status	Poor	2.2 (1.87–2.66)	2.12 (1.76–2.55)		1.80 (1.43, 2.26
	Middle	1.6 (1.31–1.95)	1.59 (1.31–1.95)		1.45 (1.17–1.79)
	Rich (R)	1	1		1
Maternal education status	No education	1.91 (1.52–2.38)	1.48 (1.17–1.87)		1.31 (1.031, 1.68)
	Primary	1.59 (1.32-1,92)	1.33 (1.11–1.61)		1.26 (1.04–1.53)
	Secondary& higher (R)	1	1		1
Place of Residence	Urban (R)	1		1	1
	Rural	1.97 (1.61–2.42)		1.44 (1.16–1.78)	1.21 (0.96–1.52)
Administrative zones	Central	2.0 (1.18-3-51)		1.48 (1.05–2.07)	1.34 (0.94–1.89)
	Northern	1.58 (0.9–2.75)		1.31 (0.92–1.86	1.21 (0.83–1.73)
	Eastern	1.32 (0.8-2,28)		1.34 (0.95–1.88)	1.17 (0.82–1.66)
	Southern	1.3 (0.68–2.47)		0.94 (0.59–1.49)	0.68 (0.42–1.10)
	Southern highland	4.23 (2.21–7.45)		3.79 (2.72–5.27)	3.21 (2.2–4.51)
	Southwest highland	3.25 (1.18–5.67)		2.4 (1.74–3.32)	2.12 (1.52–2.94)
	Western	2.13 (1.22–3.73)		1.36 (0.95–1.95)	1.16 (0.80, -1.68)
	Lake	2.1(1.26–3.44)		1.56 (1.19–2.03)	1.40 (1.06–1.85)
	Zanzibar (R)	1		1	1
Community poverty	Low (R)	1		1	1
	High	1.62 (1.35–1.93)		1.18 (0.97–1.45)	1.26 (1.05–1.53)
Community education	Low	1.64 (1.37–1.97)		1.36 (1.13–1.63)	0.99 (0.81–1.23)
	High (R)	1		1	1

AOR: adjusted odds ratio, CI: confidence interval, R: reference

assumption was satisfied (p-value = 0.34). Consequently, as the Brant test was met, the multilevel proportional odds model provided a single odds ratio (OR) for each explanatory variable (severe vs. moderate/not stunted, severe/moderate vs. not stunted). In addition to the overall test, we examined each variable in the model to determine which variables fulfilled the proportional odds assumption; and all variables had a p-value > 0.05.

Factors associated with childhood stunting levels

As shown in Table 3, a bi-variable analysis was performed to identify factors associated with stunting. Sex and age of the child, type of birth, parity, family size, household wealth status, maternal education status, residence, administrative zone, community poverty, and community maternal education were considered in the multivariable analysis (p-value < 0.2). In the multivariate multilevel proportional odds model, the sex of a child, child's age in months, type of birth, household wealth status, maternal education status, administrative zone, and community poverty level were significantly associated with the severity of stunting.

The odds of having higher levels of stunting among male children were 1.5 times higher (AOR = 1.53, CI: 1.35–1.76) than among female children. The odds of having higher levels of stunting among children aged 6–23 months and ≥ 24 months were 2.07 times (AOR = 2.07, CI: 1.62–2.63) and 2.10 times (AOR = 2.10, CI: 1.63–2.59) higher odds compared to children aged < 6 months. Twin children who were 6.15 times higher likely to be classified as having higher levels of stunting (AOR = 6.15, CI: 4.29–8.79) than single children. Children from the poor and middle household wealth index were 1.80 times (AOR = 1.80, CI: 1.43–2.26), 1.45 times (AOR = 1.45, CI:

1.17–1.79), and higher odds of a higher level of stunting compared to children from the rich household wealth, respectively. Children whose maternal educational status of no formal education and primary education had 1.31 times (AOR = 1.31, CI: 1.031–1.68), and 1.26 times (AOR = 1.26, CI: 1.04–1.53) higher odds of a higher level of stunting than children whose mother had a higher level of education, respectively.

The odds of being at higher levels of stunting among children in Southern highland, Southwest highland and lake administrative zone of Tanzania were 3.21 times (AOR = 3.21, CI: 2.2–4.51) and 2.12 times (AOR = 2.12, CI: 1.52–2.94), 1.40 times (AOR = 1.90, CI: 1.06, 1.85) compared to children in Addis Ababa. The Odds of having higher levels of stunting among children from high community poverty increased by 26% (AOR = 1.26, CI: 1.05–1.53) compared to children from low community maternal education (Table 3).

Discussion

Tanzania, like many other low-income countries, grapples with a high prevalence of stunting among its population, which posing adverse consequences for individuals and society. This study aimed to shed light on the prevalence, contributing factors, and implications of stunting in Tanzania [15].

The prevalence of stunting among Tanzanian under-5 children was 29.66%, with 20.99% classified as having moderate stunting and 8.67% classified as having severe stunting, placing it among countries with high rates of chronic malnutrition. This finding indicates that childhood stunting is a major public health concern in Tanzania. This high prevalence demands urgent attention from policymakers, healthcare providers, and communities to address the underlying causes and to find effective interventions [20].

The findings of this study are higher than those reported in Northern Brazil (14.8%) [26], Pakistan (21%), and China (20%) [27]. This may be due to differences in socioeconomic status among countries; China and Brazil have a higher socioeconomic status than Tanzania [28]. Stunting is higher in Tanzania than in other countries because of factors such as limited access to nutritious food, poor sanitation and hygiene, limited breastfeeding practices, inadequate healthcare infrastructure, lack of education and awareness, and socioeconomic factors [6]. Addressing these issues through strategies such as improving food access, promoting hygiene practices, educating communities, and enhancing healthcare infrastructure can reduce stunting rates in Tanzania [29].

This study also identifies the determinants of stunting severity levels. In the final model, we found that being male, children aged 6–23 months, low level of community maternal education, children from poor household wealth status, children whose mothers had no formal education or primary, children from (the southern highland and southwest highland administrative zones) and high community poverty were significantly associated with higher odds of stunting severity. Being male was significantly associated with increased odds of childhood stunting compared with being female. This is in line with studies conducted in Tanzania [15], Indonesia [30] and Nigeria [31]. This may be because nutrition and health tend to be worse in boys beginning in utero and continuing through childhood [32]. Another reason might be that boys are more likely to be born preterm and have low birth weights, which could also contribute to stunting [33, 34]. Differences in growth hormones and other physiological processes between males and females may contribute to stunting These differences could potentially influence the slower growth rates typically observed in boys during childhood [32, 35]. Boys, for instance, tend to have higher growth hormone levels, so they may be more sensitive to deficiencies or disruptions in these hormones [36].

Children aged 6–23 months and older have a higher likelihood of experiencing stunting than those aged less than 6 months. This could be attributed to the fact that the age range of 6–23 months is a critical period for initiating complementary feeding, which can expose young children to more infections, ultimately leading to stunting in older children [37]. This can occur because of inadequate nutrient intake, poor food quality, inappropriate feeding practices, and a lack of knowledge among caregivers. Educating caregivers on proper complementary feeding and ensuring access to nutritious and safe foods through nutrition education, breastfeeding support, diverse diets, and improved hygiene and sanitation are crucial for addressing this issue [38].

Children who were twins had higher odds of having higher stunting severity levels than those who were singletons at birth. This is in line with findings reported in Ghana, Ethiopia, and low-and middle-income countries [39–41]. This could be due to factors such as lower birth weight, competition for nutrients in the womb, and the potential for preterm birth [42]. Preterm birth, which is more common in twin pregnancies, is also associated with an increased risk of stunting as premature infants may face developmental challenges affecting their growth [43].

Children from families with low household wealth had higher odds of stunting than those from wealthy households. This is in line with the findings reported in Ethiopia [17], Indonesia [30], Nigeria [44], the Democratic Republic of Congo [16], and Rwanda [45]. A possible reason could be that low household wealth is connected to food insecurity, which prevents individuals from being well-nourished and increases their risk of growth failure.

Additionally, the widespread occurrence of stunting may be due to the fact that households with lower wealth are less likely to have sufficient purchases of nutrient-rich food and access to healthcare services for their children when they are ill [46, 47].

Children born to mothers with an educational status of primary or lower have a higher chance of being stunted than those born to mothers who have completed secondary school or higher. This is consistent with the findings reported in previous studies [2, 26, 45, 48]. The correlation between maternal education and nutritional outcomes might be explained by the fact that mothers with low educational levels might lack knowledge about appropriate nutrition and health care, leading to improper feeding practices and higher stunting risks [49, 50]. Additionally, they may face difficulties in making decisions related to their children's health, resulting in poor healthcare [51]. Low maternal education often coincides with limited economic resources, making it challenging to provide nutritious food and access to health care. Limited access to healthcare exacerbates this problem [52]. Enhancing maternal education can help reduce stunting by equipping mothers with the necessary knowledge and skills for optimal child care [53].

Children living in communities with a high levels of poverty are more likely to suffer stunting than those living in communities with low levels of poverty. This finding is consistent with the results of a previous study in Pakistan [54]. The likelihood of stunting is heightened in areas with high community poverty due to a lack of access to nutritious food, inadequate sanitation and hygiene practices, limited healthcare and essential services, and poor living conditions [55, 56]. It is crucial to address community poverty and the underlying socioeconomic factors to decrease stunting rates [57].

Children from the southern and southwest highland administrative zones were significantly associated with higher odds of having higher levels of stunting. Several factors contribute to the variation in stunting rates across the administrative zones in Tanzania. These factors include socioeconomic factors, such as income levels, poverty rates, access to clean water, sanitation facilities, and healthcare services. Food security and dietary patterns also play a role, with variations in agricultural productivity and availability of nutritious foods affecting stunting rates [58].

Strengths and limitations of the study

The strength of this study lies in the use of a recent dataset and advanced statistical models, that enhance the accuracy and reliability of the results. However, this study had notable limitations. Owing to the cross-sectional design, a causal relationship between stunting and its predictors could not be established. Additionally, the use of secondary data restricted our ability to explore all variables that are critical to understanding childhood stunting.

Conclusions

In conclusion, stunting in Tanzania, which affects nearly one in three children, remains a significant challenge that obstructs the country's progress toward achieving sustainable development goals, particularly SDG 2 (zero hunger) and SDG 3 (good health and well-being). Factors such as male sex, age (6–23 months), multiple births, low socioeconomic status, maternal education levels, and regional disparities contribute to a higher risk of severe stunting. Therefore, ensuring access to adequate nutrition for children, particularly those in vulnerable groups, is essential for achieving sustainable development goals. The link between stunting and low maternal education further emphasizes the importance of increasing women's educational opportunities. Additionally, this study highlights disparities in stunting prevalence across different socioeconomic groups and regions, indicating the need for targeted interventions to reduce inequalities, especially in areas with high poverty rates and limited resources.

Abbreviations

AOR	Adjusted Odds Rati
CI	Confidence Interval
EAs	Enumeration areas
ICC	Intra-cluster Correlation Coefficient
JME	Joint Malnutrition Estimates
HAZ	Z-score for Height-for-Age
KR	Kids Record
LLR	Log likelihood ratio
LR	Likelihood ratio
SDG	Sustainable Development Goal
SSA	Sub-Saharan Africa
TDHS	Tanzanian Demographic health survey
WHO	World Health Organization
WHA	World Health Assembly

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Author contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Data availability

The datasets generated and analysed during the current study were sourced from Demographic and Health surveys and available here: http://dhsprogram.com/data/available-datasets.

Declarations

Ethics approval and consent to participate
Permission to access the data was obtained by submitting an online request at http://www.dhsprogram.com. The data used in this study were publicly available and did not contain any personal identifiers.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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