

Predictors of Severe Acute Malnutrition among Children Aged 6 to 59 Months Attended out Patient Therapeutic Program Center in Kavre District of Nepal - A Case Control Study

Rajan Bhandari^{1,*}, Sangita Kumari Khatri² and Khadga Bahadur Shrestha³

¹Health and Nutrition Department, Save the Children, Nepal Country Office, Airport Gate Area, Shambhu Marg, Kathmandu, PO: Box 3394, Nepal

²Gorkha District Hospital, Gorkha, Nepal

³Interdisciplinary Graduate School of Medicine and Engineering, University of Yamanashi, Silk Sunshine, B-21, Kofushi, Yamanashi, Japan

Abstract: *Background:* Severe acute malnutrition is an excessive loss of weight due to the acute shortage of food or illness. It is one of the major public health problems in developing countries including Nepal. According to multiple indicator cluster survey (MICS) 2014, 2.6% severely malnourished in Nepal and 4.4% are severely malnourished in Kavre district. However, there are limited studies about predictors of severe acute malnutrition in Nepal. Thus, this study was aimed to identify the predictors of severe acute malnutrition in Kavre district of Nepal.

Methods: Health facility based matched case control study was conducted among 210 (70 cases and 140 controls) children aged 6-59 months from November 2015 to April 2016. Data was collected through face to face interview with mother of eligible children using structured questionnaires. Multivariate analysis was applied to estimate adjusted odds ratio along with 95% confidence interval.

Results: Children with severe acute malnutrition were 11.32 times more likely than control to have recurrent diarrhea in past six months (95% CI=4.64-28.21). Similarly, severe acute malnutrition was associated with female sex (AOR=2.44, 95% CI=1.88-6.78), fathers occupation daily labor (AOR=4.69, 95% CI=1.17-13.76) and agriculture (AOR=6.850, 95%CI=3.81-12.93), improper exclusive breast feeding (AOR=6.646, 95%CI=2.11-20.90), not feeding colostrum (AOR=3.89, 95% CI=2.88-11.21), severe food insecurity access (AOR=3.55, 95% CI=1.85-9.77) and monthly income less than average level (AOR=8.214, 95% CI=1.43-22.16).

Conclusion: Severe acute malnutrition was independently associated with sex of child, occupation of father, monthly household income, not feeding colostrum, improper exclusive breast feeding, severe household food insecurity access and recurrent diarrhea.

Keywords: Acute Malnutrition, Food security, Breast feeding, Therapeutic center, Diarrheal disease.

BACKGROUND

Malnutrition leads to lost opportunities in life and good nutrition can contribute to economic growth [1]. Severe Acute Malnutrition (SAM) means very low weight for height (Z score is less than -3SD) and visible severe wasting or presence of bilateral nutritional edema. In children aged 6–59 months, a mid-upper arm circumference (MUAC) less than 11.50cm is also indicative of severe acute malnutrition [2].

In developing countries, severe acute is one of the leading cause of the morbidity and mortality among children below five years of age [3]. Globally, nearly 20 million children are severely acutely malnourished. Severe acute malnutrition can be a direct cause of child death, or it can act as an indirect cause by dramatically increasing the case fatality rate in children suffering

from such common childhood illnesses as diarrhea and pneumonia. Globally, between 8 to 11 million under-five children die each year, and about 1 million children die every year from SAM [4,5]. In Nepal, despite the progress in reducing child mortality and achieving Sustainable Development Goal (SDG); the nutritional status of the children is still poor. According to the Nepal Demographic and Health Survey (NDHS) 2011, 11% of the children are wasted and 2.6% and severely wasted [6].

Globally different studies showed different predictors for developing SAM including female gender [7], Birth interval [3], type and size of family [3,8], parent's education and occupation [3,8,9], household Income [8], sub-optimal frequency of breast feeding [3], Pre-lacteal feeding [8], improper exclusive breastfeeding [8], sub-optimal frequency of complementary feeding [3], inappropriate feeding practice [9], late initiation of complementary diet [8], recurrent diarrhea [3,9,10], and food insecurity [11-13].

*Address correspondence to this author at the Health and Nutrition Department, Save the Children, Nepal Country Office, Airport Gate Area, Shambhu, Kathmandu P.O.: Box 3394, Nepal; Tel: +977-1-4468130; Mob: +977-9843288172; Fax: +977-1-4468132; E-mail: rjbhandari11@gmail.com

According to World Health Organization (WHO) Crisis Classification, the prevalence of acute malnutrition (11%) is at serious level in Nepal [14,6]. Few of the studies were found to be conducted on malnutrition using cross-sectional designs which are not adequate to explain the predictors of SAM. In the absence of in-depth research and clear evidences on predictors, the reasons for the continuing serious levels and regional patterns of acute malnutrition are difficult to explain. Thus, this study is expected to fulfill this gap by assessing the predictors of severe acute malnutrition among children aged 6-59 months attended out-patient therapeutic program (OTP) Centre in Kavre districts of Nepal.

METHODS

Study Design and Area

A matched case control study was carried out in OTP centers from November 2015 to April 2016 in Kavre district of Nepal. Kavre district was chosen for the study because it has the highest prevalence of severe acute malnutrition. As of Multiple Indicator Cluster Survey (MICS) 2014, the prevalence of acute malnutrition and severe acute malnutrition in Kavre district is 5.9% and 4.4% respectively is almost double than the national Figure (2.6) [15].

Source and Study Population

Source of the population for this study were all the children aged 6-59 months who were visited or admitted to selected OTP centers for different health concerns during the study period.

Inclusion Criteria

Cases were the children aged 6-59 months who were diagnosed as a severe acute malnutrition (weight for height less than -3SD and/or bipedal nutritional edema or MUAC less than 11.5cm) and visited OTP centers with their mothers and who gave informed consent. Controls were the children aged 6-59 months who had MUAC ≥ 12.5 cm, without bilateral nutritional edema and visited OTP center with their mother and who gave informed consent. Case and controls were matched with similar age.

Sample Size Calculation

The sample size was calculated using StatCalc application of Epi Info (version 7) with ratio of case to control 1:2, 80% power, and 95% confidence level. The

proportion of sub-optimal frequency of complementary feeding among case to be 84.8% and 64.4% among control and odds ratio was 3.03 [3]. Thus, minimum sample size required for the study was 210 consisting 70 cases and 140 control considering 10% non-response rate.

Sampling Technique

Out of thirteen OTP centers in Kavre district, nine OTP centers with highest number of severe acute malnourished children were selected for the study purpose. In each selected OTP centers, the children aged 6-59 months who admitted with SAM was listed. The children with SAM were taken as a case based on the inclusion criteria. Cases were the children having weight for height (WHZ) less than -3SD and/or, bipedal nutritional edema or MUAC less than 11.5cm who already diagnosed and admitted in OTP centers [2]. Only the mothers whose children were included in the list and met the criteria of SAM were interviewed. For control selection, age of the children who visited the same OTP center with their mother was identified using immunization and growth monitoring card. The children with similar age to case were identified and MUAC was taken and the children who had MUAC ≥ 12.5 cm and whose mother gave informed consent for the data collection were recruited as a control. Only children accompanied by their own mothers were recruited and interviewed to minimize the recall bias. The MUAC was measured and interview was taken using first come first serve strategy. Children with congenital malformation, known chronic disease like HIV, TB and physical disability were excluded from this study.

Data Collection Tools and Techniques

The quantitative data was collected by investigator in support with trained health facility staffs. Data was collected through to face interview with the mother of all eligible children using structured questionnaire and MUAC tape. The questionnaire was first developed in English based on the relevant literatures such as Nepal Demographic Health Survey (NDHS), UNICEF and Food and Nutrition Technical Assistance (FANTA) guidelines [6,16,17] and it was translated into Nepali language. Trained health person from respective OTP center have supported to measure MUAC and identify bilateral pitting edema.

Variables of the Study

The independent variables of the study were categorized into different titles as socio-demographic

variables (sex of child, age of mother, maternal parity, birth interval, types of family); socio-economic variables (educational status of parents, occupation of parents, household monthly income less than NRS 27511 or more than NRS 27511 based on the fifth house budget survey, 2015 conducted by Nepal Rastra Bank [18]); infant and young child feeding practice (breast feeding, complementary feeding and dietary diversity- dietary intakes of the children were obtained from an interactive 24-hour dietary recall. Mothers of children were asked to recall all the foods and beverages consumed by their children over the past 24-hours); household food insecurity access status (it was assessed by using the Household Food Insecurity Access Scale (HFIAS), particularly by using Household Food Insecurity Access Prevalence (HFIAP) nine questions developed by Food and Nutrition Technical Assistance Project (FANTA), USAID. The respondents were asked about the adequacy and variety of meals eaten, and the occurrence of food shortage for the household members, causing them not to eat the whole day or eat at night only, in the past twelve months preceding the data collection. All the responses of the respondents were categorized into four categories based on HFIAP criteria as: 1= Food Secure, 2=Mildly Food Insecure Access, 3=Moderately Food Insecure Access, 4=Severely Food Insecure Access [16]; Childhood diseases(recurrent diarrhea, ARI and measles). When diarrhea recurs frequently for more than 2 weeks or longer was considered as a recurrent which may cause malnutrition [19,20]. Severe acute malnutrition was the dependent variable of the study.

Data Management and Analysis

The filled questionnaires were thoroughly checked and verified for the completeness and accuracy on the same day of data collection. Data entry was done using EpiData version 3.1 and analysis was done using IBM SPSS statistics version 20. The statistical significance of the difference was observed in terms of amount of exposure among case as compared to controls by the chi-square test or Fisher's exact test (if the expected number in any cell was ≤ 5). Bivariate analysis was performed to estimate the magnitude of the association between individual risk factors and severe acute malnutrition in terms of Crude Odds Ratio (COR). Multivariate analysis was done to identify independent predictors in terms of Adjusted Odds Ratio (AOR) by adjusting among a group of independent variables. The independent variables that found an associated with the dependent variable in the bivariate analysis with p value ≤ 0.20 were entered into the final multivariate

logistic regression analysis. However, biologically plausible regardless of the p value were also included. Adjusted odds ratio along with 95% confidence interval was estimated and p value < 0.05 was used to declare the independent predictors with statistical significance in the final multivariable analysis. Variance Inflation Factor (VIF) and tolerance level among independent variable was identified through multicollinearity test before fitting into the final model. The appropriateness of the data for this model was identified by using goodness of fit by Hosmer and Lemeshow test.

Ethical Approval and Consent to Participants

Ethical approval was taken from Institute of Review Board (IRB) clearance (ref.no.128 (6-11-E) ²/072/072) of Institute of Medicine (IOM), Department of Community Medicine and Public Health. Permission was taken from the District Public Health Office (DPHO) and selected OTP centers of Kavre Districts. Verbal and written informed consent was taken from individual participants before interview, voluntary participation and freedom of refusal at any time during study was applied strongly. Information regarding the importance of breastfeeding, complementary feeding and good nutrition was given to the mothers of children immediately after data collection.

RESULTS

Socio-Demographic and Economic Characteristics

A total of 210 sample respondents, 88% mothers of children were from age group 20-34 years. Mean age of cases and controls were 20.83(SD \pm 13.12) and 19.13(SD \pm 11.10) months respectively. Mothers with age group 20-34 years have highest (80%) number of severely acute malnourished children. Almost half (49.5%) of the mother given live birth of two followed by one (33.8%) three (12.4%) and more than three (4.3%). Nearly fifty percent of cases (42.9%) and 52.9% percent control were from maternal parity two. Higher proportion (44.3%) of the children were in the age group 12-23 months followed by the age group less the 6-11 months (31%), 24-35 months (11.9%) and 36-59 months (12.9%). There were 58.1% of male and 41.9% of female. Nearly fifty percent (42.9%) of the case have birth interval less than 24 months. Majority of children (case 68.6%) and (control 66.7%) were from joint family. Similarly, mother of one third children (31.4%) had non-formal education and mothers of (30% case and 10.7% control) were illiterate. The proportion of mothers having primary and secondary level education was found higher among control than case. The

educational level of father with higher secondary contributes 12.9% in cases and 22.1% in controls. A total of respondents, 83.3% were involved in agriculture (case 91.4% and 79.3% control). Regarding the occupation of father, daily laborer (35.7%) and agriculture (25.7%) contributed more among cases, whereas employer (32.1%) and foreign employments (21.4%) contributed more among controls. Respondents from more than eighty were from household having monthly income below the average level. Whereas, 92.9% mothers were among the cases and 81.4% mothers were among controls (Table 1).

Childhood Illness of the Study Participants

More than three quarter (78.6%) of the cases and 18.6% of the controls had experienced recurrent diarrhea. Likewise, 68.6% of the cases and 25% controls had ARI (Table 2).

Household Food Insecurity Access Status of the Study Participants

Only 14.3% households among cases and nearly fifty (47.1%) household among controls were found

food secure. However, 44.3% case and 11.4% control experienced severe food insecurity (Table 3).

Childhood Feeding Practice of the Study Participants

Majority of the mother (73.3%) among the cases and (88.6%) among the controls had initiated breast feeding within one hour of birth. Whereas, 24.3% mothers among cases had not fed colostrum. Nearly one fifth (17.1%) mothers among case had given food and water before breast feeding. Similarly, more than two thirds of mothers (65.7%) among cases and one third (32.1%) of mothers among controls had not practiced exclusive breast feeding. Likewise, more than fifty percent (55.7%) of mothers among case and more than one fourth (27.1%) mothers among control initiated complementary feeding before and after six months. Nearly one fifth (23.2%) of cases and one third (29.9%) of controls had practiced optimal frequency of meal that is four or more times per day. Only 17.9 of the cases and 37.6 of the controls had consumed four or more types of food per day (Table 4).

Table 1: Socio-Demographic Characteristics of the Study Participants by Nutritional Status

Characteristics	Status		COR (95%CI)	p-value
	Case (%) (n=70)	Control (%) (n=140)		
Mother's Age at birth				
<20 and ≥35 years	14 (20%)	11 (7.9%)	2.930 (1.25-6.86)	.013
20-34 years	56 (80.0%)	129 (92.1%)	1	
Sex of Child				
Female	41 (58.6%)	47 (33.6%)	2.798 (1.55-5.05)	.001
Male	29 (41.4%)	93 (66.4%)	1	
Birth Order of the children				
3rd or more	22 (31.4%)	13 (9.3%)	4.478 (2.09-9.59)	<.001
Less than 3rd	48 (68.6%)	127 (90.7%)	1	
Maternal Parity				
Three or more	21 (30%)	14 (10%)	3.850 (1.82-8.19)	<.001
Less than 3	49 (70%)	126 (90%)	1	
Birth Interval (n=135)				
12-23 months	26 (53.1%)	12 (14%)	6.970 (3.04-15.967)	<.001
24 or more	23 (46.9%)	74 (86%)	1	
Family Type				
Joint	49 (70.0%)	98 (70.0%)	1 (.54-1.87)	1.00
Nuclear	21 (30.0%)	42 (30.0%)	1	

1= Reference category, COR= Crude Odds Ratio, Case=under five children with MUAC<11.5cm and/ or bilateral pitting edema, Control=under five year children with MUAC ≥=12.5 cm without bilateral pitting edema. Other occupations of mothers includes: employer, business, daily labors, and house management. Other occupations of father includes: employer, business, foreign employments, driver and police.

Table 2: Childhood Diseases of the Study Participants and Nutritional Status

Characteristics	Status		COR (95%CI)	p-value
	Case (%) (n=70)	Control (%) (n=140)		
Recurrent Diarrhea				
Yes	55 (78.6%)	26 (18.6%)	16.077 (7.89-32.78)	<.001
No	15 (21.4%)	114 (81.4%)	1	
ARI				
Yes	48 (68.6%)	35 (25%)	6.545 (3.48-12.33)	<.001
No	22 (31.4%)	105 (75%)	1	

1= Reference category, COR= Crude Odds Ratio, 1= Reference category, COR= Crude Odds Ratio, Case=under five children with MUAC<11.5cm and/ or bilateral pitting edema, Control=under five year children with MUAC >=12.5 cm without bilateral pitting edema.

Table 3: Household Food Insecurity Access Scale by Nutritional Status

Characteristics	Status		COR (95%CI)	p-value
	Case (%) (n=70)	Control (%) (n=140)		
Household food insecurity				
Severely Food Insecure	31(44.3%)	16 (11.4%)	12.787 (5.21-31.39)	<.001
Moderately Food Insecure	18 (25.7%)	38 (27.1%)	3.126 (1.31-7.46)	.010
Mildly Food Insecure	11 (15.7%)	20 (14.3%)	3.630 (1.346-9.787)	.011
Food Secure	10 (14.3%)	66 (47.1%)	1	

1= Reference category, COR= Crude Odds Ratio, 1= Reference category, COR= Crude Odds Ratio, Case=under five children with MUAC<11.5cm and/ or bilateral pitting edema, Control=under five year children with MUAC >=12.5 cm without bilateral pitting edema.

Table 4: Feeding Practice of the Study Participants by Nutritional Status

Characteristics	Status		COR (95%CI)	p-value
	Case (%) (n=70)	Control (%) (n=140)		
Initiation of Breast Feeding				
After one hour	18 (25.7%)	16 (11.4%)	2.583 (1.27-5.66)	.010
Within one hour	52 (74.3%)	124 (88.6%)	1	
Colostrum Feeding				
No	17 (24.3%)	16 (11.4%)	2.486 (1.17-5.39)	.018
Yes	53 (75.7%)	124 (88.6%)	1	
Prelacteal Feeding				
Yes	12 (17.1%)	7 (5%)	3.931 (1.47-10.49)	.006
No	58 (82.9%)	133 (95%)	1	
Exclusive Breast Feeding				
Less or more than 6 months	46 (65.7%)	45 (32.1%)	4.046 (2.20-7.43)	<.001
Six months	24 (34.3%)	95 (67.9%)	1	
Initiation of Complementary Feeding				
Before and after 6 months	39 (55.7%)	38 (27.1%)	3.377 (1.85-6.16)	<.001
During 6 months	31 (44.3%)	102 (72.9%)	1	

(Table 4). Continued.

Characteristics	Status		COR (95%CI)	p-value
	Case (%) (n=70)	Control (%) (n=140)		
Frequency of Breastfeeding				
Less than 8 times	52 (92.9%)	91 (77.8%)	3.714 (1.23-11.23)	.020
Eight times or more	4 (7.1%)	26 (22.2%)	1	
Minimum CF frequency				
Less than 4 times	43 (76.8%)	82 (70.1%)	1.412 (0.68-2.94)	.358
Four or more times	13 (23.2%)	35 (29.9)	1	

1= Reference category, COR= Crude Odds Ratio, 1= Reference category, COR= Crude Odds Ratio, Case=under five children with MUAC<11.5cm and/ or bilateral pitting edema, Control=under five year children with MUAC >=12.5 cm without bilateral pitting edema.

Table 5: Independent Predictors of Severe Acute Malnutrition among Children from Bivariate and Multivariate Analysis

Characteristics	Status		COR (95%CI)	AOR (95% CI)
	Case (%)	Control (%)		
Sex of the children				
Female	41 (58.6%)	47 (33.6%)	2.798 (1.55-5.05)**	2.44 (1.88-6.78)*
Male	29 (41.4%)	93 (66.4%)	1	1
Occupation of Father				
Agriculture	18 (25.7%)	19 (13.6%)	3.745 (1.74-8.11)**	6.850 (3.81-12.93)**
Daily labors	25 (35.7%)	14 (10.0%)	7.077 (3.29-15.42)***	4.690 (1.17-13.76)**
Others	27 (38.6%)	107 (76.4%)	1	1
Monthly Household Income				
Less than NRS 27511	65 (92.9%)	114 (81.4%)	2.965 (1.09-8.10)*	8.214 (1.43-22.16)**
More than NRS 27510	5 (7.1%)	26 (18.6%)	1	1
Colostrum Feeding				
No	17 (24.3%)	16 (11.4%)	2.486 (1.17-5.39)*	3.895 (2.88-11.21)**
Yes	53 (75.7%)	124 (88.6%)	1	1
Exclusive Brest Feeding				
Less or more than 6 months	46 (65.7%)	45 (32.1%)	3.931 (1.47-10.49)***	6.646 (2.11-20.90)***
Six months	24 (34.3%)	95 (67.9%)	1	1
Household Food Insecurity				
Severely Food Insecure	31(44.3%)	16 (11.4%)	12.787 (5.21-31.39)***	3.545 (1.85-9.77)**
Moderately Food Insecure	18 (25.7%)	38 (27.1%)	3.126 (1.31-7.46)*	.643 (.172-2.41)
Mildly Food Insecure	11 (15.7%)	20 (14.3%)	3.630 (1.346-9.787)*	1.389 (.276-7.075)
Food Secure	10 (14.3%)	66 (47.1%)	1	1
Recurrent Diarrhea				
Yes	55 (78.6%)	26 (18.6%)	16.077 (7.89-32.78)***	11.321 (4.64-28.21)***
No	15 (21.4%)	114 (81.4%)	1	1

Statistically significant at *p<0.05, **p<0.01, ***p<0.001, CI=Confidence Interval, COR=Crude Odds Ratio, AOR=Adjusted odds Ratio, Case=under five children with MUAC<11.5cm and/ or bilateral pitting edema, Control=under five year children with MUAC >=12.5 cm without bilateral pitting edema.

Other occupations of father includes: employer, business, foreign employments, driver and police.

Adjusted variables: age of mother, birth interval sex of child, birth order, mother education, father education, mother occupation, father occupation, income, initiation of breast feeding, colostrum feeding, prelacteal feeding, exclusive breast feeding, frequency of breast feeding, frequency of complementary feeding and minimum dietary diversity food insecurity assess category, recurrent diarrhea, Acute Respiratory Infection.

Bivariate Logistic Regression Analysis

In bivariate analysis, the SAM is found to be significantly associated with sex of child, birth order, maternal parity, birth interval, education of mother, occupation of father, exclusive breast feeding, initiation of complementary feeding, recurrent diarrhea, ARI, severe food insecurity at ($p < 0.001$, 95% CI) and age of mother at child birth, education of father, monthly household income, initiation of breast feeding, colostrum feeding, pre-lacteal feeding, frequency of breast feeding, dietary diversity at ($p < 0.05$, 95% CI).

Multivariate Logistic Regression Analysis

The variables that showed an association with SAM at $p \leq 0.20$ in bivariate analysis were included in multivariate logistic regression model. Multicollinearity test was performed before fitting final regression model.

The independent variables with high correlation coefficient (> 0.7) and high VIF were not included in the final analysis. The result of the VIF ranges from 1.145-8.354. The model was fit as shown by Hosmer and Lemeshow test of significance ($p = 0.258$). The coefficient of determination (Nagelkerke R Square) is 0.702 which revealed that 70% of change in dependent variable is explained by independent variables shown significantly associated in multivariate analysis.

The final adjusted model revealed that the odds of severe acute malnutrition was significantly higher among children who are female (AOR=2.44; 95% CI=1.88-6.78), whose father worked as a daily labor (AOR=4.690; 95% CI=1.17-13.76) and in agriculture (AOR=6.85; 95% CI=3.81-12.93), having family with household income below the average level (AOR=8.214; 95% CI=1.43-22.16), did not feed colostrum (AOR=3.895; 95% CI=2.88-11.21), did not exclusively breastfeed (AOR=6.646; 95% CI=2.11-20.90), had recurrent diarrhea in past six months (AOR=11.321; 95% CI=4.64-28.21) and household with severely food insecure access scale (AOR=3.545; 95% CI=1.85-9.77) (Table 5).

DISCUSSION

This study showed that the odds of SAM was significantly higher among female gender than in male which is contrary to the study done in Ethiopia [3] but other research conducted in Iran and Southern Africa [7,21], female gender was found more strong on risk

factors of SAM. Considering the differences between these studies, it appears that sex is a biological factor but gender is not a biological factor for SAM, gender affects the health of children at the different stages of growth and development through various social and cultural factors in different societies.

This study revealed that maternal illiteracy was not significantly associated with SAM in multivariate analysis which was contrary with other studies conducted in Ethiopia [3,8] Bangladesh [22]. This might be due to that most of the decision regarding rearing and caring of children, managing of foods, seeking health care for the children is done by the father. The occupation of father like daily labor and agriculture were independent predictors of severe acute malnutrition which is in accordance with the findings of other studies from South India and Bangladesh [22,23]. These occupations are among lowest paid employment categories in Nepal. Moreover, they often result in irregular or insecure income and ultimately lead to consumption of low diversified and low quality food.

This study revealed that the improper exclusive breast feeding was independent predictor of the SAM which is consistent with the studies for Ethiopia [8,22,24] but contrary with the hospital based case control study conducted in India [25]. However, SAM was not found statistically significant associated with initiation of breast feeding, pre-lacteal feeding, initiation of complementary feeding, frequency of breast feeding, initiation of complementary feeding and frequency of complementary feeding.

In this study, not feeding colostrum was also found as an independent predictor of SAM which was consistent with studies from Ethiopia and India [8,25]. This might either be due to low awareness regarding the importance of colostrum feeding and exclusive breast feeding or due to some social norms like most of the community people in Rural Nepal thought that colostrum may cause diarrhea and they prefer to take it out before feeding. Though, community based intervention for newborn care practice has been implemented in the study area, the proper message regarding feeding practice especially the importance of colostrum feeding and exclusive breast feeding might not be reached effectively to the hard-to-reach and disadvantaged groups of people. The study found that the children having history of recurrent diarrhea was significantly associated with SAM which consistent with finding observed in the studies done in Bangladesh and Ethiopia [3,22]. This may be due to the excess loss of

fluids and electrolytes, loss of appetite, lack of absorption of food in the intestine due to high motility of the intestine during diarrhea episodes. This study identified that the ARI and measles were not significantly associated with SAM. The household which experience food insecurity was found to be an independent predictor of SAM. Various studies have not taken this exposure variable for SAM but it was important variable in the context of this study area. This finding supports the results from other studies in Malaysia and Nigeria [26,27]. Food accessibility remains a great challenge in the study area because of difficult geographical structure; dry area, inadequate food production. Food insecurity is a condition of the family in which parents and adult care givers are assumed to cut down their own food intake first in order to maintain an adequate food provision for their children and this might force the family members to consume poor food quality and/or quantity. This study was not able to assess maternal factors such as maternal nutritional status (BMI), maternal micronutrient deficiency, maternal diseases and maternal health care practice even though different studies identified these as important risk factors of SAM. This study was based on retrospective case-control design which may be prone to recall bias during data collection, to some extent; it was minimized through careful probing and providing adequate time to recall. Maintaining Inter-observer reliability of anthropometric measurement is another limitation. However, standardized anthropometric measurements were used and proper attention was given during the data collection. Similarly, trained health worker who took the measurements as a part of their routine job have supported for taking measurements during this study time.

CONCLUSION

The evidence from this study reveals that SAM was the result of multiple factors. The different forms of multidisciplinary and interrelated determinants were female gender, paternal education level, fathers occupation with agriculture and daily labor, household monthly income less than average, not feeding colostrum, exclusive breast feeding less or more than six months, households with severe food insecurity access category and frequent diarrhea were the independent predictors of severe acute malnutrition among children under five years of age. The findings of this study recommended that the district level health facilities should strengthen community level nutritional and hygiene related activities such as promotion of

exclusive breast feeding, colostrum feeding, and complementary feeding without any gender discrimination. Similarly attention needs to be given on promotion of hygiene and sanitation. Most importantly, district level offices should give more attention for identifying and providing various opportunities for household income generation and local crop production. Targeted and integrated program needs to be implemented and scaled up to address the SAM among children in the study district. Further community based study need to be conducted to identify the prevalence and risk factors of SAM especially in other food insecure districts.

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LIST OF ABBREVIATIONS

- AOR = Adjusted Odds Ratio
- COR = Crude Odds Ratio
- DPHO = District Public Health Office
- FANTA = Food and Nutrition Technical Assistance
- HFIAP = Household Food Insecurity Access Prevalence
- IOM = Institute of Medicine
- IRB = Institute of Review Board
- MICS = Multiple Indicator Cluster Survey
- MUAC = Mid-Upper Arm Circumference
- NDHS = Nepal Demographic and Health Survey
- OTP = Out-Patient Therapeutic Program
- SDG = Sustainable Development Goal
- UNICEF = United Nations Children’s Fund

VIF = Variance Inflation Factor

WHZ = Weight for Height

COMPETING INTERESTS

The authors declare that none of the authors have any competing interests.

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REFERENCES

- [1] NPC. Multi-Sector Nutrition Plan: For Accelerating the Reduction of Maternal and Child Undernutrition in Nepal 2013-2017. 2012.
- [2] WHO, WFP, UNSCN, UNICEF. Community-based Management of Severe Acute malnutrition: Geneva 2007. Available from: http://www.who.int/maternal_child_adolescent/documents/a91065/en/
- [3] Dereje N. Determinants of Severe Acute Malnutrition among under Five Children in Shashogo Woreda, Southern Ethiopia-A Community Based Matched Case Control Study. *International Journal of Research* 2014; (6)1: 339-363. <https://doi.org/10.4172/2155-9600.1000300>
- [4] Collins S, Binns P, Bahwere P, Sadler K, Hallam A. Management of severe acute malnutrition in children. *Lancet* 2006; 368(9551): 1992-2000. [https://doi.org/10.1016/S0140-6736\(06\)69443-9](https://doi.org/10.1016/S0140-6736(06)69443-9)
- [5] Singer PA. What could infant and young child nutrition learn from sweatshops. *BMC Publ Health* 2011; 11: 276. <https://doi.org/10.1186/1471-2458-11-276>
- [6] Ministry of Health and Population (MOHP) [Nepal], New ERA, and ICF International Inc. 2012. Nepal Demographic and Health Survey 2011. Kathmandu, Nepal: Ministry of Health and Population, New ERA, and ICF International, Calverton, Maryland 2011.
- [7] Sharghi A, Kamran A, Faridan M. Evaluating risk factors for protein-energy malnutrition in children under the age of six years: a case-control study from Iran. *Int J Gen Med* 2011; 4: 607-11.
- [8] Solomon A. Risk factors for severe acute malnutrition in children under the age of five: A case-control study. *Ethiop J Health Dev* 2006.
- [9] Jamro B, et al. Risk factors for severe acute malnutrition in children under the age of five year in Sukkur. *Pak J Med Res* 2012; 51(4): 111-113.
- [10] Tesfai C, Ratnayake R, Myatt M. Measuring local determinants of acute malnutrition in Chad: a case-control study. *Lancet* 2013; 381: 144. [https://doi.org/10.1016/S0140-6736\(13\)61398-7](https://doi.org/10.1016/S0140-6736(13)61398-7)
- [11] Rohana AJ. Assessment of Food Insecurity and Nutritional Outcomes in Bachok, Kelantan. *J Nutr Food Sci* 2014; 5. <https://doi.org/10.4172/2155-9600.1000373>
- [12] Motbainor A, Worku A, Kumie A. Stunting Is Associated with Food Diversity while Wasting with Food Insecurity among Underfive Children in East and West Gojjam Zones of Amhara Region Ethiopia. *PLoS One* 2015; 10(8): 133-42. <https://doi.org/10.1371/journal.pone.0133542>
- [13] Naser I, et al. Association between household food insecurity and nutritional outcomes among children in Northeastern of peninsular Malaysia. *Nutr Res Pract* 2014; 8: 304-11. <https://doi.org/10.4162/nrp.2014.8.3.304>
- [14] WHO. The management of nutrition in major emergencies. *Rev Panam Salud Pública* 2000; 8: 218-9. <https://doi.org/10.1590/S1020-4989200000800017>
- [15] Government of Nepal, N.P.C.S. CBS and UNICEF. Multiple Indicator Cluster Survey 2014. 2015; 3-4.
- [16] Coates J, Swindale a, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide. Washington DC. Food Nutr Tech 2007; Version 3.
- [17] WHO. Indicators for assessing infant and young child feeding practices 2010; pp. 1-19.
- [18] Bank NR. Fifth Household budget survey 2015; 2016.
- [19] Talbert A, et al. Diarrhoea complicating severe acute malnutrition in kenyan children: A prospective descriptive study of risk factors and outcome. *PLoS One* 2012; 7. <https://doi.org/10.1371/journal.pone.0038321>
- [20] Roy SK, et al. Risk factors of mortality in severely-malnourished children hospitalized with diarrhoea. *J Heal Popul Nutr* 2011; 29: 229-35. <https://doi.org/10.3329/jhpn.v29i3.7870>
- [21] Setsw G. Prevalence and risk factors for malnutrition among children aged 5 years and less in the Lefaragattha village of Bophuthatswana. *Curatonia* 1994; 17: 33-35.
- [22] Fuchs C, et al. Factors associated with acute malnutrition among children admitted to a diarrhoea treatment facility in Bangladesh. *International Journal of Pediatrics* 2014. <https://doi.org/10.1155/2014/267806>
- [23] Saito K, Jekel F, Bhattacharji S. A case-control study of maternal knowledge of malnutrition and health-care-seeking attitudes in rural South India. *Yale Journal of Biology and Medicine* 1997; 70(2): 149-160.
- [24] Egata G. Predictors of acute undernutrition among children aged 6 to 36 months in east rural Ethiopia: a community based nested case - control study. *BMC Pediatrics* 2014; 14(91). <https://doi.org/10.1186/1471-2431-14-91>
- [25] Mishra K, et al. Risk factors for severe acute malnutrition in children below 5 y of age in India: a case-control study. *Indian J Pediatr* 2014; 81(8): 762-5. <https://doi.org/10.1007/s12098-013-1127-3>
- [26] Ajao KO, Ojofeitimi EO, Adebayo AA, Fatusi AO, Afolabi OT. Influence of family size, household food security status, and child care practices on the nutritional status of under-five children in Ile-Ife, Nigeria. *Afr J Reprod Health* 2010; 14: 117-26.
- [27] Wong HJ, Moy FM, Nair S. Risk factors of malnutrition among preschool children in Terengganu Malaysia: a case control study. *BMC Public Health* 2014; 14(1): 785. <https://doi.org/10.1186/1471-2458-14-785>