



Modeling Key Drivers of Under-Five Child Malnutrition in Marsabit County, Kenya: Application of the Logit Model

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Authors' contributions

This work was carried out in collaboration among all authors. Author BKR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JK and AO managed the analyses of the study. Author JK managed the literature searches. All authors read and approved the final manuscript.

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Abstract

Malnutrition remains one of the major problems in developing countries affecting both adults and children under 5 years. The use of binary logistic regression model was employed, and parameters of interest estimated. Results showed that 29.3 percent of the children were acutely malnourished. There was an insignificant difference between household food security and child malnutrition status ($p - value = 0.842$). Factors such as the age of caregivers, household size, the gender of the child, and the level of education of caregivers, if the child was weighed at birth, source of income, the occupation status, and the distance to the water source remained insignificant at a multivariate level. However, factors such as full-term maternal pregnancy, the child being ill for the past two weeks, and the study site were strong significant factors affecting the status of childhood malnutrition. Moreover, mothers with full-term pregnancy up to the birth were 53 percent less likely to have malnourished infants when compared to their counterparts whose pregnancy was not term. Mothers/caregivers who traveled more than half a kilometer were twice more likely to have their children malnourished than those who had traveled less than half a kilometer. It recommended that the policymakers and the entire County government of Marsabit should build more social amenities that provide pregnant women with full-term maternal checkups for both antenatal and postnatal care. County government of Marsabit should lobby and mobilize resources for food aid or cash transfers to households.

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1 Introduction

Malnutrition is a leading cause of death in children under the age of five. Globally, an estimated 13.6 million children die each year as a result of malnutrition [1]. At the global level, an estimated 151 million (22.2%) children under-five years of age were stunted in 2016 [2]. Furthermore, other researchers have identified childhood undernourishment as a global development issue caused by a lack of access to nutritious foods, repeated infections, and insufficient maternal and child feeding and care practices during the first 1,000 days, from conception to age two. Undernutrition has serious consequences for children's physical growth and cognitive development, as well as their overall health [3].

Despite existing interventions, child malnutrition remains a major global public health issue [4]. Child malnutrition is the root cause of nearly half (45%) of all child deaths, particularly in low socioeconomic communities in developing countries [5]. In 2018, an estimated 149 million children under the age of five were stunted and 49 million children were wasted globally [6]. However, while the prevalence of stunting has been shown to be declining in Sub-Saharan Africa, it has remained above 30% [6].

Stunting has been identified as an important outcome in and of itself, as well as a marker of several negative outcomes, and global attention has been focused on reducing the high burden of childhood stunting in low- and middle-income countries (LMICs) [7]. The World Health Assembly approved global nutrition targets for 2025 in 2012, including a 40% reduction in the number of stunted children under the age of five [8].

As a result, all countries must take immediate action to meet Sustainable Development Goal 2, which calls for the abolition of all forms of malnutrition by 2030. This, in turn, can contribute to other targets related to child survival, educational attainment, and overall well-being. Several conceptual models have been developed to better understand the causes of child malnutrition, the majority of which use a multifactor approach [9].

Furthermore, UNICEF estimates that in Kenya, 239,446 children suffer from moderate acute malnutrition (MAM) and 2600 children suffer from severe acute malnutrition (SAM) (SAM). Chronic malnutrition also contributes to approximately 35,000 deaths among children aged 5 in Kenya each year [10]. According to the Kenya Demographic Health Survey 2014, 26 percent of children under the age of five are stunted, 4 percent are wasted, and 11 percent are underweight. Malnutrition is still a public health issue in western Kenya. According to the survey, 25.2 percent of children under the age of five are stunted, with 8.2 percent severely stunted [11,12].

Furthermore, sample survey reports in Kenya show that the under-five mortality rate in Marsabit County is 52 per 1000 live births, and crude mortality rates are 10.4 per 10,000 live births per day in the county [13]. Marsabit County, on the other hand, has poor health and nutrition outcomes, which are thought to be primarily related to household food insecurity as a result of recurring droughts. According to the Marsabit County Long Rains Food Security Assessment Report (2017), the county's weighted average prevalence of Global Acute Malnutrition (GAM) was 16.9 percent, classifying the county as critical, according to the Integrated Food Security Phase Classification (IPC) [14].

Although many studies have been conducted in the country to investigate factors known to be associated with acute malnutrition, few studies have been conducted in ASAL areas, specifically in Marsabit County. As a result, the current study will be useful to policymakers in the public and private sectors in understanding the main causes of malnutrition among children under the age of five.

2 Specific Objectives of the Study

- i. To determine the prevalence rates of acute malnutrition (wasting) using WHO standards between the two study sites, in Marsabit County, Kenya.
- ii. To determine the correlation between household food security, household dietary diversity index, and acute malnutrition status of under five years children in Marsabit County, Kenya.
- iii. To fit a Logit model to determine factors that significantly affect the acute malnutrition status of under-five children in Marsabit County, Kenya.

3 Research Methodology

3.1 Study area

The Marsabit County is located in Kenya's central north. It is located on the eastern shore of Turkana Lake. The Oldonyo range (2,066M) in the southwest, Mount Marsabit (1,865M) in the central part of the county, the Hurri Hills (1,685M) in the northeastern part of the county, Mount Kulal (2,235M) in the northwest, and the mountains surrounding Sololo-M are all significant topographical features. According to the Kenya National Bureau of Statistics Census (KNBS) report of [15], Marsabit county population was 459785 persons (243548 male, 216219 female and 18 intersex) with with average household size of 5.8 person. The same reports show the county being the most sparsely populated county in the country having an average of 6 persons per square kilometer. Livestock farming (mainly pastoralism) accounts for more than 80 percent of income of residents of the county ((Kenya Food Security Brief, 2013).

Data Sources: Data was extracted from the Marsabit County SMART survey, which was conducted in July 2019. The study used a retrospective study design and used data on children's malnutrition categories, including height, weight, and age indicators for all children under the age of five, to calculate the weight-for-height (WHZ) anthropometric indicator. The index was calculated as a standard deviation unit from the reference group's median.

The World Health Organization's revised growth criteria were used to calculate children's nutritional status in 2006. Thus, children who were less than -2 SD of the median reference population were labeled as being too thin for their respective heights (wasted).

This variable was deemed to be response variable during statistical investigations. The two-level response variable wasting was defined as 1= for Acute Malnutrition and 0= for for the normal population [16,17]. The child's nutrition status was grouped into three classes which are namely; 1)-Severely under-nourished (< -3.0 Z-score), 2) Moderately under-nourished (-3.0 to -2.01 Z-score) and 3) Nourished (≥ -2.0 Z-Score). Thus, malnutrition status variable being a categorical variable was modelled using a linear model where a binary logit model was employed to predict factors linked with undernutrition among children above six months but less than 59 months.

3.2 Sample size and sampling procedure

The sample size utilized a single proportion population formula (Fishers et al., 1991) as shown in equation 1.

$$n = \frac{Z_{\alpha/2}^2 * P * Q}{D^2} * Deff \quad (1)$$

n is the desired sample size and P is the estimated probability of the acutely malnourished children in the target population. Z = standard normal deviation which is usually assumed to be 1.96 D =degree of precision which is set at 0.05, $Deff$ =Design Effect, taken as 1.4

The following assumptions was considered: 95% confidence level, Design Effect taken as 1.4, P = estimated proportion of wasting (29.9 percent) and a 5 percent margin of error [18].

A two stage stratified cluster sampling was used where villages were selected using the probability proportional to population size (PPS). Stage one sampling involved the sampling of the villages to be included in the survey while the second stage sampling involved the selection of the households from the sampled villages. The sub-counties formed the strata owing to different environmental and cultural differences of the sub-counties.

3.3 Statistical analysis

Statistical Package for Social Sciences (SPSS) version 21.0 and Microsoft office excel 2007 was utilized for entry and analysis of data. To explain the proportions and frequencies of socio-demographic features and other

applicable factors in the research, outputs from descriptive analysis were used. Output obtained from the analysis of bivariate and multivariable logistic regression analysis identified the variables related to under 5 child under-nutrition status. In order to see the extent of the correlation between the result and the chosen independent variables of interest, both the crude and adjusted odds ratios and their corresponding 95 percent confidence intervals were calculated.

3.4 Binary logistic regression model description

Consider a random variable Y that can take on one of two possible values. Given a data set with total sample of n , where each observation is independent, Y can be considered as a column vector of n Bernoulli random variables y_i . Let $X_i = (x_{0i}, x_{1i}, \dots, x_{ki})'$ be a vector of factors (explanatory variables) corresponding to the i^{th} subject, $i = 1, 2, \dots, n$, where $x_{0i} = 1$. Suppose y_i takes on the value 1 with probability $\Pi(x_i) = p(Y_i = 1 | X_i = x_i)$ and the value 0 with probability $1 - \Pi(x_i)$. In logistic regression the response probability $\Pi(x_i)$ evaluated as:

$$\Pi(x_i) = p(Y_i = 1 | X_i = x_i) = \frac{e^{\beta_0 + \beta_1 x_{1i} + \dots + \beta_k x_{ki}}}{1 + e^{\beta_0 + \beta_1 x_{1i} + \dots + \beta_k x_{ki}}} = \frac{\exp(\beta' X_i)}{1 + \exp(\beta' X_i)} \quad (2)$$

In which $\beta = (\beta_0, \beta_1, \beta_2, \dots, \beta_k)'$ refers to a column vector of coefficients of regression that are not known. The odds of success are defined as:

$$\frac{\Pi(x_i)}{1 - \Pi(x_i)} = \exp\{\beta' X_i\} \quad (3)$$

The log-odds (logit) are then given by:

$$\log\left(\frac{\Pi(x_i)}{1 - \Pi(x_i)}\right) = \beta' X_i, i=1, 2, 3, \dots, n \quad (4)$$

A key feature of the multiple binary logistic regression models is that the odds that an outcome will happen when a specific category of a given covariate compared to the odds of the outcome happening given the reference category, adjusted for all other covariates, can be calculated directly from the logistic coefficients by $OR = \exp(\beta_k)$. However, this simple relationship is true only if the relationship between the logit and X_k is in fact linear and there are no interactions between the covariates.

4 Results and Discussion

4.1 Demographic characteristics

The study details of children were matched with those of caregivers of reproductive age groups between 15-49 years of age. The mean age of caregivers was 24.68 years with a standard deviation of 7.29 years with a mean household size of 5.83 members and a standard deviation of 2.16 members. This summary was drawn up based on the parametric distribution assumptions, since the age of the caregivers, fulfilled the normality assumption. As far as marital status is concerned, 5 (1.1%) of women are single, while 400 (88.7%) were married, and 35 (7.8%) are widowed. With regards to the education level of the caregiver, 370 (82.0%) did not attend school, while (6.9 % vs. 2.7%) attended primary and pre-primary school respectively, with 21 (4.7%) having tertiary education. Lactating women, however, had the highest proportion of 306 (67.9%), those who were pregnant and lactating had 103 (22.8%), and those who were pregnant had the lowest proportion.

Conversely, concerning the occupation status of caregivers, the majority were in the informal sector, with 347 (76.9%) herders, 44 (9.8%) casual workers and 26 (5.8%) traders respectively, while the least occupation was farming with only two farm workers (0.4%). Furthermore, the North Horr study site appears to have slightly more subjects than the Laisamis site (51.0% vs 49%) respectively.

Table 1. Caregivers' socio-demographic characteristics, n = 451

Study variables	Percent (%)
Mean household size, SD	5.83 (SD=2.16)
Mean age caregivers, SD	24.68 (SD=7.29)
Education level	
Pre-primary	12 (2.7%)
Primary	31 (6.9%)
Secondary	17 (3.8%)
Tertiary	21 (4.7%)
None	370 (82.0%)
Marital status	
Single/never married	5 (1.1%)
Married	400 (88.7%)
Widowed	35 (7.8%)
Separated	8 (1.8%)
Divorced	3 (0.7%)
Physiological status of women	
Pregnant	32 (9.9%)
Lactating	201 (62.4%)
Not pregnant and not lactating	2 (0.6%)
Pregnant and lactating	87 (27.0%)
Occupation of the caregiver	
Farm labor	2 (0.4%)
Employed (salaried)	20 (4.4%)
Waged labor (casual)	44 (9.8%)
Trader	26 (5.8%)
Study site	
North Horr	230(51%)
Laisamis	221(49%)

Source: Authors Compilation, 2020

The demographic characteristics of children above six months and below 59 months of age are shown in Table 2. As the distribution of the child age was not normally distributed, the presentation of the parameters was made using a non-parametric distribution. The median age of the child was 31.19 months, and the age range was 53.83 months. It was clear that the average child size per household was approximately 1.0 In terms of gender distribution; male subjects appear to have a higher percentage than female subjects. On the other hand, the measurement of the child MUAC distribution ranged from 9.60 cm to 23 cm, with a median of 14.2 cm. Also, 136 (30.2 %) of children reported having been ill in the last two weeks. A higher percentage of caregivers were known not to have taken any water treatment measures before drinking as compared to 109 (24.2%) who made attempts to treat water.

A quarter, 112 (24.8%) of the caregivers have been walking for more than 2 km to the main source of water, while 202 (44.8%) have been walking for less than 1/2 km. Besides, only 74 (16.4 %) of infant birth weights were taken at birth meaning 337 (74.7 %) of infant birth weights were not taken, and some of their birth weight measurements were unknown at 40 (8.9 %) as summarized in Table 2.

4.2 Determining the acute malnutrition prevalence rates

The overall acute malnutrition status of children over the age of 6 months but under the age of 59 months using WHO standards in Laisamis and North Horr study sites of Marsabit County, Kenya was investigated, and results are as shown in Table 3. A proportion of 29.3 percent of children was undernourished (wasted) and a relatively higher percentage of the study cohort of children was nourished (70.7 percent).

Chi-square test was used to test the association of acute malnutrition in children 6-59 months between Laisamis and North Horr sub-counties of Marsabit County. The results presented in Table 4 show that Laisamis study site

had a higher number of acutely malnourished children compared to North-Horr (33.0% vs. 25.6%) respectively. However, the difference was statistically insignificant at alpha = 0.05(p-value 0.0851). According to KDHS [13], the national total on the prevalence of wasting was 4.9 percent which implies that the study sites had way above the national total acute malnutrition rates.

Table 2. Table showing child demographic /caregivers factors, n=451

Child study variables	Percent (%)
Child median age(months), range	31.19 (range=53.83, min=6,max=59.83)
Median child-size per household	1
Mean child weight (Kg)	10.87 (SD=2.45)
Gender of child	
Male	260 (57.6%)
Female	191 (42.4%)
Child MUAC distribution	
Minimum	9.60
Lower quartile	13.50
Median	14.2
Upper quartile	15.00
Mean (SD)	14.21 (SD=1.20)
If birth weight was taken at birth	
Yes	174 (16.4%)
No	337 (74.7%)
Don't know	40 (8.9%)
Whether your child been ill in the past two weeks?	
Yes	136 (30.2%)
No	315 (69.8%)
Do you do anything to your water before drinking?	
Yes	109 (24.2%)
No	342 (75.8%)
Trekking distance to the water source	
<1/2 km	202 (44.8%)
>1/2 km to less than 2 km	137 (30.4%)
>2 km	112 (24.8%)

Source: Authors Compilation, 2020

Table 3. Overall malnutrition status of children using WHZ Scores, n=451

Malnutrition status	N, percent (%)
Stunting (malnourished)	132 (29.3%)
Normal (Healthy)	319 (70.7%)
Total	451 (100.0%)

Source: Authors Compilation, 2020

Table 4. Malnutrition status by study site, n=451

Malnutrition status	Study site		p-value
	North-Horr, n (%)	Laisamis, n (%)	
Wasting (malnourished)	59 (25.6)	73 (33.0%)	0.0851
Normal (Healthy)	171 (74.4)	148 (67.0%)	
Total	230	221	

Source: Authors Compilation, 2020

Similarly, Chi square test was used to determine the association between the status of acute malnutrition between boys and girls. Analysis results displayed in Table 5 shows that status of sex-wide wasting was

statistically insignificant (p-value=0.3526). However, relative to their male counterparts, a significantly higher proportion of females were severely and moderately malnourished (33.5 % vs. 26.2 %), respectively.

Table 5. Malnutrition status by gender of the child, n=451

Malnutrition status	Gender of child		p-value
	Male, n (%)	Female, n (%)	
Wasting/malnourished	68 (26.2%)	64 (33.5%)	0.089
Healthy	192 (73.8%)	127 (66.5%)	
Total	260	191	

Source: Authors Compilation, 2020

4.3 Determining the correlation between household food security and childhood malnutrition status

The Women Dietary Diversity score (WDDS) and Household Hunger Score (HHS) were used as proxy indicators to access the food security status of households. Binary logistic regression was used to determine the association between food security and malnutrition status of children below 5 years of age. We used the household hunger scale [19] and women's dietary diversity score (FAO, 2016) as a proxy to the food security of households. Households with Hunger Score less than one (HHS<1) were considered to be more food secure than those with HHS>1. Similarly, women with dietary diversity scores greater than 5 (WDDS>5) were also considered to be more food secure than those with a score of 5 or less (WDDS<=5). Table 6 below shows the impact of food security in the household versus acute malnutrition status in children. Analysis showed that there is no significant difference between household food security and child malnutrition status (p-value=0.842). However, there was a slight difference in malnutrition status with households considered to be food secure having 28.8% of children being undernourished as compared to 29.6% of children from food-insecure households. Studies have shown that household food security play important roles in preventing undernutrition [20-23]. Evidence in our study to support or contradict these studies is feeble. This can be attributed to the cultural set up of these communities where households share their resources among each other where the lesser privileged households are supported by those households who fare a little better. Interventions that target to address malnutrition issues need to target community factors rather than household factors.

Table 6. Correlation between household food security and malnutrition status, n=451

Malnutrition status	Household food security status(using the household hunger Scale-HHS)		p-value
	Secure, n (%)	Not secure, n (%)	
Wasting/malnourished	57 (28.8%)	75 (29.6%)	0.842
Healthy	141 (71.2%)	178 (70.4%)	
Total	198	191	

*Food Secure Households (HHS of between 0 and 1) & food insecure households HHS> 1

The adjusted Logit regression model was fitted to investigate factors that significantly affect malnutrition status of children below 5 years of age and results are presented in Table 7 below. At a multivariate level, children who have been ill in the past two weeks preceding the survey were twice more likely to be acutely malnourished compared to children who have never been sick (AOR=2.00, 95% CI=1.282-3.19). Other studies have reported environmental factors that have a significant impact on the preference of body weight deficiencies to include the impact of previous illness [24].

Place of residence has also been shown to have significant effects of under 5 years children undernutrition [24]. Our study also found out that children in North Horr sub-county were less likely to be affected by under nutrition compared to their counterparts in the Laisamis sub-county (AOR=0.57, 95 percent CI=0.354-0.91). The implication here is that the various sub-counties have a significant difference in acute malnutrition levels and more interventions are required to curb the problem of acute malnutrition in Laisamis Sub-County. It is critical to note that North Horr sub-county also has a way higher level of malnutrition when compared with the national average of 4.9% [13].

Mothers with full-term pregnancy were 53 percent less likely to have undernourished children compared to those mothers whose pregnancy was not full term (AOR=0.47, 95% CI=0.276-0.804). This observed association is consistent with the findings of other studies [25-31].

Another finding was that children from mothers who were lactating were twice as likely to be acutely malnourished compared to those who children whose mothers were pregnant but not lactating (AOR=2.12, 95% CI=0.929-4.828). This is an interesting finding since it is an acknowledged fact that breastfeeding plays important role in prevention of various form of childhood malnutrition including acute malnutrition (Scherbaum & Srour., 2016) as it is associated with a lower risk of infectious diseases particularly in lower-income countries [32] where feeding the child with breast milk is expected to disrupt diseases and malnutrition in children. This needs to be investigated further in future studies.

Other important results were that mothers who often trekked more than half a kilometer to fetch water were 1.14 times more likely to have their children malnourished than those who trekked less than half a kilometer (AOR=1.14, 95% CI=0.722-1.798). This is aligned to study by Action Against Hunger where it found out that mothers having more time with their children were less likely to have malnourished children (Bizoueme et al., 2012). Distant water sources also compromised household hygiene [33] and this would contribute to child undernutrition.

Table 7. Adjusted logistic regression model with factors related to the overall wasting status for children above six months but below five years of age using WHZ scores, n=451

Factors	Estimate	Std error	Wald Chi-square	P-value	AOR	95% CI
Intercept	-0.0774	0.7116	0.0118	0.9134	0.93	
Caregivers age (years)	-0.0180	0.0149	1.4569	0.2274	0.98	0.954-1.011
Household size	-0.0445	0.0537	0.6862	0.4074	0.96	0.861-1.063
Child gender						
Male vs. female (Ref)	-0.3253	0.2166	2.2563	0.1331	0.72	0.472-1.104
Education level						
Ever attended school vs. never attended school (Ref)	-0.2562	0.3440	0.5549	0.4563	0.77	0.394-1.519
If child weight taken at birth						
Yes vs. No (Ref)	-0.3403	0.3416	0.9922	0.3192	0.71	0.364-1.390
Distance to the water point						
>1/2 km vs. <1/2 km (Ref)	0.1305	0.2327	0.3143	0.5751	1.14	0.722-1.798
Women physiological status						
Lactating vs. Pregnant (Ref)	0.7505	0.4204	3.1862	0.0743**	2.12	0.929-4.828
Pregnant and Lactating vs Pregnant (Ref)	0.2255	0.4546	0.2460	0.6199	1.25	0.514-3.054
Full term pregnancy						
Yes vs. No (Ref)	-0.7537	0.2730	7.6191	0.0058*	0.47	0.276-0.804
Child ill in the past two weeks						
Yes vs. no (Ref)	0.7042	0.2326	9.1680	0.0025*	2.00	1.282-3.190
Occupation status						
Herders vs. other categories (Ref)	0.2560	0.4394	0.3394	0.5602	1.29	0.546-3.057
Income						
Has income vs. No income (Ref)	-0.2003	0.3786	0.2799	0.5968	0.82	0.390-1.719
Study site						
North-Horr vs. Laisamis (Ref)	-0.5552	0.2470	5.0500	0.0246*	0.57	0.354-0.931

*AOR=Adjusted Odds Ratio, Ref=Reference Category, *(Significant at 5%), ** (Significant at 10%)

As compared to other studies [34-36], our study also found that caregivers who had ever attended school were less likely to have acutely malnourished children than those in the community who had never attended school

(AOR = 0.77, 95% CI = 0.394 – 1.519). Paul et al. [33], also found out that a mother's education was related to child illness which can also lead to children under the age of 5 being acutely malnourished.

The estimated equation concerning the parameters can be illustrated as follows:

$$\log(Y) = -0.077 - 0.018X_1 - 0.045X_2 - 0.033X_3 - 0.26X_4 - 0.34X_5 + 0.13X_6 + 0.75X_7 + 0.23X_8 - 0.75X_9 + 0.70X_{10} + 0.26X_{11} - 0.20X_{12} - 0.56X_{13}$$

Where Y is the acute malnutrition status of children 6-59 months, X_1 - is the caregivers age, X_2 - household size, X_3 - gender of the child, X_4 -educational level of the caregiver, X_5 - weight of the child taken at birth, X_6 - distance to the water point, X_7 -women physiological i.e. lactating vs pregnancy, X_8 -women physiological i.e. pregnant and lactating vs pregnant, X_9 -full term pregnancy, X_{10} - child being ill in the past 2 weeks, X_{11} - the occupation status of the caregiver, X_{12} - the income and X_{13} -the study site

5 Conclusion

The broad scope of this article was to find specific drivers of acute malnutrition in Marsabit County, Kenya. The survey results show that the specific objectives outlined have been achieved. The major conclusions were the prevalence rate of acute malnutrition in Laisamis and North Horr sub-counties is 24.4% higher than the national total. Contrary to many studies where boys are more acutely malnourished than girls, the study found out that girls were more malnourished. The study found out that household food security, household dietary diversity index and acute malnutrition status of under five years children was not significant but these factors remain as key important indicators for maternal health. Factors like child health, maternal pregnancies, and trekking distance to water sources negatively affected malnutrition status among caregivers in the current study.

6 Recommendations

The Marsabit County Lobby and resource mobilize for food aid or cash transfers to households with Severe Acute Malnutrition (SAM) and Moderate Acute Malnutrition (MAM) cases to curb the high rate of acute malnutrition. The gender inequality appears to exist in the communities studied since high proportions of girls are acutely malnourished contrary to many similar studies. Therefore, broad-based interventions will be needed to improve girls' health and nutritional status. There should be fundraising to rehabilitate and construct more sources of water to reduce trekking distance hence enabling mothers to have more time with their children. There should be existence of health and nutrition interventions to promote health pregnancies, hence enhancing full-term pregnancies.

7 Limitations and Suggestions for Future Work

The study was only conducted in the two study sites in Marsabit County. The findings may not be generalized to other counties and more research needed on the long-term effects of malnutrition in other ASAL counties so that ministry of health can use it as a policy framework document among its citizens.

Competing Interests

Authors have declared that no competing interests exist.

References

- [1] Boah MF, Azupogo DA, Amporfroand L Abada. The epidemiology of undernutrition and its determinants in children under five years in Ghana. *PLoS ONE*. 2019;14(7):e0219665. Available:<https://doi.org/10.1371/journal.pone.0219665>

- [2] United Nations Children’s Fund, WHO, World Bank Group. Levels and trends in child malnutrition: Key findings of the 2018 Edition of the Joint Child Malnutrition Estimates. United Nations Children’s Fund; 2018.
Available: www.who.int/nutgrowthdb/estimates
- [3] Blankenship JL, Cashin J, Nguyen T, TH Ip. Childhood stunting and wasting in Myanmar: Key drivers and implications for policies and programmes. *Matern Child Nutr.* 2018;16(S2):e12710.
- [4] Akombi B, K Agho D, Merom A, Renzahoand J Hall. Child malnutrition in sub-Saharan Africa: a meta-analysis of demographic and health surveys (2006-2016). *PLoS One.* 2017;12(5):e0177338.
- [5] Amare Z, Yohannes M, Ahmed Endris, Mehari A, Belete. Determinants of nutritional status among children under age 5 in Ethiopia: further analysis of the 2016 Ethiopia demographic and health survey. *Globalization and Health.* 2019;15:62.
- [6] UNICEF. Levels and trends in child malnutrition, United Nations Children’s fund (UNICEF), World Health Organization, International Bank for Reconstruction and Development/The World Bank. Levels and trends in child malnutrition: Key findings of the 2019 edition of the joint child malnutrition estimates. Geneva: World Health Organization: CC BY-NC-SA 3.0 IGO; 2019.
- [7] Leroy JL, Frongillo EA. Perspective: What does stunting really mean? A Critical Review of the Evidence. *Adv. Nutr.* 2019;10:196–204. [CrossRef].
- [8] De Onis M, Dewey KG, Borghi E, Onyango AW, Blössner M, Daelmans B, et al. The World Health Organization’s global target for reducing childhood stunting by 2025: Rationale and proposed actions. *Matern. Child Nutr.* 2013;9:6–26.
- [9] Li Z, Kim R, Vollmer S, Subramanian SV. Factors associated with child stunting, wasting, and underweight in 35 Low- and Middle-Income Countries. *JAMA Network Open/Global Health* 2020;3(4):e203386.
DOI: 10.1001/jamanetworkopen.2020.3386
- [10] Fanzo J, Hawkes C, Udomkesmalee E, Afshin A, Allemandi L, Assery O, et al. *Global Nutrition Report; 2019.*
- [11] KNBS. *Kenya Demographic and Health Survey. Nairobi; 2015.*
- [12] Gudu E, Obonyo M, Omballa V, Oyugi E, Kiilu C, Githuku J, et al. Factors associated with malnutrition in children < 5 years in western Kenya: a hospital-based unmatched case control study. *BMC Nutrition.* 2020;6:33.
Available: <https://doi.org/10.1186/s40795-020-00357-4>
- [13] *Kenya Demographic and Health Survey. National Sample Survey Report; 2014.*
- [14] *SMART SURVEY. Marsabit County Smart Survey Report- Laisamis and North Horr Zones; 2017.*
- [15] Kenya National Bureau of Statistics. *2019 Kenya Population and Housing Census Volume I: Population by County and Sub-County; 2019.*
- [16] WHO. *WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Geneva: World Health Organization Multicentre Growth Reference Study Group; 2006.*
- [17] Onis Md, Borghi E, Arimond M, Webb P, Croft T, Saha K, et al. Prevalence thresholds for wasting, overweight and stunting in children under 5 years. *Public Health Nutrition; 2018.*
DOI: 10.1017/S1368980018002434

- [18] Alimohamadi Yand Sepandi M. Considering the design effect in cluster sampling. *J Cardiovasc Thorac Res.* 2019;11(1):78.
DOI: 10.15171/jcvtr.14
- [19] Ballard T, Coates J, Swindale A, Deitchler M. Household hunger scale: Indicator definition and measurement guide. Washington, DC: Food and Nutrition Technical Assistance II Project, FHI. 2011;360.
- [20] Rose-Jacobs R, Black MM, Casey PH, Cook JT, Cutts DB, Chilton M, et al. Household food insecurity: associations with at-risk infant and toddler development. *Pediatrics.* 2008;121(1):65-72.
- [21] Yoko Iwanaga, Mizuko Tokunaga, Sayo Ikuta, Hiroyuki Inatomi, Miyuki Araki, Yuko Nakao, ... & Kazuyo Oishi; 2009.
- [22] Kanjilal B, Mazumdar PG, Mukherjee M, Rahman MH. Nutritional status of children in India: Household socio-economic condition as the contextual determinant. *International Journal for Equity in Health.* 2010;9(1):19.
- [23] Nagahori C, Tchuani JP, Yamauchi T. Factors associated with nutritional status in children aged 5–24 months in the Republic of Cameroon. *Nursing and Health Sciences.* 2015;17(2):229-235.
- [24] Larson N, Chen Y, Wall M, Winkler MR, Goldschmidt AB, Neumark-Sztainer D. Personal, behavioral, and environmental predictors of healthy weight maintenance during the transition to adulthood. *Preventive Medicine.* 2018;113:80-90.
- [25] WHO U. UNFPA, The World Bank. Trends in maternal mortality: 1990 to 2010. World Health Organization, UNICEF, UNFPA, and The World Bank; 2012.
- [26] Islam MM, Alam M, Tariqzaman M, Kabir MA, Pervin R, Begum M, et al. Predictors of the number of under-five malnourished children in Bangladesh: application of the generalized poisson regression model. *BMC Public Health.* 2013;13(1):11.
- [27] Mishra K, Kumar P, Basu S, Rai K, Aneja S. Risk factors for severe acute malnutrition in children below 5 y of age in India: A case-control study. *The Indian Journal of Pediatrics.* 2014;81(8):762-765.
- [28] Masiye F, Chama C, Chitah B, Jonsson D. Determinants of child nutritional status in Zambia: An analysis of a national survey. *Zambia Social Science Journal.* 2010;1(1):4.
- [29] Jesmin A, Yamamoto SS, Malik AA, Haque MA. Prevalence and determinants of chronic malnutrition among preschool children: a cross-sectional study in Dhaka City, Bangladesh. *Journal of Health, Population, and Nutrition,* 2011;29(5):494.
- [30] Dhar B, Mowlah G, Nahar S, Islam N. Birth-weight status of newborns and its relationship with other anthropometric parameters in a public maternity hospital in Dhaka, Bangladesh. *Journal of Health, Population and Nutrition.* 2002;36-41.
- [31] Correia LL, Campos JS, Andrade FMDO, Machado MMT, Lindsay AC, Leite ÁJM, et al. Prevalence and determinants of child undernutrition and stunting in semiarid region of Brazil. *Revista de Saude Publica.* 2014;48:19-28.
- [32] Solomons NW. Malnutrition and infection: an update. *British Journal of Nutrition.* 2007;98(S1):S5-S10.
- [33] Paul GK, Nesa MK, Mondal SK, Salan SA, Mim FN. Application of proportional odds model in identifying contributing factor of under-five child malnutrition in Bangladesh: A case study in Tangail district. *Journal of Health Research and Reviews.* 2018;5(3):128.

- [34] Frost MB, Forste R, Haas DW. Maternal education and child nutritional status in Bolivia: finding the links. *Social Science and Medicine*. 2005;60(2):395-407.
- [35] Glewwe P. Why does mother's schooling raise child health in developing countries? Evidence from Morocco. *Journal of Human Resources*. 1999;124-159.
- [36] Desai S, Alva S. Maternal education and child health: Is there a strong causal relationship? *Demography*. 1998;35(1):71-81.

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