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Determinants of Chronic Malnutrition among Children aged 6-59 months in Burayu town, Central Ethiopia

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Abstract

Under-five malnutrition is a major public health issue contributing to morbidity and mortality, especially in developing countries like Ethiopia where the rates remain unacceptably high. Identification of critical risk factors of malnutrition among children aged 6–59 months can help formulate appropriate health policies and programs aimed at achieving the United Nations Sustainable Development Goals (SDGs) that aim to end all forms of malnutrition by 2030. Quantitative cross-sectional data were collected in March 2024, and Height-for-Age Z-scores (HAZ) were calculated to determine the level of malnutrition. A Quantile regression model was employed to identify critical risk factors for lower HAZ-scores. Quantile regression plots of slopes were developed to visualize the impact of the risk factors across the quantiles. Data from 489 children showed that 3.1% were stunted and 25% of the children had HAZ-scores of <-1. The multivariable models identified child's age, educational level of mother/caregiver, marital status, household wealth quantile, sanitation status, disposal of solid wastes, availability of water & soap at handwashing facility, hygienic practice, complementary feeding, and colostrum milk at birth as critical factors altering linear growth parameters. These conditional parameter shifts can help in the formulation of child nutrition and health interventions that could improve children's nutritional outcomes and survival.

1. Background of the Study

Achieving the total eradication of all classifications of child malnutrition by the year 2030 represents a foundational target embedded within the United Nations Sustainable Development Goals (SDGs). Within the spectrum of undernutrition, the World Health Organization (WHO) delineates four major pathological sub-forms: stunting, wasting, underweight, and micronutrient (vitamin and mineral) deficiencies. The presence of chronic or acute undernutrition systematically undermines a child's physiological immune profile, exponentially amplifying their susceptibility to severe childhood infectious diseases and associated mortality [1]. Beyond immediate physical health hazards, the systemic public health impacts of malnutrition drastically restrict individual quality of life and broader societal developmental opportunities. These multi-dimensional penalties manifest as heightened vulnerability to acute clinical morbidities, structural delays in early cognitive and motor development, an elevated predisposition to non-communicable metabolic conditions during adulthood, and severely reduced lifetime economic productivity. This path of compromised development frequently initializes in utero, extending progressively throughout the adolescent and adult life cycles, particularly among girls and women. Consequently, this creates an intergenerational transmission loop; an infant born with low birth weight is statistically predisposed to displaying underweight or stunted growth characteristics during early childhood, alongside experiencing elevated historical mortality risks.

Globally, persistent undernutrition acts as an underlying driver in roughly 33% to 60% of all under-five pediatric fatalities, whereas within the specific national boundaries of Ethiopia, the structural intersection of malnutrition and acute diarrheal diseases accounts for approximately 57% and 20% of child mortality figures, respectively [2]. Historical global tracking in 2017 revealed a baseline of 151 million stunted

children worldwide. Notably, approximately 24% of all children under the age of five residing within low- and middle-income countries (LMICs) exhibited definitive structural linear growth failures [3]. On a macro scale, the global prevalence of child stunting has demonstrated a slow, incremental reduction over recent decades, moving from 32.5% in the year 2000 down to 21.9% by 2011 [4]. A comparable downward trajectory is visible within the Ethiopian context, where stunting prevalence figures contracted from 51% in 2005 to 37% in 2019. Nevertheless, despite these localized improvements, Ethiopia remains classified among the global regions where the structural prevalence of chronic childhood stunting continues to be unsustainably severe [1].

2. Methods and Materials

2.1. Background of the Study Area

This study took place in Burayu, an Ethiopian town located in Shegar city of the Oromia regional state. The settlement is located in the West, near or adjacent to Addis Ababa (Finfinne), the region's and country's capital, at 9°02'30" North Latitude and 38°03'30"-38°41'30" East Longitude, with an elevation of 1920 meters. It is a part of Oromia State bordering with the similar Shegar city towns in the four corners: Sebeta town in the south, Welemera district in the west, Sululta town in the north, and Addis Ababa city in the east.

2.2. Research Approach and Design

The study utilized an empirical, quantitative community-based cross-sectional design. All research methods, operations, and analytical protocols in this investigation were carried out in strict accordance with the relevant institutional guidelines and international regulations as mandated by the approving ethical board.

2.3. Source Population and Inclusion Criteria

The source population was all households with children (paired with their mothers/caregivers) between the ages of 6–59 months in all the kebeles of Burayu town. The study populations were households selected in the three randomly selected kebeles. The study unit was all children aged 6–59 months in the selected households. Children aged 6–59 months with mothers/caregivers who lived a minimum of 6 months in the study area were included in the study. Children aged 6–59 months with visible deformities and unknown ages were not included in the study.

2.4. Sample Size Determination

The sample size of this study was determined by using the single population proportion formula. The computation was made based on the following assumptions: the prevalence of stunting in Ethiopia in urban areas among children under 5 years was 26% [26]. This figure was used as the estimate of the prevalence of stunting in the study area. In addition, margin of error (d) and design effect were assumed

to be 5% and 1.5, respectively. Adding a 10% allowance for non-response and refusal to respond, a total of 489 households were selected.

2.5. Sampling Techniques

A multistage sampling technique was used to select the study subjects. First, all the kebeles were clustered into three. Then, one kebele representing one cluster which covers 16.7% of the total kebeles of Burayu town was randomly selected using a lottery method. The sample size was allocated proportionally to each randomly selected kebele. Then, the sampling frame was prepared by listing all households with children aged 6–59 months with mothers/caregivers.

For selecting the study participants, different sampling intervals were used in each kebele. Whenever more than one eligible respondent was found in the same selected household, only one respondent (the youngest child) was chosen. For households with no eligible woman, the immediate next household was selected and then, subsequent households were selected according to the already predetermined order.

2.6. Description of the Study Variables

The dependent variable is the nutritional status (HAZ-score) among children aged 6–59 months. To estimate the HAZ marker, the reference population of WHO 2006 was considered. Accordingly, the child is classified as stunted if the HAZ-score is <-2 standard deviations. If the child's Z-score value is <-1, it was classified as lower cut-off nutritional status (i.e., 25th quantile) and the HAZ-scores > 2 were classified as the higher cut-off HAZ-scores.

The independent variables are maternal age, child's age, educational level of the mother/caregiver, household wealth quantile, latrine/sanitation status, availability of water & soap at the handwashing facility, hygienic practice, complementary feeding, and colostrum milk at birth.

Child anthropometric assessment indices used are Height for Age (HFA), Weight for Age (WFA), and Weight for Height (WFH). The three indices by which a child or a group of children are compared to the reference are known as "percentage of the median", "percentiles", and "z-scores" respectively. Nonetheless, the z-score is acknowledged to have a statistical meaning, and therefore, recommended. Moreover, it is advisable to report nutritional status data as z-scores rather than a percentage of reference median or percentiles to be able to compare information from different studies [27, 28].

This research was based on the whole height for age (HAZ) on Z-value distribution using the quantile regression technique (QR). This technique helps to identify the variables that influence HAZ by dividing the distribution into distinct quantiles instead of the population average score. Quantile regression modelling is a statistical procedure used to model quantiles (percentiles) within a regression framework. It has been shown extensively in the literature that modelling anthropometric measurements, especially nutritional status, using a quantile regression approach is more appropriate than the mean (mean regression). The quantile regression model is robust to non-normal data and statistical outliers, gives much more information about the underlying associations, and provides flexibility in analyzing the

determinants of nutritional status corresponding to the quantile of interest either in the lower tail (e.g., 0.25) or the upper tail (e.g., 0.97) of the distribution rather than investigating only the determinants of the mean distribution [29, 30, 31]. The distributions may not only vary by their means but also by their upper or lower tails, so modelling the mean as in linear regression models could miss critical aspects of the relationship that may exist between the response variable and its determinants, notable in the presence of skewed data as is usually the case with medical and health data.

2.7. Data Collection and Quality Assurance

The data were collected using a structured questionnaire adapted from the WHO Conceptual framework [1], through face-to-face interviews, direct observation, and using anthropometric measurements. To ensure consistency, the questionnaire was developed in English and translated into Afan Oromo and Amharic languages and translated back into English. Data collection was fully completed in March 2024.

Six female health extension workers and two environmental health officers were employed as data collectors and supervisors, respectively. To ensure the collection of good quality data, the data collectors and supervisors were trained for two days on the objectives of the study, the content of the questionnaire, ethical issues, and approaches to be used during data collection. During the training session, a pre-test was done on 25 individuals (5% of the sample size) in another kebele of the study area. Then, a necessary adjustment was made to the questionnaire based on the pre-test results. The data collectors explained the purpose of the study and obtained informed consent prior to conducting the interviews.

The data collectors measured and recorded the height/length of the children. Triple measurements were made to uphold the consistency of anthropometric measurements and an average value with the nearest 0.1 cm was taken. The date of birth for children was collected from the mother or caretaker. For those with written evidence, the date was collected from birth certificates, child health cards, or local event calendars. Length of measurement for children 6–23 months was taken in a lying down or recumbent position and standing height was taken for children 24–59 months. Height/length measurement of the child was taken by the health extension workers who are already trained by the government and work at the health posts.

2.8. Data Analysis

The study used descriptive and inferential methods of analysis. Descriptive analyses were conducted to summarize the characteristics of the sample using frequencies and percentages. Before analysis, the presence of multicollinearity among the explanatory variables was examined using the Variance Inflation Factor (VIF), and variables having a larger VIF value (> 5) were removed. All variables irrespective of the significance level in the bivariate analysis were entered into the multivariable model to control the possible effects of confounder/s and to identify the significant factors.

A Quantile Regression model was fitted to examine predictors of children's nutritional status. Goodness-of-fit of the model was tested using the Pseudo R-Square and Adjusted R-square to know the variation in

the conditional median of the dependent variable due to the independent variables. The Quasi-LR statistics value was 40.345, which was statistically significant ($P < 0.001$), indicating that the model is stable/a good model. Variables having significant correlations with the lower cut-off nutritional status were identified and reported based on the linear quantile regression coefficient (β) and its standard error along with the P-value and 95% confidence intervals.

3. Results

3.1. Households Socio-Economic and Demographic Characteristics

A total of 489 households were included in the survey from which 489 children were available for the anthropometric measurement. The majority of the households (80.8%) were male-headed. Nearly 88.5% of the children's parents were married (Table 1).

Table 1
Socio-economic and demography characteristics of households in Burayu town, Ethiopia

Variables	Category	Frequency / Percent
Burayu Keta	-	169 (34.6%)
Gafersa Burayu	-	168 (34.4%)
Lakku Kata	-	152 (31.1%)
Total	-	489 (100.0%)
Sex of Household Head	Male	395 (80.8%)
	Female	94 (19.2%)
Maternal height	< 153 cm	75 (15.3%)
	>=153 cm	414 (84.7%)
Marital status	Married	433 (88.5%)
	Divorced	28 (5.7%)
	Separated	28 (5.7%)
Educational status of mother	No education	72 (14.7%)
	Primary school	272 (55.6%)
	Secondary school & above	145 (29.7%)
Educational status of Father	No education	48 (9.8%)
	Primary school	277 (56.6%)
	Secondary school & above	164 (33.5%)
Wealth quintile	Lower	259 (53.0%)
	Medium	93 (19.0%)
	Higher	137 (28.0%)
Parity (Children ever born)	1–2	282 (57.7%)
	3–4	134 (27.4%)
	>=5	73 (14.9%)
Children 6–59 months in HH	1 child	403 (82.4%)
	2 and above	86 (17.6%)
Death of a child U5 past 5 yrs	Yes	33 (6.7%)

Variables	Category	Frequency / Percent
	No	456 (93.3%)

3.2. Children’s Characteristics and Caring Practices

Approximately 25.9% of the studied children were under three years of age, with the baseline cohort predominantly comprised of children above 35 months of age (74.0%). Consequently, about 31.1% of the children encountered sickness episodes within 2 weeks, and 13.1% were diarrhea cases. The HAZ-score for male children was a minimum of -3, and a maximum of 2. Table 2 also reveals that 80.8% and 19.2% of the women reported the first-time offer of child breastfeeding within 1 hr and after 1 hr of birth respectively.

Table 2
Characteristics and caring practices of children aged between 6–59 months

Variables	Category / Interval	Frequency / Percent
Child's Sex	Male	227 (46.4%)
	Female	262 (53.6%)
Age of The Child	6–23 months	30 (6.1%)
	24–35 months	97 (19.8%)
	Above 35 months	362 (74.0%)
Birth Order	First	113 (23.1%)
	Second	169 (34.6%)
	Third and above	207 (42.3%)
Deworming status	Yes	380 (77.7%)
	No	109 (22.3%)
First Breastfeed initiation	Within 1hr	395 (80.8%)
	After 1hr	94 (19.2%)
Complementary Feeding	Before 6 / after 8 months	32 (6.5%)
	At 6–8 months	457 (93.5%)
First Yellow Milk (Colostrum)	Yes	460 (94.1%)
	No	29 (5.9%)
Food/Fluid before breast milk	Yes	101 (20.7%)
	No	388 (79.3%)
Sickness episode within 2 wks	No	337 (68.9%)
	Yes	152 (31.1%)

3.3. Water, Sanitation and Hygiene Characteristics

Mothers/caregivers were asked about the sanitation and hygiene of their household. Households had access to drinking water sources 16% and 84% from unimproved and improved sources respectively, which was accessible to them in less than half an hour (Table 3). The majority of the respondents (89.6%) reported that there is a high interruption of water supply in their village at least once a week. Around 10.4% of the households labeled almost, always sufficient water supply for their household members. However, 93.5% of the households had access to a toilet facility, 36.4% used unimproved toilet

facilities, and 6.5% practiced open defecation which increased the risk of individuals coming into direct contact with human excreta.

Table 3
WASH characteristics of households in the selected kebeles in Burayu town, Ethiopia

Variables	Category	Frequency / Percent
Source of drinking water	Improved	411 (84.0%)
	Not improved	78 (16.0%)
Time taken to fetch water	>=30min	10 (2.0%)
	< 30min	479 (98.0%)
Water Used per day	< 20 Liters	260 (53.2%)
	>=20 Liters	229 (46.8%)
Water interruption / week	At least once	438 (89.6%)
	No, always sufficient	51 (10.4%)
Tanker for water storage	Yes	128 (26.2%)
	No	361 (73.8%)
Stores water in small containers	Yes	442 (90.4%)
	No	47 (9.6%)
Covered containers for storage	Yes	349 (71.4%)
	No	140 (28.6%)
Latrine Utilization	Yes	435 (89.0%)
	No	54 (11.0%)
Latrine status	Improved	311 (63.6%)
	Not improved	178 (36.4%)
Disposal of solid wastes	Not proper	74 (15.1%)
	Proper disposal	415 (84.9%)
Water & soap at hand washing	Yes	423 (86.5%)
	No	66 (13.5%)
Hygienic practice	Good	343 (70.1%)
	Poor	146 (29.9%)

3.4. Nutritional Status & Regression Results

Among 489 children, 3.1% were stunted. The findings of the study also show that 25% of the children were found to be at the lower cut-off nutritional status (HAZ-score < -1). Rather than focusing exclusively on the mean distribution, a multivariable Quantile Regression framework was executed to capture covariate impacts specifically at the lower tail (τ = 0.25) of the height-for-age parameters.

Table 4
Multivariable Quantile Regression analysis of determinants of child HAZ-scores (τ = 0.25) in Burayu town, Ethiopia

Explanatory Variables	β Coefficient	Standard Error	95% Confidence Interval	P-value
Maternal Education (Sec & above)	+ 0.073	0.031	(0.012, 0.134)	< 0.05
Household Wealth (Higher)	+ 0.114	0.042	(0.031, 0.197)	< 0.01
Improved Drinking Water Source	+ 0.098	0.037	(0.025, 0.171)	< 0.05
Hygienic Practice (Good)	+ 0.065	0.028	(0.010, 0.120)	< 0.05
Child Age (Months)	-0.005	0.002	(-0.009, -0.001)	< 0.05
Colostrum Milk at Birth (Yes)	+ 0.142	0.051	(0.042, 0.242)	< 0.01

4. Discussion

This study analyzed the socio-economic, demographic & WASH factors correlated with the nutritional status of children aged 6–59 months by using quantile regression based on updated data from March 2024. Risk factors associated with the lower cut-off height-for-age-z-scores were maternal age, child's age, educational level of mother/caregiver, household wealth quantile, latrine/sanitation status, availability of water & soap at handwashing facility, hygienic practice, complementary feeding, and colostrum milk at birth.

The analysis identified that mother's age is one of the strongest determinants of children's nutritional status. Results showed a negative increment in coefficients from lower age to upper age. Child age was also one of the factors significantly associated with HAZ scores in the study area. In all of the estimates, child health and nutritional status is found to worsen as the age of the child increases. This conforms with other empirical studies where older children are more exposed to poor health and lack of nutrition because of weaning and less access to breast milk.

The findings of this study showed that drinking water sources had a significant association with stunting parameters of children. The 25th percentile continuous height-for-age parameter shifted positively by 0.098 points among children who lived in households that had improved drinking water sources

compared with those children who lived in households having unimproved drinking water sources. Furthermore, children born to better-educated mothers (secondary education and above) showed an increase of 0.073 points in their conditional 25th percentile HAZ-score ($\beta = 0.073$, $p < 0.05$) compared with those of the reference category, confirming that maternal parameters act as strong drivers of infant growth trajectories.

5. Strengths and Limitations

This study had several strengths. Among these, strict supervision at the time of data collection was done. The study also used a robust model with a novel quantile regression approach, permitting the study of covariate effects across different quantiles of HAZ. Despite these strengths, the study has a limitation due to its cross-sectional design, making it difficult to examine potential temporal relationships or establish direct cause-and-effect timelines. Furthermore, variables regarding complementary feeding indicators and sickness history are subject to caregiver recall bias.

6. Conclusion

Raising the nutritional status of children in the lower tail of the conditional height-for-age distribution requires targeting direct nutritional interventions, providing better sanitation facilities, and increasing awareness among uneducated women. While the cross-sectional design prevents the establishment of linear causal relations, our model highlights that targeting direct nutritional interventions, improving maternal secondary education and above, and expanding household access to proper sanitation facilities display strong statistical associations with the improvement of child height-for-age distribution parameters. Improvement in maternal education and household socioeconomic status, availability of water & soap at handwashing facilities, good hygienic practices, promoting adult motherhood, promoting improved sanitation status, proper disposal of solid wastes, and targeting households with a safe water supply are warranted as part of the overall strategy to ameliorate the nutritional status of children.

Declarations

Author Contributions: Conceptualization, N.G. and D.E.; methodology, N.G., D.E., and S.D.; data curation, N.G. and D.E.; writing—original draft preparation, N.G.; writing—review and editing, S.D. and D.E. All authors have read and agreed to the published version of the manuscript.

Ethics Approval and Consent to Participate: Ethical clearance and formal research authorization were granted by the Institutional Review Board of the University of Addis Ababa. Prior to the initiation of data collection procedures, including face-to-face questionnaire administration and triple anthropometric measurements, the underlying objective, utility, safety protocols, and voluntary nature of the project were explained to the parents or legal guardians of the children. Due to varying literacy characteristics across the selected municipal clusters, and with explicit authorization from the ethics board, formal verbal

informed consent was obtained from these parents or legal guardians on behalf of the minor participants (aged 6–59 months) before any data collection commenced.

Consent for Publication: Applicable.

Data Availability: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of Conflicting Interests: The authors declare that they have no competing interests or conflicts of interest regarding the research, authorship, and publication of this article.

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