Received: 21 March 2024 | Revised: 31 May 2024 | Accepted: 11 June 2024

DOI: 10.1111/mcn.13691

ORIGINAL ARTICLE

Maternal & Child Nutrition WILEY

Effectiveness of acute malnutrition treatment with a simplified, combined protocol in Central African Republic: An observational cohort study

Grace Heymsfield[1] | Zachary Tausanovitch[1] | Loubah Gondjé Christian[2] | M'bary Siolo Mada Bebelou[3] | Benedict Tabiojong Mbeng[4] | Anne Marie Dembele[5] | Annie Fossi[6] | Théophile Bansimba[5] | Issa Niamanto Coulibaly[7] | Victor Nikièma[8] | Suvi T. Kangas[1]

[1]International Rescue Committee, New York, New York, USA

[2]International Rescue Committee, Bangui, Central African Republic

[3]Ministry of Health and Population, Bangui, Central African Republic

[4]World Food Programme, Bangui, Central African Republic

[5]United Nations Children's Fund, Bangui, Central African Republic

[6]Community Humanitarian Emergency Board International, Bangui, Central African Republic

[7]International Rescue Committee, Bamako, Mali

[8]World Food Programme, Dakar, Senegal

Correspondence
Grace Heymsfield, International Rescue Committee, New York, NY, USA.
Email: grace.heymsfield@rescue.org

Funding information
International Rescue Committee, Grant/Award Number: U1130; World Food Programme, Grant/Award Number: FLA 2021-2022; United Nations Children's Fund, Grant/Award Number: CAR/PCA2023112/SPD2023309

Abstract

A simplified, combined protocol admitting children with a mid-upper-arm circumference (MUAC) of <125 mm or oedema to malnutrition treatment with ready-to-use therapeutic food (RUTF) uses two sachets of RUTF per day of those with MUAC < 115 mm and/or oedema and one sachet of RUTF per day for those with MUAC 115–<125 mm. This treatment previously demonstrated noninferior programmatic outcomes compared with standard treatment and high recovery in a routine setting. We aimed to observe the protocol's effectiveness in a routine setting at scale, in two health districts of the Central African Republic through an observational cohort study. The pilot enrolled children for 1 year in consortium by the Ministry of Health and nongovernmental partners. A total of 7909 children were admitted to the simplified, combined treatment. Treatment resulted in an 81.2% overall recovery, with a mean length of stay (LOS) of 38.7 days and a mean RUTF consumption of 43.4 sachets per child treated. Among children admitted with MUAC < 115 mm or oedema, 67.9% recovered with a mean LOS of 48.1 days and consumed an average of 70.9 RUTF sachets. Programme performance differed between the two districts, with an overall defaulting rate of 31.1% in the Kouango-Grimari health district, compared to 8.2% in Kemo. Response to treatment by children admitted with severe acute malnutrition (SAM) by MUAC and SAM by oedema was similar. The simplified, combined protocol resulted in a satisfactory overall recovery and low RUTF consumption per child treated, with further need to understand defaulting in the context.

KEYWORDS

acute malnutrition, Central African Republic, community management of acute malnutrition (CMAM), mid-upper arm circumference (MUAC), operational pilot, ready to use therapeutic food (RUTF), simplified approaches

1 | INTRODUCTION

Over 45 million children under the age of five are estimated to suffer from acute malnutrition (AM) at any given time, a condition defined as low weight for height (WHZ), mid-upper-arm circumference (MUAC) and/or the presence of bilateral oedema (UNICEF; WHO; International Bank for Reconstruction and Development/The World Bank, 2023; WHO, 2023). Children with AM have an elevated risk of infection, reoccurrence of malnutrition and death (Girma et al., 2022; Katona & Katona-Apte, 2008; Olofin et al., 2013). The condition is routinely treated through community-based management of acute malnutrition (CMAM) programmes. When implemented with fidelity, evidence suggests CMAM programmes have a high recovery rate (Collins et al., 2006).

In the traditional CMAM model, severe acute malnutrition (SAM) and moderate acute malnutrition (MAM) are treated separately. SAM is defined as WHZ < −3, MUAC < 115 mm and/or the presence of bilateral oedema without medical complications, whereas MAM is defined as lack of SAM and WHZ < −2 and/or a MUAC < 125 mm (World Health Organization (WHO), 2023). Outpatient therapeutic feeding programmes use weight-based dosage of ready-to-use therapeutic foods (RUTF) to provide the full nutritional needs of children with SAM and supplementary feeding programmes use ready-to-use supplementary foods (RUSF) to provide some of the nutritional needs of children with MAM (WHO and UNICEF, 2009; UNICEF, 2023; WFP, 2016). Thus, a child with AM is often treated with different nutritional therapeutic products and dosages, sometimes at different sites and on different days of the week, as the severity of his or her condition improves to recovery or worsens.

While direct global estimates of treatment coverage are lacking, modelled estimates suggest fewer than one in four children with AM benefit from treatment (Action Against Hunger, 2018). To improve treatment coverage, a suite of modifications to simplify admission and discharge criteria, integrate treatment using one product at the same site and reduce the dosage and thus cost of RUTF have been tested in a variety of contexts (Bailey et al., 2020, Cazes et al., 2023; Daures et al., 2019; Kangas et al., 2019; Maust et al., 2015). In 2023, the World Health Organization (WHO) guidelines for acute malnutrition treatment were updated to include treatment with therapeutic foods (including RUTF) for children with MAM, as well as reduced dosage of RUTF in some contexts for children admitted with SAM who no longer present with oedema or severely wasting (WHO, 2023). The new guidelines also endorsed decentralised treatment by Community Health Workers (CHWs) (WHO, 2023).

The combined protocol for acute malnutrition study (ComPAS) trial in South Sudan and Kenya demonstrated noninferior recovery rates and lower costs of a protocol where children were admitted to malnutrition treatment based on their MUAC measurement or presence of oedema and treated with two daily sachets of RUTF for those with MUAC < 115 mm or oedema and one daily sachet of RUTF for those with 115 ≤ MUAC < 125 mm (Bailey et al., 2018, 2020, 2021; Chase et al., 2020; Lelijveld et al., 2021). Per this simplified and combined protocol, SAM and MAM are treated at the same site and with the same product, based on their MUAC and oedema criteria only. Operational studies of the simplified protocol in Mali and Niger reported very high recovery of acutely malnourished children (Kangas et al., 2022; Charle-Cuéllar et al., 2023; Sánchez-Martínez et al., 2023). Whether the promising results could be replicated in different contexts remained to be shown.

Key messages

- The simplified, combined protocol with a mid-upper-arm circumference (MUAC)-based ready-to-use therapeutic food (RUTF) resulted in a recovery rate that reached SPHERE standards, low length of stay and low RUTF consumption per child among all children treated.
- Response to treatment was similar among children admitted with severe acute malnutrition (SAM) by oedema and those admitted SAM by MUAC.
- Contextual factors such as insecurity and stockouts in treatment products affect programme outcomes by increasing defaulting and decreasing recovery rates.
- The simplified, combined protocol might present an opportunity to treat more children with less product; decentralised delivery should continue to be explored.

To build further evidence for the effectiveness of a simplified, combined protocol in a routine setting, we piloted it in two adjacent health districts in CAR—Kémo and Kouango-Grimari. The aim was to observe the characteristics of children admitted to treatment based on a MUAC < 125 mm and/or oedema and their response to treatment in terms of recovery. Secondary outcomes included other treatment outcomes, mean length of stay (LOS) in days, RUTF consumption and anthropometric change during treatment. In addition, we assessed the treatment response of several potentially more vulnerable subpopulations, including children under the age of 2 years, children admitted with a lower MUAC (less than 110 mm if admitted SAM and less than 120 mm if admitted MAM), children with WHZ < −3 and children with concurrent wasting and stunting.

2 | METHODS

2.1 | Study design

This prospective observational cohort study described response to a simplified, combined protocol for the treatment of AM among children 6–59 months admitted with MUAC < 125 mm/and or oedema.

2.2 | Study setting and population

The Central African Republic (CAR) is experiencing a chronically underfunded acute public health emergency, despite reports suggesting the nationwide mortality rate is among the highest in the world (Gang et al., 2023; UNICEF, 2021). Approximately 117,000 children in CAR were estimated to suffer from AM (5.5% of the total population) in 2023, including 48,000 children with SAM (Humanitarian Response Plan [HRP], 2023).

The study was carried out in the rural health districts of Kémo and Kouango-Grimari, in the south-central prefectures of Kémo and Ouaka in CAR. The estimated total population in Kémo is 152,164 and 20,761 children 6–59 months, while the estimated total population of Ouaka is 368,293 including 57,085 children 6–59 months (MSP, RCA, 2018). In 2019, an estimated 6.1% of children under five in the Kémo prefecture and 5.2% in the Ouaka prefecture suffered from either SAM or MAM on the basis of WHZ and/or oedema alone (MSP, RCA, 2020). The Integrated Phase Classification (IPC) analyses of food insecurity in September 2021 to March 2022 and April–August 2022 indicated a range from Crisis to Emergency in the subprefectures within Kemo and Ouaka, with Ouaka generally experiencing a higher burden of food insecurity and displacement (Integrated Phase Classification [IPC], 2021, 2022). The catchment areas were chosen due to the operational presence of partners able to implement the pilot and their demonstrated need for scaled-up treatment. Both health districts include subprefectures affected by internal displacement in response to conflict.

In Kémo, 18 health facilities, including a district hospital and a secondary hospital, and 19 health posts (of 39 facilities and health posts total) in four subprefectures took part in the pilot. In Kouango-Grimari, Ouaka, 14 health facilities, including a district hospital and a secondary hospital and seven health posts (of 26 facilities and health posts total) in two subprefectures were part of the pilot. Before the pilot, SAM treatment was supported by Médecins d'Afrique (MDA) in partnership with the Ministry of Health since 2015 in both study areas. Just before the start of the pilot, support by MDA was ceded to the Community Humanitarian Emergency Board International in Kouango-Grimari. While MAM treatment was funded by WFP in both health districts before the pilot, service delivery was inconsistent due to RUSF stockouts.

2.3 | Intervention

Per the simplified protocol, children with a MUAC < 115 mm and/or oedema (+/++), without medical complications, received 1000 kcal RUTF/day (two sachets/day) until reaching MAM anthropometry (MUAC ≥ 115 mm and no oedema) for two consecutive visits. Once they reached MAM anthropometry, they were switched from two sachets of RUTF/day to one sachet of RUTF/day until discharge. A comparison of the simplified, combined protocol and standard protocol for AM treatment in CAR, which was last revised in 2014, is included in Supporting Information S1: File (Ministre de la Santé et de la Population [MSP], RCA, 2014). Compared to the standard protocol, children admitted as SAM receive a lower RUTF dose when 7 kg and heavier with the simplified and combined protocol. Children admitted as MAM receive similar caloric supplementation and a slightly different micronutrient provision (MSP, RCA, 2014). All children were followed up weekly at the treatment site. MUAC and weight measurements were taken at each visit, while height measurements were taken only on admission to and discharge from treatment. Children were treated until they reached discharge criteria as recovered or nonrespondent, transferred for care at a stabilisation centre or different treatment site, or defaulted from treatment. No discharge ration of RUTF was provided upon recovery.

In addition to the nutritional treatment, children admitted with a MUAC < 115 mm or oedema received routine medical treatment per the national protocol (MSP, RCA, 2014), detailed in Supporting Information S1: File 1.

2.4 | Implementation

Health personnel and supervisory district management teams were trained in simplified protocol administration. The field supervisors from the implementing partners were present on each treatment day for support, routine monitoring and data collection. Children were referred to treatment by community health volunteers (CHV's) in their communities (active screening) or directly at the treatment site (passive screening). In addition to active screening, CHV's conducted follow-up visits if a child missed one visit. Treatment was provided at health posts and health centres in both districts.

Admissions to the simplified treatment started in July 2022 in the Kémo health district and in August 2022 in the Kouango-Grimari health district. The first month of implementation in both health districts was characterised by insufficient staffing and stockouts of RUTF; thus, admissions per protocol and suitable for analyses commenced in August 2022 in Kemo and September 2023 in Kouango-Grimari, respectively. In the event of a RUTF stockout lasting more than two consecutive weeks, children were discharged from the programme and readmitted when stock was again available, which required the caregiver to re-enrol their child.

United Nations International Children's Emergency Fund [UNICEF] financed the supply of the RUTF in the six subprefectures of the pilot. During implementation, Blanket Supplementary Feeding for malnutrition prevention was implemented in Cooperazione Internazionale in both Kémo and Kouango-Grimari in peak months of food insecurity (twice per year). The International Rescue Committee (IRC) provided technical support during training and implementation, in addition to data quality assurance and reporting, but did not have an operational presence in either health district before the pilot.

2.5 | Outcomes

The main outcome was the percentage of children who recovered. Secondary outcomes included other treatment outcomes (defaulted, nonresponse, death and transfer to in-patient care), mean LOS in days, mean consumption of RUTF, mean MUAC gain velocity and mean weight gain velocity.

2.6 | Definitions

Recovery was defined as a MUAC ≥ 125 mm and no oedema for two consecutive visits. Nonresponse was defined as not having attained recovery by 12 weeks of treatment. Defaulting was considered as missing two consecutive visits. Transfers to a stabilisation centre or different health facilities were considered discharges and may have been readmitted for treatment. Death included death during treatment and postdefaulting deaths confirmed during defaulter tracing when possible.

The LOS was calculated as the days from admission to discharge, with discharge being the last visit the child was cared for at the health facility for all children and again among recovered children. The weight gain velocity was calculated as the difference between admission and discharge weight in grams divided by the admission weight in kilograms, divided by the LOS in days for all children and again among recovered children. If a child was admitted with oedema, weight gain velocity was calculated as the difference between the lowest weight during treatment and discharge weight divided by the lowest weight during treatment in kilograms, divided by LOS in days from the lower weight date to the date of discharge. The MUAC gain velocity was calculated as the discharge MUAC in mm minus admission MUAC in mm divided by the LOS in weeks among all children and again among recovered children.

2.7 | Data collection

Individual treatment data at admission, follow-up and discharge were recorded on registers and paper forms at the facility, and then copied by supervisors using the CommCare application. Data quality checks were completed by a statistician designated to the project on a continuous basis during data collection, and registers were cross-checked when needed. A monthly data quality review led by the IRC reported anthropometric plausibility by facility and health district.

2.8 | Data analysis

Anonymized data from the CommCare server were compiled into a master data set in STATA 15, with all admission, follow-up and exit visits (StataCorp.). Discharge outcomes were recalculated per weekly follow-up data and manually corrected if different than indicated by the health facility. Data were reviewed before analysis for duplicates, outliers and missing data and initial records were traced back if needed. STATA's zscore06 package was used to calculate z-scores using the WHO's 2006 Child Growth Standards, with outliers dropped per the same parameters (WAZ < −6 or >5, WHZ < −5 or WHZ > 5) (Leroy, 2011; World Health Organization [WHO] Multicentre Growth Reference Study Group, 2006). WHZ and WAZ were not calculated if the child was recorded as having oedema on the visit.

Before analysis, exclusions were applied before full functionality of the programme (meaning inconsistent RUTF availability, which affected both districts in the first month of implementation), children discharged after the supervision period whose outcomes could not be verified and children admitted from facilities that were excluded from the study due to insecurity. Additional exclusions were applied for children with incomplete records, meaning their follow-up data could not be verified, children incorrectly admitted according to the protocol, children with unconfirmed exit dates and children incorrectly discharged from the programme compared to manually calculated outcomes for recovery and nonresponse and children discharged from the programme due to RUTF stockouts.

Baseline characteristics and treatment outcomes of the study population are summarised as percent (*n*) for categorical variables or mean (SD) for normally distributed continuous variables and median (IQR) for nonnormally distributed continuous variables.

2.9 | Ethics

The pilot study was approved by the National Ethical and Scientific Committee of CAR (December 2021 and amended June 2022), as well as the IRC ethics committee (protocol number: H 1.00.036). No individual consent was used, as the data collected were part of the routine treatment of AM.

3 | RESULTS

After excluding children recruited before the programme's functionality, nonconfirmed discharge after the programme's surveillance period, recruited from outside the catchment area, incorrectly or incompletely treated or discharged incorrectly or due to prolonged stockouts of RUTF, 7909 children remained for analysis (Figure 1).

Around 28.5% of the children were admitted to the SAM phase of treatment with a MUAC < 115 mm or oedema, 25.6% of whom were admitted with oedema (6.9% of all admissions) (Table 1). The mean age of children at admission was 15.6 months for children admitted SAM by MUAC, 30.3 months for children admitted SAM by oedema and 17.3 months for children admitted MAM. The mean MUAC at admission was 109 for children admitted SAM by MUAC and 120.1 mm for children admitted MAM. Mean HAZ and WAZ were lower among children admitted SAM than children admitted MAM. Among the children admitted SAM by MUAC, 38.7% were also severely wasted by WHZ, compared to 11.7% of those admitted MAM. Nearly 70% of children admitted to SAM treatment were severely underweight (WAZ < −3) and over 40% were severely stunted (HAZ < −3), compared to approximately 30% of children admitted MAM.

Most children (87%) were referred by active case finding in their communities, though the percentage of children referred through passive screening was higher among children admitted SAM. Nearly three in four (71.0%) children in the pilot were admitted in the Kémo health district. When comparing admission characteristics by health district, a higher percentage of children admitted in Kouango-Grimari were admitted with oedema or with severe wasting by WHZ

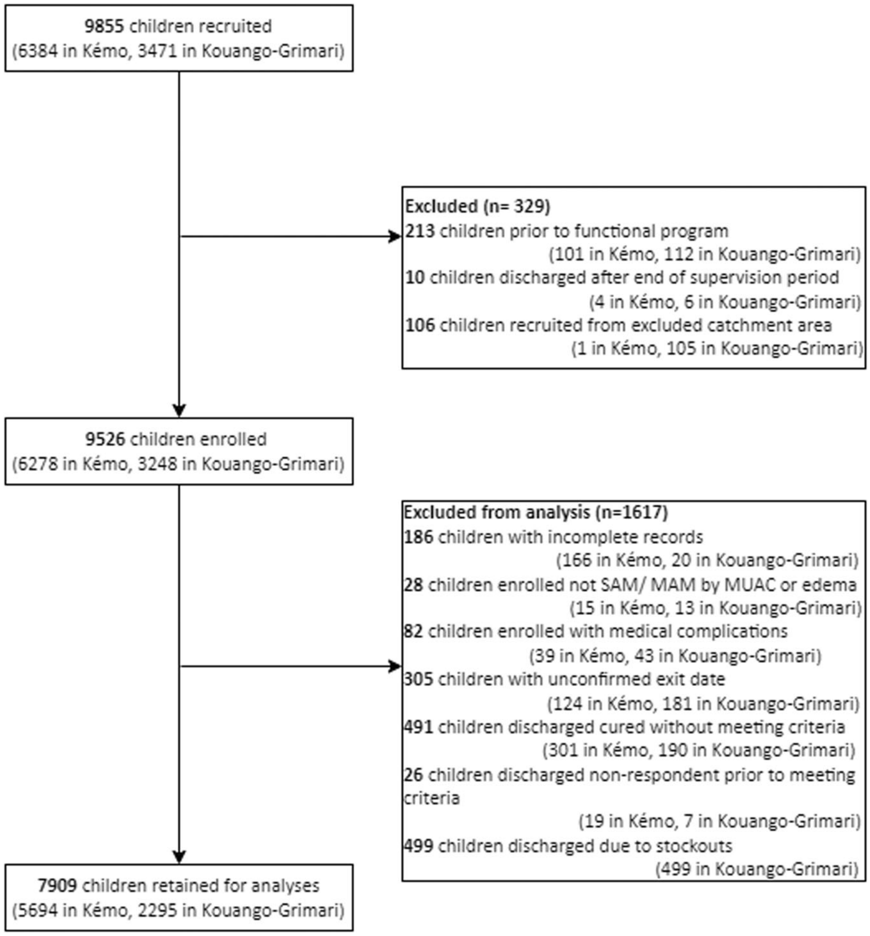

FIGURE 1 Enrolment in a simplified, combined treatment programme and inclusion in analyses in Central African Republic.

(Supporting Information S2: Table 1). A lower percentage of children enroled in Kouango-Grimari were referred by active screening in their community than in Kémo.

The overall recovery percent was 81.2%, with 14.9% defaulting and 1.9% nonresponses. Only 1.7% of children were referred to inpatient care during treatment (Table 2). The overall recovery among children admitted SAM was 67.9%, with a higher rate of defaulting (23.5%).

The recovery was the same among children admitted SAM by MUAC and those admitted SAM by oedema, while defaulting and referrals to inpatient care were higher in children admitted SAM by oedema (Table 2). When further disaggregating treatment outcomes by health district, the defaulting rate is higher in Kouango-Grimari—31.1% of all children enroled defaulted, including 40.4% of children who were enroled to the SAM phase of treatment (Supporting Information S2: Table 2). In comparison, the recovery percent is Kemo is 87.7% for overall admissions, including 76.6% for children admitted to the SAM phase of treatment, and the defaulting is below 15% for overall admissions and children admitted to either phase of treatment.

The mean LOS was 38.7 days overall and 48.1 days for children admitted to the SAM phase of treatment. LOS was longer for children admitted SAM by MUAC (52.9 days) versus by oedema (34.3 days). The overall weight gain velocity was 3.6 ± 4.2 g/kg/day for all children and 4.1 ± 5.7 g/kg/day among those admitted SAM. Children admitted SAM consumed on average 70.9 sachets (76.9 among those discharged cured), while those admitted MAM consumed on average 32.4 sachets (33.3 among those discharged cured). Only 6.1% of all recovered children missed more than one visit of treatment. Recovery rates were similar according to facility type but lower among children admitted by passive screening (Supporting Information S2: Table 3).

Recovery rates varied across the subgroups studied. Among children admitted SAM, recovery rates were 10 percentiles lower or more for children severely wasted by WHZ, children admitted with a MUAC < 110 mm, children admitted by passive screening or concurrently severely wasted and severely stunted, compared to their counterparts. The defaulting rates ranged from 8 to 20.7 percentiles higher in the same subgroups. Among children admitted MAM, children admitted by passive screening were the only subgroup with a recovery percent less than 80%, with only 69.9% recovery percent compared to 88.4% among children admitted by active screening. Analysis by the same subgroup indicated this was driven by defaulting, with a defaulting rate of 32.9% among children admitted via passive screening, compared to 12.2% among children admitted via active screening Table 3.

An analysis of selected indicators by treatment outcome revealed an average LOS of approximately 1 month among defaulters. Only

TABLE 1 Baseline characteristics of children admitted to acute malnutrition treatment by a simplified, combined protocol.

		Admission status			
	Total *N*	Overall MUAC < 125 mm and/or oedema	SAM phase of treatment MUAC < 115 mm without oedema	Oedema	MAM phase of treatment MUAC 115–<125 mm
Total, *N* (%)	7909	7909 (100)	2255 (28.5)		5654 (71.5)
			1678	577	
Boys, % (*n*)	7909	45.7 (3615)-	44.6 (748)	54.8 (316)	45.1 (2551)
Age in months, mean ± SD	7909	17.9 ± 10.5	15.6 ± 9.2	30.3 ± 13.7	17.3 ± 9.5
Age group, % (*n*)	7909				
<24 months		69.4 (5487)	77.4 (1298)	24.3 (140)	71.6 (4049)
24 months and older		30.6 (2422)	22.6 (380)	75.7 (437)	28.4 (1605)
MUAC (mm), mean ± SD	7909	118.1 ± 9.6	109.0 ± 5.8	124.5 ± 28.0	120.1 ± 2.6
Weight (kg), mean ± SD	7909	7.6 ± 1.6	6.5 ± 1.4	9.5 ± 2.3	7.7 ± 1.3
Height/length (cm), mean ± SD	7909	73.2 ± 8.0	69.9 ± 7.6	81.1 ± 10.2	73.4 ± 7.2
WHZ, mean ± SD	7176	−2.0 ± 1.1	−2.7 ± 1.1	-	−1.9 ± 1.0
WHZ category, % (*n*)	7176			-	
WHZ ≥ −2		49.5 (3549)	22.8 (366)		57.1 (3183)
WHZ ≥ −3 and <−2		33.2 (2385)	38.5 (619)		31.7 (1766)
WHZ < −3		17.3 (1242)	38.7 (621)		11.1 (621)
WAZ, mean ± SD	7296	−2.7 ± 1.1	−3.5 ± 1.1		−2.5 ± 1.0
WAZ category, % (*n*)	7296			-	
WAZ ≥ −2		27.2 (1982)	8.9 (147)		32.5 (1835)
WAZ ≥ −3 and <−2		33.8 (2466)	23.6 (389)		36.8 (2077)
WAZ < −3		39.0 (2848)	67.4 (1110)		30.8 (1738)
HAZ, mean ± SD	7735	−2.2 ± 1.7	−2.6 ± 1.7	−2.4 ± 1.8	−2.0 ± 1.7
HAZ category, % (*n*)	7735				
HAZ ≥ −2		45.6 (3526)	35.2 (566)	40.1 (221)	49.1 (2739)
HAZ ≥ −3 and <−2		23.5 (1817)	21.6 (348)	22.5 (124)	24.1 (1345)
HAZ < −3		30.9 (2392)	43.2 (695)	37.4 (206)	26.7 (1491)
WaST					
WHZ < −3 and HAZ < −3	7055	5.9 (413)	17.1 (26.4)	-	2.7 (149)
Type of facility	7909				
Health centre		56.6 (4478)	60.4 (1013)	57.9 (334)	55.4 (3131)
Health post		43.4 (3431)	39.6 (665)	42.1 (243)	44.6 (2523)
Referral method, % (*n*)	7909				
Passive screening		13.0 (1029)	18.7 (1365)	20.3 (460)	10.6 (5055)
Active screening		87.0 (6880)	81.3 (313)	79.7 (117)	89.4 (599
Health district	7909				
Kémo		71.0 (5614)	64.5 (1083)	51.1 (295)	74.9 (4236)
Kouango-Grimari		29.0 (2295)	35.5 (595)	48.9 (282)	25.1 (1418)
Presence of oedema, % (*n*)	7909	7.3 (577)	0.0 (0)	100.0 (577)	0.0 (0)

Abbreviations: CHV, community health volunteer; HAZ, height-for-age z-score; MUAC, mid-upper-arm circumference; WAZ, weight-for-age z-score; WHZ, weight-for-height z-score.

TABLE 2 Programme outcomes performance indicators for a simplified, combined treatment programme.

		Admission status				
		Overall	SAM phase of treatment			MAM phase of treatment
	Total *N*	MUAC < 125 mm and/or oedema	MUAC < 115 mm and/or oedema	MUAC < 115 without oedema	Oedema	MUAC 115–<125 mm
Total		7909	2255	1678	577	5654
Recovered, % (*n*)	7909	81.2 (6420)	67.9 (1532)	67.9 (1140)	67.9 (392)	86.5 (4888)
Defaulted, % (*n*)	7909	14.9 (1177)	23.5 (529)	22.3 (374)	26.9 (155)	11.5 (648)
Nonresponse, % (*n*)	7909	1.9 (150)	4.5 (102)	5.9 (99)	0.5 (3)	0.8 (48)
Died, % (*n*)	7909	0.3 (25)	0.8 (18)	0.2 (3)	2.6 (15)	0.1 (7)
Referred to inpatient care, % (*n*)	7909	1.7 (137)	3.3 (74)	3.7 (62)	2.1 (12)	1.1 (63)
Length of stay, mean ± SD (days)						
All discharges	7909	38.7 ± 20.6	48.1 ± 23.2	52.9 ± 22.1	34.3 ± 20.8	34.9 ± 18.1
Cured only	6420	39.0 ± 18.0	51.7 ± 18.2	56.8 ± 16.4	36.9 ± 15.1	35.0 ± 16.0
Weight gain velocity, mean ± SD (g/kg/day)						
All discharges	7660	3.6 ± 4.2	4.1 ± 5.7	4.2 ± 3.7	2.4 ± 4.2	3.4 ± 3.3
Cured only	6420	3.6 ± 3.0	4.3 ± 5.2	4.6 ± 5.2	3.2 ± 4.9	3.5 ± 2.9
Absolute WAZ change, mean ± SD (z-scores)	7566	0.7 ± 0.7	1.0 ± 0.9	1.0 ± 0.8	0.1 ± 0.2	0.6 ± 0.6
MUAC gain velocity, mean ± SD (mm/week)						
All discharges	7660	0.2 ± 0.2	0.2 ± 0.2	0.3 ± 0.1	0.1 ± 0.3	0.2 ± 0.1
Cured only	6314	0.2 ± 0.1	0.3 ± 0.2	0.3 ± 0.1	0.1 ± 0.3	0.2 ± 0.1
Number of RUTF sachets consumed, mean ± SD						
All discharges	7909	43.4 ± 27.9	70.9 ± 31.6	77.0 ± 31.4	53.0 ± 24.8	32.4 ± 0.1
Cured only	6420	43.7 ± 26.0	76.9 ± 25.7	82.6 ± 24.7	60.2 ± 21.0	33.3 ± 15.2
More than one missed visit during treatment, % (*n*)						
All discharge	7909	11.0 (873)	16.9 (381)	18.4 (309)	12.5 (72)	8.7 (492)
Recovered only	6420	6.1 (390)	8.4 (129)	10.1 (115)	3.6 (14)	5.3 (261)

Abbreviations: MUAC, mid-upper-arm circumference; RUTF, ready-to-use therapeutic food; WAZ, weight-for-age z-score.

7.6% of children who defaulted from treatment attended their admission visit only. The majority (64.6%) of defaulters returned for treatment but were classified as defaulters per the definition of two consecutive missed visits (Supporting Information S2: Table 4).

4 | DISCUSSION

This study demonstrated overall recovery exceeding 80% of a simplified, combined treatment of children with acute malnutrition in an operational pilot in two health districts in CAR. Confirmed nonresponse and death were low across the overall programme, all admission categories and when disaggregating outcomes by district. RUTF consumption and LOS to recovery were low −44 sachets and 39 days on average for all children admitted. However, recovery percent was lower than the SPHERE standards in children admitted with MUAC < 115 mm or oedema (Sphere Association, 2018).

This pilot observed a higher recovery, higher weight gain velocity and shorter LOS than the ComPAS randomised controlled trial in Kenya and South Sudan, but lower performance per the same outcomes than a routine programme in Mali and an emergency setting in Niger, both of which included treatment by community health workers (Bailey et al., 2020; Charle-Cuéllar et al., 2023; Kangas et al., 2022; Sánchez-Martínez et al., 2023). The ComPAS randomised controlled trial experienced a health personnel strike in Kenya disrupting implementation and long distance to facility discouraged adherence in both countries (Bailey et al., 2020). In comparison, the operational pilot in Mali delocalised treatment to the community level, reducing distance barriers and reported very high adherence to treatment frequency (Kangas et al., 2022). The Niger

TABLE 3 Recovery and defaulting from malnutrition following simplified, combined treatment by subgroups.

Total	Overall MUAC < 125 mm and/or oedema 7909		SAM phase of treatment MUAC < 115 mm and/or oedema 2255	MUAC < 115 mm without oedema 1678	Oedema 577	MAM phase of treatment MUAC 115–<125 mm 5654
Recovery % (*n*)						
Defaulting % (*n*)						
WHZ category						
WHZ < −3	Recovered	71.7 (891)	62.5 (388)	62.5 (388)	-	81.0 (503)
	Defaulted	20.5 (254)	25.4 (158)	25.4 (158)	-	15.5 (96)
WHZ ≥ −3	Recovered	84.8 (5032)	71.9 (708)	71.9 (708)	-	87.4 (4324)
	Defaulted	12.3 (728)	20.0 (197)	20.0 (197)	-	10.7 (531)
Age group (month)						
<24	Recovered	82.0 (4497)	67.6 (972)	67.6 (877)	67.9 (95)	87.1 (3525)
	Defaulted	13.5 (739)	21.7 (312)	21.2 (275)	26.4 (37)	10.5 (427)
≥24	Recovered	79.4 (1922)	68.4 (559)	68.9 (262)	68.0 (297)	84.9 (1363)
	Defaulted	18.1 (438)	26.6 (217)	26.1 (99)	27.0 (118)	13.8 (221)
Weight category (kg)						
≤7	Recovered	76.3 (2442)	64.2 (803)	64.8 (756)	55.3 (47)	84.0 (1639)
	Defaulted	16.9 (542)	23.7 (296)	22.8 (266)	35.3 (30)	12.6 (246)
>7	Recovered	84.5 (3977)	72.5 (728)	74.8 (383)	70.1 (345)	87.7 (3249)
	Defaulted	13.5 (635)	23.2 (233)	21.1 (108)	25.4 (125)	10.9 (402)
MUAC category (mm)						
<110	Recovered	53.3 (320)	53.3 (320)	55.0 (308)	30.0 (12)	-
	Defaulted	31.0 (186)	31.0 (186)	29.3 (164)	55.0 (22)	-
≥110	Recovered	83.4 (6099)	73.2 (1211)	74.3 (831)	70.8 (380)	86.5 (4888)
	Defaulted	13.6 (991)	20.7 (343)	18.8 (210)	24.8 (133)	11.5 (648)
MUAC category (mm)						
115–119	Recovered	80.9 (1486)	-	-	-	80.9 (1486)
	Defaulted	15.6 (286)	-	-	-	15.6 (286)
≥120	Recovered	89.1 (3402)	-	-	-	89.1 (3402)
	Defaulted	9.5 (362)	-	-	-	9.5 (362)
WAZ category						
<−3	Recovered	76.1 (2168)	65.0 (722)	65.0 (722)	-	83.2 (1446)
	Defaulted	18.4 (523)	24.6 (273)	24.6 (273)	-	14.4 (250)
≥−3	Recovered	86.4 (3843)	75.2 (403)	75.2 (403)	-	87.9 (3440)
	Defaulted	11.0 (491)	17.7 (95)	17.7 (95)	-	10.1 (396)
WaSt						
WHZ < −3 and HAZ < −3	Recovered	69.0 (285)	61.7 (163)	61.7 (163)	-	81.9 (122)
	Defaulted	22.0 (91)	26.5 (70)	26.5 (70)	-	14.1 (21)
WHZ ≥ −3 and HAZ < −3	Recovered	80.5 (1593)	69.5 (283)	69.5 (283)	-	86.3 (1158)
	Defaulted	15.9 (315)	22.4 (91)	22.4 (91)	-	12.3 (165)

TABLE 3 (Continued)

Total	Overall MUAC < 125 mm and/or oedema 7909		SAM phase of treatment MUAC < 115 mm and/or oedema 2255	MUAC < 115 mm without oedema 1678	Oedema 577	MAM phase of treatment MUAC 115–<125 mm 5654
WHZ < −3 and HAZ ≥ −3	Recovered	73.1 (606)	64.4 (215)	64.4 (215)	-	80.7 (381)
	Defaulted	19.7 (163)	24.9 (83)	24.9 (83)	-	15.9 (75)
WHZ ≥ −3 and HAZ ≥ −3	Recovered	83.9 (3935)	74.0 (402)	74.0 (402)	-	87.4 (3227)
	Defaulted	13.0 (608)	18.4 (100)	18.4 (100)	-	10.5 (387)
Screened by						
Passive screening	Recovered	61.7 (635)	50.2 (216)	55.3 (173)	36.8 (43)	69.9 (419)
	Defaulted	32.9 (339)	40.7 (175)	34.8 (109)	56.4 (66)	27.4 (164)
Active screening	Recovered	84.1 (5784)	72.1 (1315)	70.8 (966)	75.9 (349)	88.4 (4469)
	Defaulted	12.2 (838)	19.4 (354)	19.4 (265)	19.3 (89)	9.6 (484)

Abbreviations: CHV, community health volunteer; HAZ, height-for-age z-score; MUAC, mid-upper-arm circumference; WAZ, weight-for-age z-score; WHZ, weight-for-height z-score.

study, which included a decentralised treatment component, reported very high (over 84%) coverage and 0%–0.2% defaulting, suggesting high adherence to treatment despite the emergency context (Charle-Cuéllar et al., 2023; Sánchez-Martínez et al., 2023).

When disaggregating outcomes by health district, we demonstrated the effectiveness of the simplified protocol across all phases of treatment compared to the SPHERE standards in Kémo, while the programme in Kouango-Grimari did not reach SPHERE standards due to high defaulting (Sphere Association, 2018). Defaulting can be associated with a child's failure to thrive (i.e., worsened to unconfirmed hospitalisation or death), geographic barriers such as an inability to access treatment, abrupt discontinuations in service delivery or a caregiver's choice to no longer pursue treatment due to opportunity costs of sociocultural barriers, among others (Akparibo et al., 2017; Bailey et al., 2020). Based on routine data quality reviews during implementation, we attribute the high defaulting rate to contextual factors, including insecurity and inaccessibility, which varied between and within the two health districts, with particularly difficult-to-access areas excluded in both districts before the implementation of the pilot. Kouango-Grimari is generally less geographically accessible and more unstable, with frequent and prolonged facility-level stockouts resulting in the exclusion of nearly 500 cases before analysis (Figure 1).

Unlike other programmes, we do not document longer lengths of stay or frequent missed visits associated with high defaulting (Bailey et al., 2020). Indeed, most children who were classified as defaulters returned for treatment later, outside of the 2-week window. Thus, while their adherence to visit frequency was outside of the protocol, we do not have evidence to suggest dissatisfaction with the treatment regimen itself was the key driver for permanently discontinuing treatment, as many children later returned. This warrants further investigation, as the smaller RUTF ration provided with a simplified treatment regimen has been hypothesised to contribute to defaulting, but not confirmed in other contexts (Bailey et al., 2020; Kangas et al., 2022).

The overall recovery of children admitted with SAM was 67.9%. We identified several vulnerable subgroups among children admitted SAM responding less well to treatment consistent with previous work identifying worse treatment outcomes and higher mortality risk in certain children, including those SAM by both MUAC and WHZ (Bailey et al., 2020; Daures et al., 2019), children with lower MUAC (Burza et al., 2015), severely underweight children (Odei Obeng-Amoako et al., 2023) and children with concurrent wasting and stunting (Bailey et al., 2021; Myatt et al., 2018). Recovery rates among children 2 years and older were similar to younger children; a reassuring finding considering older children tend to be heavier with higher caloric needs that may not be met by a reduced RUTF dose. Our findings contribute evidence that severity of malnutrition at admission is a risk factor for lower recovery; however, in our study, lower recovery was largely driven by higher defaulting rates in vulnerable subgroups.

The most recent figures of AM prevalence in CAR (5.5%) are probably an underestimation as they are based on limited evidence of incidence in the context, prevalence estimates by WHZ and oedema only and only representative of areas accessible to survey (MSP, 2022). We document a high burden of oedematous malnutrition (kwashiorkor) at admission in the population enroled in the pilot—over one in 15 total admissions and one in four of all children admitted to the SAM phase of treatment. Prevalence of oedema is typically noted as high in Central and South Africa compared to other high malnutrition burden contexts (Frison et al., 2015); prevalence per the most recent SMART in CAR was 0.4%—constituting 23% of all SAM children identified and a similar repartition to our admissions (MSP, 2022). We demonstrate that children admitted with bilateral oedema responded similarly to their peers who were SAM by MUAC only when treated with a simplified protocol. This is the first prospective study of response to simplified and combined treatment in an oedematous population, as the sample admitted in other studies has been too low to permit comparison (Bailey et al., 2020; Kangas et al., 2022). The OpTIMA pilot in Niger demonstrated a 75% (5%–99.5%, 95% confidence interval) recovery rate among a total of 12 children admitted with oedema who were treated with an optimised dosage (Phelan et al., 2023).

We demonstrate high recovery, low LOS and low RUTF consumption in children admitted MAM. Of these children, 11% were eligible for SAM treatment per standard protocol based on a WHZ < −3 (MSP, RCA, 2014). This is much lower than in Burkina Faso, Mali and Niger, where 16%–31% of children treated as MAM with a modified protocol would have been eligible for SAM treatment with standard care (Daures et al., 2019; Kangas et al., 2022; Sánchez-Martínez et al., 2023). We note a recovery rate of 81% in this subgroup, compared to 87.4% among children admitted MAM with a WHZ ≥ −3. Among the high-risk MAM groups identified by the WHO guidelines which we were able to assess, we do not note differences in recovery rate among children younger than two or severely underweight by WAZ (WHO, 2023). Recovery was lower among children admitted MAM with a lower MUAC (115–119 mm), but still above 80%. In this setting, recovery differences by subgroups previously identified as responding less well to treatment were less noticeable among children admitted with moderate as opposed to severe malnutrition.

The average LOS and RUTF consumption among SAM patients was 51.7 days and 77 sachets, respectively, lower than in both the ComPAS trial and the Mali pilot, as well as in Democratic Republic of the Congo, Niger and Burkina Faso using the OptiMA dosage, which uses a generally larger, progressively reduced dose based on MUAC and weight (Bailey et al., 2020; Cazes et al., 2023; Daures et al., 2019; Kangas et al., 2022; Phelan et al., 2023). RUTF consumption was similar to a programme implementing the ComPAS protocol through a decentralised CHW delivery in Mali, while the LOS of SAM patients in our study was approximately 1 week longer than the trial (42 days) (Lopez-Ejeda et al., 2024). Current SAM programmes typically plan RUTF consumption between 120 and 150 sachets per child treated, while MAM programmes plan between 60 and 90 sachets of RUSF per child (Global Nutrition Cluster MAM Task Force, 2017; UNICEF, 2013). This study confirmed the potential for cost savings when using the simplified, combined protocol among SAM patients that must be further explored with comparisons to historical data and/or future findings with a standard protocol.

When considering total programme costs, however, comparisons to a SAM-only programme must consider additional children treated with a simplified, combined protocol. While MAM treatment is included in the national protocol, it was not continuously available in the study context before the pilot—therefore, these children defined MAM by standard treatment were not benefitting from treatment. As children with MAM have threefold risk of mortality compared to nonmalnourished children and would have contributed significantly to negative health outcomes in the area (Black et al., 2008). The pilot enroled more than 9000 children for the treatment of acute malnutrition, compared to approximately 3000 children treated for SAM in the same geographic zones in the year before the study, according to unpublished programme data, representing a threefold increase in the number of children treated with the simplified protocol.

The strengths of this study include a high sample size, with nearly 8000 treatment episodes suitable for analysis and construction and maintenance of an individual database in a difficult context. Data were collected in a routine programme setting; our findings on effectiveness are directly measured, as opposed to modelled. We report outcomes for the aggregate programme but also disaggregated by health district, adding the first evidence of an alternative acute malnutrition treatment protocol in CAR.

The main limitation of the current study was the absence of comparison to standard treatment in the same health districts thus preventing us from speaking to any potential differences between the simplified and standard protocols. Second, while we excluded certain catchment areas that would not benefit from sufficient supervision, treatment quality still suffered due to insecurity in certain areas during implementation. We can account for neither the qualitative differences between the two contexts—including, for example, the effects of startup of a new programme by a new partner in one district, nor the negative impact on health seeking behaviour in a context with supply disruption.

The pilot benefitted from technical oversight by an international nongovernmental organisation and monthly reviews by a technical advisory committee and hence, may reflect performance levels associated with well-supported interventions. While we relied on data collected by routine health care workers, we had robust supervision in place and thoroughly checked and cleaned the data before analysis, conservatively excluding only defaulting due to stockouts confirmed by multiple sources, thus ensuring our confidence in the analyses. The reclassification of children erroneously categorised at exit by health personnel lowered the recovery rate, as has been documented in other work regarding malnutrition treatment in a routine setting (Daures et al., 2019).

5 | CONCLUSIONS

In conclusion, the results showed that the simplified, combined protocol resulted in an acceptable recovery compared to SPHERE standards, low LOS and low RUTF consumption per child among all children treated. Response to treatment was similar among children admitted SAM by oedema and those admitted SAM by MUAC. We identified several vulnerable subgroups of children admitted with SAM presenting lower recovery and less noticeable differences for children admitted with MAM. Contextual factors such as insecurity resulting in inaccessibility of health facilities and stockouts in treatment products affect programme outcomes by increasing defaulting and decreasing recovery. The simplified, combined protocol might present an opportunity to treat more children with less product and means to improve delivery in challenging contexts should be explored, including the use of community health workers to deliver decentralised care.

AUTHOR CONTRIBUTIONS

M'bary Siolo Mada Bebelou, Benedict Tabiojong Mbeng, Anne Marie Dembele, Annie Fossi, Théophile Bansimba, Issa Niamanto Coulibaly, Victor Nikièma, and Suvi T. Kangas contributed to the design of the research and oversaw implementation. Zachary Tausanovitch and Loubah Gondjé Christian analysed the data. Grace Heymsfield wrote the manuscript. All authors have critically reviewed the manuscript and contributed to interpretation of the data. All authors read and approved the final manuscript.

ACKNOWLEDGEMENTS

We appreciate the vital contributions made by the Technical Advisory Committee and those who participated in the technical workshops to review programme findings. We thank all caregivers, study participants and staff at study health facilities who generously provided their time and with whom this study would not have been possible. Finally, a special thanks to Dr. Parfait Constant Seboulou (MSP RCA), Elyse Doron-Dambiti (MSP, RCA), Destinee Nadia Kimbolo (MDA), Gnagna Ndiaye (WFP), Mahamadou Tanimoune (WFP), Dr. Marie-Louis Boyos (UNICEF), Dr. Simeon Nanama (UNICEF), and Dr. Bruno Aholoukpe (UNICEF) for their invaluable support of the study.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ORCID

Grace Heymsfield http://orcid.org/0009-0004-2614-2215

REFERENCES

Action Against Hunger. (2018). *Accelerating action for children with acute malnutrition*. https://static1.squarespace.com/static/58da81cdd1758e39ca705526/t/5a7adf8171c10b8aa3b4462f/1518002053092/No+Wasted+Lives+Brochure+2018.pdf

Akparibo, R., Lee, A. C. K., & Booth, A. (2017). *Recovery, relapse and episodes of default in the management of acute malnutrition in children in humanitarian emergencies: A systematic review*. Humanitarian Evidence Programme. Oxfam GB. https://fic.tufts.edu/wp-content/uploads/Acute-Malnutrition-Systematic-Review.pdf

Bailey, J., Lelijveld, N., Khara, T., Dolan, C., Stobaugh, H., Sadler, K., Lino Lako, R., Briend, A., Opondo, C., Kerac, M., & Myatt, M. (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*, 1054. https://doi.org/10.3390/nu13031054

Bailey, J., Lelijveld, N., Marron, B., Onyoo, P., Ho, L. S., Manary, M., Briend, A., Opondo, C., & Kerac, M. (2018). Combined protocol for acute malnutrition study (ComPAS) in rural South Sudan and urban Kenya: Study protocol for a randomized controlled trial. *Trials*, *19*, 251. https://doi.org/10.1186/s13063-018-2626-0

Bailey, J., Opondo, C., Lelijveld, N., Marron, B., Onyo, P., Musyoki, E. N., Adongo, S. W., Manary, M., Briend, A., & Kerac, M. (2020). A simplified, combined protocol versus standard treatment for acute malnutrition in children 6–59 months (ComPAS Trial): A cluster-randomized controlled non-inferiority trial in Kenya and South Sudan. *PLoS Medicine*, *17*, e1003192. https://doi.org/10.1371/journal.pmed.1003192

Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., Mathers, C., Rivera, J., & Maternal and Child Undernutrition Study Group. (2008). Maternal and child undernutrition: Global and regional exposures and health consequences. *The Lancet*, *371*(9608), 243–260. https://doi.org/10.1016/S0140-6736(07)61690-0

Burza, S., Mahajan, R., Marino, E., Sunyoto, T., Shandilya, C., Tabrez, M., Kumari, K., Mathew, P., Jha, A., Salse, N., & Mishra, K. N. (2015). Community-based management of severe acute malnutrition in India: New evidence from Bihar. *The American Journal of Clinical Nutrition*, *101*(4), 847–859. https://doi.org/10.3945/ajcn.114.093294

Cazes, C., Phelan, K., Hubert, V., Boubacar, H., Bozama, L. I., Sakubu, G. T., Senge, B. B., Baya, N., Alitanou, R., Kouamé, A., Yao, C., Gabillard, D., Daures, M., Augier, A., Anglaret, X., Kinda, M., Shepherd, S., & Becquet, R. (2023). Optimising the dosage of ready-to-use therapeutic food in children with uncomplicated severe acute malnutrition in the Democratic Republic of the Congo: A non-inferiority, randomised controlled trial. *EClinicalMedicine*, *58*, 101878. https://doi.org/10.1016/j.eclinm.2023.101878

Charle-Cuéllar, P., Lopez-Ejeda, N., Aziz Gado, A., Dougnon, A. O., Sanoussi, A., Ousmane, N., Hamidou Lazoumar, R., Sánchez-Martínez, L. J., Toure, F., Vargas, A., & Guerrero, S. (2023). Effectiveness and coverage of severe acute malnutrition treatment with a simplified protocol in a humanitarian context in Diffa, Niger. *Nutrients*, *15*(8), 1975. https://doi.org/10.3390/nu15081975

Chase, R. P., Kerac, M., Grant, A., Manary, M., Briend, A., Opondo, C., & Bailey, J. (2020). Acute malnutrition recovery energy requirements based on mid-upper arm circumference: Secondary analysis of feeding program data from 5 countries, combined protocol for acute malnutrition study (ComPAS) stage 1. *PLoS One*, *15*, e0230452. https://doi.org/10.1371/journal.pone.0230452

Collins, S., Dent, N., Binns, P., Bahwere, P., Sadler, K., & Hallam, A. (2006). Management of severe acute malnutrition in children. *The Lancet*, *368*(9551), 1992–2000. https://doi.org/10.1016/S0140-6736(06)69443-9

Daures, M., Phelan, K., Issoufou, M., Kouanda, S., Sawadogo, O., Issaley, K., Cazes, C., Séri, B., Ouaro, B., Akpakpo, B., et al. (2019). New approach to simplifying and optimizing acute malnutrition treatment in children aged 6 to 59 months: The OptiMA single-arm proof-of-concept trial in Burkina Faso. *British Journal of Nutrition*, *123*, 1–31. https://doi.org/10.1017/S000711451900307X

Frison, S., Checchi, F., & Kerac, M. (2015). Omitting edema measurement: How much acute malnutrition are we missing? *The American Journal of Clinical Nutrition*, *102*(5), 1176–1181. https://doi.org/10.3945/ajcn.115.108282

Gang, K. B. A., O'Keeffe, J., Anonymous, & Roberts, L. (2023). Cross-sectional survey in Central African Republic finds mortality 4-times higher than UN statistics: How can we not know the Central African Republic is in such an acute humanitarian crisis? *Conflict and health*, *17*, 21. https://doi.org/10.1186/s13031-023-00514-z

Girma, T., James, P. T., Abdissa, A., Luo, H., Getu, Y., Fantaye, Y., Sadler, K., & Bahwere, P. (2022). Nutrition status and morbidity of Ethiopian children after recovery from severe acute malnutrition: Prospective matched cohort study. *PLoS One*, *17*(3), e0264719. https://doi.org/10.1371/journal.pone.0264719

Global Nutrition Cluster MAM Task Force. (2017). *Moderate acute malnutrition: A decision tool for emergencies*. https://www.nutritioncluster.net/resources/decision-tool-mam-emergencies-2014-updated-2017

Humanitarian Response Plan (HRP). (2023). *République centrafricaine: Plan de réponse humanitaire 2023 (janvier 2023)*.

Integrated Phase Classification (IPC). (2021). *Central African Republic*. https://www.ipcinfo.org/ipc-country-analysis/details-map/fi/c/1155302/?iso3=CAF

Integrated Phase Classification (IPC). (2022). *République Centrafricaine (RCA): Analyse de l'insécurité alimentaire aiguë*. https://reliefweb.int/report/central-african-republic/r-publique-centrafricaine-rca-analyse-de-l-ins-curit-alimentaire-aig

Kangas, S. T., Marron, B., Tausanovitch, Z., Radin, E., Andrianarisoa, J., Dembele, S., Ouédraogo, C. T., Coulibaly, I. N., Biotteau, M., Ouologuem, B., Daou, S., Traoré, F., Traoré, I., Nene, M., & Bailey, J. (2022). Effectiveness of acute malnutrition treatment at health center and community levels with a simplified, combined protocol in Mali: An observational cohort study. *Nutrients*, *14*(22), 4923. https://doi.org/10.3390/nu14224923

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*, *16*, e1002887. https://doi.org/10.1371/journal.pmed.1002887

Katona, P., & Katona-Apte, J. (2008). The interaction between nutrition and infection. *Clinical Infectious Diseases*, *46*(10), 1582–1588. https://doi.org/10.1086/587658

Lelijveld, N., Musyoki, E., Adongo, S. W., Mayberry, A., Wells, J. C., Opondo, C., Kerac, M., & Bailey, J. (2021). Relapse and post-discharge body composition of children treated for acute malnutrition using a simplified, combined protocol: A nested cohort from the ComPAS RCT. *PLoS One*, *16*, e0245477. https://doi.org/10.1371/journal.pone.0245477

Leroy, J. (2011). *ZSCORE06: Stata module to calculate anthropometric z-scores using the 2006 WHO child growth standards* (Statistical Software Components S457279). Boston College Department of Economics.

López-Ejeda, N., Charle-Cuéllar, P., Samake, S., Dougnon, A. O., Sánchez-Martínez, L. J., Samake, M. N., Bagayoko, A., Bunkembo, M., Touré, F., Vargas, A., & Guerrero, S. (2024). Effectiveness of decentralizing outpatient acute malnutrition treatment with community health workers and a simplified combined protocol: A cluster randomized controlled trial in emergency settings of Mali. *Frontiers in Public Health*, *12*, 1283148. https://doi.org/10.3389/fpubh.2024.1283148

Maust, A., Koroma, A. S., Abla, C., Molokwu, N., Ryan, K. N., Singh, L., & Manary, M. J. (2015). Severe and moderate acute malnutrition can be successfully managed with an integrated protocol in Sierra Leone. *The Journal of Nutrition*, *145*(11), 2604–2609. https://doi.org/10.3945/jn.115.215251

Ministre de la Santé et de la Population (MSP), RCA. (2014). Protocole national de prise en charge intégrée de la malnutrition aiguë.

Ministre de la Santé et de la Population (MSP), RCA. (2018). Carte Sanitaire de la République Centrafricaine (Mise à jour de 2018).

Ministre de la Santé et de la Population (MSP), RCA. (2020). Rapport final. Enquête nationale sur la situation nutritionnelle et la mortalité en République Centrafricaine 2020.

Ministere de la Sante et La Population (MSP), RCA. (2022). Rapport final enquete nationale nutritionelle et de mortalitie retrospective. Selon la Méthodologie SMART.

Myatt, M., Khara, T., Schoenbuchner, S., Pietzsch, S., Dolan, C., Lelijveld, N., & Briend, A. (2018). Children who are both wasted and stunted are also underweight and have a high risk of death: A descriptive epidemiology of multiple anthropometric deficits using data from 51 countries. *Archives of Public Health*, *76*, 28. https://doi.org/10.1186/s13690-018-0277-1

Odei Obeng-Amoako, G. A., Stobaugh, H., Wrottesley, S. V., Khara, T., Binns, P., Trehan, I., Black, R. E., Webb, P., Mwangome, M., Bailey, J., Bahwere, P., Dolan, C., Boyd, E., Briend, A., Myatt, M. A., & Lelijveld, N. (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*, 13434. https://doi.org/10.1111/mcn.13434

Olofin, I., McDonald, C. M., Ezzati, M., Flaxman, S., Black, R. E., Fawzi, W. W., Caulfield, L. E., & Danaei, G. (2013). Associations of suboptimal growth with all-cause and cause-specific mortality in children under five years: A pooled analysis of ten prospective studies. *PLoS One*, *8*(5), e64636. https://doi.org/10.1371/journal.pone.0064636

Phelan, K., Seri, B., Daures, M., Yao, C., Alitanou, R., Aly, A. A. M., Maidadji, O., Sanoussi, A., Mahamadou, A., Cazes, C., Moh, R., Becquet, R., & Shepherd, S. (2023). Treatment outcomes and associated factors for hospitalization of children treated for acute malnutrition under the OptiMA simplified protocol: A prospective observational cohort in rural Niger. *Frontiers in Public Health*, *11*, 1199036. https://doi.org/10.3389/fpubh.2023.1199036

Sánchez-Martínez, L. J., Charle-Cuéllar, P., Gado, A. A., Dougnon, A. O., Sanoussi, A., Ousmane, N., Lazoumar, R. H., Toure, F., Vargas, A., Hernández, C. L., & López-Ejeda, N. (2023). Impact of a simplified treatment protocol for moderate acute malnutrition with a decentralized treatment approach in emergency settings of Niger. *Frontiers in Nutrition*, *10*, 1253545. https://doi.org/10.3389/fnut.2023.1253545

Sphere Association. (2018). *The sphere handbook: Humanitarian charter and minimum standards in humanitarian response* (4th ed.). https://spherestandards.org/wp-content/uploads/Sphere-Handbook-2018-EN.pdf

UNICEF. (2021). *Global annual results report 2020: Goal area 1: Every child survives and thrives*. https://www.unicef.org/reports/global-annual-results-2021-goal-area-1

UNICEF. (2023). *Ready-to-use therapeutic food market and supply update, May 2023*. https://www.unicef.org/supply/media/17331/file/Ready-to-Use-Therapeutic-Food-Market-and-Supply-Update-May-2023.pdf

UNICEF; WHO; International Bank for Reconstruction and Development/The World Bank. (2023). *Levels and trends in child malnutrition: Key findings of the 2023 edition of the joint child malnutrition estimates*. WHO. https://iris.who.int/bitstream/handle/10665/368038/9789240073791-eng.pdf?sequence=1

United Nations International Children's Emergency Fund (UNICEF). (2013). *Ready-to-use therapeutic food for children with severe acute malnutrition* (Position Paper No. 1). https://www.unicef-irc.org/files/documents/d-3838-Position-Paper–Ready-to-.pdf

WHO. (2023). *Guideline: Updates on the management of severe acute malnutrition in infants and children*. https://www.who.int/news/item/20-11-2023-who-issues-new-guideline-to-tackle-acute-malnutrition-in-children-under-five

WHO; UNICEF. (2009). *WHO child growth standards and the identification of severe acute malnutrition in infants and children: A joint statement by the World Health Organization and the United Nations Children's Fund*. UNICEF. https://iris.who.int/bitstream/handle/10665/44129/9789241598163_eng.pdf?sequence=1

World Food Programme (WFP). (2016). *Technical Specifications for Ready-to-Use Supplementary Food (RUSF) (Specification Reference: MIXRSF000)*.

World Health Organization (WHO) Multicentre Growth Reference Study Group. (2006). *WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development*. https://www.who.int/publications/i/item/924154693X

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Heymsfield, G., Tausanovitch, Z., Christian, L. G., Bebelou, M. S. M., Mbeng, B. T., Dembele, A. M., Fossi, A., Bansimba, T., Coulibaly, I. N., Nikièma, V., & Kangas, S. T. (2024). Effectiveness of acute malnutrition treatment with a simplified, combined protocol in Central African Republic: An observational cohort study. *Maternal & Child Nutrition*, *20*, e13691. https://doi.org/10.1111/mcn.13691