

# BMJ Open Determinants of severe acute malnutrition among children under 5 years of age in Nepal: a community-based case-control study

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## ABSTRACT

**Background** Malnutrition is one of the leading causes of morbidity and mortality among children under the age of 5 years in low and middle income countries like Nepal. Children with severe acute malnutrition (SAM) are nine times more likely to die than children without malnutrition. The prevalence of SAM has increased in Nepal over the past 15 years; however, the determinants of SAM have not been clearly assessed in the country.

**Objective** To assess the determinants of SAM among children aged 6–59 months in the Bara district of Nepal.

**Setting** A community-based case-control study was conducted in 12 randomly selected Village Development Committees (VDCs) of the Bara district of Nepal.

**Participants** A random sample of 292 children aged 6–59 months (146 as cases and 146 as controls) from 12 VDCs were included in this study.

**Results** The prevalence of SAM among children under the age of 5 years was 4.14%. The following factors were significantly associated with SAM: low socioeconomic status (adjusted odds ratio (AOR) 17.13, 95% CI 5.85 to 50.13); mother's age at birth <20 or >35 years (AOR 3.21, 95% CI 1.30 to 7.94); birth interval <24 months (AOR 4.09, 95% CI 1.87 to 8.97); illiterate father (AOR 3.65, 95% CI 1.62 to 8.20); bottle feeding (AOR 2.19, 95% CI 1.73 to 12.03); and not initiating complementary feeding at the age of 6 months (AOR 2.91, 95% CI 1.73 to 12.03). Mother's educational level, initiation of breastfeeding, colostrum feeding, and exclusive breastfeeding were not significantly associated with SAM.

**Conclusion** The mother's age at birth, birth interval, socioeconomic status, father's educational level and initiation of complementary feeding at the age of 6 months were important determinants of SAM among children. A multi-sector approach is essential to address SAM. There is a need for further studies not only focusing on SAM but also moderate acute malnutrition.

## INTRODUCTION

Globally, child malnutrition is a public health problem with major consequences for child survival, damaging the cognitive and physical development of children and the economic productivity of individuals

## Strengths and limitations of the study

- This is a community-based case-control study to assess the determinants of severe acute malnutrition (SAM) in Nepal.
- Cases and controls were identified through WHO 2006 growth standards that increase the strength of the study.
- This study will help policymakers to design an effective prevention strategy for reducing SAM.
- The children with moderate wasting, stunting and underweight were not selected as controls in the study.
- The children with SAM admitted at health facilities for treatment were not considered during data collection.

and societies.<sup>1 2</sup> Malnutrition contributes to 50% of all child deaths and 11% of the total global disability-adjusted-life-years worldwide. Geographically, 70–80% of undernourished children worldwide live in lower and middle income countries, including Nepal.<sup>3</sup> Undernutrition accounts for 45% of deaths of children younger than 5 years, and contributes to more than three million deaths every year.<sup>4 5</sup> Acute malnutrition is an indicator of an emergency that requires urgent action. The UN estimates that acute malnutrition affects 8% of children (52 million) across the world (1 in 12 children in this age group).<sup>1 6</sup> Globally, acute malnutrition accounts for >50% of cases of childhood mortality (about 3.5 million deaths) in children under 5 each year.<sup>7</sup>

Severe acute malnutrition (SAM) is a major cause of child mortality under 5 years of age.<sup>8</sup> Severe acute malnourished children are nine times more likely to die than healthy children.<sup>7</sup> Globally, it is estimated that there are nearly 20 million severe acute malnourished children.<sup>9 10</sup> The UN estimates that around

one million children under the age of 5 die every year from SAM.<sup>9</sup> Similarly, the prevalence of wasting among children younger than 5 years is 3.6% (12.9 million) in Asia and 3.3% (18.5 million) in low and middle income countries.<sup>2</sup>

In Nepal, around half of the cases of mortality in children under 5 (54 per 1000 live births) are associated with malnutrition. The prevalence of SAM among children under 5 increased between 2001 (1.1%) and 2006 (2.6%), but remained constant from 2006 to 2011.<sup>10–11</sup> It is estimated that the number of preventable deaths of children due to SAM is around 1500 each year.<sup>12</sup> The prevalence of SAM among children in the area covered in this study is higher than the national average.<sup>13–15</sup> However, few studies have been conducted to assess the determinants of SAM. Therefore, the objective of this study was to determine the sociodemographic and economic factors, and child care practice-associated determinants, that may help to strengthen the management of SAM among children aged 6–59 months in the Bara district of Nepal.

## METHODS

### Study area

This study was conducted among 12 Village Development Committees (VDCs) of the Bara district of Nepal. Bara is one of the southern central districts of Nepal. It is located near the border of India and is 283 km from Kathmandu, the capital of Nepal.

### Study design and selection of participants

A community-based case-control study was conducted from July to December 2014. The sample size was calculated through STATCAL application of Epi-Info assuming a two-sided confidence level at 95%, 90% power (1- $\beta$ ) of the study, and a case-control ratio of 1:1. The percentage of control exposed for pre-lacteal feeding was assumed at 43% with an odds ratio (OR) of 2.29 based on a case-control study done in India.<sup>16</sup> The sample size was 298 (149 cases and 149 controls) assuming a 10% non-response rate. However, 292 samples (146 cases and 146 controls) were entered for final analysis. A multistage random sampling method was used to select the participants. First, the study district, Bara, was selected purposively. Bara district consists of six electoral constituencies. From each electoral constituency, two VDCs were randomly selected through a lottery method to give a total of 12 VDCs. In these 12 VDCs, six well-trained enumerators were mobilised for the screening of all children aged 6–59 months through measurement of the mid-upper arm circumference (MUAC). In addition, anthropometric measurements (weight and height) of the children aged 6–59 months were taken and compared with WHO 2006 simplified growth standards to categorise the children as a case (weight for height < -3SD) or a control (weight for height > -2SD). The cases and controls were matched in a 1:1 ratio with similar age intervals of 6–9 months, 10–12 months, 13–15 months, 16–18 months,

19–21 months, 22–24 months, 25–27 months, 28–30 months, 31–33 months, 40–42 months, 43–45 months, 46–48 months, 49–51 months, 52–54 months, 55–57 months, and 58–59 months in each VDC, and sampling frames of cases or controls were prepared for each VDC. Then the required cases and controls were randomly selected from the sampling frames. Proportional allocation of the number of cases and controls to participate in the study from each VDC was considered. Only one younger child was selected per household during data collection.

### Cases

The cases were the severely acutely malnourished children aged 6–59 months who were ascertained by using the weight for height Z-score < -3SD below the median according to WHO 2006 growth standards.

### Controls

The controls were age-matched children aged 6–59 months without malnutrition who were ascertained by using the weight for height Z-score > -2SD according to WHO 2006 growth standards.

### Data collection and statistical analysis

First author along with trained enumerators collected data through face-to-face interviews using a pre-tested structured questionnaire. Anthropometric measurements (weight and recumbent length/height) of the children were taken during daytime and compared with height for weight indicators Z-score as per WHO 2006 growth standards. For this, undressed or minimally dressed children were weighed using a SECA digital weighing machine and recumbent length/height was measured by using a height board. Validation of instruments and measurements was done on a daily basis. Collected data were entered into Epi-data version 3.1. The entered data were then exported to SPSS data analysis software (20.0 version). The association between SAM and exposure variables was analysed by using bivariate and multivariate logistic regression analysis. In order to measure the net effect size of the entered variables, calculation of adjusted OR (AOR) was carried out. A value of  $p < 0.05$  was considered to be significant where the confidence interval for OR was set at 95% (95% CI). The hypothesis was tested by the backward logistic regression method in the model of  $Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_i X_i$  after testing goodness of fit by Hosmer and Lemeshow, where Z is the log odds of the dependent variable,  $\beta_0$  is constant, X is the independent variable, and  $\beta_i$  is the regression coefficient of the  $i^{\text{th}}$  independent variable.<sup>17</sup> A multi-collinearity diagnostic test was applied between the independent variables before logistic regression was applied. Decisive criteria were set out to be a tolerance value of <0.1 or a variance inflation factor (VIF) value of >10. All the variables were found to be within the criteria and were therefore used for logistic regression.

### Variables

SAM refers to the condition that is identified through measurement of weight for height < -3SD Z-score below

the median among children aged between 6–59 months according to WHO 2006 growth standards.<sup>8</sup> Socioeconomic status for the household was assessed by adapting the validated asset index of the Nepal Demographic Health Survey 2011.<sup>11</sup> Included assets were electricity, radio, television, mobile phone, landline phone, refrigerator, table, chair, bed, sofa, cupboard, computer, fan, clock, wall, floor, roof material, cooking fuel, toilet facility, modern toilet, number of rooms, availability of land, separate kitchen and ownership of domestic animals, vehicles and land. The asset index was converted into asset scores using the Principal Component Analysis. Based on the asset scores, households were divided into five socio-economic layers from lowest to highest. To check the association with the outcome variable, tertiles generated

data were organised into low (poor), middle, and high (rich) categories. Education was categorised into literate and illiterate. Mother's age was taken as completed years as mentioned by the mother. It was categorised into two: <20 years or ≥35 years, and 20–35 years. Bottle feeding was categorised as fed or not. Initiation of complementary feeding refers to the introduction of additional food to children other than breast milk at the age of 6 months. For further analysis, it was classified into initiation at 6 months of age, and at <6 months or >6 months of age.

### Questionnaire

A structured questionnaire was developed based on the study objectives. For socioeconomic status, father's and mother's educational level, mother's age, birth interval,

**Table 1** General characteristic of participants

Characteristics	Cases (%)	Controls (%)	Total (%)
	n=146	n=146	n=292
<b>Mother's age at birth (years)</b>			
≤19	26 (17.8)	17 (11.6)	43 (14.7)
20–34	98 (67.1)	119 (81.5)	217 (74.3)
≥35	22 (15.1)	10 (6.9)	32 (11.0)
<b>Birth interval (months)</b>			
First birth	9 (6.2)	6 (4.1)	15 (5.1)
<24	87 (59.6)	40 (27.4)	127 (43.5)
24–47	48 (32.9)	78 (53.4)	126 (43.2)
≥48	2 (1.4)	22 (15.1)	24 (8.2)
<b>Family size(members)</b>			
>5	105 (71.9)	81 (55.5)	186 (63.7)
≤5	41 (28.1)	65 (44.5)	106 (36.3)
<b>Mother's educational level</b>			
Illiterate	123 (84.3)	62 (42.5)	185 (63.4)
Non-formal education	5 (3.4)	17 (11.6)	22 (7.5)
Primary	12 (8.2)	37 (25.4)	49 (16.8)
Secondary	5 (3.4)	17 (11.6)	22 (7.5)
SLC and above	1 (0.7)	13 (8.9)	14 (4.8)
<b>Father's educational level</b>			
Illiterate	95 (65.1)	35 (23.9)	130 (44.5)
Non-formal education	8 (5.5)	7 (4.8)	15 (5.1)
Primary	25 (17.1)	22 (15.1)	47 (16.1)
Secondary	13 (8.9)	37 (25.3)	50 (17.1)
SLC and above	5 (3.4)	45 (30.9)	50 (17.2)
<b>Socioeconomic status</b>			
Lowest	47 (32.2)	11 (7.5)	58 (19.8)
Second	46 (31.5)	13 (8.9)	59 (20.2)
Middle	27 (18.5)	31 (21.3)	58 (19.9)
Fourth	19 (13.0)	40 (27.4)	59 (20.2)
Highest	7 (4.8)	51 (34.9)	58 (19.9)

SLC, school leaving certificate

exclusive breastfeeding, initiation of breastfeeding and complementary feeding, a validated Nepal Demographic and Health Survey 2011 (NDHS) questionnaire measure was adapted.<sup>11</sup>

### Ethical considerations

Ethical approval was provided by the Institutional Review Board of the Institute of Medicine, Tribhuvan University. Informed written consent was obtained from the District Health Office, Bara, and from the participants. Confidentiality of the information provided by respondents was

**Table 2** Association between severe acute malnutrition and exposure variables

Characteristics	Cases (%)	Controls (%)	COR (95% CI)	p Value
	n=146	n=146		
<b>Mother's age at birth (years)</b>				
<20 and ≥35	48 (32.9)	27 (18.5)	2.16 (1.26 to 3.71)	0.005*
20–34	98 (67.1)	119 (81.5)	Ref	
<b>Birth interval(months)</b>				
<24	96 (65.8)	46 (31.5)	4.17 (2.56 to 6.80)	0.001*
≥24	50 (34.2)	100 (68.5)	Ref	
<b>Family size(members)</b>				
>5	105 (71.9)	81 (55.5)	2.06 (1.26 to 3.34)	0.003*
≤5	41 (28.1)	65 (44.5)	Ref	
<b>Mother's educational level</b>				
Illiterate	123 (84.2)	62 (42.5)	7.26 (4.18 to 12.60)	0.001*
Literate	23 (15.8)	84 (57.5)	Ref	
<b>Father's educational level</b>				
Illiterate	95 (65.1)	35 (24.0)	5.91 (3.51 to 9.81)	0.001*
Literate	51 (34.9)	111 (76.0)	Ref	
<b>Socioeconomic status</b>				
Low	82 (56.1)	15 (10.3)	19.78 (9.51 to 41.15)	0.001*
Medium	43 (29.5)	55 (37.7)	2.83 (1.51 to 5.29)	0.001*
High	21 (14.4)	76 (52.0)	Ref	
<b>Initiation of BF</b>				
After 1 hour from birth	94 (64.4)	47 (32.2)	3.81 (2.34 to 6.19)	0.001*
Within 1 hour of birth	52 (35.6)	99 (67.8)	Ref.	
<b>Colostrum feeding</b>				
No	56 (38.4)	31 (21.2)	2.31 (1.38 to 3.88)	0.001*
Yes	90 (61.6)	115 (78.8)	Ref	
<b>Frequency of BF</b>				
<8/day	56 (38.4)	26 (17.8)	2.87 (1.67 to 4.93)	0.001*
≥8/day	90 (61.6)	120 (82.2)	Ref	
<b>Exclusive BF</b>				
Before and after 6 months	97 (66.4)	53 (36.3)	3.47 (2.15 to 5.62)	0.001*
Up to 6 months	49 (33.6)	93 (63.7)	Ref	
<b>Bottle feeding</b>				
Yes	47 (32.2)	26 (17.8)	2.19 (1.27 to 3.79)	0.005*
No	99 (67.8)	120 (82.2)	Ref	
<b>Initiation of complementary feeding</b>				
<6 or >6 months	88 (60.3)	50 (34.2)	2.91 (1.81 to 4.69)	0.001*
At 6 months	58 (39.7)	96 (65.8)	Ref	

\*p<0.05.

BF, breastfeeding; COR, crude odds ratio; Ref, reference category.

**Table 3** Determinants of severe acute malnutrition

Characteristics	COR (95% CI)	AOR (95% CI)	p Value
<b>Mother's age at birth</b>			
<20 and ≥35 years	2.16 (1.26 to 3.71)	3.21 (1.30 to 7.94)	0.011*
20–34 years	Ref	Ref	
<b>Birth interval</b>			
<24 months	4.17 (2.56 to 6.80)	4.09 (1.87 to 8.97)	0.001*
≥24 months	Ref	Ref	
<b>Father's educational level</b>			
Illiterate	5.91 (3.51 to 9.81)	3.65 (1.62 to 8.20)	0.002*
Literate	Ref	Ref	
<b>Socioeconomic status</b>			
Low	19.78 (9.51 to 41.15)	17.13 (5.85 to 50.13)	0.001*
Medium	2.83 (1.51 to 5.29)	2.67 (1.12 to 6.37)	0.028*
High	Ref	Ref	
<b>Bottle feeding</b>			
Yes	2.19 (1.27 to 3.79)	4.56 (1.73 to 12.03)	0.002*
No	Ref	Ref	
<b>Initiation of complementary feeding</b>			
<6 or >6 months	2.91 (1.81 to 4.69)	7.16 (2.82 to 18.15)	0.001*
At 6 months	Ref	Ref	

\*p<0.05.

AOR, adjusted odds ratio; COR, crude odds ratio; Ref, reference category.

maintained. Those children identified as having SAM or moderate acute malnutrition but were not receiving appropriate care and treatment were referred to the nutrition rehabilitation home, Birgunj. Moreover, nutritional counselling was provided during data collection.

## RESULTS

The screening was carried out among 8500 children aged between 6–59 months in 12 VDCs. The prevalence of SAM among children aged 6–59 months was 4.14±0.01% (95% CI). The mean±SD ages of the mothers of the cases and controls were 25.92±6.22 and 26.23±4.18 years, respectively. [table 1](#) shows the general characteristics of the participants in the study. Bivariate analysis showed that mother's age at birth, birth interval, father's educational level, mother's educational level, socioeconomic status, bottle feeding, initiation of breastfeeding, colostrum feeding, exclusive breastfeeding and initiation of complementary feeding were significantly associated with SAM ([table 2](#)). In multivariate analysis, mother's age at birth, birth interval, socioeconomic status, father's educational level and initiation of complementary feeding were statistically significantly associated with SAM ([table 3](#)). However, family size, mother's educational level, initiation of breastfeeding, colostrum feeding, frequency of breastfeeding and exclusive breastfeeding did not show a statistically significant association with SAM in multivariate analysis. [table 3](#) shows that the odds of having SAM were

3.21 times higher among children whose mother's age at birth was <20 years and ≥35 years as compared with children whose mother's age at birth was 20–34 years (95% CI 1.30 to 7.94). Birth interval <24 months was also statistically significantly associated with the SAM (AOR 4.09, 95% CI 1.87 to 8.97). Similarly, the children of fathers who were illiterate were found to be significantly associated with SAM (AOR 3.65, 95% CI 1.62 to 8.20). Children from low (AOR 17.13, 95% CI 5.85 to 50.13) and medium (AOR 2.67, 95% CI 1.12 to 6.37) socioeconomic status families were more likely to be severe acute malnourished children than those from high socioeconomic status families. Bottle feeding (AOR 2.19, 95% CI 1.73 to 12.03) and initiation of complementary feeding (AOR 2.91, 95% CI 1.73 to 12.03) before or after 6 months were found to be significantly higher among children with SAM than among the controls.

## DISCUSSION

In this study, households where the family size was great than five members were not an independent determinant for SAM, which is consistent with the findings of other studies conducted in Ethiopia, Bangladesh, Vietnam, India, and Pakistan.<sup>16–22</sup> This might be due to the rural set up of the study area in which many of the community are living in a socially integrated environment. In this study, the mother's age at birth was an independent determinant for SAM. This finding is in contrast with those



studies from Vietnam and Iran.<sup>22–24</sup> This could be due to cultural practices and the practice of early marriage in this study area. Birth interval <24 months was also an independent determinant for SAM which is similar to studies from Ethiopia, Bangladesh and India.<sup>25–28</sup> The reason might be inadequate knowledge of the spacing method.

In this study, it was observed that the mother's educational level was not significantly associated with SAM among children. This finding is similar to the studies from Ethiopia, Iran, Bangladesh, Gambia and Nigeria,<sup>21–23 25 26 29–31</sup> but it is inconsistent with studies from India, Vietnam and Pakistan.<sup>16 18 24 32 33</sup> The children of fathers who were illiterate were found to be significantly associated with SAM, which is consistent with studies from Bangladesh, Vietnam, Pakistan and Ethiopia,<sup>20 24 26 32 34</sup> but differs from the findings of studies in India, Ethiopia and Iran.<sup>16 18 21 23 25 30</sup> An explanation for this variation might be that the fathers were the decision makers, farmers and money earners, so they could not provide sufficient time to care for their children. Socio-economic status was found to be significantly associated with SAM, a finding consistent with those of case-control studies from India, Pakistan, Iran, Vietnam and Ethiopia.<sup>16 23 24 31 32 35–38</sup> This could be explained by the fact that children from families of low socioeconomic status have limited access to food, health services, hygiene and sanitation.

This study showed that the exclusive breastfeeding of children before or after 6 months, the initiation of breastfeeding and lack of colostrum were not found to be significantly associated with SAM, findings that are consistent with those from studies in India and Vietnam.<sup>16 22 24 27 39</sup> but not from studies in Ethiopia and Chad.<sup>18 25 38 40</sup> The reason for these findings could be that community-based intervention for newborn care has been implemented in the study area. Bottle feeding was an independent determinant for SAM in this study, which was consistent with the findings of hospital based case-control studies in India and Ethiopia.<sup>16 18</sup> The reason might be poor hygiene associated with the bottle or inappropriate preparation of the formula, leading to diarrhoea and other diseases. In this study, the initiation of complementary feeding was an independent determinant for SAM, which is in line with the results of studies from Kenya, Chad and China.<sup>33 39–42</sup>

## CONCLUSION

In this study, mother's age at birth, birth interval, father's educational level, socioeconomic status, bottle feeding and initiation of complementary feeding were independent determinants of SAM among children under 5 years of age. An effective family planning programme, an awareness for delay marriage, the provision of education to fathers, a poverty alleviation programme, the timely initiation of complementary feeding, and avoidance of bottle feeding are needed to address these determinants in an effective and timely manner. There is a need for further studies not

only focusing on SAM, but also on SAM with bilateral oedema, and moderate acute malnutrition.

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**Contributors** NKP was involved in conceptualising the study, reviewing the literature, designing the protocol, developing the questionnaire, data collection, statistical analysis, and preparing the manuscript. SP was involved in statistical analysis, interpretation of data and preparing the manuscript. SPC was involved in statistical analysis, interpretation of data and critically reviewing the manuscript. RK, SS and RKT helped in conceptualising the study and critically reviewed the manuscript. All authors read and approved the final manuscript.

**Competing interests** None declared.

**Patient consent** None declared.

**Ethics approval** Institute Ethical Review Board, Institute of Medicine, Kathmandu, Nepal.

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