Evaluation of Integrated Management of Acute Malnutrition (IMAM), POSHAN-II in Rajasthan, India: A Quasi-Experimental Study

Shobana Sivaraman (shobanasivaraman5@gmail.com)
IIHMR University

Ishank Gorla
Global Alliance for Improved Nutrition

Laxman Sharma
IIHMR University

Daya Krishna Mangal
IIHMR University

Shiv Dutt Gupta
IIHMR University

Research Article

Keywords: Severe acute malnutrition, wasting, Quasi experimental, CMAM, Rajasthan, India

DOI: https://doi.org/10.21203/rs.3.rs-320169/v1

License: © This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License
Abstract

Background

According to National Family Health Survey (NFHS) the percentage of severely wasted children has increased from 6.4 percent (NFHS-3, 2005-06) to 7.5 percent (NFHS-4, 2015-16). In 2018, National Health Mission (NHM), Government of Rajasthan implemented Integrated Management of Acute Malnutrition (IMAM), POSHAN -II in 20 districts of Rajasthan. The research study is aimed to evaluate the effectiveness of IMAM POSHAN-II with respect to the percentage of cured, non-recovered and defaulted children and rate of weight gain.

Methods

Community based quasi experimental pre post test research study was conducted among 1105 SAM children aged 6-59 months. The baseline study conducted during enrollement of SAM children, mid line and endline study was conducted after eight and twelve weeks of treatment. Socio demographic factors and nutritional status of children was collected from primary caregivers and sampled children of the study.

Results

After 8 weeks of treatment, the outcomes were 42.4 percent of cured cases, 4.1 percent of defaulters and 53.5 percent continued in the program. After 12 weeks of treatment, outcomes were – 66.9 percent of cured cases, 8.1 percent of defaulters and 25 percent of non-recovered cases. The mean rate of weight gain among cured cases at 8 weeks was 3.2 g/kg/day. Binary logistic regression model indicates that after 8 and 12 weeks of treatment, the odds of SAM children getting cured increases with increasing family income. Children of educated mothers were 6.3 times more likely to recover than children of mothers with no education. Compliance towards EDNS is significantly associated with recovery of children at 8 and 12 weeks.

Conclusion

The IMAM POSHAN-II program being first of its kind to be implemented on large scale in India demonstrate a piece of evidence that SAM children without medical complications can be treated successfully at community and household level. The program deserves be integrated with the existing primary health system of the state. The program was successful with high level of political commitment and collobration with partner agencies for technical and financial assistance.

Background

As per the Global Nutrition Report 2020, India has 17.3 per cent of children under 5 years of age who are wasted, higher than the average for the Asia region (9.1 per cent) and highest in the world(1). In 2018, World Health Organization (WHO) report on child nutrition states that globally 21.9 percent (149 million)
U5 children are stunted, followed by 7.3 percent (49 million) U5 children are wasted and 5.9 percent (40 million) U5 children are overweight (2). According to National Family Health Survey (NFHS) the percentage of wasted and severely wasted children has increased from 19.8 percent and 6.4 percent in NFHS-3, 2005-06 to 21 percent and 7.5 percent in NFHS-4, 2015-16.(3) Especially states like Jharkhand (29 percent), Gujarat (26.4 percent), Karnataka (26.1 percent), Madhya Pradesh (25.8 percent), Maharashtra (25.6 percent), Rajasthan (23 percent), Chhattisgarh (23.1 percent) and Haryana (21.1 percent) contribute to the major burden of wasting in India. (3–5) Severe wasting is also termed as Severe Acute Malnutrition (SAM). SAM is a life-threatening factor for children because of their lack of immunity to infections and diseases. Severely wasted children show poor growth and cognitive developmental delays. They also reflect the poor nutritional status of women during pregnancy, poor breastfeeding and complementary feeding practices, poor dietary intake and lack of adequate health services.(6) Children with SAM are 11.6 times more likely to die and children with MAM are three times more likely to die than the normal children.(7)

As per WHO guidelines children with SAM are identified using Weight for Height Z score (WHZ) below – 3 Standard Deviation (SD) and or Mid Upper Arm Circumference (MUAC) less than 11.5cm.(8,9) Treatment guidelines for SAM has evolved from facility-based to Community Management of Acute Malnutrition (CMAM).(8,10) It was found that inpatient or facility-based engagement of SAM children required skilled health personnel and expensive treatments. In addition, accessibility to Malnutrition Treatment Centers (MTC) or Nutrition Rehabilitation Centers (NRC) is a challenge in rural areas.(11,12) Also, often community and families are not aware that the severely wasted children require immediate medical attention to prevent them from further morbidity and mortality.(4,12) With this background, many countries adopted community-based management for uncomplicated cases of SAM.(13–15)

CMAM is an evidence-based approach implemented in more than 70 countries to manage and treat SAM and MAM U5 children.(16) CMAM categorizes SAM into children with medical complications and children without medical complications.(17,18) Children without an appetite and/or with any medical complications are treated using inpatient facility.(17,18) Children without medical complications and with appetite fall under uncomplicated cases. Such uncomplicated SAM cases are treated using Ready to Use-Therapeutic Food (RUTF)[1] with a weekly or biweekly visit to a nearby health facility.(17,18) CMAM follows a decentralized approach, empowering the community health workers by increasing the availability and accessibility for effective treatment of acute malnutrition.(18,19) In 2000, CMAM was first tested as a pilot study in humanitarian emergencies.(20) Later in 2007, it was supported and recommended by the United Nation (UN) agencies that CMAM could be used as a standard procedure for treating and managing severe acute malnutrition in emergency and developmental contexts.(8)

In India, Community Management of Acute Malnutrition (CMAM) is adopted by many states and the outcomes were tested in pilot studies.(21) Initially, in 2009, CMAM was introduced in India as an emergency response in Bihar during Kosi floods. (4) Later, pilot studies were conducted in Maharashtra, Rajasthan, Odisha and Jharkhand to treat SAM children either community based or combination of both facility and community-based management.(4,11,12,22,23) In 2015, National Health Mission,
Government of Rajasthan implemented CMAM by adopting POSHAN (Proactive and Optimum care of children through Social Household Approach for Nutrition) strategy to treat SAM children without medical complication using Medical Nutrition Therapy (MNT) Kit[2].\(^{24,25}\) The community-based intervention was implemented in two phases. The CMAM POSHAN-I was implemented from 2015-16 covering 10 High Priority Districts (HPD) and 3 tribal districts of Rajasthan. Around 234,404 children aged 6-59 months were screened and 9,640 children were identified as SAM and enrolled for treatment.\(^{24,25}\) After treating the enrolled SAM children using Energy Dense Nutrition Supplement (EDNS) for 8 to 12 weeks, 88 percent of children recovered 7 percent did not recover and were referred to MTCs.\(^{24,25}\) With this achievement of internationally comparable success rate, the second phase of POSHAN-II was implemented in 2018, covering 20 districts of Rajasthan.\(^{24}\) In Integrated Management of Acute Malnutrition (IMAM), POSHAN-II around 375,533 children were screened and 10,344 children were identified and enrolled for treatment.\(^{24,26}\) This research study is aimed to evaluate the effectiveness of IMAM POSHAN-II with respect to the percentage of cured, non-recovered and defaulted children and rate of weight gain. We have also attempted to examine the factors associated with cured, non-recovered and defaulted SAM children.

IMAM POSHAN-II

Under IMAM POSHAN-II, treatment services were provided through Subcenters\(^{3}\) at block level through frontline health workers such Auxiliary Nurse Midwife (ANM)\(^{4}\), Accredited Social Health Activist (ASHA) \(^{5}\) and Anganwadi Workers (AWW).\(^{27}\) Before implementation, ASHAs, AWWs and ANMs were trained intensively for anthropometric measurements at the district level to ensure quality delivery of health services. During this intervention, Subcenters were designated as POSHAN centres and ASHA’s were called POSHAN Prahari. \(^{27}\)

**Process of diagnosing Severe Acute Malnutrition (SAM) under IMAM POSHAN-II**

The process to diagnose Severe Acute Malnutrition included screening, identification and enrollment. The process flow is illustrated in figure 1.

- **POSHAN Prahari’s** carried out the screening process which also known as active case finding by visiting all the households with children aged 6-59 months in their respective operational geographies.\(^{27}\) POSHAN Prahari’s measured the Mid Upper Arm Circumference (MUAC) for all the children aged 6-59 months.\(^{27}\) The children with MUAC<12.5cm were short-listed for validation by ANM at the nearest Subcenter.\(^{27}\)
- During identification, the shortlisted children with MUAC<12.5cm were brought to nearest sub-centre by POSHAN Prahari where ANM measured for weight, height or length and MUAC. Children were also checked for bilateral pedal oedema and any medical complications. Later, ANM along with mother or caregiver conducted appetite test for the screened children using EDNS\(^{6}\).\(^{27}\) If the child was diagnosed with bilateral pedal oedema and or identified with any medical complication and or failed in appetite test, then he or she was referred to the nearest Malnutrition Treatment Center (MTC) irrespective of the anthropometric measurements.\(^{27}\) If WHZ<-3SD and or MUAC<11.5cm, then the
child was identified as SAM. Identified SAM children without any medical complications with adequate appetite were enrolled in the program for treatment. (27)

- The children with MUAC between 11.5 to 12.4 cm and WHZ -3SD to <-2SD were categorized under Moderate Acute Malnutrition (MAM). They were referred to Anganwadi Center (AWC) for treatment through Integrated Child Development Services (ICDS) Supplementary Nutrition Program (SNP). (27)

Table 1. Admission and discharge criteria, POSHAN-II (27)

| Anthropometric measurement | Enrollment criteria | Discharge criteria |
|----------------------------|---------------------|-------------------|
| MUAC                       | MUAC <11.5 cm       | MUAC ≥12.5 cm     |
| WHZ                        | WHZ < -3SD          | WHZ ≥ -2SD        |
| WHZ and MUAC               | WHZ < -3SD and MUAC < 11.5 cm | WHZ ≥ -2SD        |

Treatment of Severe Acute Malnutrition (SAM) children

Under POSHAN-II SAM children were identified and enrolled as per the program guidelines (table 1). Albendazole and amoxicillin were provided to all the enrolled children before initiating treatment with EDNS (additional file 1). (27) During treatment, the enrolled children were provided with Energy Dense Nutrition Supplement (EDNS), weekly according to their weight (additional file 1). (27) The child consumed EDNS every day as per the prescribed dosage along with regular home-based food. Every Tuesday, children with their mother or caretaker, reported to subcenter. These Tuesdays were called POSHAN Divas (days). On POSHAN Divas, ANM measured for weight, height and MUAC of the enrolled children to track their nutritional status. (27) After measurements, ANM provided EDNS packets to the mothers or caretakers for the following week. (27) Caregivers were informed that EDNS packets was specially made for the malnourished children and should not be shared with other family members. Caregivers were also educated about the method of feeding EDNS inadequate portions. Children with ≤ 24 months were encouraged for continued breastfeeding. They were also counselled on minimum meal frequency, handwashing practices and immunization. They were advised to seek medical care or reach out to ASHA (POSHAN Prahari) immediately if the child became unwell during EDNS consumption.

Throughout the treatment phase, POSHAN Prahari’s visited the households of the enrolled children every day. During home visits, POSHAN Prahari’s monitored for regular consumption of EDNS by the SAM children and counselled the mother for adequate dietary intake and hygiene practices. (27) As the anthropometric measurements of the child improved (table 1) they were further observed for one more week for consistent improved nutritional status. In the following week, if the nutritional status of the child did not deteriorate, the child was categorized as cured and discharged from POSHAN program. (27) The cured children were followed up for four months, and the non-recovered children were referred to MTC. In the follow-up phase, POSHAN Prahari’s made home visits of cured children to track their nutritional status and dietary intake. (27) The detailed process flow of the treatment phase is shown in figure 2.
[1] Ready to Use-Therapeutic Food (RUTF): It is a high energy fortified ready to eat food suitable for treatment of severely malnourished children. This food should be soft or crushable, palatable and easy for children to eat without any preparation. At least half of the proteins contained in the product should come from milk products.(33)

[2] Medical Nutrition Therapy (MNT) kit consist of Energy dense Nutritional Supplement (EDNS), antibiotics and albendazole which is used for the treatment of SAM children in POSHAN-II.(24)

[3] In Indian rural health system, a subcenter is the peripheral and first point of contact between the community and primary health center system serving 5000 population in plains and 3000 population in hilly region.(44)

[4] ANM is key field level health functionary who are posted in Subcentre for maternal and child health besides treatment of common illnesses and are viewed as replacement of professional cadre of midwives in Primary Health Center (PHC).(44)

[5] ASHA is a community level health activist whose primary task is to create awareness, counsel, mobilize and facilitate the community in accessing health services from subcenters or Primary Health Center (PHC). (45)

[6] Energy Dense Nutrient Supplement (EDNS): In IMAM POSHAN-II, Ready to Use-Therapeutic Food RUTF was called as EDNS.(24)

Methods

IMAM POSHAN-II enrolled 10,344 SAM children aged 6 -59 months in 52 blocks covering 20 districts of Rajasthan.(24) A cohort of SAM children was sampled for baseline, mid-line and end-line evaluation study. Quasi-experimental pre and post-test research design were used to assess the effectiveness of community-based management of SAM children aged 6 – 59 months from December 2018 to February 2019. The baseline study was conducted during the phase of identification and enrollment of SAM children, mid-line and end-line study was conducted after eight weeks and twelve weeks of treatment.

Sampling

Assuming 8.7 percent prevalence of SAM in rural areas (NFHS-4)(28) with ~60 percent and ~80 percent recovery rate (POSHAN 1)(25) after 8 and 12 weeks of EDNS treatment, risk ratio of 2.0, 95 percent Confidence Interval (CI), 80 percent power and 10 percent non-response rate, it was estimated that 750 and 1,486 SAM children will be required for midline and end-line study. The 20 program districts of Rajasthan were divided into five zones based on geographical, cultural, social and economic variations in coverage and performance. One program district was selected randomly from each zone. In each district, two blocks were selected randomly. Further 8 POSHAN centres were sampled in each block using systematic random sampling. There were few districts where only one program block was available, in such cases 16 POSHAN centres were systematically sampled from the single program block. The study targeted to cover 1,486 SAM children from 80 POSHAN centres of five selected districts. The list of SAM children enrolled in the program was available with the ANM at respective Subcenters. However, only 1,322 SAM children were enrolled in 80 POSHAN centres which were sampled for the study. With 1,322
enrolled SAM children as a target, baseline study covered 1,105 (83.1 percent) children. During the midline study and end line study, 753 (100 percent) and 1,091 (82.5 percent) children were covered as per the sample design.

Data Collection

The primary respondent of the survey were mothers and enrolled SAM children. If the mother was not available, the primary caregiver of the child was interviewed. During the Baseline study, all the target children were covered at the sub-centre, whereas, for the mid-line and end-line survey, most of the children were covered at the household level. Ethical approval for the study was received from IIHMR Institutional Review Board (IRB). In the field, before initiating the interview, informed consent was received from all the study respondents. The study targeted to collected data on demographic variables, parents or caregiver background information, dietary intake, compliance towards EDNS consumption, anthropometry and pedal oedema. The data was recorded by trained interviewers using Computer Assisted Personal Interviewing (CAPI) technique. Weight, height or length and MUAC was measured using the instruments available in Subcenters. At the household level, instruments were carried by the field data collectors from house to house from sub-centre. SECA and SECA were used to measure weight, length or height. The data from CsPro was later exported to IBM SPSS version 23 for further statistical analysis. Anthropometric data was exported to the WHO Anthro software version 3.2.2 developed based on WHO 2006 child growth standards to calculate gender and age-specific WHZ score.

Variables used for data analysis

WHZ and or MUAC measurement were used to derive the outcome or dependent variable. The dependent variable used for the analysis was the nutritional status of the child at 8 and 12 weeks of the program. The independent variables used for the analysis were maternal education, annual family income, gender and age of the child, number of weeks of EDNS consumption. The percentage of cured, non-recovered, defaulted children were calculated using anthropometric data based on the enrollment and discharge criteria of the program (Table). After eight weeks of EDNS treatment, if the nutritional status of the child had not improved, they were continued in the program from 9 to 12 weeks. After 12 weeks, non-recovered children were referred to MTC or health facility for treatment. Enrolled children who failed to report during POSHAN divas for continuously three weeks, were categorized as defaulters. The mean weight gain (gm/kg/day) was calculated using the formula

\[
\frac{\text{Mean weight after discharge (gm) } - \text{Mean weight on enrollemnt (gm)}}{\text{Total duration of stay (days) } * \text{Mean weight on enrollemnt (kg)}}
\]

Descriptive analysis was carried out for categorical variables to calculate Number (N) and percentage. For continuous variables, mean and standard deviation was calculated. Binary logistic regression was applied to find the factors associated with the outcomes of community-based management of SAM
children after 8 and 12 weeks of treatment. The results of the regression model are presented with odds ratio ($\beta$), probability (p value) and 95 percent of Confidence Interval (CI). Binary logistic regression considers the independent variable to be significant when the p-value < 0.05.

**Findings**

**Background characteristics of the enrolled SAM children**

In the baseline study, 1,105 SAM children aged 6-59 months were covered. It was found that 46.1 percent (N=509) children were male, 53.9 percent (N=596) children were female. Around 47 percent of enrolled children were aged 12-23 months followed by 21.3 percent aged 24-35 months, 14.3 percent aged 6-11 months, 10.2 percent aged 36-47 months and 7.4 percent aged 48-59 months. As shown in figure 3, 69.1 percent (N=764) were enrolled with WHZ < -3SD followed by 16.2 percent (N=179) enrolled with both WHZ < -3SD and MUAC < 11.5cm and 14.7 percent with MUAC < 11.5cm. Socio-demographic analysis of mothers or caregiver shows that 30.9 percent of women were aged 15-24 years, 60.8 percent aged 25-34 years and 8.3 percent aged 35 years and above (table 2). It was found that 89 percent (N=983) and 11 percent (N=122) belonged to Hindu and Muslim region. Majority of study respondents belonged to scheduled tribe (39.7 percent) and other backward classes (38.9 percent) followed by scheduled caste (16.5 percent). Annual family income was less than Rs.50,000 for 46.2 percent of families, 35.3 percent of families earn between 50,000 to 1 lakh and 18.4 percent of families earn more than 1 lakh per year. Around 55 percent of women have no school education followed by 23.3 percent of women with primary education and 21.4 percent of women with secondary and higher education (table 2).

**Table 2. Socio-demographic characteristics of enrolled SAM children**
| Background Characteristics (N=1105) | Number (N) | Percentage (%) |
|------------------------------------|------------|----------------|
| **Age of enrolled SAM children**   |            |                |
| 6 - 11 months                      | 158        | 14.3           |
| 12 - 23 months                     | 517        | 46.8           |
| 24 - 35 months                     | 235        | 21.3           |
| 36 - 47 months                     | 113        | 10.2           |
| 48 - 59 months                     | 82         | 7.4            |
| **Gender**                         |            |                |
| Male                               | 509        | 46.1           |
| Female                             | 596        | 53.9           |
| **Age of mother**                  |            |                |
| 15 to 24 years                     | 341        | 30.9           |
| 25 - 34 years                      | 672        | 60.8           |
| 35 years and above                 | 92         | 8.3            |
| **Religion**                       |            |                |
| Hindu                              | 983        | 89             |
| Muslim                             | 122        | 11             |
| **Caste**                          |            |                |
| Scheduled caste                    | 182        | 16.5           |
| Scheduled tribe                    | 439        | 39.7           |
| Other backward class               | 430        | 38.9           |
| None of these                      | 44         | 4.0            |
| Don't know                         | 10         | 0.9            |
| **Annual Family Income**           |            |                |
| < 50000                            | 511        | 46.2           |
| 50000 - 1 Lakh                     | 390        | 35.3           |
| 1- 2 Lakh                          | 153        | 13.9           |
| > 2 Lakh                           | 51         | 4.6            |
| **Maternal Education**             |            |                |
No schooling  612  55.4  
Primary education  257  23.2  
Secondary and higher education  236  21.4  

Nutritional Outcomes of SAM children enrolled with MUAC < 11.5 cm

Around 14.7 percent (N=162) of children were enrolled with MUAC < 11.5 cm. During the midline and endline study, 111 and 162 children were followed to measure the nutritional outcomes. It was found that 43.2 percent (N=48) and 72.2 percent (N=117) of children were cured after 8 weeks and 12 weeks of treatment (Table 3). Defaulters were 5.4 percent and 9.3 percent after 8 and 12 weeks. After 8 weeks, around 51.4 percent (N=57) of children were not recovered and hence continued treatment from 9 to 12 weeks. After 12 weeks, 18.5 percent (N=30) children were non recovered, hence were referred to MTC for further treatment. As shown in figure 4 and 5, female children have shown the highest cure rate at 8 weeks (52.2 percent) and 12 weeks (74.2 percent) when compared to male children.

Nutritional outcomes of SAM children enrolled with WHZ < -3SD

Majority of children (69.1 percent, N= 764) were identified and enrolled with WHZ < -3SD SAM criteria. During the midline and endline study, 523 and 750 children were followed to assess nutritional outcomes (table 3). The following were the outcomes after 8 weeks: Cured – 43.8 percent (N=229), defaulters – 3.3 percent (N=17), continued for treatment from 9 to 12 weeks (non-recovered) – 53 percent (N=277). After 12 weeks: cured – 68.8 percent (N=516), defaulter – 8.7 percent (N=65) and non-recovered – 22.5 percent (N=169). The rate of weight gain among cured cases (N=229) after 8 weeks was 3.1 gm⁻¹/kg⁻¹/day⁻¹ (table 4). The cured cases were higher among female children at 8 (47.8 percent) and 12 weeks (71.8 percent) when compared to male children (figure 4 and 5).

Nutritional outcomes of SAM children enrolled with WHZ < -3SD and MUAC < 11.5 cm

Out of 1,105 children, 179 children (16.2 percent) were enrolled with WHZ < -3SD and MUAC < 11.5 cm SAM criteria. During the midline and endline study, 119 and 179 children were followed to assess nutritional outcomes (table 3). The following were the outcomes after 8 weeks: Cured – 35.3 percent (N=42), defaulters – 6.7 percent (N=8), continued for treatment from 9 to 12 weeks (non-recovered) – 58 percent (N=69). After 12 weeks: cured – 54.2 percent (N=97), defaulter – 4.5 percent (N=8) and non-recovered – 41.3 percent (N=74). The rate of weight gain among cured cases (N=42) after 8 weeks was 3.4 gm⁻¹/kg⁻¹/day⁻¹ (table 4). The cured cases were higher among female children at 8 weeks (60 percent) when compared to male children (figure 4 and 5).

Table 3. Nutritional status of SAM children at 8 and 12 weeks
| Program Outcomes | 8 weeks (N=753) | 12 weeks (N=1091) |
|------------------|-----------------|------------------|
|                  | Number (N) | Percentage (%) | Number (N) | Percentage (%) |
| Cured            | 319        | 42.4            | 730        | 66.9            |
| Defaulters       | 31         | 4.1             | 88         | 8.1             |
| Continued for treatment at 8 Weeks / Not Cured and referred to MTC at 12 Weeks | 403 | 53.5 | 273 | 25 |
| MUAC< 11.5 cm    |              |                 | 8 weeks (N=111) | 12 weeks (N=162) |
|                  | Number (N) | Percentage (%) | Number (N) | Percentage (%) |
| Cured            | 48         | 43.2            | 117        | 72.2            |
| Defaulters       | 6          | 5.4             | 15         | 9.3             |
| Continued for treatment at 8 Weeks / Not Cured and referred to MTC at 12 Weeks | 57 | 51.4 | 30 | 18.5 |
| WHZ ≤ -3SD       |              |                 | 8 weeks (N=523) | 12 weeks (N=750) |
|                  | Number (N) | Percentage (%) | Number (N) | Percentage (%) |
| Cured            | 229        | 43.8            | 516        | 68.8            |
| Defaulters       | 17         | 3.3             | 65         | 8.7             |
| Continued for treatment at 8 Weeks / Not Cured and referred to MTC at 12 Weeks | 277 | 53 | 169 | 22.5 |
| MUAC < 11.5cm & WHZ ≤ -3SD | N=119 | N=179 |
|                  | Number (N) | Percentage (%) | Number (N) | Percentage (%) |
| Cured            | 42         | 35.3            | 97         | 54.2            |
| Defaulters       | 8          | 6.7             | 8          | 4.5             |
| Continued for treatment at 8 Weeks / Not Cured and referred to MTC at 12 Weeks | 69 | 58 | 74 | 41.3 |

Table 4. Mean weight gain at 8 weeks to the time of admission
| **Mean Weight gain at 8 weeks** |
|--------------------------------|
| **Cured Cases (N=319)**        |
| Mean weight at enrolment       | 7.3 ± 1.5 |
| Mean weight at 8 weeks         | 8.6 ± 1.7 |
| Mean weight gain (gm\(^{-1}\)kg\(^{-1}\)day\(^{-1}\)) | 3.2      |
| **Z Score -3 SD (N=229)**      |
| Mean Weight at enrolment       | 7.6 ± 1.5 |
| Mean weight at 8 weeks         | 8.9 ± 1.7 |
| Mean Weight gain (gm\(^{-1}\)kg\(^{-1}\)day\(^{-1}\)) | 3.1      |
| **Z Score -3 SD & MUAC < 11.5 cm (N=42)** |
| Mean Weight at enrolment       | 6.3 ± 1.4 |
| Mean weight at 8 weeks         | 7.5 ± 1.3 |
| Mean Weight gain (gm\(^{-1}\)kg\(^{-1}\)day\(^{-1}\)) | 3.4      |

Table 5. Factors associated with recovery among SAM children at 8 and 12 weeks
### Background information

|                          | Nutritional status at 8 weeks (N=753) | Nutritional status at 12 weeks (N=1091) |
|--------------------------|--------------------------------------|-----------------------------------------|
|                          | Non recovered | Cured | p-value | Non recovered | Cured | p-value |
| **Maternal Education**   |            |      |         |            |      |         |
| No Schooling             | 192 (85)    | 34 (15) | p<0.001 | 255 (42)    | 352 (58) | p<0.001 |
| Primary education        | 130 (47.6)  | 143   | (52.4)  | 68 (27)     | 184 (73) |
| Secondary and Higher     | 112 (44.1)  | 142   | (55.9)  | 38 (16.4)   | 194     |
| Education               |            |      |         |            |      |         |
| **Annual Family Income** |            |      |         |            |      |         |
| Less than 50000          | 240 (77.4)  | 70    | (22.6)  | 227 (45.7)  | 270    | (54.3)  |
| 50000 – 1Lakh            | 120 (47.1)  | 135   | (52.9)  | 95 (24.4)   | 295    | (75.6)  |
| 1-2 Lakh                 | 74 (39.4)   | 114   | (60.6)  | 29 (19)     | 124 (81) |
| More than 2 Lakh         | -           | -     |         | 10 (19.6)   | 41 (80.4) |
| **Gender of the child**  |            |      |         |            |      |         |
| Male                     | 207 (60.2)  | 137   | (39.8)  | 178 (35.4)  | 325 (64.6) | 0.136 |
| Female                   | 227 (55.5)  | 182   | (44.5)  | 183 (31.1)  | 405    | (68.9)  |
| **Age of the child**     |            |      |         |            |      |         |
| 6-23 months              | 265 (55.7)  | 211   | (44.3)  | 200 (29.9)  | 468    | (70.1)  |
| 24-59 months             | 169 (61)    | 108   | (39)    | 161 (38.1)  | 262    | (61.9)  |
| **EDNS consumption**     |            |      |         |            |      |         |
Table 6. Factors associated with cured and non-recovered SAM children aged 6-59 months using binary logistic regression

|                  | Cured | Non-cured | P-value |
|------------------|-------|-----------|---------|
| Less than 4 weeks| 246 (73.4) | 89 (26.6) | p<0.001 |
| 5 to 8 weeks     | 188 (45)  | 230 (55)  | 178 (38.6) | 283 (61.4) |
| 9 to 12 weeks    | -      | -         | 108 (20.9) | 409 (79.1) |
| Variables                      | 8 Weeks                      | 12 Weeks                      |
|--------------------------------|------------------------------|------------------------------|
|                                | Exp  | p-Value | 95 % of | Exp  | p-Value | 95 % of |
|                                | (β)  |         | C.I     | (β)  |         | C.I     |
| Mother education               |      |         |         |      |         |         |
| No schooling ®                 |      |         |         |      |         |         |
| Primary Education              | 5.9  | p<0.001 | 3.71,9.43 | 1.7  | p<0.001 | 1.23,2.45 |
| Secondary and higher education | 6.4  | p<0.001 | 3.98,10.21 | 3.222 | p<0.001 | 2.15,4.82 |
| Annual Family Income           |      |         |         |      |         |         |
| Less than 50000 ®              |      |         |         |      |         |         |
| 50000 - 1 Lakh                 | 3.2  | p<0.001 | 2.16,4.79 | 2.5  | p<0.001 | 1.86,3.46 |
| 1 - 2 Lakh                     | 4.0  | p<0.001 | 2.64,6.30 | 3.0  | p<0.001 | 1.92,4.90 |
| More than 2 Lakh               | NA   | NA      | NA      | 3.0  | 0.005   | 1.37,6.33 |
| Child gender                   |      |         |         |      |         |         |
| Male ®                         |      |         |         |      |         |         |
| Female                         | 1.2  | 0.229   | 0.87,1.73 | 1.2  | 0.153   | 0.92,1.62 |
| Age of the child               |      |         |         |      |         |         |
| 6-23 months ®                  |      |         |         |      |         |         |
| 24-59 months                   | 0.8  | 0.109   | 0.52,1.06 | 0.75 | 0.052   | 0.56,1.00 |
| EDNS Consumption               |      |         |         |      |         |         |
| Less than 4 weeks ®            |      |         |         |      |         |         |
| 5 to 8 weeks                   | 3.1  | p<0.001 | 2.20,4.41 | 3.0  | p<0.001 | 1.87,4.69 |
| 9-12 weeks                     | NA   | NA      | NA      | 6.6  | p<0.001 | 4.10,10.47 |

Overall nutritional outcomes of enrolled SAM children

The study covered 1,105 children, out of which 753 and 1,091 children were covered for midline and endline study. As shown in Table 3, the program yields the following nutritional outcomes at 8 weeks: Cured – 42.4 percent (N=319), defaulter – 4.1 percent (N=31), continued in the program from 9 to 12 weeks (non-recovered) – 53.5 percent (N=403). After 12 weeks: cured – 66.9 percent (N= 730), defaulter – 8.1 percent (N=88) and non-recovered – 25 percent (N=273). The rate of weight gain among all cured children was 3.2 gm/kg/day. Overall female children showed higher cure rate at 8 weeks (44.5 percent)
and 12 weeks (68.9 percent) when compared to male children (figure 4 and 5). At 12 weeks, SAM children enrolled with MUAC has shown higher cure rate (72.2 percent) when compared to children enrolled with WHZ (68.8 percent) followed by children enrolled with MUAC and WHZ (54.2 percent).

Socio-demographic variables with nutritional outcomes of SAM children

Pearson Chi-square test was applied to analyze the association of socio-demographic variables and compliance with EDNS consumption with nutritional outcomes. As shown in Table 5, with increasing annual family income, percentage of cured children increases at 8 (22.6 percent < Rs.50,000 to 60.6 percent between 1-2 lakhs, p<0.001) and 12 weeks (54.3 percent < Rs. 50,000 to 80.4 percent > 2lakhs, p<0.001) of treatment. The proportion of cured children are high among will educated mothers (55.9 percent at 8 weeks, p<0.001; 83.6 percent at 12 weeks, p<0.001) when compared to mothers with no education (15 percent at 8 weeks, p<0.001; 58 percent at 12 weeks, p<0.001). A high proportion of cured children was observed among younger children aged 6-23 months (44.3 percent at 8 weeks, 61.9 percent at 12 weeks). The proportion of cured cases was significantly high among children who consumed EDNS for 5-8 weeks (61.4 percent, p<0.001) and 9-12 weeks (79.1 percent, p<0.001).

Factors associated with nutritional outcomes of SAM children using binary logistic regression model

The binary logistic regression model was used to analyze the sociodemographic factors associated affecting the nutritional outcomes of SAM children. From the analysis (table 6), it was observed that annual family income, maternal education and compliance towards EDNS consumption is statistically significant. It was found that with increasing annual family income the odds of a child getting cured increases at 8 weeks (50,000-1lakh – OR: 3.2, CI:2.16-4.79; >1 lakh – OR:4.0, CI: 2.64-6.30) and 12 weeks (50,000-1lakh – OR:2.5, CI: 1.86-3.46; >2 lakh – OR: 2.9, CI:1.37-6.33). SAM children of educated women are 6.3 and 3.24 times more likely to recover at 8 and 12 weeks when compared to women with no education. Children aged 24-59 months are less likely (OR:0.7, CI:0.56-1.0) to recover when compared to children aged 6-23 months at 12 weeks. The regression model also shows that children who consumed EDNS for 5-8 weeks are 3.1 and 2.9 times more likely to recover at 8 and 12 weeks when compared to children who consumed EDNS less than four weeks. Children who consumed EDNS for 9-12 weeks are 6.5 times more likely to recover from SAM.

Discussion

In this evaluation research study, the effectiveness of community-based management of SAM through EDNS was assessed between December 2018 to February 2019. Majority of children enrolled in the program were females (53.9 percent) and children aged 6–23 months (61.1 percent). Mothers of more than half of the children (55.4 percent) had no school education. Around 81.5 percent of families with SAM children earned less than one lakh in a year. The program outcomes were assessed after 8 and 12 weeks of treatment. After 8 weeks of treatment, the outcomes were 42.4 percent of cured cases, 4.1 percent of defaulters and 53.5 percent continued in the program (non-recovered) from nine to 12 weeks. After 12 weeks of treatment outcomes were - 66.9 percent of cured cases, 8.1 percent of defaulters and
25 percent of non-recovered cases. The non-recovered cases (25 percent) were referred to MTC or health facility for treatment. The mean rate of weight gain among cured cases at 8 weeks was 3.2 g/kg/day. There was no mortality observed during the study. The IMAM POSHAN-II program being first of its kind to be implemented on large scale (10,344 SAM children in 20 districts) demonstrate a piece of evidence that SAM children without medical complications can be treated successfully using EDNS at community and household level. The proportion of defaulter (5.4 percent) at 8 weeks is lower than the international standards (< 15 percent).(29) Survival outcomes (100 percent survival rate) can be favourably compared with international standards (< 10 percent).(29) Overall cure rate at 8 weeks was 42.4 percent which is comparatively low with international standards (< 10 percent).(29) The comparison of program outcomes with national and international standards is shown in Table 7.

In the Indian context, there are two research studies which discuss the outcomes of facility-based treatment for SAM. In Madhya Pradesh (MP) 2012, 93 children were successfully treated for 14 days in-facility and recovered from SAM. Later, the improved condition was not sustained after discharge.(30) Another facility-based study at Jharkhand treated 3,595 SAM children in MTC’s. Mean length of stay was 16 days with 0.6 percent mortality, 18.4 percent defaulters and mean weight gain was 9.6 g/kg/day.(23) Three research studies from Bihar, MP and Mumbai analyses the effectiveness of community-based management of SAM using commercially or locally produced RUTF. In Bihar (2011), 44.1 children were enrolled with MUAC < 11.5 cm and discharged with MUAC > 12.0 cm. The CMAM model adopted the combination of both inpatient (complicated SAM) and outpatient (uncomplicated SAM) facility for treatment. The program was implemented in Biraaul block of Darbhanga district after Kosi floods. (4) It achieved a cure rate of 57.4 percent, 36.2 percent of defaulter rate and 0.8 percent of mortality. (4) In 2013, a study conducted at MP (N = 2740) adopted the model of 14 days compulsory inpatient treatment at NRC for all identified SAM children followed by treatment using Integrated Child Development Services (ICDS) Supplementary Nutrition Program (SNP) for 60 days.(12) The program exhibited 43.9 percent of cure rate, 32 percent of defaulters, 23.7 percent as non-recovered and 0.4 percent of mortality. (12) With this background, evaluation study of IMAM POSHAN-II, Rajasthan with a cure rate of 42.4 and 66.9 percent at 8 and 12 weeks confirms that SAM children without medical complications can be successfully treated using EDNS (as per WHO recommendations). (31–33) It also acts as evidence that EDNS is well accepted by Indian Children for improved growth and can be safely used in the community (Survival rate of 100 percent). The outcomes of the defaulted SAM children were not studied in the evaluation study. The mean weight gain (3.2 g/kg/day) after 8 weeks of treatment was comparably high as reported by Ciberto, et al (2.8 g/kg/day) but was also lesser than the weight gain reported by other authors. (34–37)
Table 7
Comparison of IMAM POSHAN-II outcomes with national and international standards (SPHERE)(11, 12, 29)

| S. No | Indicators                                      | IMAM POSHAN II (%) | Indian studies (%) | International standard (SPHERE) |
|-------|------------------------------------------------|--------------------|--------------------|---------------------------------|
|       |                                                |                    |                    | Acceptable (%) | Alarming (%) |
| 1     | Proportion of children cured from SAM           | 66.9               | 43 to 57           | >75               | <50          |
| 2     | Proportion of SAM children defaulted            | 8.1                | 32 to 38           | <15               | >15          |
| 3     | Proportion of children died                     | 0                  | 0.4 to 1.1         | <10               | >25          |
| 4     | Mean Weight gain (gm⁻¹kg⁻¹day⁻¹)                | 3.2                | 1.6 to 5.1         | >=8               | <8           |

Research studies have indicated that children identified using MUAC are at higher risk than children identified by WHZ. In limited-resource settings, MUAC is recommended than WHZ. In contrast, global evidence also shows that children identified using WHZ and MUAC are not the same. Researches also prove that using MUAC as single admission criteria leads to a low estimation of the actual burden of SAM. With this background and WHO guidelines as a backbone, IMAM POSHAN-II has used both WHZ < -3SD and MUAC < 11.5 cm independently or combined to identify SAM children. It was observed that majority of children were enrolled as SAM with WHZ < -3SD (69.1 percent) followed by MUAC < 11.5 cm (16.2 percent) and both MUAC < 11.5 cm and WHZ < -3SD (14.7 percent). After 12 weeks of treatment, it was found that children enrolled with MUAC show higher cure rate (72.2 percent) followed by WHZ (68.8 percent) and WHZ and MUAC (54.2 percent. Also, the overall cure rate was high among female children (68.9 percent) when compared to male children (64.6 percent).

Binary logistic regression model indicates that after 8 and 12 weeks of treatment, the odds of SAM children getting cured increases with increasing family income. Children of educated mothers were 6.3 times more likely to recover than children of mothers with no education. Compliance towards EDNS is significantly associated with recovery of children at 8 and 12 weeks. Children who consumed EDNS for five to eight weeks are 3.1 times more likely to recover than children who consumed EDNS for less than four weeks. Over a treatment period of 8–12 weeks, it is observed that consumption of appropriate EDNS (as per recommended WHO guidelines) is the key for successful recovery of SAM children. EDNS tested for international and national quality standards could be manufactured as per the needs. To reduce the increasing burden of SAM, IMAM POSHAN-II proves to be a promising alternative to treat uncomplicated SAM children.

The experience in Rajasthan demonstrates that community-based management of SAM can detect malnourished children at an early stage and can bring rapid improvement in nutritional status through
EDNS. Further government and other partners should strengthen the existing health systems. ANM, ASHA and Anganwadi Worker (AWW) should be trained and empowered to deliver quality healthcare services. (12, 22) A follow up research study at 12 months may help us to understand the full impact and sustainability of the program. (42) Cost-effective analysis of IMAM POSHAN-II will provide further insights on long term policy implementation and management. (43)

**Declarations**

**Ethical approval and consent to participate**

Ethical approval was granted by Institutional Review Board (IRB) for the Protectionof Human Subjects (IORG0007355) of The Indian Institute of Health management research (IIHMR) of Jaipur, Rajasthan. Informed consent was obtained and witnessed from each participant before conducting the interview. An consent form (in Hindi) was given read out and given to the particpnats by the field data collection team. Informed written (or thumb print if illiterate) consent was received from caregivers. It was made clear that the participation was voluntary. The research performed was part of the nutrition intervention program implemented by Government of Rajasthan. The research study followed the norms as in accordance with the declaration of Helsinki.

**Consent for publication**

Participants gave written consent for publishing the study findings without identifying an individual or any personal details.

**Availability of data and materials**

The datasets used and or analysed during the current study are avaible from the corresponding author on reasonable request.

**Competing interest**

The authors declare that they have no competing interests

**Funding**

The study was funded by Global Alliance for Imporved Nutrition (GAIN), New Delhi. The funders had no role in the design of the study, implementation, data collection, analysis, interpretation and writing of the report.

**Authors contributions**

Original research design and conceptualization of the study: DKM, SS, LS, IG; methodology: DKM,SS, IG, LS; training of research team: LS, SS; Implementation of field data collection: LS, SS; data curation: SS; project management, coordination and administration: DKM, SS, LS; Supervision: DKM, SDG, IG, LS and
Acknowledgements

The authors wish to thank all the study respondents for their participation in the study; GAIN, UNICEF, CIFF for their time, advice and support.

Authors information (optional)

Affiliations

IIHMR University, Jaipur, Rajasthan, India

Shobana Sivaraman, Laxman Sharma, Daya Krishna Mangal, Shiv Dutt Gupta

Global Alliance for Improved Nutrition (GAIN), New Delhi, India

Ishank Gorla

References

1. Global Nutrition Report - Action on equity to end malnutrition [Internet]. Global Nutrition Report. 2020. Available from: https://globalnutritionreport.org/reports/2020-global-nutrition-report/

2. United Nations Children’s Fund (UNICEF), World Health Organization, International Bank for Reconstruction and Development/The World Bank. Levels and trends in child malnutrition: key findings of the 2019 Edition of the Joint Child Malnutrition Estimates [Internet]. Geneva, Switzerland; 2019. Available from: http://www.unicef.org/media/files/JME_2015Edition_Sep_2015.pdf

3. International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-4), 2015-16: India. International Institute for Population Sciences (IIPS) and ICF. 2017.

4. Swaminathan S, Hemalatha R, Pandey A, Kassebaum NJ, Laxmaiah A, Longvah T, et al. The burden of child and maternal malnutrition and trends in its indicators in the states of India: the Global Burden of Disease Study 1990–2017. Lancet Child Adolesc Heal. 2019;3(12):855–70.

5. Menon P, Headey D, Avula R, Nguyen PH. Understanding the geographical burden of stunting in India: A regression-decomposition analysis of district-level data from 2015–16. Matern Child Nutr. 2018;14(4):1–10.

6. Development Initiatives. 2018 Global Nutrition Report Shining a light to spur action on nutrition. Bristol, UK; 2018.
7. Olofin I, Mcdonald CM, Ezzati M, Flaxman S, Black RE. Associations of Suboptimal Growth with All-Cause and Cause-Specific Mortality in Children under Five Years: A Pooled Analysis of Ten Prospective Studies. PLoS One. 2013;8(5).

8. World Health Organization, World Food Programme, United Nations System Standing Committee on Nutrition, The United Nations Children's Fund. COMMUNITY-BASED MANAGEMENT OF SEVERE ACUTE MALNUTRITION: A Joint Statement by the World Health Organization, the World Food Programme, the United Nations System Standing Committee on Nutrition and the United Nations Children's Fund. 2007.

9. WHO. Guideline Updates on the Management of Severe Acute Malnutrition in Infants and Children [Internet]. Geneva; 2013. Available from: https://apps.who.int/iris/bitstream/handle/10665/95584/9789241506328_eng.pdf?sequence=1

10. World Health Organization. Management of Severe Acute Manlutrition: A Manual for Physicians and other Senior Health Workers. Geneva, Switzerland; 1999.

11. Burza S, Mahajan R, Elisa M, Sunyoto T, Shandilya C, Tabrez M, et al. Community-based management of severe acute malnutrition in India: new evidence from Bihar. Am J Clin Nutr. 2015;101:847–59.

12. Aguayo VM, Agarwal V, Agnani M, Agrawal D Das, Bhambhal S, Rawat AK, et al. Integrated program achieves good survival but moderate recovery rates among children with severe acute malnutrition in India. Am J Clin Nutr. 2013;(5):1335–42.

13. Rogers E, Myatt M, Woodhead S, Guerrero S, Alvarez JL. Coverage of Community-Based Management of Severe Acute Malnutrition Programmes in Twenty-One Countries, 2012–2013. PLoS One. 2015;10(6):1–12.

14. Yebyo HG, Kendall C, Nigusse D, Lemma W. Outpatient Therapeutic Feeding Program Outcomes and Determinants in Treatment of Severe Acute Malnutrition in Tigray, Northern Ethiopia: A Retrospective Cohort Study. PLoS One. 2013;8(6):2–10.

15. Tadesse E, Worku A, Berhane Y, Ekström EC. An integrated community-based outpatient therapeutic feeding programme for severe acute malnutrition in rural Southern Ethiopia: Recovery, fatality, and nutritional status after discharge. Matern Child Nutr. 2018;14(2):1–8.

16. United Nations Children's Fund (UNICEF). EVALUATION OF COMMUNITY MANAGEMENT OF ACUTE MALNUTRITION (CMAM) Global Synthesis Report. New York; 2013.

17. World Health Organization, United Nations Children's Fund (UNICEF). WHO child growth standards and the identification of severe acute malnutrition: A joint Statement by the WOrld Health Organization and the United Nations Children's Fund. Geneva, Switzerland; 2009.

18. Collins S. Treating severe acute malnutrition seriously. Arch Dis Child. 2007;92(5):453–61.

19. Kapil U, Sachdev HPS. Management of children with severe acute malnutrition: A national priority. Indian Pediatr. 2010;47(8):651–3.

20. Collins S, Sadler K. Out patient care for severely malnourished children in emergency relief programmes: a retrospective cohort study. Lancet. 2002;360(9348):1834–1830.
21. Mathur M, Halim A, Gupta M, Panda B, Syed A. Community-based management of acute malnutrition (CMAM) in India: a position paper. Int J Res Med Sci. 2018;6(12):4128.
22. Pati S, Mahapatra S, Sinha R, Pati S, Samal SN. Community Management of Acute Malnutrition (CMAM) in Odisha, India: A Multi-Stakeholder Perspective. Front Public Heal. 2018;6(June):1–7.
23. Aguayo VM, Jacob S, Badgaiyan N, Chandra P, Kumar A, Singh K. Providing care for children with severe acute malnutrition in India: new evidence from Jharkhand. Public Health Nutr. 2014;17(1):206–11.
24. National Health Mission, Government of Rajasthan. POSHAN [Internet]. 2019. Available from: http://nrhmrajasthan.nic.in/POSHAN.htm
25. National Health Mission, Government of Rajasthan. Technical Consultation and Symposium on POSHAN Project in Rajasthan: A Report. Jaipur, Rajasthan; 2016.
26. National Health Mission, Government of Rajasthan. Factsheet POSHAN-II, Rajasthan. Jaipur, Rajasthan; 2019.
27. National Health Mission, Government of Rajasthan. Guidelines for IMAM POSHAN II. Jaipur, Rajasthan; 2018.
28. International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-4), India, 2015-16: Rajasthan. Mumbai; 2017.
29. The Sphere Project. Humanitarian charter and minimum standards in humanitarian response: 2011 edition [Internet]. The Sphere Handbook. United Kingdom: Practical Action Publishing; 2011. Available from: https://www.ifrc.org/PageFiles/95530/The-Sphere-Project-Handbook-20111.pdf
30. Taneja G, Dixit S, Khatri A, Yeshikar V, Raghunath D, Chourasiya S. A Study to Evaluate the Effect of Nutritional Intervention Measures on Admitted Children in Selected Nutrition Rehabilitation Centers of Indore and Ujjain Divisions of the State of Madhya Pradesh (India). Indian J Community Med. 2012;37(2):107–15.
31. United Nations Childrens Emergency Fund. Ready-to-use therapeutic food for children with severe acute malnutrition. Position Paper. 2013.
32. World Health Organization, United Nations Children’s Fund (UNICEF). WHO, UNICEF, WFP and UNHCR Consultation on the Programmatic Aspects of the Management of Moderate Acute Malnutrition in Children under five years of age. 2010. p. 1–18.
33. Caron O. RUTF Product Specifications [Internet]. Unicef. 2013. Available from: https://www.unicef.org/supply/files/Odile_Caron_RUTF_Product_Specifications.pdf
34. Ciliberto M, MJ M, MJ N, A B, Ashorn P. Home-based therapy for oedematous malnutrition with ready-to-use therapeutic food. Acta Paediatr. 2006;95(8):1012–5.
35. Diop EHI, Dossou NI, Ndour MM, Briand A, Wade S. Comparison of the efficacy of a solid ready-to-use food and a liquid, milk-based diet for the rehabilitation of severely malnourished children: A randomized trial. Am J Clin Nutr. 2003;78(2):302–7.
36. Manary MJ, Ndekha MJ, Ashorn P, Maleta K, Briend A. Home based therapy for severe malnutrition with ready-to-use food. Arch Dis Child. 2004;89(6):557–61.

37. Thakur GS, Singh HP, Patel C. Locally-prepared ready-to-use therapeutic food for children with severe acute malnutrition: A controlled trial. Indian Pediatr. 2013;50(3):295–9.

38. Briend A, Marie B, Fontaine O, Garenne M. Mid-upper arm circumference and weight-for-height to identify high-risk malnourished under-five children. Matern Child Nutr. 2011;8(1):130–3.

39. Myatt M, Khara T, Collins S. A review of methods to detect cases of severely malnourished children in the community for their admission into community-based therapeutic care programs. Food Nutr Bull. 2006;27(3).

40. Trehan I, Manary MJ. Management of severe acute malnutrition in low-income and middle-income countries. Arch Dis Child. 2015;100(3):283–7.

41. Grellety E, Golden MH. Weight-for-height and mid-upper-arm circumference should be used independently to diagnose acute malnutrition: policy implications. BMC Nutr [Internet]. 2016;2(1):1–17. Available from: http://dx.doi.org/10.1186/s40795-016-0049-7

42. O’Sullivan NP, Lelijveld N, Rutishauser-Perera A, Kerac M, James P. Follow-up between 6 and 24 months after discharge from treatment for severe acute malnutrition in children aged 6–59 months: A systematic review. PLoS One. 2018;13(8):1–18.

43. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? Lancet. 2013;382(9890):452–77.

44. Directorate General of Health Services. Indian Public Health Standards (IPHS) Guidelines for Sub-Centres Revised 2012 [Internet]. Ministry of Health and Family Welfare, Government of India. 2012. Available from: http://nhm.gov.in/images/pdf/guidelines/iph/iph-revised-guidlines-2012/sub-centers.pdf

45. Ministry of Health and Family Welfare (MoHFW), Government of India. Update on ASHA Programme [Internet]. 2016. Available from: http://nhsrcindia.org/sites/default/files/Update on ASHA Programme July 2016.pdf

46. Declarations

Figures
Figure 1

Process flowchart for diagnosing SAM children in POSHAN-II (27)
Figure 2

Treatment process flow of SAM children, POSHAN-II(27)
Figure 3

Percentage of enrolled children by admission criteria

Figure 4

Nutritional status of SAM children at 8 weeks by gender
Figure 5

Nutritional status of SAM children at 12 weeks by gender

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile1.docx