

# Prevalence of severe acute malnutrition and associated sociodemographic factors among children aged 6 months–5 years in rural population of Northern India: A population-based survey

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## ABSTRACT

**Introduction:** National Family Health Survey (NFHS)-3 documented that nearly 57 million children are undernourished in India, which is one-third of the world's share. We planned a study to identify the prevalence of severe acute malnutrition (SAM) among children aged <5 years in a rural population of Northern India. **Materials and Methods:** A cross-sectional study was conducted at 2 blocks of District Meerut during 2012–2014. A total of 70 villages were identified and all children in the age group 6–60 months were approached through house-to-house visits. Data on sociodemographic profile and anthropometry were collected utilizing standards methods and equipment. The Z-scores for weight-for-age, height-for-age, and weight-for-height (WHZ) were calculated using the World Health Organization (WHO) reference data as standard. SAM (severe wasting) was defined as per the WHO criteria (WHZ score <−3 standard deviation or severe visible wasting or bipedal edema). **Results:** A total of 19,449 children were screened and 18,463 children (age, 32.6 ± 15.4 years, and 53.4% males) were enrolled, and 466 were excluded due to erroneous age estimation and physical deformities. The prevalence of SAM was 2.2%, 95% confidence interval (CI) 2.02–2.44%, (409/18,463). Multivariate logistic regression documented age (odds ratio [OR]: 0.97, 95% CI 0.96–0.98), nuclear family (OR: 1.25, 95% CI 1.01–1.54), lower occupation of head of family (OR: 1.29, 95% CI 1.05–1.59), and lower paternal education (OR: 1.49, 95% CI 1.16–1.91) as independent predictor of SAM. **Conclusion:** The prevalence of SAM was lower (2.2%) in this Northern district of India as compared to national prevalence (7.9%). Younger age, nuclear family, lower parental education, and poor occupation of the head of the family predispose a child to SAM.

**Keywords:** Nutritional indicators, severe acute malnutrition, under 5 children

## Introduction

As per the sustainable development goal 3, target 3.2 talks about to end preventable deaths of children under 5 years of age and to reduce under-5 mortality to at least as low as 25/1000 live births by 2030 in all countries.<sup>[1]</sup>

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Undernutrition is one of the leading causes of morbidity and mortality in children under the age of 5 years in developing countries. Severe acute malnutrition (SAM) remains a major health threat to children, as the mortality rates among SAM children are nine times higher than those in well-nourished children.<sup>[2]</sup> SAM is diagnosed when the child has any one of the following criteria: weight for height (WFH) Z score <−3

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standard deviation (SD), mid-upper arm circumference (MUAC) <115 mm, malnutrition with bipedal edema or visible severe wasting (anyone).<sup>[3]</sup>

Despite economic growth and development in India, the prevalence of severe wasting among children is increasing.<sup>[4]</sup> The second National Family Health Survey (NFHS)-2 (1998–99) indicated that 6.7% of children aged 0–35 months were severely wasted, and it increased in 2006 when the NFHS-3 indicated that 7.9% of children below 60 months of age were suffering from severe wasting.<sup>[5,6]</sup> According to NFHS-3, there are nearly 57 million undernourished children in India which is one-third of the world's share.<sup>[6]</sup> In India, 5 million children die every year due to the direct or indirect influence of malnutrition (1 child death for every 10 s).<sup>[6]</sup> The NFHS-3 also documented the prevalence of severe underweight, and severe stunting among children in India as 16% and 24%, respectively.<sup>[6]</sup>

According to NFHS-3, 7.9% of under-five children in India suffer from SAM.<sup>[6]</sup> With the current estimated total population of India has 1260 million, it is expected that about 8–9 million are likely to be suffering from SAM.<sup>[7]</sup> This is more prevalent in socioeconomically deprived communities.<sup>[8]</sup>

The reported sociodemographic risk factors for malnutrition from India includes age, gender, parental illiteracy, income, occupation, and large family size.<sup>[9–11]</sup>

There was scarcity of data on the prevalence of SAM in Meerut District of Uttar Pradesh. Hence, we planned a cross-sectional survey with the primary objective to determine the prevalence of SAM among children in the rural population of 2 blocks of district Meerut. A secondary objective was to determine the prevalence of other malnutrition indicators such as moderate wasting, severe stunting, moderate stunting, severe underweight, and moderate underweight. We also planned to depict the sociodemographic risk factors of SAM.

## Materials and Methods

A cross-sectional survey was conducted in Meerut district of Uttar Pradesh, India during 2012–2014. District Meerut is located at 60 km from Delhi and has a population of around 3.4 million (as per the 2011 census). Out of this, 1.7 million lives in rural areas. The two rural blocks, namely (i) Parikshitgarh (0.17 million population) and (ii) Macchra (0.16 million population), were randomly selected and all the 70 villages, in these blocks were included in the study.

### Preparatory phase

The administrative permissions were obtained from the Departments of Health and Family Welfare and Women and Child Development, Government of Uttar Pradesh. The Health and Integrated Children Development Services functionaries, namely, Anganwadi worker (AWW), auxiliary nurse midwife (ANM), and accredited social health activist (ASHA) at the district, block, and village levels were briefed about the aims

and objectives of the project. All the villages in 2 blocks were enlisted, and maps were developed with important landmarks.

Five research teams were made including one research assistant, one field investigator, and one field attendant. All the research team members (RTM) were trained by the principal investigators (PI) and Co-PIs (Co-PIs) in the methodology of undertaking survey, anthropometric measurements, assessment of age using local event calendar (LEC). Induction training was also taken by external experts from the National Institute of Nutrition, Hyderabad.

A project manual was developed which had the standard operating procedures (SOP) for (i) how to approach the family, (ii) taking consent of mother/guardian of child, (iii) methods for measurements of height, length, weight and MUAC, (iii) assessment of age, (iv) methodology of conducting nutritional counseling, and (vi) assessment of visible severe wasting and bipedal edema. All RTMs utilized same methodology and SOPs for data collection.

The study pro forma was developed, and field tested. Patient information consent form (PICF) and patient information sheet were developed to acquire well-informed consent from parents/guardians of each child. The PICF was also countersigned by the AWW/ANM/ASHA. A patient referral slip was also developed. The SAM children identified during the survey were referred (after obtaining the consent of the parents/guardians) to the nearest primary health center (PHC). A nutrition education pamphlet was given to all mothers of undernourished children after nutrition counseling.

### Definition of severe acute malnutrition

SAM was diagnosed when the child has any one of the following criteria:<sup>[2]</sup>

- WFH Z score < -3SD
- MUAC <115 mm
- Malnutrition with bipedal edema or visible severe wasting.

### Steps undertaken for data collection

House-to-house visits were undertaken to locate the children. The mopping of each village was done for 2–3 days, to cover remaining eligible children before completing the survey of the village. This step ensured maximum inclusion of eligible children in the study from each village. The children were brought to Anganwadi Centers/Sub-Health Centers/Schools/Households, for anthropometric measurements, where adequate facilities of light and hard flat surface were available. Hard flat surface was ensured with the help of Water Level Meter.

The data on the sociodemographic profile of the child were obtained. The age of the child was determined by (i) birth certificate issued by a local health authority, (ii) Horoscope (Janam Patri), and (iii) any other valid Government document. If none of these documents were available, then the age of the child was assessed using LEC.

Each child was subjected first to measurement of length or height. For children <2 years of age, recumbent length was measured. Subsequently, MUAC and body weight measurement was assessed. The weight of the child was assessed in minimal clothing. The child was wrapped in a sheet of cloth with a known weight. The weight of sheet was subtracted from the total body weight of child measured.

After anthropometric measurement, the nutritional status of child was determined. The weight of the child was compared with height, and corresponding Z scores was calculated as per the World Health Organization (WHO) WFH Chart. Children having Z scores below  $-3SD$  were identified as SAM. A laminated sheet of WHO WFH reference chart was made available to each team to identify SAM child. Children classified as SAM were referred to nearest PHC after obtaining consent from their parents/guardian. The medical officer in charge of the local PHC was informed every week about the details of each SAM child identified during the survey in the Village, for further management.

At the end of each day, all RTMs assembled at the field headquarters (PHC). Each pro forma was examined for its completeness by RTMs.

### Equipment utilized for assessment of anthropometry

To undertake the anthropometric measurements, following equipment were procured:

- SECA 383 Weighing scale: to record variation up to 10 g
- SECA 213 Stadiometer: to record Variation up to 0.1 cm
- SECA 417 Infantometer: to record Variation up to 0.1 cm
- SECA 212 MUAC tape: to record Variation up to 0.1 cm
- SECA 201 Measuring tape: to record Variation up to 0.1 cm.

### Quality control

#### Internal quality control measures

The standard weights of 1 kg, 2 kg, 5 kg, and 10 kg were procured. The weighing scale instrument was standardized and calibrated each week before the start of the data collection. For standardization, the standard weights were kept on the weighing balance, and three readings were taken with each weight. Similarly, a standard one-meter rod made of steel was procured. The stadiometer and infantometer were calibrated by this rod.

A Log Book was maintained by each research team for the standardization of the weighing balance, stadiometer, and infantometer.

The exercise of assessing inter- and intra-observer variations was done as a part of the internal quality control process. All RTMs were subjected to inter- and intra-observer variation exercises, once in a month, to ensure the quality of anthropometric measurements.

Further, a checklist was developed including all steps to be taken during measurement of each of the anthropometric parameters.

One supervisor (PI/Co-PI/research officer) observed the RTM while they were assessing the anthropometric measurements. The supervisor marked noted each of the specific step performed by RTM. Subsequently, the checklists were reviewed with RTMs. This step helped in determining missing steps/wrong steps/incomplete steps undertaken by RTM while they took anthropometric measurements of the child. The RTM were made aware of errors to improve the quality of data collection.

The research officer also took videos of RTM's when they were undertaking anthropometric measurements of the child. These videos were shown to RTM's to identify their deficiency if any. This step also made RTMs more diligent in taking anthropometric measurements.

#### External quality control measures

Supervisory visits were made by external expert and external monitoring agency to assess the quality of data collected in the study. The expert critically examined the different steps in the assessment of age, height, weight MUAC measurements performed by RTMs. The suggestions provided by an external expert to improve the data collection were shared with RTMs.

#### Calculation of sample size

The study documents the finding of a survey that was planned and conducted to validate MUAC against weight for height z-score to diagnose SAM among children of age 6-59 months. No sample size was calculated to estimate the prevalence of SAM. However, a sample size of 18463 children to document prevalence of 2.2% had a precision as narrow as 0.4%.

Inclusion criteria were children in the age group of 6–60 months, permanent resident of study area, expected to remain in the area during the study and consent of parents. Children with physical deformities such as spinal bifida, bow legs, spinal deformities, and knock knees were excluded from the study.

#### Data management

Data were collected and entered into Excel sheet by Data Entry Operator. Dual data entry was done. The entire data into the Excel sheet were checked for its validity and outliers were identified through different methods. The outliers were rechecked from the hard copies of pro forma and verified. The data collected in the study were compared with similar data set of NFHS-III belonging to lowest wealth index of Uttar Pradesh (2005–2006).<sup>[6]</sup> The comparison showed a similar trend of anthropometric parameters in the children of the present study and that of NFHS-III. This substantiated the validity of data collected. After the data were cleaned, it was freeze and subjected to statistical analysis. The tables were developed after the statistical analysis was undertaken.

#### Assumption made

The date of the birth was calculated using LEC in majority of the cases. The age was recorded in months. An assumption was made that if a child was born in any date in a month, say the

month of July; he was considered to be born on 1<sup>st</sup> July. This was done to have uniformity in calculation of age of the children when local event calendar was utilized for assessment of age.

**Statistical analysis**

The WHO Anthro Software was utilized to calculate Z scores. SPSS for Windows version 22.0 (SPSS Inc., Chicago, IL) was used to calculate mean, SD, proportion for descriptive statistics and Chi-square test, Student’s t-test, and regression analysis for inferential statistics. P < 0.05 was considered statistically significant.

**Ethical consideration**

Ethical clearance was taken from the institutional ethical committee, and well-informed written consent was taken from parents or guardian of each child.

**Results**

A total of 19,449 children were approached and screened. A total of 466 children were excluded from final data analysis due to erroneous age estimation (183), knock-knees (183, physically challenged (90), spinal deformities (5), and with unacceptable Z scores (2). Finally, we had 18463 children with complete data. The Mean age of children was 32.6 ± 15.4 years. Out of the total, 9863 (53.4%) children were males and 8600 (46.6%) were females.

Table 1 describes the nutritional status of children as per different nutritional indicators. The children with low WFH Z scores are referred to determine different categories of wasting. The prevalence of SAM (WFH Z scores <−3SD) was found as 2.2%, 95% confidence interval (CI) 2.02–2.44%, (409/18463), which includes 8 children with severe visible wasting. One child was found to have bipedal edema. It was found that 2527 (13.7%) were suffering from moderate acute malnutrition (WFH Z scores <−3 to −2 SD). A total of 7160 (38.8%) children had WFH <−2 to −1 SD, and 8376 (45.3%) children had WFH Z score <−1SD.

Different categories of underweight refer to low weight for age (WFA). In the present study, 2,254 children (12.2%) had WFA Z score <−3 SD (severe underweight), 5,515 (29.9%) had Z scores between <−3 and −2 SD (underweight), 6,822 (36.9%) had Z scores between <−2SD and −1SD and WFA Z scores <−1 SD were in 3880 (21.0%) children.

Different categories of stunting refer to low height for age (HFA). It was found in the present study that 3017 (16.2%) children were in the category of HFA Z score <−3SD (severe stunting), 5418 (29.1%) children between <−3 and −2 SD (stunting), 5950 (32.0%) between <−2 and −1 SD and 4207 (22.7%) children in WFH Z score <−1 SD.

It was found that 286 (1.5%) children had body mass index (BMI) for age <−3 SD, 1806 (9.8%) children had between <−3 and −2SD, 6396 (34.7%) between <−2 and −1 SD and 9975 (54.0%) children had BMI for age <−1 SD A total of 201 (1.1%) children had MUAC for age <−3SD, 1344 (7.2%) had the Z scores between <−3 and −2 SD, 5665 (30.6%) children were<−2 SD to −1 SD, and 11,298 (61.1%) children were with Z scores <−1SD The percentage of severely malnourished children Z-score <−3SD identified by WFH, WFA, HFA, BMI for age, and MUAC for age varied significantly.

We have also analyzed our data to depict sociodemographic predictors of SAM. On univariate analysis, it was found that age, male gender, lower education of parents (<8<sup>th</sup>/Middle class), occupation of head of family (semi-skilled, unskilled, and unemployed), child in a nuclear family with lesser number of family members (<8) and with lower socioeconomic status (middle, lower-middle, and lower class) was significantly associated with SAM [Table 2].

Multivariate logistic regression documented age (OR 0.97, 95% CI 0.96–0.98, P < 0.001), nuclear family (odds ratio [OR] 1.25, 95% CI 1.01–1.54, P = 0.036), lower occupation of head of family (OR 1.29, 95% CI 1.05–1.59, P = 0.016), and lower education of father (OR 1.49, 95% CI 1.16–1.91, P = 0.002) as independent predictor of SAM [Table 3].

**Discussion**

In this study, we screened a huge number of children aged 6 months–5 years to document the prevalence of SAM. We found that in a rural community of a district of Northern India, the prevalence of SAM was as low as 2.2% (95% CI 2.02–2.44%) as compared to national prevalence of 6.4%. In a similar community-based study from Puducherry, the authors reported the prevalence of SAM among children from slums in the similar age group (6 months–5 years) as 3.6% (95% CI: 1.9–6.1).<sup>[12]</sup>

In 2011, a survey was conducted, covering over 100 districts, representing over 160 million people and including areas at risk

**Table 1: Distribution of children according to Z-scores of weight for height, weight for age, height for age, body mass index for age, and mid upper arm circumference for age**

Z-scores	WFH (n=18,463) (%)	WFA (n=18,471) (%)	HFA (n=18,592) (%)	BMI for age (n=18,463) (%)	MUAC for age (n=18,498) (%)
<−3 SD	409 (2.2)	2254 (12.2)	3017 (16.2)	286 (1.5)	201 (1.1)
≥−3−2 SD	2527 (13.7)	5515 (29.9)	5418 (29.1)	1806 (9.8)	1344 (7.2)
≥−2−1 SD	7160 (38.8)	6822 (36.9)	5950 (32.0)	6396 (34.7)	5655 (30.6)
>−1 SD	8367 (45.3)	3880 (21.0)	4207 (22.7)	9975 (54.0)	11,298 (61.1)

WFH: Weight for height; WFA: Weight for age; HFA: Height for age; BMI: Body mass index; MUAC: Mid upper arm circumference; SD: Standard deviation

**Table 2: Comparison of sociodemographic characteristics of children with and without severe acute malnutrition (n=18,463)**

Parameter	SAM children (409) (%)	Non-SAM children (18,054) (%)	OR (95% CI)	P
Age (months)	26.7±15.8	32.7±15.5	0.97 (0.960-0.98)	<0.001
Gender				
Male (9863)	259 (2.6)	9604 (97.4)	1.52 (1.24-1.86)	<0.001
Female (8600)	150 (1.7)	8450 (98.3)	Reference	
Type of family				
Nuclear (10,139)	253/10,139 (2.5)	9886 (97.5)	1.34 (1.09-1.64)	0.004
Joint (8324)	156/8324 (1.9)	8168 (98.1)	Reference	
Religion				
Hindu (9446)	214 (2.3)	9232 (97.7)	3.84 (0.54-27.6)	0.189
Muslim (8850)	194 (2.2)	8656 (97.8)	3.72 (0.52-26.7)	0.191
Others (167)	1 (0.6)	166 (99.4)	Others	
Occupation				
Professional, semi- professional, clerical, shop owner, farmers and skilled workers (9873)	177 (1.8)	9696 (98.2)	Reference	<0.001
Semi-skilled and unemployed (8590)	232 (2.7)	8358 (97.3)	1.52 (1.251-85)	
Fathers education				
<8 <sup>th</sup> class (12,113)	313 (2.6)	11,800 (97.4)	1.73 (1.37-2.17)	<0.001
≥8 <sup>th</sup> class (6350)	96 (1.5)	6254 (98.5)	Reference	
Mothers education				
<8 <sup>th</sup> class (15,063)	363 (2.4)	14,700 (97.6)	1.80 (1.32-2.45)	<0.001
≥8 <sup>th</sup> class (3400)	46 (1.4)	3354 (98.6)	Reference	
Total family member				
<8 (5093)	94 (1.8)	4999 (98.2)	Reference	0.035
≥8 (13,370)	315 (2.4)	13,055 (97.6)	1.28 (1.02-1.62)	
Socioeconomic status (modified BG Prasad Scale 2014)				
Upper and upper-middle class (1227)	15 (1.2)	1212 (98.8)	Reference	0.014
Middle, lower-middle, and lower class (17,234)	394 (2.3)	16,840 (97.7)	1.89 (1.12-3.18)	

SAM: Severe acute malnutrition; OR: Odds ratio; CI: Confidence interval

**Table 3: Multivariate logistic regression analysis to depict independent predictors of severe acute malnutrition**

Parameters	OR (95% CI)	P
Age in months	0.97 (0.96-0.98)	<0.001
Nuclear family	1.25 (1.01-1.54)	0.036
Occupation of head of family (semi-skilled, unskilled and unemployed)	1.29 (1.05-1.59)	0.016
Education of father (<8 <sup>th</sup> class)	1.49 (1.16-1.91)	0.002

SAM: Severe acute malnutrition; OR: Odds ratio; CI: Confidence interval

of malnutrition, documented the prevalence of severe wasting, severe underweight, and severe stunting as 3.3%, 16.4%, and 34.0%, respectively.<sup>[13]</sup> The India fact sheet of Rapid Survey on Children 2013–2014, which was jointly conducted by UNICEF and Ministry of Women and Child Development, Government of India, documented the prevalence of severe wasting, severe underweight, and severe stunting as 4.6%, 9.4%, and 17.3%, respectively.<sup>[14]</sup>

In this study, on univariate analysis, it was found that younger age, male gender, lower education of parents, occupation of head of family, child in a nuclear family with lesser number of family members and with lower socioeconomic status was significantly associated with SAM [Table 2]. However, multivariate logistic regression analysis documented younger age, nuclear family, lower

occupation of head of family, and lower education of father as an independent predictor of SAM [Table 3].

During the first few years of life, the risk of SAM is higher, as initials 2 years of life is a critical period for growth and development of a child. We found that the younger age was an independent predictor of SAM and similar results were documented by NFHS-3 report and other two published studies.<sup>[6,11,15]</sup>

Male gender was found to have higher odds and being more at risk for SAM as compared to female child. Similar findings were observed by few studies.<sup>[16,17]</sup> However, in some studies, females were found to have more SAM, and this difference may be due to discrimination of female child regarding amount and nutritious content of diet and more attention given to growth of male child in the community.<sup>[11]</sup>

Few case–control studies also documented similar results in terms of family size, parental education, income, and occupation.<sup>[10,11,18]</sup>

The most important limitation of our study includes lack of information on many other risk factors for SAM such as birth weight, ANC visits, immunization status, breastfeeding factors, and childhood illness among our study population. We only commented on limited sociodemographic factors.

## Conclusion

The prevalence of SAM was lower (2.2%) in this Northern district of India as compared to national prevalence (7.9%). Younger age, nuclear and small family, lower parental education, poor occupation of the head of family, and lower socioeconomic status predisposes a child to SAM. Improvement in our education system among vulnerable community and economic development might decrease the prevalence of SAM in India.

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## Conflicts of interest

There are no conflicts of interest.

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