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Research Article

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

Ashish Satav*, Vibhawari Dani, Jayashri Pendharkar, Dipty Jain and Kavita Satav

MAHAN Trust, Mahatma Gandhi Tribal Hospital, Karmgram, Utavali, Tahsil, Dharni, Amaravati, Maharashtra, India

More Information

***Address for Correspondence:**
Dr. Ashish Satav, MD, MAHAN Trust, Mahatma Gandhi Tribal Hospital, Karmgram, Utavali, Tahsil, Dharni, Amaravati, Maharashtra, India, Email: drashish@mahantrust.org

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Abstract

Background/Introduction: WHO recommended 'ready to use therapeutic food' (RUTF) for community-based management (CMAM) of severely malnourished children (SMC). This is often rejected by children. The objective is to identify and map the locally produced and socio-culturally acceptable food items to treat SMC.

Methods: Through community participation, eight varieties of MAHAN Local therapeutic foods (LTFs) were prepared by tribal females at our center as per WHO norms with a shelf life of 4 weeks. LTFs with micronutrients were given at the feeding centers in the villages under supervision 3 - 4 times a day.

Results: Multiple, palatable, culturally acceptable, safe, feasible with local womanpower, and cost-effective recipes were developed. Hence, our LTFs are qualitatively superior to other therapeutic foods. This mapping exercise provides a ready reference to other government or non-government organizations for CMAM.

Conclusion: MAHAN-LTF is a multiple, palatable, generalizable, and sustainable therapeutic food and are being used in other tribal blocks of India.

Abbreviations

WHO: World Health Organization; RUTF: Ready to Use Therapeutic Food; CMAM: Community-based Management Of Severe Malnutrition; SAM: Severe Acute Malnutrition; POSHAN: Prime minister's Overarching Scheme for Holistic Nutrition; L-RUTFs: Local Ready-to-Use Therapeutic Food; RUTF-C: Commercial RUTF; RUTF-L: Local RUTF; A-HPE: Augmented Energy-dense Home-Prepared foods; Kcal: kilocalorie; MNT: Medical Nutrition Therapy; LTF: Local Therapeutic Food; SNT: Standard Nutrition Therapy; ARF: Amylase-Rich Food; MAHAN: Meditation, Addiction, Health, AIDS, Nutrition; SUW: Severely Underweight; ICMR: Indian Council of Medical Research; NIN: National Institute of Nutrition

Introduction

World Health Organization (WHO) has recommended Ready to Use Therapeutic Food (RUTF) for Community based management of severe malnutrition (CMAM) [1]. RUTF is an energy-dense lipid-based micronutrient enhanced pastes for therapy of severely malnourished children (SMC). Each 100 gm sachet of RUTF contains 15 gms of proteins and 500 calories along with micronutrients. This pasty RUTF is used as a complete food providing 46 gms - 6 gms of proteins /kg/day and 200 calories/kg/day with gradual escalation to an SMC

for a period of 12 weeks - 16 weeks. RUTF is sterile and has a long shelf life [2].

However, this RUTF is not palatable and not socio-culturally perceived as food by parents. This is the only dish and there is no variety of tastes or types of food. Hence, it is not accepted by the child as the sole food, to be consumed four times a day for 12 - 16 weeks for therapy of SAM. Therefore, we felt a strong need to have therapeutic food with WHO formulation of proteins, calories, micronutrients, etc. This should be from local produce, socio-culturally acceptable, palatable to a variety of tastes, and in the form of different recipes. Thus, after a search in Google scholar, PubMed, NIN publication of ICMR, and thorough discussion with local people and mothers, several food items in the form of snacks and hot meals liked by children were prepared by local tribal women. Children were fed 3 - 4 times a day under direct supervision. These recipes continued to be perceived as food, which could be home-cooked even after the study period is over as it is well accepted by the mothers and the community.

Information was collected about the studies of RUTF, L-RUTFs/Local Therapeutic Foods (LTFs) given to severely malnourished children (SMC) and associated outcomes by inserting the keywords. We have shortlisted the relevant studies. In the Malawian study [3], peanut butter-based RUTF which is an energy-dense, lipid paste made of 25% peanut butter, 28% sugar, 30% full-cream milk, 15% vegetable oil and 1.4% CMV Nutriset (vitamin and mineral supplement). For the standard therapy, SAM children were provided with micronutrient fortified maize and soya flour which are their local staple foods of daily consumption. Children of the standard group were treated at home with these fortified flours. They observed higher rates of recovery with lowered relapse with this LTF.

In another study done by Bhandari [4], a comparison of commercial RUTF (RUTF-C), Local RUTF (RUTF-L) and micronutrient-enriched augmented home-prepared energy-dense food (A-HPE)- was done in SAM children. RUTF-C was WHO confirmed commercial RUTF, whereas, RUTF-L was prepared by the study group under stringent hygienic conditions. Contents of both RUTF-C and RUTF-L were the same. Both are comprised of peanut paste, sugar, milk solids, vegetable oil, mineral mix and vitamin mix. The energy value of RUTF-C and RUTF-L were 543 and 528 kcal/100g respectively. Micronutrient-rich A-HPE was given to the comparison group. It contains, raw, uncooked ration like local cereals and pulses, sugar, eggs, milk and oil. Energy-rich and minerals-rich foods were prepared with these ingredients and it was made micronutrient rich by adding a prescribed daily dose of vitamins and minerals-rich preparation to the cooked meal just before its consumption. They got better recovery with RUTF-L.

Jadhav [5] in an urban-based population (Dharavi, Mumbai, Maharashtra) compared two groups. One group received medical nutrition therapy (MNT), containing indigenous Ready-to-use Therapeutic Food(RUTF-1with MNT), which contains 25% peanut butter, 28% powdered sugar, 24% skimmed milk, 21% soya bean oil and 1.6% micronutrients with 0.4% emulsifier providing 540 kcal and 16 gms proteins. The second group received Standard Nutrition Therapy (SNT) containing milk with blended oil and sugar, rice, green-gram porridge with vegetables, jaggery and oil, banana, and boiled eggs that provided 100 kcal with 3 gms proteins, for eight weeks and followed up for next four months. Children with RUTF-1 i.e., MNT recovered better than standard nutritional therapy with SNT.

Nandurbar's study [6] has shown that commercial RUTF (C-RUTF) was more efficacious than local RUTF (L-RUTF) and amylase-rich food (ARF). C-RUTF was a WHO-recommended commercial RUTF. L-RUTF is locally produced with similar ingredients as C-RUTF. ARF is prepared in porridge form with powdered, sprouted, dried green grams and wheat. ARF is the feed available at the Anganwadi center under Government schemes. The study showed better results with C-RUTF, however complicated SAM was not included.

We hypothesized that an SMC with poor appetite, would not be able to eat the same food with the same taste, 3 - 4 times a day for 12 weeks to 16 weeks, which too culturally not acceptable. Hence, there was a need for locally prepared, culturally acceptable, cost-effective, therapeutic food with a variety of palatable recipes as per WHO-UNICEF norms which should be perceived as own food by the community for the management of severe malnutrition.

Methodology

Hypothesis

Objectives were to identify and map the locally produced, palatable, replicable and sustainable food items that can be used to treat the SAM and SUW children.

Recruitment methods

Local trained semiliterate tribal female village health workers (VHWs) recruited study participants from the community (39 tribal villages) in which they lived. VHWs screened all under 5 children present in the village over the period of 10 years by door-to-door survey and conducted anthropometry. By using the WHO scale, the severely malnourished children (SMC), both SAM and SUW were identified by the VHW and confirmed by trained medical/ behavior change communication/data collection supervisors. VHWs recruited all SMCs whose parents gave written consent to the study.

Study timeline

1. Microplanning: April 2011.
2. Hypothesis testing: May 2011.

3. Staff recruitment, cases recruitment, training, and Pilot study: June 2011 to December 2011.

4. Full implementation of the project:

a) Phase 1: January 2012 to December 2015.

A. Development of MAHAN LTF recipes: Focus group discussion.

A pilot focus group discussion of 14 community-based tribal women was conducted for food grains and dietary surveys. The instrument for the focus group discussion was developed after a meeting with experts including a nutritionist, social scientist, pediatrician, local physician with experience of more than fifteen years in the field, and a local tribal person. Focus group discussions were conducted in ten representative villages of Melghat. The results obtained from focus group discussions regarding locally consumed food grains, socio-cultural ways of cooking and dietary patterns of children were compile

B. Selection of appropriate food items: The following steps were followed:

Step I – We made a list of food items consumed and socio-culturally accepted by society. A chart was made wherein locally available food items like, cereals, millet, pulses and milk with their respective caloric protein, fats, micronutrients, and vitamins per 100 gms was calculated.

Step II – Various therapeutic recipes were prepared based on findings of focus group discussions. Some of them were snacks and some were in the meal form. Each recipe was containing 450 - 550 calories and 13 - 17 gms of protein and 20 gms to 30 gms of fat per 100 gms and few micronutrients. The nutritional contents were analyzed from an independent nutritional laboratory. The shelf life was tested in our base center at MAHAN.

Step III - In our base center at Melghat, a hall was designated and 8 - 10 tribal women and a tribal supervisor were trained for the preparation of food items. Strict vigilance was kept for hygiene. Daily hand washing with soap before food preparation, weekly nail cutting, continuous face mask and the head cover was maintained strictly. Pre-requisite for making LTFs:

1. Dry roast groundnuts and separate the skin

2. Dry roast til (sesame).

Dry roast puffed Bengal gram after removing the skin. (daaliya). Details of Local therapeutic food prepared at our center are:

There were eight types of LTFs prepared hygienically while maintaining the WHO-specified guidelines. Each 100 gm. packets of LTFs contain 13 - 17 gms of protein, 450 - 550 Calories, and 20 - 30 gm. of fat. It is mandatory to give 5 gm. of MAHAN vitamin mix along with each 100 gms LTFs. Figure 1 shows the preparation of LTFs at our center and Table 1 shows the ingredients of MAHAN vitamin mix powder.

Following are the LTFs prepared by us (Table 2):

A. Ready to consume LTF for 24 months - 59 months age group

B. Powdered ready-to-use snacks for 6 months to 24 months age group

LTF to be cooked for 6 months - 59 months age group

Step IV - Testing the hypothesis: Next step was to check the palatability and acceptance by the children from the 6 months - 59 months age group and their mothers. A feasibility trial of ten food items was done First the investigators consumed the food items and later fed them to 10 - 15 normal children on MAHAN base hospital campus. Items refused by them were not included in the study. Further, the LTF was administered to 10 severely malnourished children in the community. The acceptance rate of LTF was 95%.

Figure 1: Preparation of LTFs at Melghat tribal center.

Table 1: Ingredients and nutritional information of MAHAN Vit-mix powder given as micronutrient supplements along with MAHAN LTFs.

Nutritional information	
Per 5 g provides approx.	
Calcium 350 mg	D-Panthenol 3 mg
Phosphorus 181 mg	Vitamin A 1 mg
Magnesium 80 mg	Vitamin D3 800 IU
Potassium 50 mg	Vitamin E 20 mg
Zinc 11 mg	Vitamin K3 25 mcg
Iron 9 mg	Vitamin B1 0.5 mg
Copper 1.4 mg	Vitamin B2 1.5 mg
Iodine 100 mcg	Vitamin B6 0.6 mg
Selenium 20 mcg	Vitamin B12 1.6 mcg
Nicotinamide 5 mg	Vitamin C 50 mg
	Folic Acid 200 mcg
	Biotin 60 mcg

Table 2: Types of MAHAN LTFs, its composition and macronutrients.

1	2	3	4	5	6	7	8
Sr. No.	LTF	Ingredients	Amount Gram	Protein Gram	Oil Gram	Energy Calories	Remarks
WHO RUTF			**100**	**13-16**	**26-36**	**520-550**	**Ready to use pack**
A. Ready to consume LTF (24-59 months):							
A.1	Sesame jaggery groundnut daaliya chikki	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	
		Total	100	14.02	32.335	531	
A.2	Chiwada	Groundnut	30	7.59	11.94	170.1	Ready to eat
		Daliya	30	6.75	1.56	110.7	
		Pohe	10	0.66	0.12	34.6	
		Murmure	10	0.7035	0.01	32.5	
		Soya oil	20	0	18.76	180	
		Total	100	14.02	32.335	531	
A.3	Jaggery groundnut Chikki	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	14.06	31.93	535.9	
B. Powdered ready-to-use snacks for 6-months to 24-month age group SMC							
B.1	Groundnut jaggery powder	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	
B.2	Pohe daaliya powder	Pohe	20	1.98	0.03	97.5	Ready to eat
		Daaliya	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 home of VHW (for children of 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	

Step V - Testing the hypothesis: All LTF were given to > 1500severely malnourished children (SAM and SUW) in the community at the feeding center under direct observation of village health workers (VHW). Children came to the feeding center 3 - 4 times a day at the specified time. No LTF was given to the mother at home, to ensure that the LTF was given to the target child only. The LTF meal and snacks were given as per Table 2. The acceptance rate of LTF was > 95%.

Children were allowed to choose LTF of their own choice and they could eat the same LTF in multiple time frames. Shelf life is a key consideration for the logistical feasibility of providing food for the management of SMC at the community level. The shelf life of each of our LTFs was a minimum of four weeks. Each100 gm LTF was weighed and packed in polythene bags and double sealed.

Step VI - Micronutrients: Average micronutrient from each LTF was calculated and deficit micronutrients as compared to the WHO directive were calculated. With each 100 gm of LTF, 5 gm of special pharmaceutically prepared micronutrient (MAHAN vit-min mix) was given to make it similar to the WHO formula. The micronutrient Chart providing ingredients and nutritional information is given in Table 1.

Step VII- Supply chain: The weekly supply of all varieties of LTF was maintained with VHW according to the number of SMC in the village. No packet was used after the expiry date. All LTF preparations were dry preparations and desiccated.

For preparation that needed cooking; instructions were printed on each packet

Contamination

Contamination was prevented by checking and cleaning all raw materials. All grains were roasted. Every LTF was hygienically prepared. Sterile gown, cap, nail cutting, hand washing, no shoes inside the room, mopping and cleaning of platform and floor with disinfectant cleaner and phenyl was done daily.

Storage

The raw material and ready-to-use packets were stored in drums with an airtight lid and were properly labeled.

Results

Out of the 10 food items prepared as LTF, 8 items were accepted easily by the SMC. Five to ten percent of SMC refused to accept 2 varieties of LTF which were also difficult to feed. Hence, we removed those 2 items from our LTF list. The acceptance rate of the remaining 8 items was > 95% by the SMC. Hence, we continued to use these 8 varieties of LTF for 10 years.

For younger children (6-months to 24-month age group), two powdered ready-to-use LTFs and two cooked soft LTFs were prepared.

The dietary analysis of the developed foods is attached to Table 3. All of the LTF dishes contained 13.5 to 15.9 grams of protein, 484 to 552 calories, and 27.71 to 34 grams of fats per 100 grams of LTF. The average micronutrients in the 100 grams of LTF are 76.56 mg of calcium, 216.81 mg of phosphorus, 3.99 mg of iron, 33.75 mg of carotene, 0.36 mg of thiamine, 0.177 mg of riboflavin, 7.218 mg of niacin, 39.043 micrograms of folate, 43.6 mg of magnesium, 28.281 mg of sodium, 192.75 mg of potassium, 0.525 mg of copper, 1.958 mg of zinc, 4.702 grams of omega 6 fatty acids and 0.255 grams of omega 3 fatty acids.

Using the MAHAN LTF, a longitudinal two-intervention group study: (a) MAHAN LTF, (b) control, was implemented in SMC in tribal Melghat. The recovery rate of SAM was 75.9%, 77.8% and 79.4% at the end of the 8^{th}, 10^{th} and 12^{th} week, respectively; the recovery rate for SUW was 37.5%, 42.7% and 45.4%, respectively. Case fatality rates for SAM was 0.6%, 0% , 0% and for SUW was 0.2%, 0%, 0% after 8^{th}, 10^{th} and 12^{th} weeks respectively. There is a significant reduction in the prevalence of SAM (p – 0.005) and SUW (p – 0.0001) in children at the end of the study done from 2012 to 2015.

Defaulter rate of SAM children is 6.7%, 0.6%, and 0%, and for SUW children, it is 5.5%, 1.2% and 0.7% at the end of 8^{th}, 9^{th} to 10^{th} and 11^{th} to 12^{th} weeks, respectively.

Discussion

For the care and recovery of SAM children, the government of India has provided various platforms and started schemes at different levels and at different scales. The government's POSHAN (Prime Minister's Overarching Scheme for Holistic Nutrition) Abhiyan or National Nutrition Mission is a new flagship program dedicated to reducing under-nutrition cases of all types (started on 8 March 2018). The government of India is providing recommended RUTF for the community-based management of SAM children without complication. However, due to the lack of consensus on supplements specifically articulated for children, there is still a requirement for alternative RUTFs at the local level for use in community-based management of acute malnutrition (CMAM) programs. Various organizations and state governments are exploring and implementing local, nutrient-dense, and energy-rich food items at the community level to manage SAM children in India.

Treatment of uncomplicated severe malnutrition requires feeding the children not only with the appropriate energy-dense food but also requires macro and micronutrient-rich supplements to be given under vigilance [7]. Every food item provided to treat SMC does not meet the micronutrient and macronutrient requirements. Therefore, food items are either fortified with micronutrients or appropriate micronutrients are mixed along with energy-dense macronutrient foods. This would provide the required amount for the recovery of undernourished children.

For the treatment of uncomplicated SAM, WHO has prescribed RUTFs which are commercially available in the market in sachet in the paste form. Although it provides energy-dense food supplements along with macro and micronutrients yet it is not perceived and accepted as a food item by the children [8]. RUTF used in various studies is WHO-based RUTF (peanut butter) or locally prepared L-RUTF (whole milk powder 30%; sugar 28%; vegetable oil 15.4%; peanut paste 25%; and mineral vitamin mix 1.6%), which is not socio-culturally accepted as a food by severely malnourished children or their parents in the community. The monotony of the taste prevents it from being consumed by the children as the sole food for 12-16 weeks. The supply chain in most parts is irregular which is affecting the therapy and outcome. Owing to the rejection of these RUTFs at community levels, various trials have surfaced to rectify the situation [9] and also had less recovery rate, more default rate, and more CFR as compared to our study. LTFs were tried in different studies. A publication by NIN, Hyderabad (2019), 'Mapping Foods for Community Based Management of Children with Severe Acute Malnutrition in India', states that in India there are 42 such therapeutic foods [10] that have been studied and reported. However, none of the food items met the WHO standards in providing all the necessary nutrients (macro and micronutrients). At the energy density level, the criteria may be fulfilled. However, the fulfillment of micronutrients has not met the demand yet. Some products like modified Balamrutham [11] have come close to providing the necessary micro and macro nutrients as per WHO standards.

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Table 3: MAHAN LTF dietary analysis.

S. No.	LTF	Quantity	Proteins	Fats	Energy	Calcium	Phos-phorus	Iron	Carotene	Thia-mine	Ribo-flavin	Niacin	Folate	Magne-sium	Sodium	Pota-ssium	Copper	Zinc	n-6 FA	n-3 FA	Vit. C	Panto. Acid	Biotin	Vit D	Vit E	Vit K	Sele-nium	Iodine	Vit. B6	Vit B12
		gms.	gms.	gms.	Calories	mg	mg	mg	mg	mg	mg	mg	ug	mg	mg	mg	mg	mg	gms	gms	mg	mg	ug	ug	mg	ug	ug	ug	mg	ug
1	Chikki	100	14.02	32.335	531	203.6	240	5.31	39.7	0.383	0.073	6.67	41.2	26	14.64	144	0.767	2.73	4.72	0.205	0								0	0
2	Chiwada	100	15.7035	32.39	527.9	48.7	245.8	6.26	45	0.372	0.396	7.17	41.7	59.2	24.14	246.8	0.478	1.68	4.4	0.24	0								0	0
3	Sago-Gr. Nut Powder	100	13.99	31.96	524.65	53	192.5	1.51	20.35	0.495	0.072	10.945	0	0	0	0	0.495	2.145	6.2	0.2	0								0	0
4	Til Gul Gr. Nut Daaliya Powder	100	14.02	27.71	552.6	207.6	242	4.37	39.7	0.252	0.073	6.67	41.2	26	15.73	144	0.767	2.73	4.37	0.25	0								0	0
5	Thalipeeth/ Upamaa	100	15.91	34	531.5	48.8	248.7	2.91	59.2	0.482	0.119	7.31	48.25	73.2	22.106	242.2	0.764	2	5.45	0.3	0.03								0	0
6	Gulpatti	100	14.06	31.93	535.9	73	189	2.17	18.5	0.45	0.065	9.95	0	0	0	0	0.45	1.85	6.05	0.235	0								0	0
7	Pohe Daaliya Gr. nut Powder	100	14.07	33.01	521.4	40	243.9	5.01	37.5	0.348	0.0475	5.7	34.75	62.8	21.57	226.2	0.671	1.4	3.9	0.23	0								0	0
8	Mung Khichadi	100	13.435	28.56	484.2	39.75	173	2.435	20.25	0.243	0.1625	5.54	69.9	57.8	1.89	287.5	0.3285	1.83	4.05	0.319	0	0	0	0	0	0	0	0	0	0
Average nutrition of 100 gms of LTF.			14.435	31.521	529.96	76.56	216.81	3.99	33.75	0.36	0.177	7.218	39.043	43.6	28.281	192.75	0.525	1.958	4.702	0.255	0	0	0	0	0	0	0	0	0	**0**

This product is energy dense as it provides 460 Kcal and 11 gm protein per 100 gm. Moreover, this product contains improved calcium, niacin and folic acid content. With some augmentation and adjustments, they may be brought closer to the WHO standards.

Undernutrition is caused by deficiencies of Type I and Type II nutrients. RUTFs made as per WHO guidelines are used to overcome severe malnutrition. Different studies with industrial and locally made RUTFs are conducted to treat severe malnutrition in children.

A study was done in Maharashtra [6] with three arms of three therapeutic feeds i.e., commercially available ready-to-use therapeutic feed (C-RUTF), locally prepared ready to use therapeutic feed (L-RUTF) & amylase rich food (ARF). In this study, C-RUTF was found to be more efficacious when compared to L-RUTF & ARF. However, based on our field study in the tribal block, C-RUTF may not be accepted by children as a sole food for a longer period of time hence, could be rejected and discarded. In our study, children were eager and inclined to come to the center to be fed with a variety of LTF.

In the Malawian study [3], locally produced energy-dense lipid paste (RUTF) has been prepared. Typically, children ate the RUTF directly from the jar, without diluting it or mixing it with other foods. In MAHAN LTF, there are eight types of LTFs fed to SMC, 3 - 4 times a day, so that their interest in eating and finishing the therapeutic foods was enhanced and maintained.

Bhandari N, et al. [4] have compared Local RUTF, RUTF-C (Centrally produced) with micronutrient (A-HPE) energy dense home-based formulation in SAM children. This is a community-based interventional study done at home wherein the food was distributed and it is not given under direct supervision. However, in our study, all the LTFs were given timely under direct supervision.

Jadhav AL, et al. [5] in an urban-based population have compared indigenous RUTF-1 prepared at their manufacturing unit with LUTF. This study was conducted on SAM children and concluded that with RUTF-1, children gained weight faster than with LUTF.

Local foods were also tried in making RUTFs like NumTrey [12] which is a fish-based RUTF developed for SAM children in Cambodia. It is comprised of rice, soybean, moong bean, canola oil, and small indigenous fish. It was given as a two-week takeaway ration to the caretaker at home and results were analyzed at the end of 8 weeks. It was not found to be effective. On the contrary, in our study, children were directly fed LTF as a sole food under observation at our feeding center, 3 - 4 times a day for 12 weeks, with results better than WHO and international Sphere standards.

In an open-labeled randomized control trial, locally prepared RUTF-Mushpro health drink powder was studied in 30 SAM children [13]. Mushpro is a mushroom-based drink with wheat flour, skimmed milk, and cocoa powder, which was given 3 gm/kg twice a day i.e., 1.6 g proteins per kg/day for SAM children along with regular home-based meal and one meal from State Government ICDS program for 60 days. The mean weight gain in SAM was 1.36 gm/kg/day, and in the control group, it was 0.28 g/kg/day. The recovery rate of SAM children was not given. Although this may prevent malnutrition in children; however, it is not appropriate therapeutic food for the treatment of SMC in the community. This is not a sole food but is given as a supplementary therapeutic product. Our LTFs are as per WHO guidelines.

The therapeutic effect of 10 g of Spiruline (which contains a high amount of iron, amino acids, and carotenoids) and 200 gms Misola (mixture of 60% millet, 20% soya, 10% peanut, 9% sugar, and 1% salt) [14] in children of Burkina Faso in 2003, given in four divided dosages irrespective of age group to 170 severely malnourished children in the form of take away ration for eight weeks. At the end of eight weeks 63% SAM recovered and 38% SUW recovered. Micronutrients were given at the end of the studies.

A Hyderabad-based hospital study [15] showed that 250 grams of khichdi (rice and daal), banana, 1 or 2 slices of bread, and 350 ml milk with oil provide 170 to 200 kcal/kg/day and 3-4 grams of protein/kg/day to a 7 kg SAM child. Micronutrients were also given. At the end of 5 weeks of hospital stay, 60% of SAM recovered. Even a hospital-based study did not give 4-6 grams of proteins per day and the five weeks' duration of the therapy was also not enough.

A study by Etienne Nel has shown that partial soybean, sorghum flour, and whey protein replacement RUTF were inferior to standard RUTF. In contrast, soy-based RUTF was as effective as milk-based RUTF and an alternative RUTF with added oats lead to superior recovery in comparison to standard RUTF [16]. Our study has shown that LTFs have equally good results as per international sphere standards and RUTF.

The major shortcomings associated with these studies are that these locally produced RUTFs were made only in one form of the food item. A single recipe was given as a sole food or partially with home food till the end of therapy. Food was not given under direct observation. In some studies, children were partially monitored till the completion of training of the staff for the RUTF/LTF preparation, or collection of emptied jars or sachets was done once a week from the house of SMC who were under therapy. The sachet or packet made as L-RUTF were in powder or paste form often considered as medicine and subsequently rejected and abandoned both by mother and children as well.

MAHAN LTFs are an appropriate source of therapeutic food that provides complete nourishment to the SMC. There are eight varieties of LTFs and SMC can choose from them as per their choice. Children often have their own selection

of food driven by individuals' respective tastes and choices. MAHAN LTFs contain both sweet and non-sweet varieties, hence catering to different tastes. As each variety carries approximately the same nutritional value hence, treatment was not affected if the child is inclined to eat only a selective variety of LTFs. All the LTFs were hygienically made local foods specifically prepared by local people who were trained under the vigilance of experts. Each ingredient's nutritional value was calculated and externally verified through laboratory analysis. All the LTFs were designed to meet the WHO guidelines for the treatment of SMC. There were three forms of LTFs viz., ready-to-use snack form, ready-to-use powdered snack form, and the third category for meal purposes that needed to be cooked freshly before consuming. Moreover, due consideration was given to different age groups. Powdered form LTFs and cooked meals LTFs are appropriate for children between 6 months to 2 years which was not done in any of the other studies. All the children were fed under direct observation 3 - 4 times a day. Mothers were also trained to make all food items at home so that even after the study time period gets over, they will continue cooking these on their own and children will be happy to consume them. This aspect was also not found in any of the studies.

The pilot CMAM program using SMS-RUTF recipe that contains no milk or peanuts achieved SPHERE minimum standards. Based on this evidence, SMS-RUTF should be encouraged for treatment of SAM in children between 6 and 59 months in routine CMAM programs in Malawi and globally [17]. Our study has shown that LTFs without milk, have equally good results as per international sphere standards and RUTF.

RUTF with lower protein from dairy or dairy-free RUTF may not be as effective as standard RUTF for treatment of children with SAM based on weight gain, recovery and WAZ evaluated using meta-analysis, although further research is required to explore the potential of alternative formulations [18]. But our study has revealed that daily free LTF is equally effective as standard RUTF.

Amino-acid-enriched milk-free plant-source-protein RUTF has the potential to restore all the EAA, but it is possible that enrichment with amino acids may require more methionine and tryptophan for edematous children [19].

Another study of MAHAN LTFs has revealed a 79.4% recovery rate of SAM with a 0.6% case fatality rate(CFR) after 12 weeks of therapy [20]. This result is better than the International Sphere Standards in the form of less CFR, default rate and relapse rate.

Conclusion

Our study at Melghat Tribal center is community-based management of severe malnutrition with local therapeutic foods that we have specifically formulated as per WHO norms which proved to be a key treatment strategy. LTFs were prepared with definite composition and formulation and nutrient density, anti-nutritional factor, and direction of the use of food from the available source are well specified on each packet. This mapping exercise and LTFs could provide a ready reference to other government or non-government organizations for the treatment of SMC at the community level. MAHAN-LTFs are multiple, palatable, culturally acceptable, safe, feasible with local womanpower, cost-effective, efficacy proven and easily replicable recipes. These factors make our LTFs better than other studies. It has also generated employment for tribal females.

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