

4

INTEGRATED MANAGEMENT OF MALNUTRITION PROGRAMME

‘MAHAN’, Melghat, India

Ashish Satav, Vibhawari Dani, and Kavita Satav

Introduction

Malnutrition is a critical issue in India, contributing to one-third of global undernutrition cases. Nearly half of the child deaths under five are linked to this disease (Dani et al., 2017; Satav et al., 2024; Surve et al., 2022; WHO, 2022). Severely malnourished children have high mortality and morbidity rates and are known to have long-term impacts, including cognitive impairment, reduced education, and lower productivity besides an increased risk of chronic diseases (Black et al., 2008).

MAHAN, a voluntary NGO, with an aim to provide medical and nutritional services to the tribal community of Melghat in Maharashtra, started its operations in 1998. In its almost three decades of existence, MAHAN's hospital and community-based services, along with research and its advocacy, have benefitted around one million inhabitants of the tribal regions of Maharashtra.

MAHAN's journey started with a small hut-hospital for the downtrodden, poor tribal community of Melghat. Since its inception, MAHAN has been working with the tribals of Melghat on various issues like malnutrition, high mortality, and morbidity in various age groups through operational community research to develop cost-effective intervention models for the same. Slowly but surely a rapport was built to understand the healthcare needs and socio-cultural practices of the tribal communities. Since community participation was at the heart of this intervention, focused group discussions (FGDs), interviews, and community health surveys were undertaken along with organising therapeutic, medical, and surgical specialty camps.

Community Participation: Patient and Public Involvement (PPI)

MAHAN spearheaded a collaborative research initiative from 1998 to 2007, bringing together local community patients including families, service providers, social workers, local community-based organisations, Traditional Faith Healer (TFH) and tribal counsellors of government hospitals (Satav et al., 2011). This collective effort was aimed at identifying and addressing health issues within the community. More than 60% of villagers attended gram sabhas (community meetings) which were organised periodically, focusing on understanding healthcare needs and acceptable methods for healthcare service delivery. Door-to-door surveys; (Dani et al., 2015) interviews; FGDs with target groups and key resource persons such as the sarpanch of the village and the Adya Patel,¹ etc., were held, besides free therapeutic and operative camps involving the community to understand the gravity of health problems at the village level. These activities were undertaken to also understand the critical and common causes of malnutrition and deaths in the area.

It was discovered that the community wanted free, easily accessible and culturally acceptable, community-based healthcare services provided in the local language by someone who respected the community and understood the problems. Since MAHAN was closely associated with the traditional health system, all the interventions were crafted keeping in mind their culture, language and socio-economic conditions (Satav et al., 2022a).

The health concerns presented by the community formed the rationale behind MAHAN's community-based research. While planning systematic research on undernutrition and U5MR, PPI was integrated (Satav et al., 2022a, 2024) Their study revealed a high prevalence of SUW (18.7%) and severe stunting (32.7–36.1) (Dani et al., 2015) Table 4.1 explains the major health indicators in rural and urban areas of India. The existing policies, healthcare system, and government interventions were misaligned with the community's needs and socio-cultural practices. Government programmes had low priority for the management of SUW and stunting.

People in the region were reluctant about the hospitalisation of Severely Malnourished Children (SMC) and hospital-based delivery. They preferred the treatment of SMC by TFHs² and delivery by Traditional Birth Attendants (TBAs).³ Accordingly, in our community-based programmes, we trained tribal, socially sensitive, married female VHWs, and male *yuvadoots*⁴ selected in the community meetings.

All the interventions were implemented through village health workers (VHWs), under the supervision of qualified medical supervisors, Behaviour Change Communication (BCC) supervisors, and data collection supervisors.

The VHWs were selected after holding community meetings (gram sabhas) with a minimum 60% attendance of villagers, wherein the research was

TABLE 4.1 Percentage of Major Health Indicators in India

Indicator	India: Rural + Urban	Urban	Rural	Tribal	MAHAN Intervention Area 2023–24
IMR (per 1000 live births)	35.2 ⁽¹⁰⁾	26.6 ⁽¹⁰⁾	38.4 ⁽¹⁰⁾	76 ^(11–15)	26.37
U5MR (per 1000 live births)	41.9 ⁽¹⁰⁾	31.5 ⁽¹⁰⁾	45.7 ⁽¹⁰⁾	80–101 ^(11, 15, 16)	36.51
NMR (per 1000 live births)	24.9 ⁽¹⁰⁾	18 ⁽¹⁰⁾	27.5 ⁽¹⁰⁾	48.3–70 ^(13, 14, 17)	18.26
SAM (%)	7.70 ⁽¹⁰⁾	7.60 ⁽¹⁰⁾	7.70–8.3 ^(10, 18)	10–22.2 ^(10, 19)	2.8
SUW (%)	11 ^(20 21)	6 ⁽²²⁾ –12 ^(23, 24)	12.1–18.7 ^(8, 18, 23, 25, 26)	15.5–36.1 ^(8, 9, 19, 27–29)	6.4
Severe stunting (%)	15 ⁽²¹⁾	9.8–19.1 ⁽²⁴⁾	25.1 ⁽³⁰⁾	34.4 to 36.2 ^(8, 19, 27)	25.75
Underweight (SUW + MUW) (%)	30–32.10 ⁽¹⁰⁾	26–45.2 ^(10, 31, 32) (10, 23, 24, 33)	33.80–45.7 ^(10, 18, 23)	43–63 ^(8, 19, 29, 34)	40.32
Stunted (severe + mod) (%)	35.5–38.4 ⁽¹⁰⁾	27.7–46.8 ^(24, 32)	40.3–52.3 ^(18, 30)	48–66.1 ^(19, 34)	61.07
Wasted % severe + mod	19.3 ⁽¹⁰⁾	12.6–22.7 ^(10, 24, 32)	19.5–22 ^(10, 18)	26–31 ^(19, 29)	14.94

Indicator	India: Rural + Urban	Urban	Rural	Tribal	MAHAN Intervention Area 2023–24
BMI <18.5 female 15–49 yrs	18.7 ⁽¹⁰⁾	13.2 ⁽¹⁰⁾	21.2 ⁽¹⁰⁾	50 ⁽³⁵⁾	27.36

Source: NFHS-4, NFHS-5, NNMB, MAHAN-Control.

10 = NFHS-5 DPI, 2019–21.

11 = Ranjan et al., 2018.

12 = Kusuma et al., 2024.

13 = Bills et al., 2018.

14 = Niswade et al., 2011.

15 = Verma et al., 2021.

16 = Kusuma et al., 2024.

17 = Horwood et al., 2020.

18 = Prabhu et al., 2020.

19 = Sunny et al., 2021.

20 = NFHS, 2017.

21 = Karlsson et al., 2021.

22 = Goyal et al., 2023.

23 = Yadav et al., 2016.

24 = Boregowda et al., 2015.

25 = Kim et al., 2021.

26 = Murarkar et al., 2020.

27 = Sinha et al., 2018.

28 = Ghosh and Varekar, 2019.

29 = Jaleel et al., 2023.

30 = Deshmukh et al., 2013.

31 = Jeyakumar et al., 2022.

32 = Agarwal et al., 2015.

33 = Prasad et al., 2023.

34 = Jeyakumar et al., 2021.

35 = Das, 2015.

explained, and due consent was obtained for the selection of the VHWs. The VHWs underwent rigorous, five-day residential training each month for a year. Additional refresher residential training was provided for three days a month throughout the project.

Consequently, VHWs conducted a baseline survey regarding births, under-five deaths, maternal and child healthcare practices, and demographic information from January to December 2004. This information was then cross-verified by government agencies, parents, cluster heads, and independent retrospective surveyors to detect any missed events.

VHWs provided health and nutrition care, while the Yuvadoots developed nutrition farms and mobilised government schemes to benefit the last person. Trained TBAs provided safe and hygienic home deliveries.

Community participation played a crucial role in understanding the problems, and appropriate solutions have helped sustain our interventions for the past 25 years. The Government of India, through the Maharashtra government, assisted in replicating MAHAN's PPI model in 20 new villages (Jain et al., 2023).

Dissemination of the study results to participants and linked communities was carried out by VHWs, TBAs, supervisors, programme managers, and key persons in the villages, who shared these during gram sabhas once every four months and mobilised the community for the programme further.

Counsellor Programme for Strengthening of Government Hospitals

As established above, Melghat had inadequate and inefficient healthcare facilities with limited coverage and impact on community. TFHs were preferred over hospitalisation for sick persons. Hospital deliveries were less than 5%, and hospitalisation of SAM children was 0.12% in 2006 (Satav et al., 2011; Petition 3278, 2010; Satav, 2018), prevalence of severe malnutrition was more than 20%, (Dani et al., 2015) the U5MR was more than 147.21/1000 live births (Satav et al., 2022a), and maternal mortality was as high as 400/100000 (Satav et al., 2011).

The counsellor programme was developed in collaboration with district administration and voluntary organisations for the strengthening of government hospitals. The intervention area consisted of 14 government hospitals in Melghat, and control area comprised hospitals in the Nandurbar and Gadchiroli tribal blocks. The research phase was from 2006–07 to 2009–10, and the service phase started in 2011 and continues to this day (Petition 3278, 2010; PIL, 2010; Satav et al., 2011, Satav, 2018).

The programme was implemented by locally trained tribal matriculate male and female counsellors. The counsellors were able to bring about

behaviour change, implement BCC, and motivate patients and relatives for hospitalisation, thereby strengthening hospitals by ensuring proper delivery of required services through external monitoring, establishing a round-the-clock help desk for patients. They further ensured proper referrals and the availability of vehicles for patients, accessibility of food and other basic facilities to the patients, and tried to build confidence in hospitals.

The research phase resulted in proportional improvement among hospitalised malnourished children by 96% in Melghat, 53.8% in Gadchiroli, and 34% in Nandurbar in 2009–10 over the baseline of 2006–2007 (Satav, 2011 #427). The service phase of the study continued from 2011 to 2024. There was a statistically significant improvement in GH deliveries from 2% to 70.72% ($p < 0.0001$), SMC hospitalisation from 0.12% to 14.53% ($p < 0.0001$), and increase in the recovery rate of hospitalised SAM ($p < 0.001$) as compared to other tribal blocks without counsellors like Nandurbar and Gadchiroli (Petition 3278, 2010, 2011; PIL, 2010; Satav et al., 2011; Satav, 2018; Vyas, 2022; Commissioner HDoGoM, 2022; PIL no. 133, 2023).⁵

The success story of Melghat led to the acceptance of the ‘Counsellor Programme for Strengthening Government Hospitals’ at policy level by the government across all government hospitals in Maharashtra, following a directive from the Honourable High Court.

Direct Interventions

A pilot study on community-based supplementary food for severely malnourished children for 100 days was undertaken in 2004. The insights gathered rationale for community-based quality research and locally produced therapeutic foods. Consequently, a Randomised Controlled Trial (RCT) and Prospective Controlled Community-based study with long follow-up for clinical and community health research were undertaken.

Integrated approach to nutrition and health in Melghat: MAHAN conceptualised an integrated approach for the prevention and therapy of malnutrition in children under five years of age, which would lead to sustained long-term effects on tribal health. All the interventions were implemented through VHWs, under the supervision of qualified medical supervisors, Behaviour Change Communication (BCC) supervisors, and data collection supervisors.

Home-Based Child Care (HBCC): A Cluster Randomised Control Trial (CRCT)

At baseline (2004), Melghat had a prevalence of severe malnutrition (IAP Grades 3 and 4) as 9.6% (D’Alimonte et al., 2016) while the rest of Maharashtra and India had 3.92% (Ray et al., 2001). The causes included illiteracy, ignorance, superstitions, traditional faith healer care, low

health-seeking behaviour, teenage pregnancy, poor diet during pregnancy, delayed and non-exclusive breastfeeding, and extremely faulty complementary feeding, along with inadequate and ineffective medical facilities with limited coverage and impact on community (see Figure 4.1).

There was high prevalence (34–43%) of malnourished mothers with a BMI of less than 18.5 BMI suffering from common infections like diarrhoea, pneumonia, malaria, poor hygiene, and neonatal sepsis due to home deliveries, along with more than 50% of LBW babies experiencing a very high prevalence of severe malnutrition and U5MR in all rural-tribal areas of India (Ranjan et al., 2018). The under-five mortality rate in Melghat was as high as 147.21 per 1000 live births (Satav et al., 2022a) as against the national average of 76, indicating a dire need for a separate, dedicated policy and programme (Dawn and Basu, 2016; Dehury and Samal, 2016). Thus, in the

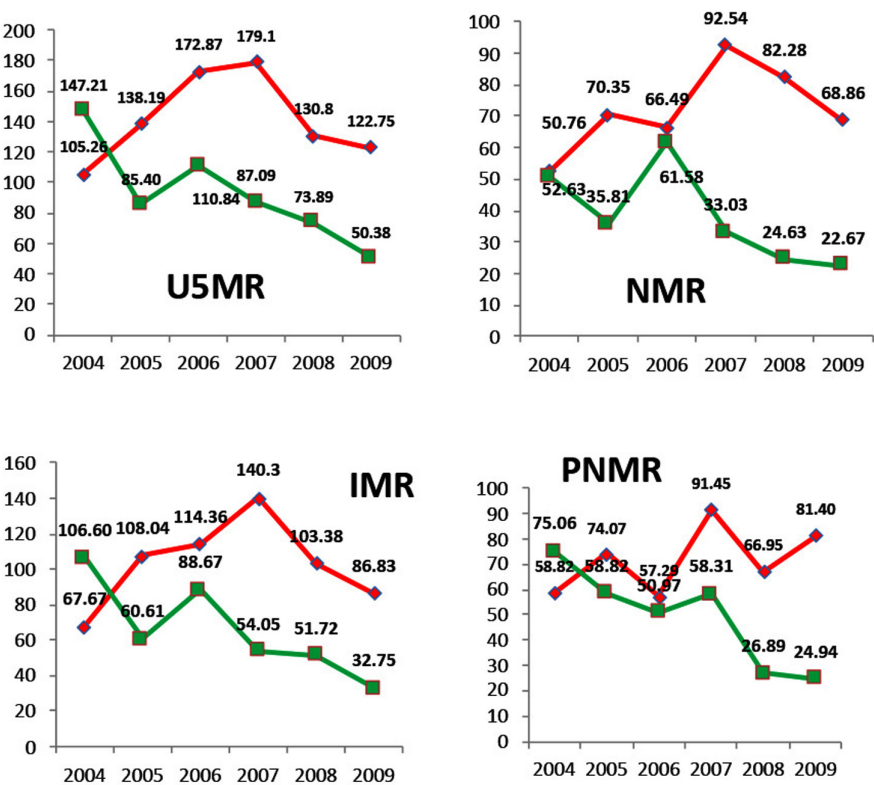


FIGURE 4.1 Mortality rates in intervention and control villages during the research phase of HBCC

Source: Author’s own creation. *Note:* Statistically significant reduction in mortality rates in IA vs CA ($p < 0.001$).

prevailing situation, HBCC implemented through VHWs appeared to be the only option for reducing malnutrition and child mortality.

Difference in differences (DID): The crude rate ratios for mortality rates with reference to the base year 2004 were obtained until 2015. DID of adjusted rate ratios greater than two between the two arms is considered significant. Our DID is significant throughout the intervention period.

There were three phases of the HBCC programme: the 'research phase' between 2004 and 2009, the 'service phase' from 2010 to 2015, which was implemented in the same villages, and the 'Replication phase', which was held between 2017 and 2023 and was implemented in 20 new villages, other than the initial study area. A cluster randomised controlled trial (CRCT) was conducted in 34 clusters of Melghat, between 2004 and 2009. The replication phase was a collaborative project with the Government of India via the Government of Maharashtra from September 2017 to August 2020. However, MAHAN continued the project until December 2023.

Dharni block in the Melghat region was divided into five zones. Eight villages were chosen randomly from each of these five zones. To get a broader picture, two extra villages from the neighbouring Chikhaldara block were added to the study. By including villages from a different block, the researchers hoped to apply the findings to a wider area and understand how the results might vary in places with different administrative setups.

A blinded stratified random sampling approach was used. The sample size was estimated to detect a reduction of at least 50% in the under-five mortality rate in the IA. The intra-cluster correlation coefficient (ICC) for the under-five mortality rate was assumed to be 0.01, and the average live births per cluster per year was 20, which resulted in a variance inflation factor or design effect of 1.19. Hence, to detect a desired mortality reduction of 50%

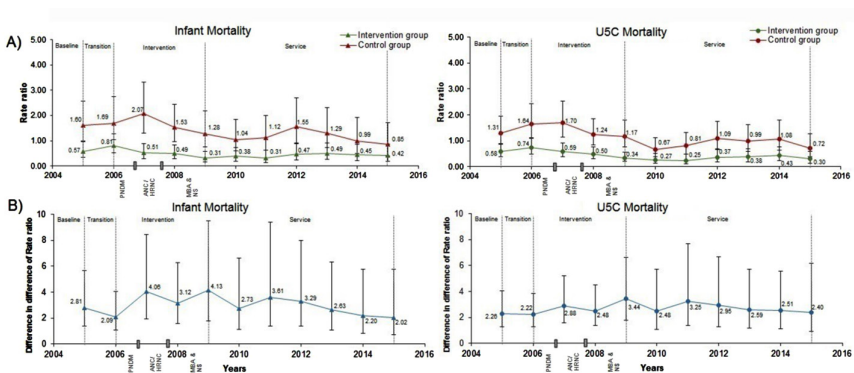


FIGURE 4.2 Difference in difference (DID) of the incidence rate ratio of IMR and U5MR between IA and CA during the research and service phases

Source: Satav et al., 2022a.

in IA with 95% confidence and 80% power, a sample size of 359 live births was needed per arm, with 18 clusters per arm.

Primary outcome indicators were under-five mortality rate, infant mortality rate, and prevalence of severe malnutrition. Secondary outcome indicators were neonatal mortality rate (NMR) and perinatal mortality rate (PMR). The analysis was by intention to treat at the individual level.

Interventions consisted of community-based management of common infections like ARI, diarrhoeal diseases, and clinical malaria in under-five children. The WHO protocol was followed for the management of infections (Satav et al., 2022a).

BCC for health, hygiene, nutrition, newborn care, and antenatal care played a pivotal role in the success by prevention of preventing infections and changing breastfeeding and dietary practices. These regular activities were implemented through pictorial flip charts, one-to-one and group counselling, community growth charts, demonstrations of nutritious recipes, and the demonstration and supervision of handwashing and nail cutting; street plays, quarterly gram sabhas, audio-visual shows, etc.

MAHAN integrated HE, IEC, and BCC to create a unique approach for sustainable behaviour change related to health and nutrition. PPI ensured that BCC methods were people-centric and apt for the needs and socio-cultural context of the beneficiaries, thus creating a long-term impact. It was given to parents of all under-five children, pregnant and lactating mothers.

Intensive BCC sessions were delivered more frequently (once a week) to parents of SMC. The VHWs and supervisors implemented the programme in villages. It had the following components:

- Nutrition and health education to the parents of all children aged 0–5 years.
- Complementary feeding education to the parents of children—4 months to 2 years.
- Disease health education (ARI, diarrhoea, malaria, vitamin A, anaemia, scabies) is provided in villages by VHVs and supervisors.

Antenatal care (ANC), focused on recognition of danger signs, was provided by VHVs, with appropriate hospital referral. It was ensured that the government ANC programme was availed with regular consumption of iron, folic acid tablets, sonography, etc. We encouraged hospital deliveries, but if they were refused, then clean, safe community deliveries by trained traditional birth attendants (TBAs) and VHVs were conducted.

Home-based normal and high-risk newborn care (HBNC): To mitigate risks associated with post-delivery cases both in normal newborns and high-risk newborns (those with LBW, premature babies, breastfeeding problems)

and sepsis, the VHWs paid 7 and 13 visits, respectively (within 28 days of birth). VHW offered treatment under appropriate medical supervision. The ‘Bang’ model of HBNC, as initiated by Dr Abhay Bang in Gadchiroli, was adopted in reducing neonatal and infant mortality rates when delivered by a dedicated worker, even in settings with high rates of facility births (Rasaily et al., 2020; Bang et al., 1999, 2005).

Patient and public involvement was carried out from planning and implementation to results dissemination.

Severe Malnourished Children (SMC), Severe Acute Malnutrition (SAM), and Severe Underweight (SUW): They represent a heavy burden on the healthcare system in India, particularly in Melghat, Maharashtra, with significant morbidity affecting physical and intellectual productivity, as well as mortality, with pooled mortality hazard ratio (HR) of 4.6–11 (Hossain et al., 2011; Moramarco et al., 2018; Bailey et al., 2021; Gausman et al., 2021; Odei Obeng-Amoako et al., 2023; Satav et al., 2024).

WHO provides guidelines for SAM management with Ready to Use Therapeutic Food (RUTF); however, there are no guidelines for the management of SUW. Industrially prepared RUTF has a pasty form and is not perceived as food by the community. Hence, there is need for an alternative, as locally available therapeutic food with RDA as per WHO norms, to make it sustainable and replicable. There should be a variety of socio-culturally acceptable, palatable preparations to make it sustainable and replicable. Thus, the SAMMAN intervention was launched as a strategy for the community-based management of SMC and prompted, ‘a prospective controlled community-based trial to study the impact on SMC, between 6–60 months age, from 14 intervention villages of Melghat’. The research phase for this intervention was between 2011 and 2015, which was followed by the replication phase from 2017 to 2023. MAHAN added 20 new villages during the replication phase with financial support from the Government of India, Bajaj CSR, and others (Jain et al., 2023).

Sample Size Calculation

The primary objective was to achieve a recovery rate of 30% of SMC children based on the review literature and our pilot study. Thus, with 95% confidence level and 5% tolerable error, a sample of 323 is required. Assuming a 5% loss to follow-up, the total sample will be 340 per group. The baseline prevalence of SMC before the intervention was 21.7% in 2011. Expecting a reduction of 40%, the required sample size with a 5% error and 80% power is 294 per group. Considering a 15% loss to follow-up, a sample of 345 is required.

TABLE 4.2 Important Differences between RUTF and LTF Innovated by ‘MAHAN’

SN	RUTF for 90 days treatment of SMC	LTF-MN for 90 days to SMC
1	Recovery rate of SUW after RUTF is <30%. ^(49, 52, 54) Recovery rate of SAM after RUTF is 39.2%. ⁽⁵⁵⁾ or 47.5–56.9%. ⁽⁵⁶⁾	Recovery rate of SUW is 36.8% after 90 days, 78.2% at 60 months age. ⁽²⁾ Recovery rate of SAM is 79.4% after 90 days. ⁽¹⁾
2	CFR is 1–5% ^(52–54, 57) in uncomplicated SUW/SAM.	CFR is 0.63% and 0.29% for SAM and SUW, respectively, during 3 months treatment in both complicated and uncomplicated SMC. ⁽¹⁾
3	Single preparation, hence acceptance is less (40%). ⁽⁵⁸⁾	LTF are multiple, palatable, culturally acceptable preparations. Acceptance rate is > 93%. ⁽¹⁾
4	RUTF cost: 26.80 (Rs/-92 g). ⁽⁵⁹⁾	LTF’s cost is less—Rs 11–14/100 g (cost-effective). ⁽¹⁾
5	RUTF given at home is shared by other siblings. ⁽⁶⁰⁾ So, recovery is less.	LTF is fed by VHW in their presence. Hence no sharing in family. ⁽¹⁾ Therapeutic feeding should be supervised in feeding centres.
6	RUTF is industrial food so people lose confidence in home food as therapy.	LTF is socio-culturally accepted, building confidence in the community for malnutrition treatment. So similar pattern of cooking continues. ^{(1) (48)}
7	Not sustainable.	Sustainable and replicable. ⁽⁴⁸⁾

1 = Dani et al., 2017.
2 = Satav et al., 2024.
48 = Satav et al., 2024.
49 = Hossain et al., 2011.
52 = Odei Obeng-Amoako et al., 2023.
53 = Gausman et al., 2021.
54 = Bailey et al., 2021.
55 = Kundan et al., 2021.
56 = Bhandari et al., 2016.
57 = Schoonees et al., 2019.
58 = Ali et al., 2013.
59 = Compliance Report, 2022.
60 = Kabalo, 2018.

We recruited 339 SMC children with age-matched controls (normal WAZ/WHZ children) in a 1:2 ratio, 678 controls, to understand the impact of LTF-MN.

Severely Malnourished Children were enrolled from 2011 to 2015, after passing the appetite test as per WHO guidelines. Those with medical complications or who failed the appetite test but refused hospitalisation were also enrolled after parents' high-risk consent.

SAMMAN Intervention Methodology

The Intervention Areas (IA) received:

- Locally prepared therapeutic food with micronutrients (LTF-MN) was provided four times a day at community feeding centres supervised by VHWs for 90 days. LTF-MN was the sole food given, except for breast milk, to ensure that each child received 4–6 g of protein/kg/day and 175 kcal/kg/day with gradual escalation. The WHO protocol for RDA of nutrients and minerals was achieved by the addition of 5 g of specially prepared micronutrient (MN) powder, containing deficient micronutrients, per 100 g of LTF. Eight palatable recipes of LTF were designed following WHO norms for SAM management, each one containing 13–16 g of protein, 450–550 calories, and 25–35 g of fat per 100 g. The LTF-MN was given four times a day; the morning LTF was 'chikki' for breakfast, afternoon 'thalipith' for lunch, evening snacks in the form of 'chivada', and dinner in the form of 'khichadi'. This food pattern was culturally accepted. When a malnourished child is fed four times a day, the satiety centre is satisfied, and the child does not feel hungry. It fulfils the requirement as per WHO/UNICEF guidelines for SAM management, i.e., 4–6 grams of protein and 170–200 calories per kg of body weight per day. LTFs are culturally acceptable, and hence it is advised as the sole food. Home-cooked food does not contain proteins or calories in appropriate amounts. Thus, supplementary feeds will not fulfil the RDA as per WHO guidelines.

After 90 days, the child received home-cooked food. The intensive BCC and parents watching the improvement in the child made positive impact, leading to cooking of nutritious food at home, and the parents were providing a diet with improved RDA after the SAMMAN intervention. Community-based appropriate and timely treatment of infections led to a healthy child with improved growth and development. Some other components of the intervention are listed below:

TABLE 4.3 Types of MAHAN LTFs—Composition and Macronutrients

1	2	3	4	5	6	7	8	
Sr. No.	LTF	Ingredients	Amount	Protein	Fat	Energy	Remarks	
		Gram	Gram					Gram
WHO RUTF				100	26–36		520–550	Ready-to-use pack
A. Ready-to-consume LTF (24–59 months):								
A.1	Chikki (Mixed)	Sesame	10	1.83	4.33	56.3	Ready to eat	
		Jaggery	25	0.1	0.025	95.8		
		Groundnut	30	7.59	11.94	170.1		
		Daaliya	20	4.5	1.04	73.8		
		Soya oil	15	0	15	135		
A.2	Chiwada	Total	100	14.02	32.335	531	Ready to eat	
		Groundnut	30	7.59	11.94	170.1		
		Daliya	30	6.75	1.56	110.7		
		Pohe	10	0.66	0.12	34.6		
		Murmure	10	0.7035	0.01	32.5		
A.3	Chikki groundnut	Soya oil	20	0	18.76	180	Ready to eat	
		Total	100	14.02	32.335	531		
		Jaggery	35	0.14	0.04	134.05		
		Groundnut	55	13.92	21.89	311.85		
		Soya oil	10	0	10	90		
		Total	100	14.06	31.93	535.9		
B. Powdered ready-to-use snacks :(6–24 months)								
B.1	Powder chikki groundnut	Jaggery	35	0.14	0.04	134.05	Ready to eat	
		Groundnut	55	13.92	21.89	311.85		
		Soya oil	10	0	10	90		
		Total	100	13.99	31.98	524.65		

1	2	3	4	5	6	7	8
Sr. No.	LTF	Ingredients	Amount	Protein	Fat	Energy	Remarks
			Gram			Gram	
WHO RUTF							
B.2	Powder poha-daliya	Poha	20	1.98	0.03	97.5	Ready to eat
		Daliya	30	4.5	1.04	73.8	
		Groundnut	30	7.59	11.94	170.1	
		Soya oil	20	0	20	180	
		Total	100	14.07	33.01	521.4	
C. LTF to be cooked at the feeding centre of VHW (age group 6-59 months)							
C.1	Thalipeeth/ upma	Jawar	20	2.08	0.38	69.8	Cook before serving
		Groundnut	30	7.59	11.94	170.1	
		Chana dal (besan)	30	6.24	1.68	111.6	
		Soya oil	20	0	20	180	
		Total	100	15.91	34	531.5	
C.2	Moong khichdi	Moong dal	25	6.1	0.3	87.0	Cook before serving
		Red rice	25	1.9	0.3	86.3	
		Groundnut	30	7.6	11.9	170.1	
		Soya oil	20	0.0	20.0	180.0	
		Total	100	15.6	32.5	523.4	
C.3	Sabudana khichdi	Groundnut	55	13.92	21.89	311.85	Cook before serving
		Sabudana	35	0.07	0.07	122.8	
		Soya oil	10	0	10	90	
		Total	100	13.99	31.98	524.65	

Source: Satav et al., 2022b, 2024).

- Intensive (weekly) behaviour change communication (BCC) to parents of severely malnourished children (SMC) in IA during 90 days of LTF-MN therapy.
- Community-based management of illnesses (treatment of infections) by VHWs in accordance with standard WHO protocols.
- Daily childcare included proper handwashing, nail cutting, and examination for any medical complications and adverse effects.
- Community participation was sought from planning, implementation, to results dissemination.
- Long-term follow-up: The children were followed with quarterly anthropometry up to the age of five years.

The control arm (CA) consisted of age-sex-matched SMC children from control villages. They did not receive LTF-MN nutritional therapy but were referred to government hospitals for treatment.

Results

- The recovery rate of SUW was 36.8% at the end of nutritional therapy of 90 days, which increased to 78.2% at the age of five years ($p < 0.001$) (Satav et al., 2024).
- The recovery rate of SAM was 79.4% at the end of nutritional therapy of 90 days (Dani et al., 2017), which increased to 90.8% at the age of five years ($p < 0.001$).
- WAZ scores of the intervention arm of SUW children showed highly significant improvement compared to control arm of normal children by the age of five years ($p < 0.001$) (Satav et al., 2024).
- WHZ scores of the intervention arm of SAM children showed highly significant improvement compared to control arm of normal children by the age of five years ($p < 0.0001$ using Pearson's Chi-square test).
- Significantly, SMC's catch-up with the normal growth velocity curves of the age-matched controls by five years of age (Satav et al., 2024).

The prevalence of SMC reduced significantly in intervention villages as compared to control villages ($p < 0.005$) (Dani et al., 2017; Satav et al., 2024).

- Case fatality rate (CFR) was found to be low at 0.63% and 0.29% for SAM and SUW respectively (Dani et al., 2017).

At the population level, the study found a significant decrease in severe malnutrition (IAP Grades iii, iv) by 56.25% in IA from 9.6% to 3.63%, among children under five in the intervention area (IA) compared to the control area (CA). This reduction was more than half. Additionally, there was a dramatic drop (65.78%) in the under-five mortality rate in the intervention area as

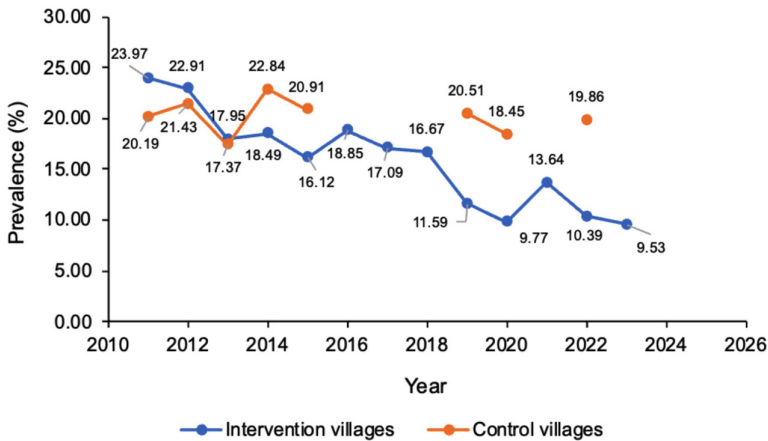


FIGURE 4.3 Prevalence of severe malnutrition (SAM and SUW) in intervention villages and control villages

Source: Author's own creation.

compared to control area. This improvement continued even after the main programme ended, i.e. in the service and the replication phases. The study also showed a decrease in the number of low-birth-weight babies in both areas, but the reduction was more pronounced in the intervention area. The prevalence of LBW went down from 50% to 28% in IA, while it reduced to 43% in CA until the end of the service phase.

Cost-Effectiveness and Policy Implications

MAHAN's HBCC model demonstrated cost-effectiveness with an average treatment cost of INR 592 (US\$8) per child annually, at the time of research intervention (Satav et al., 2022a). The intervention featured a robust design, strong scientific underpinning, cultural adaptability, institutional support, and a comprehensive approach encompassing home-based newborn care, post-neonatal infection management, antenatal care, and behaviour change communication. It led to significant and sustained reductions in under-five mortality (U5MR), infant mortality rate (IMR), neonatal mortality rate (NMR), and postnatal mortality rate (PNMR) over a decade, indicating its feasibility for large-scale implementation in challenging rural and tribal settings. The model influenced state policies, with the baseline survey contributing to the establishment of the Rajmata Jijau Mother and Child Health and Nutrition Mission in Maharashtra to address malnutrition (D'Alimonte et al., 2016).

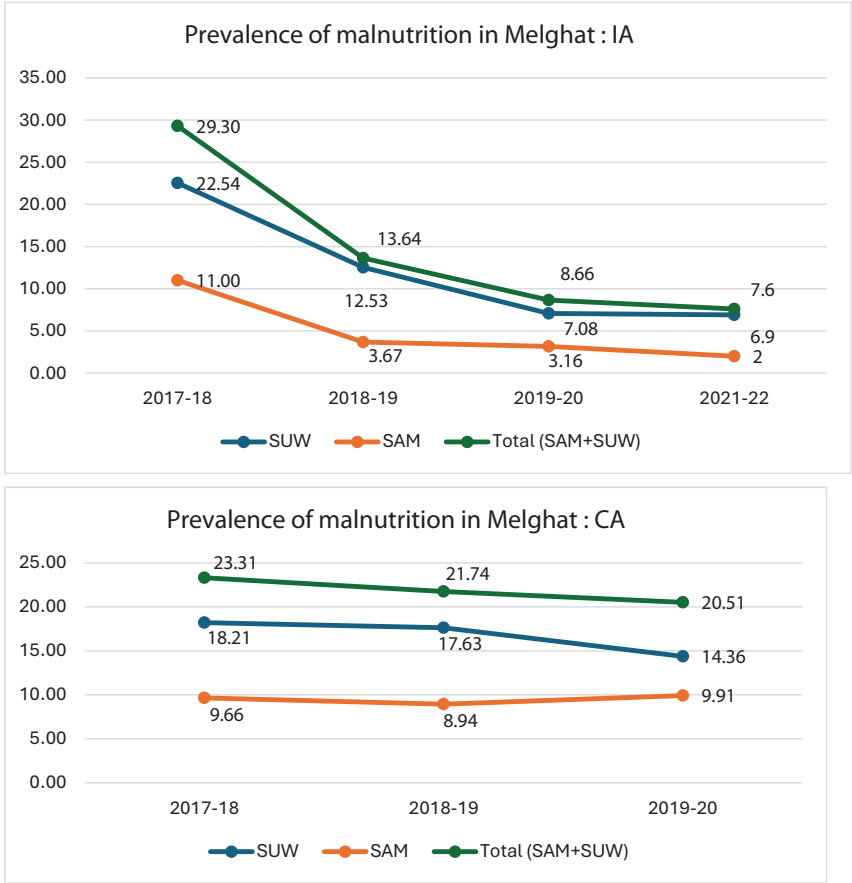


FIGURE 4.4 Prevalence of severe malnutrition in IA vs CA⁽³⁶⁾

Source: Author's own creation

Kitchen Garden and Nutrition Farming (KG-NF)

To create awareness around a balanced diet which helps prevent malnutrition, MAHAN initiated these programmes in 2007–08. Melghat is a hilly region with significant seasonal variations, e.g., dry summer months from February to June leading to food scarcity, especially fresh produce, followed by heavy rains during the monsoon (July to September) leading to a significant rise in infections. The erratic weather, along with a lack of nutritional awareness, often led to an increase in malnutrition and child deaths in the area. MAHAN's BCC addressed the flawed dietary cultural practices and emphasised the importance of a balanced diet and the consumption of green vegetables, pulses, and oils to prevent malnutrition. However, the tribal

people faced difficulties in getting fresh vegetables and fruits because they had to travel 50 km to reach the weekly market. Transportation was limited and expensive, making it difficult for them to buy fresh produce regularly. In light of these difficulties, MAHAN developed kitchen gardens and nutrition farms as a solution.

Consequently, kitchen gardens were cultivated in about 200 square feet of area in each household, using recycled water to grow vegetables. People grew a variety of food in these gardens during both winter and rainy seasons, which gradually helped them improve their diets and overall nutritional status.

Another method utilised was the introduction of Nutrition Farm (NF) (Dilasa Pata method), which is a holistic approach to agriculture wherein approximately one acre of land is cultivated. The focus is on producing enough quantity of 20 varieties of food (cereals, pulses, vegetables, oil seeds, and fruits) so that on average two children in a family can have a balanced diet for at least six months.

Kitchen gardens and nutrition farms played a significant role in addressing malnutrition.

Yuvadoots trained and helped households and farmers develop KG-NF, e.g., preparing land, distributing seeds to beneficiaries (free for pregnant women and malnourished children), sowing, irrigating, protecting the farm from pests and wild animals, and harvesting. They supervised kitchen gardens and nutrition farms.

BCC of the beneficiaries regarding the link between KG-NF and health and malnutrition prevention is associated with this intervention. KG-NF provides access to fresh vegetables and ensures dietary diversity and food quality. It is cost-effective, empowers families, and promotes self-sustainability and capacity building in the community.

Water Conservation by ‘Doh Model’ and ‘Contour Banding’

As Melghat is a hilly terrain, water gets drained from the river after the rainy season, and there is a severe water crisis during the summer. Therefore, it is difficult to develop KG-NF during the summer and winter seasons. Hence, MAHAN developed two different types of water conservation activities in many villages, e.g., contour banding and the doh model. This helped to improve the water table of the villages and supplied sufficient water to grow KG-NG even during the winter and, to some extent, in the summer, where doh models were developed.

MAHAN developed more than 11,000 KG-NF; the tribals produced more than 500,000 kg of agricultural produce, which could supply sufficient nutrition to two children for six months in families and prevent malnutrition.

UMANG Programme for Government Scheme Mobilisation

UMANG, an initiative spearheaded by 'MAHAN' in 2007, through its male tribal Yuvadoots, serves as a beacon of hope for tribal communities, aiming to uplift their socio-economic status through the facilitation of various government schemes. One such scheme is the ration card initiative, wherein villagers are guided and helped to obtain subsidised food grains, alleviating the burden of high market prices. Currently, efforts are being undertaken to ensure the seamless update of Aadhaar cards and bank accounts, particularly for married women, enabling them to access vital schemes like Janani Shishu Suraksha Yojana and Matrutwa Vandana Yojana, thus enhancing maternal and child welfare. Agricultural prosperity is fostered through mobilisation of schemes like PM Kisan Yojana, wherein farmers receive financial aid for farming inputs, contributing to increased productivity and economic stability. Addressing unemployment challenges, the MAHAN trust helped tribals to get better benefits from the Mahatma Gandhi Rural Employment Guarantee Scheme (MREGS) through public interest litigation and empowered villagers by guiding them through job application processes, thereby reducing migration rates and fostering local economic growth. Moreover, community issues such as non-functional water pumps, inadequate clean water supply, and erratic electricity are diligently addressed through collaborative efforts with relevant authorities, ensuring that basic amenities are met. Through UMANG, heightened awareness, strengthened trust in supervisors, and coordinated efforts within the community pave the way for improved health, socio-economic well-being, and nutritional outcomes among tribal populations through enhanced community participation.

Impact on Policies

1. Rajmata Jijau Mother and Child Health, Nutrition Mission (RJMCHNM) M.S.: Meetings and correspondences with district and state administration between 1998 and 2005, and data exposure through print and electronic media, led to questions in the Maharashtra state legislative assembly. MAHAN documented a very high prevalence of malnutrition and mortality rates, with information from village mapping, census, vital data collection, and anthropometry of all USC (Dani et al., 2015; D'Alimonte et al., 2016; Satav et al., 2022a). This was contrary to the data reported by the state government. This eventually led to the formation of Rajmata Jijau Mother and Child Health and Nutrition Mission (RJMCHNM) by the state government in 2005. This confirmed the high malnutrition and mortality rates of children reported by MAHAN (D'Alimonte et al., 2016; UNICEF, 2016). RJMCHNM then implemented multiple interventions and reduced child and maternal malnutrition and deaths in Maharashtra (D'Alimonte et al., 2016).

2. Counsellor programme: Advocacy with district/state administration, research paper publication in medical journals (Satav et al., 2011; Satav, 2018) and a PIL in the High Court (PIL, 2022) from 2005 to 2022 led to the implementation of the counsellor programme in Melghat from 2007 till date (Petition 3278, 2010, 2011; PIL, 2010).
3. Reclassification of severe malnutrition: The government's nutrition programme was extended only to only severely acute malnourished (SAM) children. Consequently, severely underweight (SUW) children were denied special care, leading to high morbidity and mortality. The MAHAN trust presented its research on SUW to the Honourable High Court of Maharashtra, following which the then Chief Justice of Maharashtra gave a directive to the government to include SUW children in the malnutrition treatment programme. (PIL, 2010; Petition 3278, 2011) Since May 2011, the Maharashtra government has been providing special therapeutic food to all SUW children, which has benefitted more than 10 lakh SUWs, thus saving their lives (PIL, 2011, 2013) (Commissioner HDoGoM, 2022; Petition 3278, 2013).
4. Village Child Developmental Centres (VCDC) and Child Development Centres (CDC) in Maharashtra: MAHAN reported high IMR and severe malnutrition in Melghat, contrary to the state government's figures. These were verified by UNICEF (2016; D'Alimonte et al., 2016). MAHAN relentlessly advocated with the RJMCHNM and filed a PIL for community-based management of severe malnutrition, after a successful MAHAN experiment in Melghat. After directives from the Hon. High Court of Maharashtra, VCDC and CDCs were not only restarted, but they also received more funds and the numbers were increased (Petition 3278, 2010). It has benefitted more than 300,000 severely malnourished children in Maharashtra.
5. IAS/IFS officer as Integrated Tribal Development Project Officer (PO): Since May 2011, after the PIL by Dr Satav, the Hon. High Court of Maharashtra has given directives to the state government, which appointed IAS officers in all tribal blocks of Maharashtra as special nodal officers for the coordination of all government schemes in tribal areas (assistant collector or project officer). It has improved government administration for many years benefiting millions of tribal people (PIL, 2011; Petition 3278, 2011).
6. Hot cooked food at anganwadis: After the PIL by Dr Satav, the Hon. High Court of Maharashtra gave various directives to the state government. Consequently, instead of Take Home Ration (prepared by industries), fresh hot cooked food (prepared by self-help groups of tribal/Integrated Child Development Services (ICDS) workers) is being provided to children below the age of three years (> 30,000 children every year) to prevent malnutrition in Melghat since May 2011(PIL, 2011; Petition 3278, 2011).

7. Compulsory rural/tribal posting in government hospitals for one year for MBBS doctors: MBBS doctors who studied at government medical colleges in Maharashtra have to complete one year of posting in government hospitals, especially in rural and tribal areas of Maharashtra, or they don't get their degree certificates. They must sign the bond of rupees 50,00,000. Only after the completion of the said bond in rural areas by MBBS doctors, admission is allowed for post-graduation (PG).
8. The Government of Maharashtra has reserved PG seats in government medical colleges for doctors who served tribal government hospitals for three years (50% PG diploma seats and 20% PG: MD/MS seats) (PIL, 2007, 2022; Tayade, 2022; Vyas, 2022).
9. Tribal Ashram School inmates' death prevention technical committee: The Government of Maharashtra has changed five policies as per the recommendations of the committee to reduce deaths of students in Ashram schools of Maharashtra (Salunke et al., 2016).
10. The Government of Maharashtra has accepted the transfer policies for doctors who have worked for three years in tribal areas (Tayade, 2022) and promotion of doctors who have worked in tribal areas for three years (Commissioner HDoGoM, 2022; PIL, 2022; Compliance Report, 2023).
11. SOPs regarding treatment protocols and referrals have been prepared by the health department (Commissioner HDoGoM, 2022; PIL, 2022; Vyas, 2022).
12. The government agreed to start intensive locally appropriate BCC activities in tribal areas that will reduce malnutrition and deaths (Commissioner HDoGoM, 2022; Tayade and Public Health Department, 2022; PIL, 2022; Vyas, 2022).
13. WCD department has started third-party verification of vital statistics and various government schemes by an independent agency, e.g., UNICEF (Commissioner HDoGoM, 2022; Compliance Report, 2022; Tayade and Public Health Department, 2022; PIL no. 133, 2022).
14. The kitchen garden project has been started by the government around public institutes (PIL, 2022; PIL no. 133, 2022) Community-based monitoring of government schemes has been started (Compliance Report, 2022; PIL, 2022; PIL no. 133, 2022).
15. The involvement of local voluntary organisations in government programmes, especially for reducing malnutrition, has been accepted by the state tribal department (Commissioner HDoGoM, 2022; Compliance Report, 2022; PIL, 2022; PIL no. 133, 2022).
16. Plans were also made for the upgradation of government hospitals in Melghat (PIL, 2007) and filling of vacant posts of doctors in government

tribal hospitals, especially paediatricians, obstetricians, and nutritionists (Commissioner HDoGoM, 2022; Compliance Report, 2022; PIL, 2022; Tayade and Public Health Department, 2022; PIL no. 133, 2022).

Net Results of an Integrated Approach

There was a statistically significant reduction in U5MR during the last 20 years (see Figures 4.5–4.7).

2. There is statistically significant reduction in the prevalence of severe malnutrition in intervention villages compared to control villages (see Figures 4.8 and 4.9).

During the integrated phase, the prevalence of severe malnutrition (SAM, SUW) was reduced from 23.97% to 9.5% (p-value <0.001) in intervention villages, while there was no significant change in control villages over four years. This revealed significant reduction in SMC prevalence in intervention villages as compared to control villages (p-value <0.001) (Jain et al., 2023).

- At present, the prevalence of severe wasting in our intervention villages is 2.94% (September 2023), which is significantly less compared to the rest of India (7.7%) (James et al., 2022)

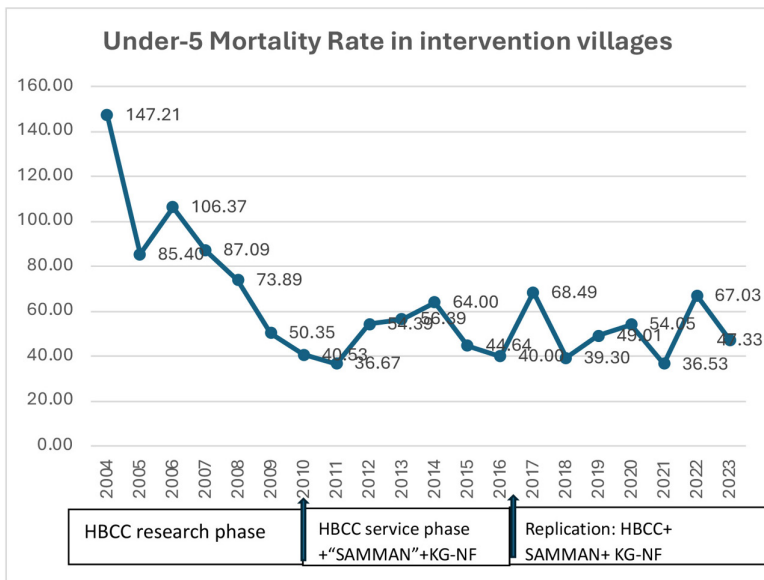


FIGURE 4.5 U5MR in intervention villages from 2004 to 2023

Source: Author's own creation.

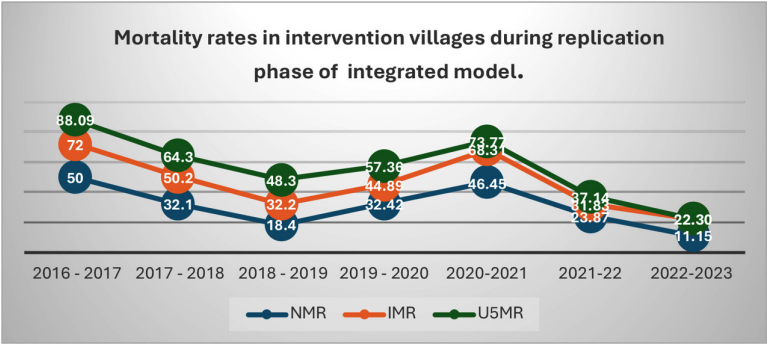


FIGURE 4.6 Mortality rates in intervention villages during the replication phase of the integrated model: September 2017 to August 2023

Source: Satav et al., 2022a; Jain et al., 2023.

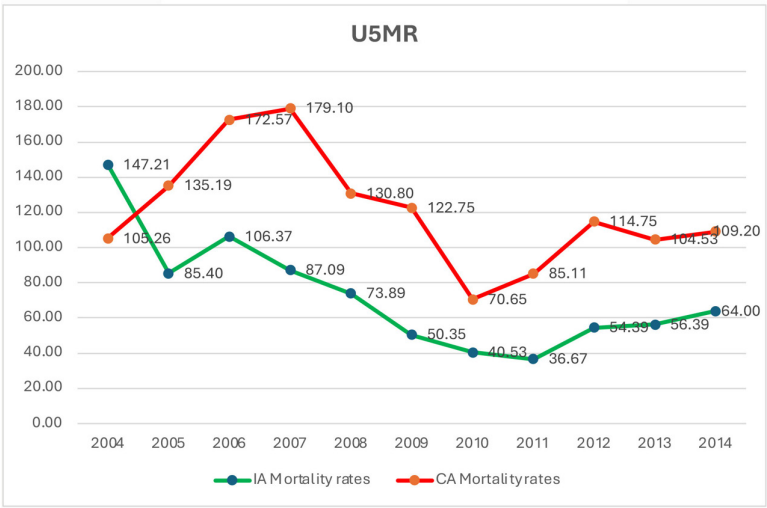


FIGURE 4.7 Under-5 mortality rate in intervention and control villages from 2004 to 2014

Source: Satav et al., 2022a.

Case fatality rate (CFR)

3. The CFR is significantly less than the WHO norm.

The CFR of treated SMC is 0.49%, which is significantly less than the WHO target of <4%. (Jain et al., 2023) This is the major achievement of our study compared to other studies (Schoonees et al., 2019; Gausman et al., 2021; Odei Obeng-Amoako et al., 2023).

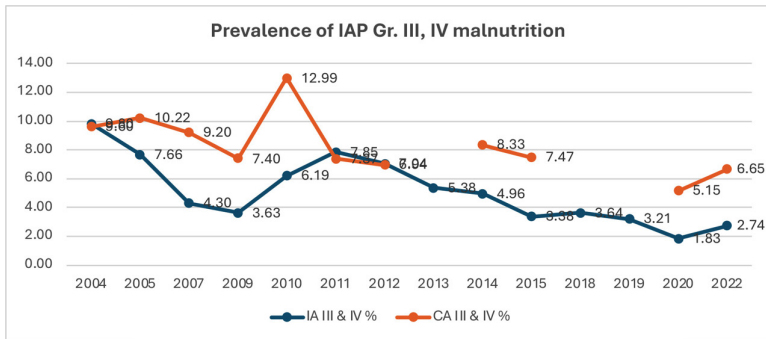


FIGURE 4.8 Prevalence of IAP gr. III and IV,—severe malnutrition in intervention and control villages: 2004 to 2022

Source: From unpublished data and graph of MAHAN.

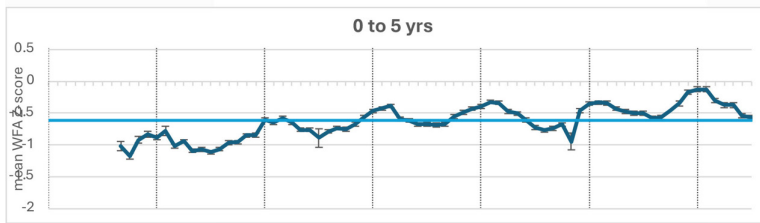


FIGURE 4.9 Change in mean WFAZ scores during the period of 2017–23 in IA

Source: From unpublished data and graph of MAHAN.

4. The mean weight-for-age Z score is significantly higher over a period of five years in the intervention area.

Challenges and Learnings for Scaling up and Replicability

MAHAN's model of integrated management of malnutrition can be replicated on a wider scale to reduce malnutrition and mortality in children.

However, there are certain roadblocks in the way of fully replicating and scaling up this model as mentioned below:

- Legal acceptance of the treatment of infections by VHWs and ASHAs in villages.
- The government is unwilling to provide focused, abbreviated, intensive residential training for ASHA workers for the duration of five days per month for one year, followed by regular refresher training.
- Intensive monitoring and supervision of the programme are needed to prevent adverse effects.

- Reluctance to accept LTF-MN as per WHO RDA by the state government in place of RUTF or EDNF.
- LTF-MN recipes will vary in different states and need to be designed according to local socio-cultural practices.
- There is a need of active involvement of experts from various organisations like IAP and IMA.
- Unwillingness of the government and technical medical bodies for task shifting in health care (Balsari et al., 2017).

A convergence approach must be followed by the government which will foster interdepartmental cooperation among public health and medical education departments, ICDS, the nutrition department, the agricultural department, the irrigation department, and general administration. There is a need of coordination between the government and voluntary organisations to reduce malnutrition in India.

In Conclusion: Advocacy with the Policymakers

Institutionalising documentation and learning processes for nutrition programmes to anchor policy decisions in evidence is essential. This ensures efficient resource utilisation, continuous improvement, and adaptability, fostering accountability and transparency. An evidence-based approach is needed in decision-making and effective policymaking. Community-based research is necessary to evaluate and understand the grassroots-level problems of various geographical and social contexts so that policymakers can frame policies according to the local issues and ensure that policies are cost-effective and sustainable to address the needs of the community.

As described, observational studies were conducted to understand the social structure and beliefs of the local tribal community in relation to their health and nutritional habits. They revealed low health-seeking behaviour within the community, which led to low coverage and impact of the health-care facilities.

Advocacy of these community-based programme results was conducted through research paper publications, paper and poster presentations at scientific conferences, talks and articles in the media, and interactive discussions and personal meetings with local, district, and state administration to modify or frame new policies.

As a last resort, a PIL was filed in the Honourable High Court to seek attention to solve important public health and nutrition-related problems and to initiate change in policies promoting social activism. This approach has made an impact on various public policies at the state level. These policy changes have benefitted lakhs of poor children and pregnant women of Maharashtra by reducing morbidity, malnutrition, and mortality. The

U5MR, IMR, NMR, and prevalence of severe malnutrition have been reduced significantly in intervention villages as compared to control villages ($p < 0.001$). There is significant improvement in the recovery of SAM and SUW in IA. The intervention arm has significantly lower mortality (CFR of SMC is $< 1\%$ during 2011–23) than the WHO accepted target of CFR of treated SAM to $< 4\%$.

Throughout this journey, MAHAN's commitment to evidence-based solutions, strong PPI, and community-driven intervention played a pivotal role in influencing policy changes, garnering recognition from both government and international agencies.

Integrated approach of MAHAN is culturally acceptable, safe, feasible with local resources, cost-effective, easily accessible, measurable, and therefore sustainable and replicable for community-based management of childhood illness and SMC, aimed at reducing severe malnutrition and child deaths in difficult-to-access rural areas of India.

Notes

- 1 Major decisions for the tribal villages in a traditional panchayat system are the older and key tribal members of the villages. The head of the panchayat is called Adya Patel. This traditional panchayat is different from the gram panchayat.
- 2 TFHs are local tribal elders who treat the patients in villages using mantras, herbs, and *damma* i.e., burning the skin with a red-hot iron rod. They are of three types—Bhagat, Bhumakas, and Parihars.
- 3 TBAs conduct home deliveries in the absence of doctors. They are local tribal semi-literate women who are respected by the community.
- 4 Yuvadoots are local, trained, tribal young men from the same community selected by the community members.
- 5 Public Interest Litigation (PIL) was filed by MAHAN Trust and KHOJ in 2010 for restarting the counsellor programme, which was stopped by the government.
- 6 Doh refers to a saucer-shaped waterbody in Maharashtra.

References

- Agarwal, D., Misra, S.K., Chaudhary, S.S., Prakash, G. (2015). Are we underestimating the real burden of malnutrition? An experience from community-based study. *Indian Journal of Community Medicine* 40(4): 268–272.
- Ali, E., Zachariah, R., Dahmane, A., Van den Boogaard, W., Shams, Z., Akter, T., et al. (2013). Peanut-based ready-to-use therapeutic food: acceptability among malnourished children and community workers in Bangladesh. *Public Health Action* 3(2): 128–135.
- Bailey, J., Lelijveld, N., Khara, T., Dolan, C., Stobaugh, H., Sadler, K., et al. (2021). Response to malnutrition treatment in low weight-for-age children: secondary analyses of children 6–59 months in the compas cluster randomized controlled trial. *Nutrients* 13(4).
- Bang, A.T., Bang, R.A., Baitule, S.B., Reddy, M.H., Deshmukh, M.D. (1999). Effect of home-based neonatal care and management of sepsis on neonatal mortality: field trial in rural India. *Lancet* 354(9194): 1955–1961.

- Bang, A.T., Reddy, H.M., Deshmukh, M.D., Baitule, S.B., Bang, R.A. (2005). Neonatal and infant mortality in the ten years (1993 to 2003) of the Gadchiroli field trial: Effect of home-based neonatal care. *Journal of Perinatology: Official Journal of the California Perinatal Association* 25(Suppl 1): S92–107.
- Balsari, S., Simon, G., Nair, R., Saunik, S., Phadke, M. (2017). Task shifting in health care: The risks of integrated medicine in India. *The Lancet Global Health* 5(10): e963–e964.
- Bhandari, N., Mohan, S.B., Bose, A., Iyengar, S.D., Taneja, S., Mazumder S., et al. (2016). Efficacy of three feeding regimens for home-based management of children with uncomplicated severe acute malnutrition: a randomised trial in India. *BMJ Global Health* 1(4): e000144.
- Bills C.B., Newberry, J.A., Darmstadt, G., Pirrotta, E.A., Rao, G.V.R., Mahadevan, S.V., et al. (2018). Reducing early infant mortality in India: results of a prospective cohort of pregnant women using emergency medical services. *BMJ Open* 8(4): e019937.
- Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., de Onis, M., Ezzati, M., et al. (2008). Maternal and child undernutrition: Global and regional exposures and health consequences. *Lancet* 371(9608): 243–260.
- Boregowda, G.S., Soni, G.P., Jain, K., Agrawal, S. (2015). Assessment of under nutrition using Composite Index of Anthropometric Failure (CIAF) amongst toddlers residing in urban slums of Raipur City, Chhattisgarh, India. *Journal of Clinical and Diagnostic Research* 9(7): Lc04–06.
- Commissioner, Health Department, Government of Maharashtra. (2022). Compliance report by government to PIL No. 133 of 2007. Government of Maharashtra, Public Health Department.
- Compliance Report. (2022). Women and Child Development Department Public Interest Litigation No. 133 of 2007 PIL.
- D’Alimonte, M.J.C., Singh, S., Kaushal, K., Levinson, J. (2016). Pushing the nutrition agenda forward. In Documentation of the Rajmata Jijau Mother-Child Health & Nutrition Mission in Maharashtra (Ed.). Mumbai: Government of Maharashtra and UNICEF.
- Dani, V., Satav, K., Pendharkar, J., Satav, A., Ughade, S., Adhav, A., et al. (2017). Community-based management of severe malnutrition: SAM and SUW in the tribal area of Melghat, Maharashtra, India. *Clinical Epidemiology and Global Health* 5(2): 62–69.
- Dani, V., Satav, A., Pendharkar, J., Ughade, S., Jain, D., Adhav, A., et al. (2015). Prevalence of under nutrition in under-five tribal children of Melghat: A community based cross sectional study in Central India. *Clinical Epidemiology and Global Health* 3(2): 77–84.
- Dawn, A. & Basu, R. (2016). Status of Maternal and Child Health in Empowered Action Group of Indian States: A Spatio-Temporal Analysis. *International Journal of Development Research*. 6(10): 9798–9803.
- Dehury RK, Samal J. (2016). Maternal Health Situation in Bihar and Madhya Pradesh: A Comparative Analysis of State Fact Sheets of National Family Health Survey (NFHS)-3 and 4. *J Clin Diagn Res* 10(9): 1e01–ie4.
- Deshmukh, P.R., Sinha, N., Dongre, A.R. (2013). Social determinants of stunting in rural area of Wardha, Central India. *Medical Journal Armed Forces India* 69(3): 213–217.
- Gausman, J., Kim, R., Subramanian, S.V. (2021). Associations of single versus multiple anthropometric failure with mortality in children under 5 years: A prospective cohort study. *SSM Population Health* 16: 100965.
- Ghosh, S., Varerkar, S.A. (2019). Undernutrition among tribal children in Palghar district, Maharashtra, India. *PLOS One* 14(2): e0212560.

- Goyal, M., Singh, N., Kapoor, R., Verma, A., Gedam, P. (2023). Assessment of nutritional status of under-five children in an urban area of South Delhi, India. *Cureus* 15(2): e34924.
- Horwood, G., Opondo, C., Choudhury, S.S., Rani, A., Nair, M. (2020). Risk factors for maternal mortality among 1.9 million women in nine empowered action group states in India: secondary analysis of Annual Health Survey data. *BMJ Open* 10(8): e038910.
- Hossain, M.I., Nahar, B., Hamadani, J.D., Ahmed, T., Brown, K.H. (2011). Effects of community-based follow-up care in managing severely underweight children. *The Journal of Pediatric Gastroenterology and Nutrition* 53(3): 310–319.
- In the High Court of Judicature at Bombay Appellate Side. (2013). Writ Petition No. 3278 of 2010 (PIL). Sect. 1,3,6,8,11 (2010).
- In the High Court of Judicature at Bombay Civil Appellate Jurisdiction. (2010, December 4). Writ Petition No. 3278 of 2010.
- In the High Court of Judicature at Bombay Civil Appellate Jurisdiction. (2011). *Writ Petition No. 3278 of 2010*.
- In the High Court of Judicature at Bombay Civil Appellate Jurisdiction. (2022, September 23). Public Interest Litigation No. 133 of 2007.
- Jain, V.S.D., Gaidhane, A., Jadhav, K., Deshpande, N., Khadse, V. (2023). *Evaluation of project: A community-based approach to improve health and nutrition status and to reduce deaths of tribals of Melghat*. Tribal Development Department, GoM.
- James, K.S., Lhungdim, H., Shekhar, C., Pedgaonkar P.L.K. (2022). *National Family Health Survey (NFHS-5)*. In Ministry of Health and Family Welfare (Ed.). Delhi Government of India, p. 116.
- Jaleel, A., Arlappa, N., Ramakrishna, K.S., Sunu, P.V., Jayalakshmi, G., Neeraja, G., et al. (2023). Examining the triple burden of malnutrition: insights from a community-based comprehensive nutrition survey among indigenous tribal children (0–19 years) in the Western Ghats hills of India. *Nutrients* 15(18).
- Jeyakumar, A., Godbharle, S., Giri, B.R. (2021). Determinants of anthropometric failure among tribal children younger than 5 years of age in Palghar, Maharashtra, India. *The Food and Nutrition Bulletin* 42(1): 55–64.
- Jeyakumar, A., Babar, P., Menon, P., Nair, R., Jungari, S., Tamboli, A., et al. (2022). Is Infant and Young Child-feeding (IYCF) a potential double-duty strategy to prevent the double burden of malnutrition among children at the critical age? Evidence of association from urban slums in Pune, Maharashtra, India. *PLOS One* 17(12): e0278152.
- Kabalo, M.Y. (2018). Manifolds boosting severe acute malnutrition burden among children in and around Wolaita Zone, Southern Ethiopia: mini-review. *BMC Research Notes* 11(1): 870.
- Karlsson, O., Kim, R., Sarwal, R., James, K.S., Subramanian, S.V. (2021). Trends in underweight, stunting, and wasting prevalence and inequality among children under three in Indian states, 1993–2016. *Scientific Reports* 11(1): 14137.
- Kim, R., Bijral, A.S., Xu, Y., Zhang, X., Blossom, J.C., Swaminathan, A., et al. (2021). Precision mapping child undernutrition for nearly 600,000 inhabited census villages in India. *Proceedings of the National Academy of Sciences* 118(18): e2025865118.
- Kundan, I., Nair, R., Kulkarni, S., Deshpande, A., Jotkar, R., Phadke, M. (2021). Assessment, outcomes and implications of multiple anthropometric deficits in children. *BMJ Nutrition, Prevention & Health* 4(1): 267–274.
- Kusuma, Y.S., Santoshkumar, P.S., Sudhanarao T.M., Rambabu, D., Babu, B.V. (2024). Under-five child mortality and associated factors among tribal populations from a South Indian district. *Biodemography and Social Biology* 69(1): 43–54.

- Moramarco, S., Amerio, G., Kasengele, Chipoma, J., Nielsen-Saines, K., Palombi, L., Buonomo, E. (2018). Filling the gaps for enhancing the effectiveness of community-based programs combining treatment and prevention of child malnutrition: Results from the rainbow project 2015–17 in Zambia. *International Journal of Environmental Research and Public Health* 15(9): Article 1807.
- Murarkar, S., Gothankar, J., Doke, P., Pore, P., Lalwani, S., Dhumale, G., et al. (2020). Prevalence and determinants of undernutrition among under-five children residing in urban slums and rural area, Maharashtra, India: A community-based cross-sectional study. *BMC Public Health* 20(1): 1559.
- NFHS I. (2017). Fact sheets for key indicators based on final data.
- NFHS-5 DPI. 2019–21. Ministry of Health and Family Welfare GoI. International Institute for Population Sciences.
- Niswade, A., Zodpey, S.P., Ughade, S., Bangdiwala, S.I. (2011). Neonatal morbidity and mortality in tribal and rural communities in Central India. *Indian Journal of Community Medicine* 36(2): 150–158.
- Odei Obeng-Amoako, G.A., Stobaugh, H., Wrottesley, S.V., Khara, T., Binns, P., Trehan, I., et al. (2023). How do children with severe underweight and wasting respond to treatment? A pooled secondary data analysis to inform future intervention studies. *Maternal & Child Nutrition* 19(1): e13434.
- Prabhu, S.A., Shukla, N.K., Mandala, S.R. (2020). Assessment of nutritional status of rural children (0–18 years) in Central India using World Health Organization (WHO) child growth standards 2007. *Indian Journal of Community Medicine* 45(3): 323–327.
- Prasad, R., Shukla, A., Galhotra, A. (2023). Feeding practices and nutritional status of children (6–23 months) in an urban area of Raipur, Chhattisgarh, India. *Journal of Family Medicine and Primary Care* 12(10): 2366–2372.
- Public Health Department. (2022). Compliance report on affidavit filed by Dr. Ashish Satav, PIL No. 133 of 2007. Government of Maharashtra.
- Public Health Department. (2023, January 12). Compliance report to PIL No. 133 of 2007. Government of Maharashtra.
- Ranjan, M. Dwivedi, L.K., Sharma, B. (2018). Infant mortality among tribes population in India: Regional analysis from multiple surveys. *Stud Tribes Tribals* 16(1–2): 11–23.
- Rasaily, R., Saxena, N.C., Pandey, S., Garg, B.S., Swain, S., Iyengar, S.D., et al. (2020). Effect of home-based newborn care on neonatal and infant mortality: A cluster randomised trial in India. *BMJ Global Health* 5(9).
- Ray, S.K., Halder, A., Biswas, B., Misra, R., Kumar, S. (2001). Epidemiology of undernutrition. *Indian Journal of Pediatrics* 68(11): 1025–1030.
- Salunke, A.S., Ashtekar, S., Belkhode, A., Ture, P., Upadhyay, P., Deshmukh, D., Bidkar, H., Patil, P. M., Jadhav, M., Madhusudan, K. (2016). *In Search of Hope: Report of the Technical Committee for Prevention of Deaths of Students from Ashram Schools*. In Tribal Development Department Gom (Ed.). Government of Maharashtra, p. 80.
- Satav, A.R., Sane, B.L., Bhapkar, P., Shankarnarayan, M., Parhi, R., Bobde, K., et al. (2011). Counsellor program for saving severely malnourished children by improvement of government hospitals of Melghat: Result of a field trial. *Pediatric Research* 70(5): 828.
- Satav, A. (2018). Counselors Program, *Indian Journal of Applied Research*, 8(1): 63–66.
- Satav, A.R., Satav, K.A., Bharadwaj, A., Pendharkar, J., Dani, V., Ughade, S., et al. (2022a). Effect of home-based childcare on childhood mortality in rural Maharashtra, India: A cluster randomised controlled trial. *BMJ Global Health* 7(7): e008909.

- Satav, A.S., Dani, V.D., Pendharkar, J., Jain, D., & Satav, K. (2022b). Mapping of local therapeutic foods (LTF) and Micronutrients (MN) their logistics in community- based management of Severe Malnutrition (SAM, SUW) as a benchmark in tribal Melghat, Maharashtra. *Archives of Food and Nutritional Science* 6(1): 26–34.
- Satav, A.R., Dani, V.S., Pendharkar, J.S., Satav, K.A., Raje, D., Jain, D., et al. (2024). Locally prepared therapeutic food for treatment of severely underweight children in rural India: An interventional prospective controlled community-based study with long follow-up:-'SAMMAN' trial. *Nutrients* 16(17): 2872.
- Schoonees, A., Lombard MJ, Musekiwa A, Nel E, Volmink J. (2019). Ready-to-use therapeutic food (RUTF) for home-based nutritional rehabilitation of severe acute malnutrition in children from six months to five years of age. *The Cochrane Database of Systematic Reviews* 5(5): Cd009000.
- Sinha, R.K., Dua, R., Bijalwan, V., Rohatgi, S., Kumar, P. (2018). Determinants of stunting, wasting, and underweight in five high-burden pockets of four Indian states. *Indian Journal of Community Medicine* 43(4): 279–283.
- Sunny, R., Elamana, J., Olickal, J.J. (2021). Determinants of nutritional status among under-five children in the tribal population of the Nilgiris, Southern India: A cross-sectional study. *Indian Journal of Community Medicine* 46(3): 554–558.
- Surve, S., Kulkarni, R., Patil, S., Sankhe, L. (2022). Impact of intervention on nutritional status of under-fives in tribal blocks of Palghar District in Maharashtra, India. *Indian Journal of Public Health* 66(2): 159–165.
- Tayade, D., Public Health Department. (2022). *Order of Director Health Services*. In Director Health Services GoM (Ed.). Director Health Services, Government of Maharashtra, p. 151, 64.
- Verma, A., Sharma, R.K., Saha, K.B. (2021). Diversity in child mortality and life expectancy at birth among major tribes in selected states of India. *Indian Pediatrics* 58(1): 20–24.
- Vyas, P. (2022). ACS, TDD, *Government of Maharashtra. Affidavit of Additional Chief Secretary in reply to PIL 133 of 2007*. In Tribal Development Department GoM (Ed.). In the High Court of Judicature of Bombay 16.12.2022.
- World Health Organization. (2022). Child mortality (under 5 years). World Health Organization.
- Yadav, S.S., Yadav, S.T., Mishra, P., Mittal, A., Kumar, R., Singh, J. (2016). An epidemiological study of malnutrition among under five children of rural and urban Haryana. *Journal of Clinical and Diagnostic Research* 10(2) :Lc07–10.