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## Cost Effectiveness Analysis of The Community and Hospital Based Management of Acute Malnutrition: A Case From Jharkhand, India

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## Abstract

**Background:** Severe Acute Malnutrition (SAM) among children remains unacceptably high in Jharkhand. A Community-based Management of SAM (CMAM) intervention, which provides full continuum of care provided by the CMAM intervention, from inpatient treatment for medically complicated SAM cases to outpatient treatment for uncomplicated SAM cases, was conducted to treat children with SAM by the government appointed community health workers.

**Methods:** Costs of treating a case of uncomplicated SAM in the CMAM intervention were estimated from the provider's and societal perspectives, in the research setting and from the provider's perspective in the government setting. Costs of the In-patient/Facility-based Management of SAM (FSAM) intervention were estimated from the provider's perspective alone. Costs were estimated at 2023 prices. Outcomes were also collected for both FSAM and CMAM components. The cost-effectiveness ratios (CER) of CMAM and FSAM interventions were calculated, by dividing the costs with number of cases treated, and compared.

**Results:** The CER of the FSAM intervention was Rs. 17,890 (US\$ 217) per child treated. The provider's and societal CERs of the CMAM intervention in a research setting were Rs. 15,289 (US\$ 185) and Rs. 17,950 (US\$ 217) per child treated, respectively while the provider's costs in the government setting was Rs. 7,137 (US\$ 86) per child treated. The robustness of the findings to assumptions was tested using one-way sensitivity analyses.

**Conclusion:** The CMAM intervention is more cost effective than the FSAM intervention. CMAM can effectively complement FSAM in India to address the high burden of SAM in the country.

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## 1. Background

West Singhbhum district is one of the poorest districts of Jharkhand, a State in East India. As defined by Government of India indicators, this rural state faces multiple social, health and nutrition challenges. Nearly 70 percent of the population is from a Scheduled tribe with a similar proportion dependent on agriculture (Census, 2011). The female literacy rate is 48 percent. Health service utilization is low, with only 68 percent of births taking place in an institution and 87 percent of children between one and two years fully immunized. Child care practices are sub-standard with 22 percent of infants breastfed within 1 h and only 12 percent of children receiving the minimum adequate diet at

the critically important stage between 6 and 23 months. The confluence of these factors has led to a poor nutritional state: 73 percent of children less than 5 years of age are anemic; nearly 61 percent stunted; 31 per cent wasted; and close to 63 per cent underweight. Notably, the prevalence of severe wasting is above the national average at 13 percent (National Family Health Survey, 2021). These findings show that there is an urgent need to implement a comprehensive programme to address acute malnutrition<sup>1</sup> in the district.

Consequently, a community-based management of severe acute malnutrition (CMAM) intervention was implemented in Khuntpani block of the district. This evidence-based approach, used across the globe, enables the early identification and treatment

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<sup>1</sup> Acute malnutrition is defined using criteria of WHZ, MUAC and Edema. Wasting is defined using only WHZ criteria.

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of children with severe acute malnutrition (SAM), both at the facility and in the community. The block is made up of 115 villages, served by 137 Anganwadi centres (AWCs).

### 1.1. CMAM program design

The government led CMAM program involved the timely detection of children with SAM by AWWs and treatment for those without medical complications by ANMs in the community-based AWCs. These services were linked with existing Malnutrition Treatment Centre (MTC, the facility component of the model known as FSAM) in the district, enabling the referral of complicated cases to appropriate care.

The CMAM component followed a standard protocol adapted specifically for the intervention block. All children were screened by AWWs, with a campaign approach using anthropometric measurements and checking for the presence of bilateral pitting edema. Those identified as SAM without complications were referred to the CMAM clinic held at the Village Health, Sanitation & Nutrition Day (VHSND) for further assessment. Those that passed an appetite test were enrolled in the CMAM program. Children with SAM and medical complications were referred to the MTC Chaibasa for treatment.

Children enrolled in the CMAM program had their nutritional status further assessed using anthropometry, were provided with nutrient dense food according to their nutritional needs and provided with routine medicines (antibiotics and deworming). Caregivers were counseled by ANMs on their child's status and the nutrient dense food feeding protocol. Children were followed up at the AWC every week for a maximum period of 16 weeks. On each weekly visit, the child was assessed (anthropometry, medical) and they were given their nutrient dense food.

Children were discharged from the program as cured (attaining the 'normal' anthropometric criteria and no medical complications), defaulted (absent for two consecutive weekly visits), died (if died during treatment) or as a non-responder (failed to respond to treatment). All children classified as not responding to treatment after 16 weeks in the programme, and were found to have no underlying medical conditions, were referred to the MTC for further assessment and treatment. After discharge,

all children returned to the CMAM clinic each month for routine monthly follow up for six months, where anthropometry was taken and medical examinations were conducted to monitor their post discharge status. If any of them relapsed into SAM identified during their monthly follow up, they were re-enrolled in the CMAM program.

Under the program's community component, caregivers were also counseled on essential nutritional practices for children, with the aim of preventing cases of malnutrition. Topics covered included standard infant and young child feeding (IYCF) messages<sup>2</sup> and hygiene promotion. A monitoring system was instituted to monitor the outcomes of the children enrolled in the program.

## 2. Cost effectiveness analysis methodology – analytical strategy

Cost effectiveness analysis compares the costs and outcomes of two or more courses of action which is primarily used to assist in allocating competing resources where maximum effect is likely to be achieved. In this study, the costs were assessed for two program components – CMAM and FSAM– looking at human and financial resources used from the implementer's perspective. Additionally, for the CMAM component, the costs to society were also assessed (known as the 'societal perspective') including the cost to the child's family of attending treatment in actual and opportunity costs. This is the most comprehensive form of cost-effectiveness analysis (Skordis-Worrall et al., 2016). All costs were assessed retrospectively. Effects are generally measured in non-monetary terms (Murray, 1994). In this study, the number of SAM children treated is considered as effectiveness measure for both CMAM and FSAM components. Total costs and the cost effectiveness ratio were calculated by dividing the respective provider and societal costs with number of children treated.

Costs calculated under this study:

1. Total cost and cost-effectiveness from a provider's perspective for children treated in the CMAM intervention by CHWs in the research setting. This accounted for treatment across the whole treatment continuum of care including treatment for complicated SAM at an inpatient facility and treatment for uncomplicated SAM at an outpatient facility.

<sup>2</sup> Early and exclusive breastfeeding for the first six months, continued breastfeeding for two years or more, together with nutritionally adequate, safe, age appropriate, responsive complementary feeding starting at six months, feeding during illness.

2. Total cost and cost effectiveness from the societal perspectives of the CMAM intervention by adding the household costs to the total provider's costs. As above, both inpatient and outpatient treatment are included.
3. Total cost and cost effectiveness of the CMAM intervention from a provider's perspective in the government setting. As above, both inpatient and outpatient treatment costs are included. This is to guide policy makers to understand the cost implications of implementing the program, guiding them in making budgetary provision for future implementation. In this analysis, the costs of technical support provided by the development partner such as routine monitoring, training and mentoring support were excluded. As monitoring and supervision is an essential component of the program, which was largely undertaken by the development partner under the research setting, it was assumed that necessary monitoring and supervision in the government setting would 20 percent of the total provider's costs before adding monitoring and supervision cost.
4. Total cost and cost-effectiveness from a provider's perspective for children treated in the FSAM intervention by MTC Hazaribagh, a government-run facility. This included the treatment of both complicated and uncomplicated cases. The purpose of doing this was to facilitate comparison of cost and cost effectiveness of FSAM and CMAM for treatment of uncomplicated SAM cases as several studies have found that, a large proportion of medically uncomplicated SAM cases are also being treated in MTCs in absence of the CMAM program, thus the two treatment settings were comparable. MTCs are in-patient care facility to treat medically complicated SAM cases.

### 2.1. FSAM provider costs-methodology

The 20 bedded MTC, located at the Hazaribagh district hospital, was selected purposively to assess the cost effectiveness of the FSAM component. The time frame for the analysis was April 1, 2018 to March 31, 2019. Primary data on different cost items was collected from the MTC using a simple cost-capture form. Costs data was collected through semi-structured interviews with implementing staff and from the MTC accounting records. [Table-1](#) provides details of implementation costs and their data source.

As per government policy, mothers/caregivers receive wage compensation for a hospital stay with their children or when accompanying their children for the follow up visits. Since it was found that there were significant delays in making payments to mothers/caregivers, for estimating the true economic cost, number of patient days and number of such follow up visits made were multiplied by the average wage compensation to estimate total wage compensation due to payment to mothers/caregivers. Patient records and outcome details were also collected from the center.

### 2.2. CMAM provider and societal costs-methodology

#### 2.2.1. Programme costs

The time frame for the CMAM cost effectiveness analysis was April 1, 2018 to March 31, 2019. Assessing the costs, whether direct or indirect, to both the provider and household assessed multiple components of program implementation. Information on program activities was collected to be able to assess their associated cost. For the CMAM component, activities included identification and enrollment of SAM children, follow up, consumption of nutrient dense food and referral between

Table 1. FSAM implementation costs allocated to programme activities.

Cost center	Description	Data sources	Comments
Intervention	Salaries and incentives (medical officer, staff nurses, nutrition counselor, cook cum caretaker, accountant, other support staff and ASHAs), training cost, logistics (rent, utilities, medical and other supplies, MTC ward and kitchen equipment), transport, caregiver lost wage costs	Review of MTC's financial accounts, records and national guidelines on budgetary provision for MTC	<ul style="list-style-type: none"> <li>• As no rent changed on ward, estimations of the rental value were taken based on similar infrastructure in the locality.</li> <li>• For capital costs, the national guidelines for MTC ward set up were used where budgetary provisions for civil work, ward equipment and kitchen equipment are outlined.</li> <li>• Average life of equipment was assumed to be 5 years to determine their annual value.</li> </ul>

MTC and CMAM. Monthly data on costs incurred by the supporting organizations and monthly time motion studies (self-reported assessment of staff time allocated to the intervention) with staff were used to allocate costs. Data on quantity of medicines and nutrient dense food allocated to the children were also collected on regular basis. Unit costs of medicines and nutrient dense food were derived from the health system records. Time motion studies, which assess the proportion of staff time spent on undertaking programme activities, were also conducted with the CHWs (ANMs and AWWs) on sample basis to quantify opportunity costs of their involvements in the program. Similarly, time motion study was conducted with sampled caregivers to assess opportunity cost of their participation in the CMAM program as well as their actual expenses.

An Activity Based Costing (ABC) system was used whereby costs from the project accounts were entered into a customized tool created in MS Excel. Using the ABC method, costs were separated into one of the following categories: staff cost, travel cost, overhead expenditure (printing & stationary, postage & communication, accounting & administrative expenses), material and resources and training. Thereafter, these costs were allocated into different cost pools, namely the Intervention, Monitoring and Supervision, Research and Joint Costs.

A breakdown of these costs and their data sources are presented in [table-2](#).

### 2.2.2. Treatment cost of medically complicated children in the MTC-Chaibasa

As a few medically complicated children enrolled in the CMAM program, were referred and treated in MTC Chaibasa, unit cost of treating a SAM child in the MTC-Chaibasa was assessed using MTC records. The methodology for collecting and analyzing costs and outcome data was similar to what was undertaken in the MTC, Hazaribagh for conducting the cost effectiveness analysis of the FSAM as explained above. For calculating the total cost of the CMAM intervention, the cost of children who were treated in the MTC-Chaibasa was also included by multiplying the number of children referred and treated in the MTC, Chaibasa and unit cost of treating a SAM child.

### 2.2.3. Other provider costs

Provider costs also include the cost of involvement of CHWs under the CMAM program. Time motion studies were conducted with CHWs on a sample basis to estimate their opportunity costs and they were allocated to different components of the CMAM intervention e.g. intervention, monitoring and overseeing the treatment and management of SAM cases. The study was conducted with sampled

Table 2. CMAM implementation costs allocated to cost pools.

Cost pool	Description	Data sources	Comments
Intervention	Salaries and incentives, transport, printing of intervention materials, training cost of Community Health Workers, nutrient dense food, routine medicines.	Time allocation interviews with staff (as part of time motion studies), expenditure statements and bills, health system records, program records.	
Monitoring and supervision	Salaries and travelling expenses of key monitoring staff, printing of monitoring formats	Time allocation interviews with staff (as part of time motion studies), expenditure statements.	
Research	Salaries and travelling expenses of key research staff.	Time allocation interviews with staff (as part of time motion studies)	Additional research activities included household level survey with mothers on nutritional status of mothers and children and nutritional practices, collecting weekly data of children enrolled in the CMAM intervention from AWCs and time motion studies with CHWs and care-givers for conducting the cost effectiveness analysis. For assessing cost effectiveness of the CMAM program, Research Costs were excluded.
Joint costs	Salaries and travelling expenses of staff involved in above activities and cannot be easily identified for a particular activity, expenses on general accounting and overhead expenses.	Time allocation interviews with staff (as part of time motion studies), expenditure statements	Finally, the total joint costs were allocated under the three cost pools- Intervention, Monitoring and Supervision and Research Costs, using suitable cost drivers.

43 AWWs and 17 ANMs which was generalized for all AWWs and ANMs worked in the program. Other details such as number of children covered in the screening rounds, number of children enrolled in the program, cumulative follow ups, number of referrals, participation of CHWs in the trainings and meetings were accessed from the program records for estimating their time spent in the CMAM intervention. For estimating the cost of their time devoted into the CMAM intervention, their average hourly rate was multiplied by total hours spent by all CHWs.

### 2.3. Societal costs

There were also opportunity costs (wage loss) and direct costs (transportation, food, medicines etc.) for caregivers that participated in the CMAM activities. A time motion study was conducted with a sample of 60 caregivers, to assess their average time spent for participating in CMAM activities. Other relevant details related to enrolment, follow up and discharge were accessed from the program records. For estimating the opportunity cost of their time devoted in the CMAM intervention, their average hourly rate, using predefined daily wage rate provided under employment guarantee act (MNREGA) was multiplied by total hours spent by all caregivers of children enrolled in the CMAM intervention. Also, data on direct costs spent by caregivers for participating in the program were collected. [Table-3](#) provides a breakdown of the programme staff/caregivers activities.

For the purpose of the current analysis, as large part of the costs belongs to the year 2018, we adjusted these costs for inflation and costs are presented both in year 2023 Indian Rupees and US Dollar (US\$ 1 = INR 82.65) (<https://www.poundsterlinglive.com/history/USD-INR-2023>).

## 3. Results

### 3.1. Intervention outcomes

During the study period of the FSAM in the MTC, Hazaribagh, 193 children were treated.

During the CMAM study period, 303 children with SAM were enrolled and treated.

*Table 3. Breakdown of programme staff/user activities.*

Programme staff/user	Activities included in the costing exercise
Anganwadi workers	Trainings, screening of children, record keeping, enrollment, follow ups, referral of sick children to MTC and participation in CMAM related meetings
ANMs	Training, admission and discharge process of children, record keeping, counseling of mothers and follow ups
Caregivers	Accompanying their children for their screening, follow ups, visit to MTC for any treatment required in case of referral etc.

### 3.2. Costs of FSAM and CMAM interventions

#### 3.2.1. FSAM

During the study period of one year, MTC Hazaribagh cost a total of Rs. 3,452,804 (US\$ 50,494) which includes cost incurred on staff (Medical Officers, Nurses and other support staff), medical and kitchen supplies, rent, maintenance, utilities and wage loss compensation for accompanying their children. Of the total cost, 75% were staff cost, 7% were medical and kitchen supplies, 8% were rent, maintenance and utilities and 8% were wage loss compensation for mothers ([Table-4](#)).

#### 3.2.2. CMAM

**3.2.2.1. Provider's costs.** In the research setting, total provider's cost, which includes cost incurred by development partner and the government, opportunity costs of time spent by CHWs and MTC-Chaibasa was Rs. 46,32,452 (US\$ 56,049). Of the total providers' costs, 28% were intervention cost, 30% were monitoring and support cost, 14% was spent on nutrient dense food and 28% were health system cost (routine medicines was 0.22%, opportunity cost of CHWs was 11% and treatment cost of children referred to MTC Chaibasa was 17%) ([Table-5](#)).

**3.2.2.2. Societal costs.** Total societal cost, which includes providers' cost-plus household costs was Rs. 54,38,727 (US\$ 65,804). Of all societal costs, 24% were intervention cost, 26% were monitoring and supervision cost, 12% was spent on nutrient dense food, 23% was health system cost (routine medicines 0.2%, opportunity cost of CHWs was 9.3%, and treatment cost of children referred to MTC Chaibasa was 14%) and 15% was household costs ([Table-5](#)).

### 3.3. Cost effectiveness ratios of FSAM and CMAM interventions

#### 3.3.1. Cost effectiveness ratios of FSAM intervention

Average cost of treating a SAM child was Rs. 17,890 (US\$ 217). Average cost per patient day was Rs. 1261 (US\$ 15.3). We also calculated average length of stay of medically complicated and uncomplicated cases using patient data collected as part of the study. It was

Table 4. Estimated annual cost of FSAM at MTC Hazaribagh.

MTC-related cost items	Economic Cost (INR)	Remarks
Total staff costs	2,584,800	Collected from center records
Estimate of staff training costs	10,000	It generally organizes 2 trainings/orientation per year with an approximate expenditure of INR 5000/training
Expenses on medical supplies (Medicine, vaccine) costs	92,637	Collected from center records
Expenses on non-medical consumables/supplies (kitchen supplies and therapeutic food, non-medical consumables/supplies (kitchen supplies and therapeutic food)	141,276	Collected from center records
Estimate of equipment and other setting up costs	80,000	National/State MTC guideline provides that for a 10 bedded MTC, one time set up cost is Rs. 2,00,000. Hence for setting up a 20-bedded MTC, it was assumed that the one-time setup cost would be Rs. 4,00,000. Average lives of equipment are assumed to be 5 years. Hence, depreciation value of one year has been taken.
Rent (or equivalent rental cost)	180,000	Estimated rental value of the premise in that locality
Expenses on maintenance costs (miscellaneous exp, photocopy, gas fitting, others)	60,891	Collected from centre's records
Estimate of utility cost (electricity, water)	24,000	Collected from centre's records
Wage loss compensation for mothers	271,000	Collected from centre's records for financial cost. For economic cost, expected wage loss compensation was calculated based on number of patient day
Wage loss compensation for mothers in follow up visits including incentives to frontline workers	8200	Collected from centre's records for financial cost. For economic cost, expected wage loss compensation was calculated based on number of follow ups in that year
<b>Total costs- INR (US\$)</b>	<b>3,452,804</b>	<b>(US\$ 41,776)</b>

Table 5. Costs of CMAM intervention-provider's and societal costs.

CMAM-related cost items	Costs (INR)	Remarks
Programme costs of development partner (after allocating the Joint Cost) (INR)	1,313,842	Details of this cost is provided in <a href="#">Table 11</a>
Monitoring and Supervision cost of development partner (after allocating the Joint Cost) (INR)	1,390,804	Details of this cost is provided in <a href="#">Table 11</a>
Cost of nutrient dense Food (INR)	652,376	Details of this cost is provided in <a href="#">Table 12</a>
Cost of Drugs & Medicines (INR)	10,381	Details of this cost is provided in <a href="#">Table 12</a>
Cost of treating medically complicated children at MTC-Chaibasa (INR)	754,840	Details of this cost is provided in <a href="#">Table 13</a>
<b>Frontline Workers (FLWs)- Time Costs</b>		Details of this cost is provided in <a href="#">Table 14</a>
Anganwadi Workers (AWWs) (INR)	423,067	
Accredited Social Health Activists (ASHAs) (INR)	15,450	
Auxiliary Nurse Midwives (ANMs) (INR)	71,692	
<b>Mothers/Caregivers- Opportunity Costs</b>		Details of this cost is provided in <a href="#">Table 15</a>
Opportunity Cost of Wage Loss (INR)	798,843	
Direct Cost incurred by Mothers/Caregivers (INR)	7432	
<b>Total Providers' Cost-INR (US\$)</b>	<b>4,632,452 (US\$ 56,049)</b>	
<b>Total Societal Cost- INR (US\$)</b>	<b>54,38,727 (US\$ 65,804)</b>	

found that, average length of stay for medically uncomplicated cases was 15.4 days while that of medically complicated cases was 14.74 days. This is due to children in inpatient care on average reaching the discharge criteria for the facility more rapidly due to rapid recovery once in treatment and the less stringent recovery criteria in inpatient care compared to outpatient care. Average cost of treatment per

medically complicated SAM child was Rs. 17,470 (US\$ 212) and that of uncomplicated SAM child was Rs. 18,235 (US\$ 221) ([Table 6](#)).

### 3.3.2. Cost effectiveness ratios of the CMAM intervention

Cost effectiveness ratio from a provider's perspective, using primary outcome indicator i.e.



Table 6. Outcome.

	Number	Cost Effectiveness Ratios	Cost Effectiveness Ratio-Economic Cost INR (US\$)
Total number of patients treated	193	Cost per SAM child treated	17,890 (US\$ 217)
Total Patient Day	2739	Cost per patient day	1261 (US\$ 15.3)
Total number of medically complicated patients treated	87	Cost per medically complicated SAM child treated	17,470 (US\$ 212)
Total number of medically uncomplicated patients treated	106	Cost per medically uncomplicated SAM child treated	18,235 (US\$ 221)

number of cases treated shows that cost per child treated was Rs. 15,289 (US\$ 185). Cost effectiveness ratio from societal perspective shows that cost per child treated was Rs. 17,950 (US\$ 217). The above costs were inclusive of cost incurred for treating medical complicated SAM children, who were referred to MTC-Chaibasa from the CMAM program (Table 7).

#### 3.4. Costs and cost effectiveness ratio of the CMAM-government settings

We also estimated costs and cost effectiveness ratio of the CMAM intervention in the government setting. Overall government cost estimated was Rs. 21,62,400 (US\$ 26,163) inclusive of cost incurred at the in-patient facility for children referred from the CMAM program and treated in MTC-Chaibasa.

This cost includes cost of nutrient dense food (30%), health system cost (35%), opportunity cost of time spent by CHWs for CMAM (24%) and monitoring and supervision cost (11%) (Table 8).

Cost effectiveness ratio in the government setting shows that, cost per child treated was Rs. 7137 (US\$ 86) (Table 9).

#### 4. Univariate sensitivity analysis to assess changes in the COST effectiveness ratios by changing a few uncertain parameters

Univariate sensitivity analysis was carried out to assess the impact on the cost-effectiveness results, of changes in variables and parameters with the greatest uncertainty or with the greatest impact on the total costs. This was done in order to assess the potential best case and worst-case variability in

Table 7. Outcome.

	Number	Cost Effectiveness Ratios	Cost Effectiveness Ratio- (US\$)
Total number of children treated	303	Cost per SAM child treated (provider's perspective) Cost per SAM child treated (Societal perspective)	15,289 (US\$ 185) 17,950 (US\$ 217)

Table 8. COSTS of CMAM intervention-government setting.

CMAM-related cost items	Costs (INR)	Remarks
Cost of Nutrient Dense Food (INR)	652,376	Details of this cost is provided in Table 12
Cost of Drugs & Medicines (INR)	10,381	Details of this cost is provided in Table 12
Cost of treating medically complicated children at MTC-Chaibasa (INR)	754,840	Details of this cost is provided in Table 13
<b>Frontline Workers (FLWs)- Time Costs</b>		Details of this cost is provided in Table 14
Anganwadi Workers (AWWs) (INR)	423,067	
Accredited Social Health Activists (ASHAs) (INR)	15,450	
Auxiliary Nurse Midwives (ANMs) (INR)	71,692	
Monitoring and Supervision Cost (INR)	2,34,593	20% of the above costs
<b>Total Providers' Cost (Government setting)-INR (US\$)</b>	<b>21,62,400 (US\$ 26,163)</b>	

Table 9. Outcome.

	Number	Cost Effectiveness Ratios	Cost Effectiveness Ratio- (US\$)
Total number of children treated	303	Cost per SAM child treated (Government setting)	7137 (US\$ 86)

Table 10. Univariate sensitivity analysis.

Parameters	Base case		Worst case		Best Case		Source
	Provider's	Societal	Provider's	Societal	Provider's	Societal	
Number of children treated	303	303	227	227	379	379	±25%
Cost per child treated (USD)	185	217	238	280	143	168	
Exchange rate (USD to INR)	82.65	82.65	80.96	80.96	83.44	83.44	Observed variations in 2023 ( <a href="https://www.poundsterlinglive.com/history/USD-INR-2023">https://www.poundsterlinglive.com/history/USD-INR-2023</a> )
Cost per child treated (USD)	185	217	189	222	187	219	
Overall costs	100%	100%	125%	125%	75%	75%	±25%
Cost per child treated (USD)	185	217	231	271	139	163	

costs and outcomes. Areas of potential variability were determined through exploration of the cost and effectiveness data. By varying the number of children treated ( $\pm 25\%$ ) values resulted in a change in the cost effectiveness ratios (cost per child treated) from US\$ 168 to US\$ 280 compared to the base case of US\$ 217 from societal perspective. By varying the exchange rate from maximum to minimum values, which were observed during the year 2023, cost per child treated changed from US\$ 219 to US\$ 222 from the base case of US\$ 217. Similarly, by varying the overall cost of child treated ( $\pm 25\%$ ), the cost per child treated varied from US\$ 163 to US\$ 271 compared to the base case of US\$ 217. The variation in the cost effectiveness result was marginally significant when the number of children treated was set at minimum which shows that the result is sensitive to the number of children treated (Table 10).

## 5. Conclusion

### 5.1. CMAM

Under the CMAM intervention, the full cost of treating a child with complicated SAM in an inpatient facility, followed by the completion of treatment for uncomplicated SAM in an outpatient facility in the research setting was US\$ 185 from a provider's perspective. The cost increased slightly to US\$ 217 with the addition of the actual and opportunity costs borne by beneficiary while accessing treatment, as expected. It is estimated that it would cost US\$ 86 to treat children under this protocol solely through the government system, not considering costs to the beneficiary.

For comparison, a similar intervention delivered in Delhi, Udaipur and Vellore in 2013–14, cost with centrally produced nutrient dense food from a provider's perspective in a research setting was slightly more (US\$ 227) as compared to provider's cost estimated in the present study (US\$ 185). However, estimation of costs under government

provisions were less (US\$ 53) compared to cost estimated by the present study (Garg et al., 2018). Comparisons of the costs of community-based treatment services are challenging as they are not always directly comparable due to variability of costs included. In the latter study, unlike the present study, the cost of inpatient treatment was not included and therefore does not represent the full continuum of care.

In Bangladesh, where CHWs treated cases of SAM without medical complications in the community, the cost per child treated was again similar at US\$ 173 (Puett et al., 2012). Compared to the Bangladesh study, the present intervention's estimate was slightly higher at US\$ 185. In African studies, cost per child treated varied considerably between US\$ 46 to US\$ 805 (Bachmann, 2010).

### 5.2. FSAM

In the FSAM intervention, the cost per child treated (complicated and uncomplicated cases) was US\$ 217. This reduced to US\$ 212 for medically complicated cases and increased to US\$ 221 for uncomplicated cases. The increased cost for the uncomplicated case compared to the complicated case is due to the longer length of stay for the uncomplicated case which is on average 14 days, compared to 15 for the complicated case. This result is due to the faster recovery time of complicated cases compared to uncomplicated cases.

Currently, FSAM facilities treat both medically complicated and uncomplicated cases due to a lack of alternative facilities in which to treat uncomplicated cases. If we compare the cost of treating an uncomplicated SAM child in the FSAM intervention with the CMAM intervention which provides the full continuum of care from complicated case to cured, costs per child treated in the CMAM intervention were significantly lower (US\$ 221 for FSAM in the government setting compared to US\$ 86 for CMAM). Other studies have shown that the

community-based programme for treatment of uncomplicated SAM cases is much lower compared to their treatment in in-patient/facility care (Puett et al., 2012; Tekeste et al., 2012).

There were a few key factors which affected cost-effectiveness. The cohort size was small ( $n = 303$ ) and if it was increased, cost-effectiveness would also increase as fixed costs would largely remain the same. Ensuring regular (monthly) growth monitoring of children with high coverage will enable reaching services to all cases and will increase the number of children being treated.

The most cost-effective approach for the treatment of SAM is facility-based management of children with medically complicated SAM (FSAM) in the MTC followed by community-based management of children with uncomplicated SAM (CMAM). However, currently a large proportion of children with uncomplicated SAM are being treated in MTCs unnecessarily due to the absence of a community-based program. This is not only expensive for the state but children are at an increased risk of cross-infection when attending inpatient services which should be avoided if possible. Additionally, families are hesitant to attend inpatient services due to the high opportunity cost associated with doing so. Therefore, this evidence along with other example of social entrepreneurship for larger health benefit (Uddin & Akther, 2019) demonstrates that all uncomplicated SAM children should be treated in the community under the CMAM program. For FSAM, only children with complicated SAM should be treated and once their medical complications disappear and weight gain starts, they should be transferred to the community-based intervention.

The strength of the study is that it adds value in bringing out information on cost effectiveness on integrated model (community plus facility care) for management and treatment of SAM children. However, there were some limitations to this study. The paper has considered cost of time of CHWs and caregivers; a potential bias in the cost calculation could be from either the overestimation or underestimation of time spent by CHWs and caregivers on each activity. The program performance was not independently evaluated and outcomes presented are based on routine data collected by the CHWs managing the program. Even though the data was regularly validated by the development partner and the supervisory staff of the government on sample basis, there could be

some errors. Also, the study was done in only one Block, so the findings, while being indicative, may not be generalized. A large-scale multi-site studies are required for this purpose.

This study has demonstrated that CMAM is a feasible and cost-effective mechanism under which the full continuum of care can be provided for the treatment of acute malnutrition through the government system. The findings of CMAM costing in an integral model may inform the government for allocating optimum resources for treatment of SAM children in community setting.

### Conflict of interest

The author declares that there is no conflict of interest.

### Appendix

#### Annexure-1

Table 11 provides a summary of program costs of the development partner divided between Intervention, Monitoring & Supervision, Research and Joint Cost. It also provides details of program cost both before and after allocating Joint Cost to Intervention, Monitoring & Supervision and Research Cost. Intervention, Monitoring & Supervision and Research Costs, after allocating Joint Cost were INR 13,13,842 (US\$ 15,897), INR 13,90,804 (US\$ 16,828) and INR 21,25,524 (US\$ 25,717) respectively.

Table 11. Program costs of the development partner (INR).

	Intervention	Monitoring and Supervision	Research	Joint Cost
Before allocating joint cost	12,02,679	12,73,130	19,45,686	408,675
After allocating joint cost	13,13,842 (US\$ 15,897)	13,90,804 (US\$ 16,828)	21,25,524 (US\$ 25,717)	

#### Annexure-2

Table 12 provides details of costs of nutrient dense food and routine medicines allocated to the enrolled children. Total costs of nutrient dense food and routine medicines allocated to the enrolled children were INR 6,52,376 (US\$ 7893) and INR 10,381 (US\$ 125) respectively.

Table 12. Cost of nutrient dense food and medicines.

	Unit Cost	Number	Total Cost
Cost of nutrient dense food	21.3	30,628	6,52,376 (US\$ 7893)
Cost of medicines			
Amoxicillin (60 ml bottle)	17	303	5151 (US\$ 62)
Albendazole (10 ml bottle)	8.26	303	2503 (US\$ 30)
Folic Acid (Table 5 mg)	9	303	2727 (US\$ 33)

## Annexure-3

The average cost of treating one SAM child was INR 18,871 in MTC Chaibasa. Program records captured the number of children referred and treated at MTC. 40 children with SAM, who were enrolled in the CMAM intervention, were referred to the MTC Chaibasa for treatment of their medical complications. Total treatment cost of these 40 children in MTC-Chaibasa as part of the CMAM program was INR 7,54,840 (US\$ 9133) (Table 13).

Table 13. Estimated annual cost of MTC chaibasa.

MTC-related cost items	Economic Cost (INR)	Remarks
Total staff costs	7,344,000	Collected from centre's records
Estimate of staff training costs	5400	It generally organizes 2 trainings/orientation per year with an approximate expenditure of INR 5000/training
Expenses on medical supplies (Medicine, vaccine) costs	461,269	Collected from centre's records
Expenses on non-medical consumables/supplies (kitchen supplies and therapeutic food, non-medical consumables/supplies (kitchen supplies and therapeutic food)	313,501	Collected from centre's records
Estimate of equipment and other setting up costs	80,000	National/State MTC guideline provides that for a 10 bedded MTC, one time set up cost is Rs. 2,00,000. Hence for setting up a 20-bedded MTC, it was assumed that the one-time setup cost would be Rs. 4,00,000. Average lives of equipment are assumed to be 5 years. Hence, depreciation value of one year has been taken.
Rent (or equivalent rental cost)	120,000	Estimated rental value of the premise in that locality
Expenses on maintenance costs (miscellaneous exp, photocopy, gas fitting, others)	67,126	Collected from centre's records
Estimate of utility cost (electricity, water)	138,000	Collected from centre's records
Wage loss compensation for mothers	914,800	Collected from centre's records for financial cost. For economic cost, expected wage loss compensation was calculated based on number of patient day
Wage loss compensation for mothers in follow up visits including incentives to frontline workers	29,100	Collected from centre's records for financial cost. For economic cost, expected wage loss compensation was calculated based on number of follow ups in that year
<b>Total costs</b>	<b>9,473,196</b>	
<b>Number of Children Treated</b>	<b>502</b>	
<b>Unit cost of treating a SAM child</b>	<b>18,871</b>	
<b>Number of children referred from CMAM and treated in MTC-Chaibasa</b>	<b>40</b>	
<b>Total treatment cost in MTC-Chaibasa</b>	<b>7,54,840 (US\$ 9133)</b>	

## Annexure-4

Table 14 below provides opportunity costs of involvement of community health workers in the CMAM program. Estimated time spent by AWWs in the CMAM program was 14,666 h and by ANMs was 932 h. Opportunity cost of AWWs' time was INR 4,23,067 (US\$ 5119) and that of ANMs' time was INR 71,692 (US\$ 868).

Table 14. Opportunity cost of time used by community health workers (CHWs) for CMAM activities.

Total hours spent by AWWs	14,666
Tourly rate of AWWs (Rs.)	29
<b>Total opportunity cost (Rs.)</b>	<b>4,23,067 (US\$ 5119)</b>
Total hours spent by ANMs	932
Hourly rate of ANMs (Rs.)	77
<b>Total opportunity cost (Rs.)</b>	<b>71,692 (US\$ 868)</b>

## Annexure-5

Table 15 provides opportunity cost of caregivers' participation in the CMAM activities and actual cost

incurred by them. Total opportunity cost was estimated to be INR 7,98,843 (US\$ 9665) and actual costs incurred were INR 7432 (US\$ 109).

Table 15. Opportunity cost of time spent and other direct cost incurred by caregivers under the CMAM program.

Total hours spent by mothers/caregivers	38,040
Hourly wage rate of workers under MNREGA (rs.)	21
Total opportunity cost (Rs.)	7,98,843 (US\$ 9665)
Total costs spent by caregivers (Rs.)	7432 (US\$ 90)

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