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Research article

Severe acute malnutrition and associated factors among children under-five years: A community based-cross sectional study in Ethiopia

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ABSTRACT

Background: Despite consistent efforts to reduce child undernutrition, severe acute malnutrition (SAM) continues to be a serious obstacle to child survival and development in Ethiopia. This study aimed to identify severe acute malnutrition and associated factors among children aged 6–59 months in Ethiopia.

Methods: A cross-sectional study was undertaken with 384 under-five children from February to March, 2020 in Ethiopia. A mid-upper arm circumference (MUAC) tape, weight scale, height board (standing) and recumbent length measurements (for children <24 months) were measured. To determine the variables associated with SAM, adjusted odds ratio was computed using multivariable analysis and $p < 0.05$ was declared as significant.

Results: The prevalence of acute undernutrition was 26%; 18% and 8% of the children were moderately and severely undernourished, respectively. Family size (≥5 members) (AOR: 3.71, 95% CI: 1.55–8.89), younger age group (6–11 months) (AOR: 4.80, 95% CI: 1.61–14.31) and history of diarrhea in the two weeks prior to the survey (AOR: 5.36, 95% CI: 1.97–14.61) were independently associated with SAM in the study population.

Conclusion: Large family size, child age, diarrheal and household insecurity were important determinants of SAM among children. Therefore, aligning social protection programmes and improving health related interventions along with improving optimal breastfeeding, prevention and control of child morbidity, and strengthening family planning services are recommended to reduce child SAM.

1. Introduction

.Globally, severe acute malnutrition (SAM) is a significant contributor to disease burden and associated with higher risk of child mortality. In 2018, SAM affected approximately 17 million under-five children worldwide [1]; of these, more than three-fourths lived in low income countries.

SAM is defined as mid-upper arm circumference (MUAC) measurement <11.5 cm or severe wasting (low weight-for-height/length) (<−3SD) or the presence of pitting nutritional edema in children 6–59 months old [2]. Children with SAM usually have weakened immunity and are more vulnerable to infectious diseases [3]. SAM is life-threatening causing globally about one million under-five deaths every year [4]. Due to a weakened immune system, children with SAM have been estimated to have nine-fold higher risk of death compared with normal [5].

Despite remarkable progress, the majority of the SAM cases were found in Africa where 4.4 million children suffered from SAM [1]. Furthermore, SAM contributes from 9 to 46% under-five mortality in the region [6, 7, 8]. Ethiopia has demonstrated significant progress in reducing undernutrition over the past three decades, but it remains as a threat for child growth and survival. As per the 2019 Mini Ethiopia Demographic and Health Survey (MEDHS), 7% of children under the age of five were wasted with 1% suffering from severe wasting [9]. Regional variation of SAM also has been found, ranging from 6% in Somali to 0.4% in Addis Ababa. In Amhara region, 3% of the under-five children suffered from SAM [10]. In Ethiopia, about 45% of mortality among under five-year children is directly or indirectly associated to undernutrition [11] and SAM accounts for 8% of these deaths [12]. Several studies observed child age, morbidity, feeding practices [13], family size and maternal educational status [14] as determinants of SAM. Additional variation also may be associated with agro-ecological zone, seasonality, and urban versus rural residence [15, 16]. Another very important factor associated with child undernutrition is household food insecurity. Food insecurity is widespread in sub-Saharan Africa; in Ethiopia, from 2002 to 2014, nearly 20% of the population required food assistance, partly due to seasonal food shortage and frequent drought-related famine [17]. As an underlying cause for child undernutrition, food insecurity influences

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nutritional status of children by compromising the quantity and quality of the child's diet [18].

Recognizing irreversible consequences of child undernutrition, the Ethiopian government has been implementing various programmes that aim to reducing childhood undernutrition [19]. Despite these efforts, the rates of SAM is still prevalent in the country [20], indicating the need for further investment and action in order to achieve global nutrition targets for 2025 [21]. Evidence-based health and nutrition findings have a crucial role in improving the level of the problem and associated mortality reduction in children [22]. This requires identification of contributing factors for the high magnitude of SAM among children. Therefore, the objective of the study was to identify the factors associated with SAM in food-insecure rural areas of north Ethiopia. Findings generated could be helpful to focus significant investments on specific areas to accelerate the reduction of acute nutritional problem [23].

2. Methods and materials

2.1. Study design, setting and participants

A cross-sectional study was carried out to assess factors associated with SAM among 6-59 months-old children in rural areas of Seqota district, Amhara region, Ethiopia. The study was conducted from February to March, 2020. The region is characterized by a high prevalence of acute undernutrition (7.6%) in under-five children [9]. The inhabitants are predominantly subsistence farmers.

2.2. Sample size determination and sampling procedure

The required sample size was calculated by using a single population proportion formula, $n = Z^2_{\alpha/2}*P(1 - P)/d^2$, where n is the number of samples required, with the assumptions of a 5% significance level (i.e., $Z_{\alpha/2} = 1.96$), 5% margin of error ($d = 0.05$), and prevalence of severe malnutrition of 16.3% ($P = 0.163$) was used from previous study [24]. The estimated sample size was 240 and was increased to 396 to allow ~10% non-response rate and a design effect of 1.5.

Of the total 25 *kebeles* (the lowest administrative unit in Ethiopia) in the district, 15 (60%) were selected by a lottery method. A list of all the mothers with children aged 6–59 months was completed. The number of mother-child pairs to be selected was proportionally allocated to the 15 *kebeles* in the district based on the total number of the households with 6–59-months old children in each *kebele*. The study participants were then selected using systematic random sampling method from the sampling frame.

2.3. Dependent variable

The dependent variable for this study was severe acute malnutrition (SAM) among 6–59 months old children. SAM was considered for children with MUAC <11.5 cm and moderate acute malnutrition (MAM) was MUAC ≥ 11.5 cm and <12.5 cm [3].

2.4. Data collection instruments and study variables

Data were collected using a structured interviewer-administered questionnaire. All the questions were pre-tested in non-sampled neighboring *kebeles*. Data collectors were recruited from the study area and surrounding communities and one week intensive training was provided by the author. Major data such as socio-demographic and economic related characteristics, feeding practices, morbidity status of child, health-seeking behaviour and practices of mother, hygiene and sanitation related variables were collected.

Anthropometric measurements such as height and weight were measured by standard equipment and procedure [25], in duplicates with minimal clothes and without chappal/shoes. Child length was measured to the nearest 0.1 cm using a recumbent (infantometer) for <24 month children and standing height board (Stadiometer) for >24 month, and weight was measured to the nearest 0.1 kg using a calibrated SECA electronic balance. A mid upper arm circumference (MUAC) was measured using MUAC measuring tape from the child's left arm to the nearest 1 mm. All anthropometric measurements were taken by the author and two supervisors.

Household food insecurity status was assessed using the household food insecurity access scale (HFIAS) [26] during the four weeks preceding the survey. The tool consisted of nine questions that represent generally increasing level of severity of food insecurity and four frequency of occurrence. The nine generic occurrence questions relate to three domains of food insecurity. The first generic question relates to anxiety and uncertainty about the household food supply; the next three generic questions relate to insufficient diet quality; and the rest five generic questions relate to insufficient food intake and its physical consequences.

2.5. Data processing and analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 22. Based on responses given to the nine severity questions and frequency of occurrence over the past 30 days, households were assigned a score that ranges from 0 to 27. A higher HFIAS score is indicative of poorer access to food and greater household food insecurity. The lower the score, the less food insecurity (access) a household experienced. Finally, households with HFIAS score of 0–1 were classified as food secure, 2 and above were considered as food insecure. Descriptive data were analyzed using the complex survey analysis approach on the basis of poststratification weights specified for *kebeles*. Descriptive statistics were presented as frequencies and percentages along with the calculation of Pearson's chi-square test to determine associations between predictors and the outcome variable. Anthropometric status of children, the Emergency Nutrition Assessment for Standardized Monitoring and Assessment of Relief and Transitions (ENA for SMART, 2011) software (Action against Hunger, Canada and US Agency for International Development) was used to convert the weight and length or height for age into WHO z-scores. All characteristics associated with the outcome variable in chi-square test were included in the multivariable analysis and significance was considered at $p < 0.05$ level. A multicollinearity diagnostic test was applied between the independent variables before logistic regression was applied. Criteria were set out to be a variance inflation factor (VIF) value of >10.

2.6. Ethical approval and consent to participate

Hawassa University Institutional Review Board, Ethiopia reviewed and approved this study (approval number: IRB/178/10). The purpose of the study was explained in a formal letter to district administration and then written consent was obtained from the Seqota district health office. Informed verbal consent was obtained from all participants. Counseling was given for the mothers/caregivers whose children were identified as SAM.

3. Result

In this study, 384 under-five children were included to assess the predictors of SAM. The mean (SD) age of the mothers was 28.3 (±5.5) years, and 90% were married. Over two-third (68%) of mothers were illiterate while only 32% had some education. Of the 384 children, 59% were males, and the mean age of all children was 22.7 (±13.0) months. Nearly half (47.1%) of the studied children were in the 23–59 months age and the male-to-female ratio was 1.46. Average family size was 4.85 (±1.61) and mean family size was larger for SAM children (Table 1). More than half (52.9%) of the households had no toilet facility, and fewer than a third (27.9%) of households used protected sources of drinking water. About 48% of the households had less than a half hectare of farm

Table 1. Sociodemographic characteristics of households, mothers and children in north Ethiopia (n = 384).

Characteristics	Child with SAM		Total (%)	p-value*
	No	Yes		
	91.7%	8.3%		
Maternal and household factors				
Maternal age				0.687
15–24	86 (22.4)	10 (2.6)	96 (25.0)	
25–34	201 (52.4)	17 (4.4)	218 (56.8)	
35–49	65 (16.9)	5 (1.3)	70 (18.2)	
Maternal education				0.004
Some education	120 (31.2)	3 (0.8)	123 (32.0)	
Not educated	232 (60.4)	29 (7.6)	261 (68.0)	
Place of delivery				0.075
Health institution	211 (54.9)	14 (3.6)	225 (58.6)	
Home	141 (36.7)	18 (4.7)	159 (41.4)	
Marital status				0.192
Married	316 (82.3)	31 (8.1)	347 (90.4)	
Single/separated/ widowed	36 (9.4)	1 (0.3)		
Maternal occupation				0.636
Housewife	287 (74.7)	25 (6.5)	312 (81.2)	
Working	65 (16.9)	7 (1.8)	72 (18.8)	
Used family planning				0.876
Yes	148 (38.5)	13 (3.4)	161 (41.9)	
No	204 (53.1)	19 (4.9)	223 (58.1)	
Family size				<0.001
<5	250 (65.1)	11 (2.9)	261 (68.0)	
≥5	102 (26.6)	21 (5.5)	123 (32.0)	
Mean (±SD)	4.16 ± 1.61	5.82 ± 1.58	4.85 ± 1.61	
Monthly income (ETB)				0.739
≥500 ETB	109 (28.4)	9 (2.3)	118 (30.7)	
<500 ETB	243 (68.3)	23 (6.0)	266 (69.3)	
Toilet facility				0.689
Yes	167 (43.5)	14 (7.7)	181 (47.1)	
No	185 (48.2)	18 (4.7)	203 (52.9)	
Source of drinking water				0.015
Improved	104 (27.1)	3 (0.8)	107 (27.9)	
Not improved	248 (64.6)	29 (7.6)	277 (72.1)	
Household food insecurity				<0.001
Food secure	180 (46.9)	3 (0.8)	183 (47.7)	
Food insecure	172 (44.8)	29 (7.5)	201 (52.3)	
Land size				0.039
<0.5hectar	164 (42.7)	21 (5.5)	185 (48.2)	
≥0.5hectar	188 (49.0)	11 (2.9)	199 (51.8)	
Child factors				
Child age (months)				0.002
6–11	84 (21.9)	15 (3.9)	99 (25.8)	
12–23	93 (24.2)	11 (2.9)	104 (27.1)	
24–59	175 (45.6)	6 (1.6)	181 (47.1)	
Mean age in month (±SD)	23.1 ± 13.0	18.5 ± 13.2	22.7 ± 13.1	
Child sex				0.70
Female	144 (37.5)	12 (3.1)	156 (40.6)	
Male	208 (54.2)	20 (5.2)	228 (59.4)	
Diarrhea history/last 2 weeks				<0.001
Yes	120 (30.3)	26 (6.7)	146 (38.0)	
No	232 (60.4)	6 (1.6)	238 (62.0)	
Initiation of breastfeeding				0.005
Immediately	249 (64.8)	15 (3.9)	264 (68.8)	
Delayed	103 (26.8)	17 (4.4)	120 (31.2)	

* Pearson chi-square test, ETB = Ethiopian Birr.

land, and 52% of the households were food insecure. Nearly a quarter (24.5%) and two thirds (65%) of mothers had ≥4 and ≤3 antenatal care (ANC) services during their pregnancy of the current child, respectively (Data not shown). More than two thirds of children (68.8%) started breastfeeding within 1 h after birth.

Prevalence of acute undernutrition based on MUAC criteria was 26% (95% CI: 22.1–30.7), of which 18% (95% CI: 14.1–22.1) and 8% (95% CI: 6.0–11.5) were moderately and severely undernourished, respectively. The proportion of SAM based on the definition of WHZ < −3 were 7% (95% CI: 4.4–9.9). Around 45% (95% CI: 38.9–50.3) of the children were stunted and 24% (95% CI: 20.1–28.9) were underweight.

Table 2 shows the mean for MUAC, weight-for-length/height z-score, length/height-for-age z-score and weight-for-age z-score for SAM and non-SAM children. The mean ± SD for MUAC of SAM and the non-SAM group was 10.6 cm ± 1.2 versus 13.1 ± 0.79, respectively. Similarly, the mean ± SD of weight-forage z-score of SAM cases and non-SAM group was -2.18 ± 1.83 versus -1.23 ± 1.11 (p < 0.001), respectively. Multicollinearity was checked by using the variance inflation factor (VIF). Nevertheless, no multicollinearity between independent variables was found. In multivariable logistic regression analysis adjusted for all associated factors family size (≥5 members), younger child age, recent diarrheal illness and household food insecurity remained significant determinants of SAM among children (Table 3).

Households with family size (≥5 members) significantly associated with an increased likelihood of having SAM (AOR = 3.71; 95% CI: 1.55–8.88). The odds of SAM were 3.42 times higher among children of households experiencing food insecurity (AOR = 3.42, 95% CI: 1.15–10.17) compared to children in the food secure households compared to 24–59 months old children, increased odds of SAM were found among children 6–11 months (AOR = 4.80, 95% CI: 1.61–14.31) and 12–23 months (AOR = 4.07, 95% CI: 1.30–12.74). Finally, it was also found that recent diarrheal illness associated with SAM among children (AOR = 5.36; 95% CI: 1.97–14.61).

4. Discussion

This study investigated prevalence of SAM and associated factors among children aged 6–59 months in rural areas of Seqota district of Ethiopia. It was found that only 8% of the studied children were severely undernourished. The finding was similar with other studies conducted in Ethiopia [27] and Sudan [28], but higher than the SAM rates reported from Nepal (5.8%) and (4.1%) [29, 30], from the recent 2019 MEDHS (2.9%) [9], other rates from SNNPR (3.3%) [31] and Oromia (2.3%) [32] regions in Ethiopia. The high burden of SAM may be explained in terms of suboptimal child feeding practices and chronic food insecurity in the study district as food insecurity compromises quality and quantity of children's diets.

Four characteristics were associated with SAM in Chi-square test and in the bivariate analysis but did not remain significant in the multivariable analysis. These factors were: initiation of breast feeding, lack of maternal education, small farm land size and use of unprotected water. Most literature supports each of these factors as contributors to prevalence of SAM; however, there are at least two reasons they may not have remained in present study adjusted models. The sample size may have been insufficient for the number of factors tested or the sample variability may have been limiting because all the *kebeles* had been identified for the Productive Safety Net Programme. The findings of a multivariable analysis showed that family size, household food insecurity, child age and history of diarrhea in the 2 weeks preceding the survey were significantly associated with SAM.

Congruent with previous literatures [33, 34, 35], the present study found that households with five or more members were statistically associated with higher odds of SAM. This is due to the fact that higher the family sizes may compromise intra-household food allocation [36] and will be the load to the mothers to provide nutritious diets to all the household members and children. Moreover, in higher family members,

Table 2. Mean (standard deviation) anthropometric measurements and Z-scores by SAM of the studied children, north Ethiopia (n = 384).

Characteristics	Child with SAM		p-value*
	No	Yes	
Length/height-for-age z-score	-1.94 (1.88)	-2.01 (1.49)	0.87
Weight-for-length z-score	-0.15 (1.31)	-1.59 (1.79)	<0.001
Weight-for-age z-score	-1.23 (1.11)	-2.18 (1.83)	<0.001
MUAC, cm	13.1 (0.8)	10.63 (1.2)	<0.001

* Significantly different by anthropometric status from the t-test, equal variances assumed.

Table 3. Multivariable analysis for SAM with independent variables (maternal, household and child characteristics) among children 6–59 months in north Ethiopia (n = 384).

Characteristics	COR (95%CI)	AOR (95%CI)	p-value for AOR
Maternal and household factors			
Maternal education			
Some education	1	1	
Not educated	5.0 (1.49–16.75)	2.72 (0.57–8.36)	0.24
Family size			
<5	1	1	
≥5	4.6 (2.17–10.05)	3.71 (1.55–8.887)	0.003
Household food security			
Food secure	1	1	
Food insecure	5.52 (2.08–14.67)	3.42 (1.15–10.17)	0.027
Source of drinking water			
Improved	1	1	
Not improved	4.05 (1.21–13.60)	3.65 (0.94–13.91)	0.06
Land size			
≥0.5hectar	1	1	
<0.5hectar	2.18 (1.02–4.67)	1.97 (0.81–4.78)	0.13
Child factors			
Age (month)			
6–11	5.20 (1.95–13.90)	4.80 (1.61–14.31)	0.005
12–23	3.45 (1.23–9.62)	4.07 (1.30–12.74)	0.016
24–59	1	1	
Diarrheal history/last 2 weeks			
No	1		
Yes	8.39 (3.36–20.91)	5.36 (1.97–14.61)	0.001
Initiation of breastfeeding			
Immediately	1	1	
Delayed	2.74 (1.32–5.69)	1.82 (0.77–4.30)	0.16

1 = reference category, COR = Crude odds ratio, AOR = Adjusted odds ratio, statistically significant at $p < 0.05$.

it is difficult for the parents to provide optimal caring that each child is expected to get from parents, putting them at a higher risk of being undernourished. This result is in contradicting with the studies done in India, and Nepal [30, 37]. This could be due to socio-economic and food insecurity status in the study population.

In this study, children from the food insecure households were more likely to be undernourished. Several studies found that household food insecurity had a statistically significant effect on the nutritional status of the children [38, 39]. This finding is plausible as food insecurity limits food availability and compromises quality of child's diet, could not meet the nutrient requirements of a child to sustain needs for growth and development. This is unfortunate; quality diet particularly animal-source foods are correlated with lower risk of undernutrition [40]. This finding is in contrast with those studies from Bangladesh and elsewhere in Ethiopia [41, 42].

It was observed that age had a significant effect on SAM of the children. The findings of this study are in agreement with other countries like Senegal, Mozambique, and Nepal [43, 44, 45]. This might from the fact that younger children have low stomach capacity as compared to the older children, and at the same time they are in transition from predominant breast milk based-diet to family foods. This finding suggests the need for increased frequency of feeding for the younger children compared to the older age group. Moreover, the complementary feeding time is a particularly vulnerable period because energy and micronutrient requirements are high for increased physical and cognitive development [46]. Optimal feeding practice during the first 1000 days of life helps to prevent SAM and growth failure [47]. However, inadequate feeding and an early introduction of family foods for children in Ethiopia are widespread [48], and that could be a possible reason why SAM was higher among younger age group compared to older children.

The results from this study showed a strong association between recent diarrheal morbidity in a child and SAM. Diarrheal infection plays a major role in the etiology of SAM as it results in reduced food intake, decrease in absorption of nutrients and increase in catabolism of nutrient reserves. Although the causal relationship between diarrheal infection and SAM is unclear in this study, previous literatures have long been documented a vicious circle [49, 50]. This finding is consistent to studies from Chad and South Africa [38, 51].

There are some limitations in this study. First, sample size might be considered inadequate to accommodate more than four predictors and the strength of associations between SAM and breast feeding and maternal education may have been underestimated. Second, the cross-sectional nature of the present study does not account for seasonal variations nor does it allow causal inferences to be made. A further limitation is that the present findings came from a single district and thus cannot be generalized to other districts of the Ethiopia. Nevertheless, this study is one of a few studies in Ethiopia to investigate the determinants of SAM in rural households among the most vulnerable 6–59 months age group. The three important factors determined in this study may be targets for nutrition interventions to reduce undernutrition among study population and other similar settings in Ethiopia. These are important findings that can have implications for design and for directing important nutrition interventions that aim to reducing SAM and future research initiatives.

5. Conclusion

This study highlights that prevalence of SAM was higher compared with other studies. Although the government of Ethiopia has declared its commitment to end undernutrition by 2030 [23] through government commitment programme, the findings from this study show that much remains to be done within the remaining years. Large family size, child age, diarrheal illness and household food insecurity were significantly associated with SAM among children 6–59 months. This is an important finding in a PSNP area that can have implications in the development and implementation of interventions to tackle SAM. Although further detailed studies are warranted to establish the causal association between aforementioned factors focusing on SAM with bilateral oedema, and moderate acute malnutrition of children, aligning social protection programmes and improving health services along with improving breast feeding practices, prevention and control of child illness, and strengthening family planning services are recommended to reduce child SAM.

Declarations

Author contribution statement

Anchamo Anato: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available upon a reasonable request.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

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