Appetite 168 (2022) 105751

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Availability, use, and consumption practices of ready-to-use therapeutic foods prescribed to children with uncomplicated severe acute malnutrition aged 6–59 months during outpatient treatment in Burkina Faso

Victor Nikièma [a,b,*], Nadia F. Fogny [b], Suvi T. Kangas [c], Carl Lachat [d], Cécile Salpéteur [c]

[a] Nutrition and Health Department, Action Contre la Faim, mission in Burkina Faso, France
[b] School of Nutrition and Food Sciences and Technologies, Faculty of Agronomic Sciences, University of Abomey-Calavi, Benin
[c] Expertise and Advocacy Department, Action contre la Faim, Paris, France
[d] Department of Food Technology, Safety and Health, Faculty of Bioscience Engineering, Ghent University, Belgium

ARTICLE INFO

Keywords:
Severe acute malnourished children
Ready-to-Use-Therapeutic-Foods co
Availability
Consumption
Perceptions
Randomized clinical trial
Burkina Faso

ABSTRACT

Ready-to-use-therapeutic-foods (RUTF) was designed for the nutritional management of children with uncomplicated severe acute malnutrition (SAM) treated as outpatients. However, to our knowledge, no study has evaluated the availability, use and consumption of RUTF within the beneficiary household in programs and in the context of a reduction in the dose of RUTF.

This study, assessed the effect of a reduction in RUTF dose on the availability, use, consumption, and perceptions of caregivers on RUTF prescribed to 516 children treated for SAM, aged 6–59 months in Burkina Faso.

Children received a weekly dose of RUTF according to their treatment arm until recovery. Data were collected by structured individual in-depth interviews, with caregivers one month and two months post-admission. Differences between children receiving reduced RUTF (intervention arm) and those receiving standard RUTF (control arm) were assessed by Poisson, logistic, and ordered logistic regression model.

RUTF was available for the whole week in 95% in intervention arm compared to about 98% in control arm ($p > 0.05$). Starting from week 3 onwards, children in intervention arm consumed an average of 9 sachets of RUTF per week compared to 15 sachets in control arm ($p < 0.001$) and 5% of children in intervention arm reported leftover compared to 11% in control arm ($p < 0.05$). About 40% of children in intervention arm consumed RUTF at least 3-times per day compared to 82% in control arm ($p < 0.001$). The amount of RUTF prescribed was perceived as sufficient in 93% by caregivers in intervention arm against 97% in control arm ($p > 0.05$).

In conclusion, reducing the dose of RUTF did not affect the availability of RUTF during treatment but did reduce leftover and the frequency of consumption of RUTF.

1. Introduction

In children 6–59 months of age, severe acute malnutrition (SAM) is defined as having a mid-upper 3 arm circumference (MUAC) <115 mm or weight-for-height/length (WHZ) z-score <–3 or presence of bilateral edema (WHO, 2013). Health interventions related to the management of SAM were initially implemented in hospital care and especially in emergency situations with therapeutic milks F75 & F100 (WHO, 1999). However, treatment in the hospital presents several problems such as a high risk of diseases linked to cross-infection, a high cost for families and the health system and the need for qualified health professionals (Collins, 2007).

The development of ready-to-use therapeutic food (RUTF) in mid-90s enabled a radically new approach to treating SAM within a community-based management of acute malnutrition (CMAM) framework (Briend et al., 1999). Since 2007, children with SAM without medical complications at admission are recommended to be treated as outpatients with RUTF in the community and return to health centers

Abbreviations: FAO, Food and Agricultural Organization; HAZ, height-for-age z-score; HFIAS, Household Food Insecurity Access Scale; MUAC, Mid-Upper Arm Circumference; RUTF, Ready-to-Use-Therapeutic-Foods; SAM, Severe Acute Malnutrition; UNICEF, United Nations Children's Fund; WAZ, Weight-for-Age z-score; WFP, World Food Program; WHO, World Health Organization; WHZ, Weight-for-Height z-score.

* Corresponding author. Nutrition and Health Department, Action Contre la Faim, mission in Burkina Faso, France.
E-mail address: nikiema.victor@yahoo.fr (V. Nikièma).

https://doi.org/10.1016/j.appet.2021.105751
Received 17 May 2021; Received in revised form 25 September 2021; Accepted 9 October 2021
Available online 11 October 2021

once a week for treatment (WHO UNICEF&WFP, 2007). RUTF is made from peanut butter, milk powder, oil, sugar, and a vitamin and mineral supplement, packed in 92 g individual sachets providing 500 kcal and has similar nutritional profile as F100 therapeutic milk. RUTF can be eaten directly from the packaging at home, even where hygienic conditions are poor (Briend et al., 1999; WHO UNICEF&WFP, 2007). The standard dose of RUTF is defined according to the weight of child under treatment (UNICEF, 2013).

Several previous studies and systematic review have shown the efficacy of RUTF in the treatment of children with SAM (Schoonees et al., 2019), the acceptability of RUTF by patients (Brown et al., 2015; Cames et al., 2017; Nga et al., 2013) and described RUTF sharing practices and perceptions (Tadesse et al., 2015). The success of SAM treatment at community level with RUTF could depend on the availability, use and consumption practices of RUTF within the household, and perception of caregivers on the quantity of RUTF received. However, to our knowledge, no study has evaluated the availability, the use and consumption of RUTF in programs and in the context of a reduction in the dose of RUTF.

This study is part of the Modelling an Alternative Nutrition Protocol Generalizable to Outpatient care (MANGO) individually randomized trial, testing the non-inferiority of a reduced RUTF dose compared to a standard dose in the management of children with uncomplicated SAM 6–59 months of age (SAM children 6–59 months without any medical complication). The trial showed that a reduced RUTF dose is non-inferior to standard RUTF dose in terms of weight gain velocity and results in similar recovery rates (Kangas et al., 2019). However, the energy and nutrient intake from RUTF were higher in standard RUTF (Nikièma, Kangas, et al., 2021) which suggests that the reduction in RUTF dose could affect RUTF availability during treatment. The present sub-study is essentially exploratory and aimed to assess the effect of a reduction in RUTF dose on the availability, consumption of RUTF by children, and perceptions of caregivers on RUTF prescribed to children treated for SAM, aged 6–59 months, in the health district of Fada N'Gourma.

2. Methods

2.1. Sub-study design

The present sub-study was a longitudinal study nested within the main trial MANGO (Kangas et al., 2019). It was not subject to the non-inferiority principle.

2.2. The MANGO original study

The MANGO study design has been described in detail elsewhere (Kangas et al., 2019; Nikièma, Kangas, et al., 2021). The study was conducted in 10 health centers in East Burkina Faso, from December 2016 to August 2018.

Before enrolment, all parents of eligible SAM children received information on the trial objectives and processes, and the possibility to withdraw at any time, and provided written consent to participate into the trial. SAM treatment followed the Burkina national CMAM guidelines (Ministèrede la santé, 2014) except for the RUTF dose: from the third treatment week onwards, 402 children were randomized to the intervention arm and received either 1 or 2 sachets per day if they weighed <7 kg or ≥7 kg respectively (Table 1) (Kangas et al., 2019).

At enrollment, data were collected about the sociodemographic characteristics, anthropometry, 2-week retrospective morbidity of the child, and a clinical examination was performed. The household food insecurity access scale (HFIAS) was also assessed (Coates et al., 2007). As per the national SAM treatment protocol, all caregivers of the two arms were advised weekly not to sell or share the RUTF dose. They were also encouraged to give complementary and family foods to the children if they were still hungry after having consumed the RUTF and to breastfeed at all times on demand.

Table 1
Number of RUTF sachets[a] per week in reduced and standard dose groups in MANGO trial.

Weight (kg)	Sachets/week			Reduction of RUTF dose (%)
	Standard RUTF dose	Reduced RUTF dose		
	Admission to discharge	Weeks 1–2	Weeks 3 to discharge	From week 3 to discharge
3.0–3.4	8	8	7	13
3.5–4.9	10	10	7	30
5.0–6.9	15	15	7	53
7.0–9.9	20	20	14	30
10.0–14.9	30	30	14	53

RUTF, ready-to-use therapeutic foods.
[a] from (Kangas et al., 2019a).

2.3. Sampling of sub-study

Sample size and sampling were previously described (Nikièma, Kangas, et al., 2021). In brief, 516 children (66% of MANGO main study sample), including 243 in the reduced RUTF and 273 in the standard RUTF dose, were included in the sub-study.

2.4. Data collection

Data were collected in a longitudinal study, by structured individual in-depth interviews with caregivers one month (at week 4) and 2 months (at week 8) after the start of treatment. Additional data were collected at week 6 of treatment. At weeks 4 and 8, caregivers were asked about their perception of whether the amount of RUTF prescribed for the child's treatment was sufficient or not, availability of RUTF throughout the week and consumption of RUTF by the child. Variables of RUTF's consumption that were assessed were the total amount of RUTF consumed during the week, the amount of RUTF remaining at the end of the week, the frequency of RUTF daily's consumption, and the children's appreciation of RUTF. Additionally, a questionnaire related to the use of RUTF within the household, including sharing and knowledge about the RUTF, forms of consumption, side effects following the consumption of RUTF during the week, practices of conservation and access to RUTF by other members of the household were administered at week 6 of treatment. The data was directly collected on tablets using the Open Data Kit application.

2.5. Data management

The prescription of RUTF-based treatment was weekly. The prescribed RUTF is defined as the number of RUTF sachets (92 g per sachets) given to the caregiver for the weekly care of the child according to the child's weight and their randomization group. RUTF consumed is defined as the number of RUTF sachets consumed by the child during the whole week of treatment according to caregiver's declarations and returned in empty sachets. The total quantity of RUTF prescribed corresponded to the number of RUTF sachets received by the caregiver for the treatment of their child during the entire stay according to the weight of the child and the randomization. The total quantity of RUTF consumed is defined as being the number of RUTF sachets consumed by the child throughout his/her stay according to the weekly declarations of the caregiver.

The availability of RUTF was declared using 3 response categories each week: week with leftover; week without leftover; finished before next visit. "Week with leftover" means RUTF covered the whole week and there were still full sachets of RUTF remaining at the next visit. "Week without leftover" is defined as RUTF having covered the whole

week until the day of the next visit but without leftover of full sachets. "Finished before next visit" means that the RUTF was finished before the next treatment visit. Thus, the variable "RUTF available" combines two of the three categories and is defined by the proportion of children with RUTF covered all week: i.e. with or without leftover.

The perception of caregivers concerning the quantity of RUTF prescribed was evaluated using 3 modalities each week: More than desired; Enough; Less than desired. Thus, the variable "RUTF sufficient" combines two of the three categories and is defined by the proportion of caregivers who reported that prescribed RUTF was "enough" or "more than desired".

2.6. Data analysis

The statistical software package Stata version 15.0 (Stata Corp) was used to perform the statistical analyses. Descriptive analysis was summarized as proportion and means (±Standard Deviations: SDs) in order to present the general profile of children at baseline and at time of the recall concerning their socio-demographic, maternal, and household characteristics.

Differences between intervention and control arms were assessed using Standard Poisson regression model for RUTF weekly quantity prescribed and consumed, RUTF total prescribed and consumed during treatment, mixed logistic regression models for binomial variables (RUTF availability during week, Proportion of caregivers who perceived that "RUTF sufficient", side effect of RUTF consumption), and ordered logistic regression model for multinomial ordered variables (frequency of daily RUTF consumption, modalities of perception on RUTF quantities received, form of RUTF consumption; types of sides effects, conservation of RUTF in household, sharing of RUTF). All models used study site as random effects and were adjusted for sex, age, breastfeeding, morbidity. A significance level of 5% was used to determine statistical significance for all analyses.

2.7. Ethical considerations

As part of the MANGO main trial, this study received the approval of the Ethical Committee (Comité d'éthique pour la Recherche en Santé) in Burkina Faso in December 2015 and the clinical trials board (Direction Générale de la Pharmacie, du Médicament et des Laboratoires) in September 2016. It was registered at the ISRCTN registry http://www.isrctn.com/ISRCTN50039021.

3. Results

3.1. Children's characteristics at admission and RUTF consumption and use during the first week of severe acute malnutrition treatment

Characteristics of children did not differ between the two groups of children in terms of age, sex, morbidity, breastfeeding status at admission, and RUTF quantity prescribed and consumed during first week of treatment (Table 2). For both groups of children, the average age was 13 months at admission; just over half of the children were girls and over 87% of children were still breastfed. During first week (before reduction in RUTF dose), the RUTF prescribed for each of the 2 groups of children was 16 sachets on average per week of treatment with an average consumption of 13 and a half sachets. During the first week of treatment, RUTF was available in over 98% of children in both groups, and over three-quarters of children consumed the product at least 3 times a day. RUTF was strongly appreciated by children at over 95% in both groups. At least 95% of caregivers perceived that the amount of RUTF prescribed for treatment was sufficient (Table 2). There was no significant difference between availability, consumption and perception of caregivers on the amount of RUTF prescribed before reduction in RUTF dose.

Table 2
Children's characteristics at admission and RUTF consumption and use during the first week of severe acute malnutrition treatment.

Variables	*N*	Reduced RUTF (*n* = 219)	Standard RUTF (*n* = 240)	*P* value
Children's characteristics at admission				
Age, *months*	516	'13.2 ± 8.53	13.3 ± 8.59	0.87
Girls, *% (n)*	516	52.3 (127)	53.8 (147)	0.72
Morbidity, *% (n)*	516	48.6 (118)	52.4 (143)	0.39
Breastfeeding, *% (n)*	516	87.7 (213)	86.8 (237)	0.78
RUTF Quantity per week				
RUTF prescribed, sachets/day	516	2.27 ± 0.51	2.27 ± 0.52	0.94
RUTF consumed, sachets/day	475	1.95 ± 0.70	1.91 ± 0.75	0.60
RUTF prescribed, sachets/week	516	15.9 ± 3.57	15.9 ± 3.67	0.94
RUTF consumed, sachets/week	475	13.6 ± 4.88	13.4 ± 5.26	0.60
Consumption rate (%)	475	86.7	85.5	0.60
Perception on RUTF quantity received	463			
RUTF at least sufficient[a], *% (n)*		95.8 (203)	96.8 (243)	0.55
More than desired, *% (n)*		7.55 (16)	8.37 (21)	0.80
Enough, *% (n)*		88.2 (187)	88.4 (222)	
Less than desired, *% (n)*		4.25 (9)	3.19 (8)	
RUTF's availability during week	463			
RUTF available[b], *% (n)*		99.1 (210)	98.0 (246)	0.36
week with remains, *% (n)*	463	23.58 (50)	23.90 (60)	0.65
week without remains, *% (n)*		75.5 (160)	74.1 (186)	
Finished before visit, *% (n)*		0.94 (2)	1.99 (5)	
RUTF's frequency of consumption				
Once a day, *% (n)*	463	1.89 (4)	1.20 (3)	0.76
Twice a day, *% (n)*		22.6 (48)	21.1 (53)	
Three times or more a day, *% (n)*		75.5 (160)	77.7 (195)	
Appreciation of RUTF, n (%)				
Likes, *% (n)*	463	95.8 (203)	96.4 (242)	0.83
Neutral, *% (n)*		2.36 (5)	2.39 (6)	
Doesn't like, *% (n)*		1.89 (4)	1.20 (3)	

Data are means ± SDs (standard deviation) unless otherwise indicated; RUTF, ready-to-use therapeutic-food.
[a] RUTF at least sufficient, *% (n)* = More than desired, *% (n)*+Enough, *% (n)*.
[b] RUTF available, *% (n)* = week with remains, *% (n)*+ week without remains, *% (n)*.

3.2. Availability, consumption and perceptions of caregivers on amount of RUTF consumed by children at 4 and 8 weeks after admission into treatment

RUTF was available for the whole week in 95% households in the intervention arm compared to about 98% in control arm at weeks 4 and 8 ($p > 0.05$) (Table 3). Children in intervention arm consumed an average of 9 sachets of RUTF per week compared to 15 sachets consumed by children in control arm ($p < 0.001$).

Less than half of children in intervention arm consumed the product at least 3-times per day compared to 82% in control arm ($p < 0.001$). RUTF was strongly appreciated by children: according to mothers, approximately 85% of children in both groups liked RUTF 1 month after treatment and at least of 98% of children in both groups liked RUTF 2 months after ($p > 0.05$). During their entire stay in treatment, children in the reduced arm consumed an average of 97 sachets of RUTF out of a total of 117 sachets prescribed (82.9% of sachets consumed) and children on standard arm consumed 143 sachets of RUTF out of a total of 175 prescribed (81.7% of sachets consumed) ($p < 0.001$).

Table 3
RUTF availability, consumption and perceptions of caregivers on amount prescribed for outpatient treatment of children with SAM aged 6–59 months, receiving reduced and standard RUTF dose in Burkina Faso.

Outcomes	Week 4 (1 month after admission)				Week 8 (2 months after admission)			
	Reduced RUTF	Standard RUTF	Difference (95% CI)	*P* value	Reduced RUTF	Standard RUTF	Difference (95% CI)	*P* value
RUTF availability during week[a]								
[c]RUTF available, *% (n)*	95.5 (232)	97.4 (266)	−1.90 (−4.95, 1.15)	0.222	95.4 (124)	99.2 (132)	−3.78 (−7.85, 0.29)	0.069
Week with remains, *% (n)*	4.53 (11)	12.8 (35)			6.15 (8)	10.5 (14)		
Week without remains, *% (n)*	90.9 (221)	84.6 (231)	−6.90 (−10.9, −2.89)	0.001	89.2 (116)	88.7 (118)	−6.10 (−12.0, −0.21)	0.042
Finished before visit, *% (n)*	4.53 (11)	2.56 (7)			4.62 (6)	0.75 (1)		
RUTF Quantity per week[b]								
Prescribed, in *sachets 92g*	9.46 ± 4.01	15.9 ± 4.90	−0.52 (−0.57, −0.46)	<0.001	10.0 ± 3.49	17.6 ± 3.68	−0.56 (−0.61, −0.50)	<0.001
Consumed, in *sachets 92g*	9.19 ± 3.79	15.7 ± 5.33	−0.52 (−0.58, −0.46)	<0.001	9.3 ± 4.02	15.9 ± 5.21	−0.53 (−0.62, −0.44)	<0.001
Consumption rate, *%*	93.7	92.9	0.01 (−0.03, 0.05)	0.676	95.0	92.8	0.03 (−0.06, 0.11)	0.509
RUTF frequency of consumption[a]								
Once a day, *% (n)*	13.2 (32)	1.10 (3)			10.4 (12)	0.00 (0)		
Twice a day, *% (n)*	48.1 (117)	17.2 (47)	10.4 (6.88, 13.9)	<0.001	47.0 (54)	17.3 (22)	6.80 (2.27, 11.3)	0.003
Three times or more a day, *% (n)*	38.7 (94)	81.7 (223)			42.6 (49)	82.7 (105)		
Appreciation of RUTF[a]								
Likes, % (n)	85.2 (207)	84.6 (231)			100 (130)	97.7 (130)		
Neutral, % (n)	9.90 (24)	12.1 (33)	0.75 (−5.24, 6.74)	0.806	0.00 (0)	0.8 (1)	0.00 (−0.30, 0.30)	0.999
Doesn't like, % (n)	4.94 (12)	3.30 (9)			0.00 (0)	1.50 (2)		
Perception on RUTF prescribed[a]								
[d]RUTF at least sufficient, *% (n)*	93.8 (228)	96.3 (263)	−2.01 (−5.51, 1.49)	0.260	92.3 (120)	97.7 (130)	−5.42 (−10.90, 0.06)	0.053
More than desired, % (n)	6.17 (15)	6.59 (18)			1.54 (2)	7.52 (10)		
Enough, % (n)	87.7 (213)	89.7 (245)	−0.07 (−4.31, 4.18)	0.975	90.8 (118)	90.2 (120)	−5.20 (−9.19, −1.21)	0.011
Less than desired, % (n)	6.17 (15)	3.66 (10)			7.69 (10)	2.26 (3)		

[a] Ordered logistic regression models adjusting for sex, age, breastfeeding, morbidity.
[b] Poisson Standard regression models adjusting for sex, age, breastfeeding, morbidity.
[c] RUTF available, *n (%)* = week with remains, *n (%)* + week without remains, *n (%)*.
[d] RUTF at least sufficient = More than desired, *n (%)*+Enough, *n (%)*.

The amount of RUTF prescribed for a week was perceived as sufficient by 93% of caregivers in intervention arm compared to 97% of caregivers in control arm ($p > 0.05$) (Table 3)

3.3. Forms of consumption of RUTF and reported side effects

RUTF was mainly consumed directly from sachet by over 80% of children in both groups. About 18% of the children in each group consumed RUTF mixed with porridge primarily to increase children's acceptance of RUTF (Table 4).

Side effects from RUTF consumption were investigated only during week 6 and reported for 18% of children in intervention arm and 24% of children in control arm ($p = 0.16$). Of the reported side effects, diarrhea was the most common (60% in intervention arm versus 75% in control arm); then combined diarrhea and vomiting (28% in intervention arm versus 20% in control arm) and finally vomiting (11% in intervention arm versus 5% in control arm) (Table 4).

3.4. Sharing practices, behaviors linked to RUTF storage and use at week 6 of treatment

RUTF was consumed by 99% of the beneficiary child in both groups according to caregiver's self-report. There was rarely any sharing with other people. RUTF was kept mainly with the caregiver and very rarely with the head of the household. Sometimes in the absence of the caregiver, some other people, especially children, had access to and consumed it themselves.

Caregivers of the 2 groups of children perceived RUTF to be 75% a product used for the treatment of malnutrition and 25% for the prevention of malnutrition (Table 4).

4. Discussion

The primary aim of the present study was to investigate the availability of RUTF within the household for the treatment of children with SAM in the context of reduced RUTF. The reduction in the dose of RUTF did not impact RUTF availability but impacted RUTF leftover and frequency of consumption. Before reduction in RUTF dosage, 24% of children in the two groups had leftovers until next treatment visit. After reduction, approximately 5% of children in intervention arm reported leftover compared to 11% in control arm. The percentage is high at start maybe indicating that when children enter treatment they don't have the capacity to consume it all but then when they start recovering and maybe also getting used to the product the left overs decrease (as indicated by the 24% to 11% left over percent in control from week 1–4). Previous studies (Sigh et al., 2018; Wieringa et al., 2013) showed that the acceptability of RUTF and similar products for nutritional therapy increases over time during treatment. The fact that the proportion of children with leftover RUTF decreased in two groups of children also impacted the total amount of leftover RUTF remaining during treatment. Previous studies in Burkina Faso on nutritional supplements for treating children with MAM had reported remains of 34% of the daily intake for Corn-Soy Blends and 17% for Lipid-based nutrient supplement (Iuel-Brockdorf et al., 2016).

During their stay in treatment, RUTF's leftovers averaged 20 sachets per child in intervention arm versus 32 sachets per child in standard arm. Despite the reduction in RUTF dose, there were some leftovers in children receiving reduced RUTF and this appears considerable for an

Table 4
Forms of consumption, sides effects, sharing practices and storage place of RUTF, among outpatient SAM children, aged 6–59 months receiving reduced RUTF and standard RUTF, in Burkina Faso (measured at week 6 of treatment).

Outcomes	Reduced RUTF	Standard RUTF	Difference[a] (95% CI)	*P* value
Form of RUTF consumption				
From sachet, n (%)	82.8 (130)	80.3 (147)		
Mixed with porridge, n (%)	17.2 (27)	19.1 (35)	0.38 (−89.7, 90.5)	0.99
Others	0.00 (0)	0.55 (1)		
Mixed with porridge reason				
Consumes more RUTF by mixing, n (%)	88.9 (24)	91.4 (32)	−0.07 (−49.2, 49.1)	0.998
Other, n (%)	11.1 (3)	8.6 (3)		
RUTF consumption side effects				
No, n (%)	82.7 (129)	76.0 (139)	6.38 (−2.23, 15.0)	0.146
Yes, n (%)	17.8 (28)	24.0 (44)		
RUTF consumption side effects types				
Diarrhea, n (%)	60.7 (17)	75.0 (33)		
Vomiting, n (%)	10.7 (3)	4.55 (2)	−16.2 (−38.6, 6.19)	0.156
Diarrhea & vomiting, n (%)	28.6 (8)	20.5 (9)		
RUTF consumption benefits				
prevents malnutrition, n (%)	22.3 (35)	23.5 (43)		
treats malnutrition, n (%)	75.2 (118)	76.0 (139)	−2.81 (−11.5, 5.87)	0.525
Other, n (%)	2.55 (4)	0.55 (1)		
People consuming RUTF				
Beneficiary child, n (%)	98.7 (155)	98.9 (181)		
Other children under five, n (%)	0.64 (1)	1.09 (2)	−0.01 (−5.62, 5.60)	0.997
Others, n (%)	0.64 (1)	0.00 (0)		
RUTF storage place				
In my house, n (%)	99.4 (156)	97.8 (179)		
At the head of household house, n (%)	0.64 (1)	1.64 (3)	0.01 (−7.18, 7.19)	0.999
At grandmothers house, n (%)	0.00 (0)	0.55 (1)		

[a] Ordered logistic regression models with study site as random effects and adjusting for sex, age, breastfeeding, morbidity.

average of 8 weeks in treatment. RUTF's leftovers may even be underestimated because the empty RUTF sachets reported during the next visits may not be only consumed by the beneficiary child with SAM. This overestimates the amount consumed by the SAM child and therefore underestimates the amount of RUTF that should in principle have remained. Commonly in programs, this means there will be on average 32 sachets of RUTF not consumed per child during their stay in the treatment and which will be shared with other members of the household, children and adults included.

The reduction impacted the weekly amount of RUTF consumed and the total amount of RUTF consumed during treatment. This difference in the amount of RUTF consumed over a week and throughout the treatment confirms the previous results which found a difference in daily energy intake from RUTF but the daily energy requirements were covered in both groups of children (Nikièma, Kangas, et al., 2021). The reduction in RUTF dose decreased the frequency of daily consumption of RUTF in intervention arm. Less than half of the children in the intervention arm consumed their RUTF ration of 1 or 2 sachets prescribed at least 3 times a day. Children in the intervention arm consumed less times per day compared with those in standard arm because they received 1 or 2 sachets of RUTF per day. However, caregivers felt that this was sufficient, perhaps because there was a high contribution of complementary and family foods and children did not necessarily finish their dose of RUTF before consuming other foods. Also, the children in the intervention arm consumed family and complementary meals more times (Nikièma, Nadia, et al., 2021). The fact that reduction in RUTF dose led to a decrease in the amount of RUTF consumed per week and throughout treatment may because for concern. RUTF is prescribed to meet daily energy needs based on the child's weight, but is also an important source of micronutrients. The MANGO trial has previously shown that dose reduction does not affect weight gain, recovery rate, defaulter, died, and referred to hospital of these children (Kangas et al., 2019). The intake of supplementary and family foods helped to meet the daily energy requirements in intervention arm (RUTF only cover 92% of energy requirement in intervention arm au more than 100% in standard arm) and the coverage of certain nutrients in intervention arm were lower, as previously reported (Nikièma, Kangas, et al., 2021). The perception of caregivers about the amount of RUTF received for the treatment of their child did not differ depending on the reduction in the dose. This could be explained by the consumption of complementary and family foods previously reported (Nikièma, Kangas, et al., 2021).

RUTF is highly appreciated by the majority of children regardless of their study arm. The main form of consumption of RUTF by children was directly from the sachet. RUTF were also mixed with porridge in order to increase children's appetite for RUTF. The 2 mains forms of consumption of RUTF by SAM children had also been reported as part of previous studies using ready-to-use supplementary foods (RUSF) for moderate acute malnourished (MAM) children in Burkina Faso (Iuel-Brockdorf et al., 2016) and Niger (Cohuet et al., 2012).

According to caregivers, RUTF was very rarely shared with other people. This could be underreported due to the advice against sharing, selling or using RUTF for any other purpose but the child's treatment. In this study, full sachets of RUTF not consumed (leftover) were brought for inspection during the next visit. This potentially contributed to reducing the sharing of RUTF. Previous studies had reported high sharing practices of RUSF mainly with children during the treatment of MAM: 25% in Niger (Cohuet et al., 2012) and at least 33% in Burkina Faso (Iuel-Brockdorf et al., 2016).

Among the 18% of caregivers in intervention arm and 24% of caregivers in control arm reporting that consuming RUTF caused side effects, the latter were in order of importance: diarrhea, vomiting and a combination of diarrhea and vomiting. This could be explained by the fact that RUTF is mainly made from peanut paste, and high consumption could cause stomach aches and hence diarrhea and/or vomiting (Ogbo, 2018). An allergy to the cow milk (in RUTF) could cause diarrhea (Ogbo, 2018). Also diarrhea could be due to complementary feeding practices or inappropriate hygiene common in young children (Gizaw, 2017). This change in diet could also help explain the side effects observed. The consumption of RUTF has led to a change in the diet of children who switch from a complementary diet mainly based on cereals or plant-based porridge (Dewey, 2013) to the consumption of more compact foods, in this case RUTF. There was a (not significantly) higher tendency for side effects in children receiving standard RUTF including the onset of diarrhea which could be explained by high consumption of RUTF.

4.1. Generalizability of the study result

This study was done in a context of somewhat stable food security with a complete research team that gave awareness messages and administered appropriate care to children. Consumption of other foods could help in making RUTF available throughout the week. Also, the study was done with 85% of the children still breastfed; this could further increase RUTF availability. In addition, about 90% of the children who participated in the study were under 2 years old, which can justify a leftover of RUTF during treatment. The generalization to other

settings is not warranted and that further confirmation of the findings in other populations is needed to generalize the findings and/or formulate policy recommendations.

4.2. Limitation of the study

Sharing practices within households could be under-reported due to the declarative method used. Other methods of assessing RUTF sharing and use practices in the household, such as focus groups and direct observation, could further describe the use of RUTF within households given the potential impact of these actions on the effectiveness of SAM treatment programs.

5. Conclusion

This study was the first to assess the availability of RUTF for children with SAM in context of reduced dose of RUTF. Reducing the dose of RUTF did not affect the availability of RUTF nor the perception of caregivers on the amount during treatment. However, reducing the RUTF dose reduced the frequency of RUTF consumed. More qualitative studies could further describe the use of RUTF within households and its links to treatment effectiveness. The reduction of the dose of RUTF can be done in stable food security contexts. This reduction should be accompanied by awareness messages on the consumption of supplementary and family foods when the daily ration of RUTF is consumed. During week 4 of treatment, more than 80% of the children were already at the MAM stage. We will suggest further analyses to see if availability and perception will change depending on the child's SAM or MAM status.

Author contributions

VN, CS, and STK conceived the research project, VN and STK collected data in the field. VN performed the data cleaning and analysis, interpreted the results wrote the first draft of the manuscript, revised subsequent drafts and coordinated the contributors. NFF, CS, CL and STK, contributed to interpretation of results and revised subsequent drafts. VN and CS acquired the funding for the study.

Funding sources

This study was funded by Action Against Hunger office in France, the Humanitarian Innovation Fund (HIF), a programme managed by ELRHA (Enhancing Learning and Research for Humanitarian Assistance), European Commission's Civil Protection and Humanitarian aid Operations (grant number ECHO/-WF/BUD/2015/91065), Children's Investment Fund Foundation (grant: "CIFF03: Reinventing community based management of malnutrition"), European Commission's Civil Protection and Humanitarian aid Operations Enhanced Response Capacity (grant number ECHO/ERC/BUD/2016/91006) and Action Against Hunger (AAH) Foundation & Institut of France for research & innovation. Funding covered the study conception and field implementation of the study, including the salary of V.N and S.T.K for the full length of the trial, as well as data cleaning & analyses and articles writing. Other authors received no specific funding for their work related to the current study. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Ethical statement

As part of the MANGO main trial, this study received the approval of the Ethical Committee (Comité d'éthique pour la Recherche en Santé) in Burkina Faso in December 2015 and the clinical trials board (Direction Générale de la Pharmacie, du Médicament et des Laboratoires) in September 2016. It was registered at the ISRCTN registry http://www.isrctn.com/ISRCTN50039021.

In addition, detailed information about the project was given to participants prior to the request for free and informed consent.

Acknowledgements

We thank children and mothers/caregivers for participating in the trial and the research teams for their everyday efforts in implementing the trial.

References

Briend, A., Lascala, R., Prudhon, C., Mounier, B., Grellety, Y., & Golden, M. H. N. (1999). Ready-to-use therapeutic food for treatment of marasmus. *The Lancet*.

Brown, M., Nga, T. T., Hoang, M.-A., Maalouf-Manasseh, Z., Hammond, W., Thuc, T. M. L., Minh, T. H. N., Hop, T. L., Berger, J., & Wieringa, F. T. (2015). Acceptability of two ready-to-use therapeutic foods by HIV-positive patients in Vietnam. *Food and Nutrition Bulletin, 36*(2), 102–110. https://doi.org/10.1177/0379572115587498

Cames, C., Varloteaux, M., Have, N. N., Diom, A. B., Msellati, P., Mbaye, N., Mbodj, H., Sy Signate, H., & Diack, A., for the ANRS 12279 MAGGSEN Cohort Study Group. (2017). Acceptability of outpatient ready-to-use food-based protocols in HIV-infected Senegalese children and adolescents within the MAGGSEN cohort study. *Food and Nutrition Bulletin, 38*(1), 27–36. https://doi.org/10.1177/0379572116679053

Coates, J., Swindale, A., & Bilinsky, P. (2007). *Household food insecurity access scale (HFIAS) for measurement of food access: Indicator guide*. Version 3. 34.

Cohuet, S., Marquer, C., Shepherd, S., Captier, V., Langendorf, C., Ale, F., Phelan, K., Manzo, M. L., & Grais, R. F. (2012). Intra-household use and acceptability of ready-to-use-supplementary-foods distributed in Niger between July and December 2010. *Appetite, 59*(3), 698–705. https://doi.org/10.1016/j.appet.2012.07.019

Collins, S. (2007). Treating severe acute malnutrition seriously. *Archives of Disease in Childhood, 92*(5), 453–461. https://doi.org/10.1136/adc.2006.098327

Dewey, K. G. (2013). The challenge of meeting nutrient needs of infants and young children during the period of complementary feeding: An evolutionary perspective. *Journal of Nutrition, 143*(12), 2050–2054. https://doi.org/10.3945/jn.113.182527

Gizaw, Z. (2017). *Child feeding practices and diarrheal disease among children less than two years of age of the nomadic people in Hadaleala District, Afar Region, Northeast Ethiopia* (p. 10).

Iuel-Brockdorf, A.-S., Draebel, T. A., Ritz, C., Fabiansen, C., Cichon, B., Brix Christensen, V., Yameogo, C., Oummani, R., Briend, A., Michaelsen, K. F., Ashorn, P., Filteau, S., & Friis, H. (2016). Evaluation of the acceptability of improved supplementary foods for the treatment of moderate acute malnutrition in Burkina Faso using a mixed method approach. *Appetite, 99*, 34–45. https://doi.org/10.1016/j.appet.2015.12.030

Kangas, S. T., Salpéteur, C., Nikièma, V., Talley, L., Ritz, C., Friis, H., Briend, A., & Kaestel, P. (2019). Impact of reduced dose of ready-to-use therapeutic foods in children with uncomplicated severe acute malnutrition: A randomised non-inferiority trial in Burkina Faso. *PLoS Medicine*. https://doi.org/10.1371/journal.pmed.1002887

Ministère de la santé. (2014). *Protocole national. Prise en charge intégrée de la malnutrition aiguë (PCIMA)*. Burkina Faso 2014.

Nga, T. T., Nguyen, M., Mathisen, R., Hoa, D. T., Minh, N. H., Berger, J., & Wieringa, F. T. (2013). Acceptability and impact on anthropometry of a locally developed Ready-to-use therapeutic food in pre-school children in Vietnam. *Nutrition Journal, 12*(1), 120. https://doi.org/10.1186/1475-2891-12-120

Nikièma, V., Kangas, S. T., Salpéteur, C., Ouédraogo, A., Lachat, C., Bassolé, N. H. I., & Fogny, N. F. (2021a). *Adequacy of nutrient intakes of severely and acutely malnourished children treated with different doses of ready-to-use therapeutic food in Burkina Faso* (Vol. 10).

Nikièma, V., Nadia, F. F., Cécile, S., Carl, L., & Suvi, T. K. (2021b). Complementary feeding practices and associated factors of dietary diversity among uncomplicated severe acute malnourished children aged 6-23 months in Burkina Faso. *Maternal and Child Nutrition*. https://doi.org/10.1111/mcn.13220

Ogbo, F. A. (2018). *The association between infant and young child feeding practices and diarrhoea in Tanzanian children* (Vol. 9).

Schoonees, A., Lombard, M. J., 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. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD009000.pub3

Sigh, S., Roos, N., Sok, D., Borg, B., Chamnan, C., Laillou, A., Dijkhuizen, M. A., & Wieringa, F. T. (2018). Development and acceptability of locally made fish-based, ready-to-use products for the prevention and treatment of malnutrition in Cambodia. *Food and Nutrition Bulletin, 39*(3), 420–434. https://doi.org/10.1177/0379572118788266

Tadesse, E., Berhane, Y., Hjern, A., Olsson, P., & Ekström, E.-C. (2015). Perceptions of usage and unintended consequences of provision of ready-to-use therapeutic food for management of severe acute child malnutrition. A qualitative study in Southern Ethiopia. *Health Policy and Planning, 30*(10), 1334–1341. https://doi.org/10.1093/heapol/czv003

UNICEF. (2013). *Position_Paper_Ready-to-use_therapeutic_food_for_children_with_severe_acute_malnutrition_June_2013.pdf*.

WHO. (1999). Management of severe malnutrition: A manual for physicians and other senior health workers. *Revista Panamericana de Salud Públic,* 6(2), 146–147. https://doi.org/10.1590/S1020-49891999000700020

WHO. (2013). *World health organization. Guideline. Updates ON the management OF severe acute malnutrition IN INFANTS and children*.

WHO, UNICEF, & WFP. (2007). *Community-based management of severe acute malnutrition. pdf*.

Wieringa, F. T., Trần, N. T., Hoang, M.-A., Brown, M., Maalouf-Manasseh, Z., Lưu, T. T. M., Nguyễn, M. T. H., Hợp, L. T., & Berger, J. (2013). *Acceptability of two ready-to-use therapeutic foods among HIV-positive patients in Vietnam* (Vol. 39).