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Utilization patterns, outcomes and costs of a simplified acute malnutrition treatment programme in Burkina Faso

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Abstract

Access to treatment for acute malnutrition remains a challenge, in part due to the fragmentation of treatment programmes based on case severity. This paper evaluates utilization patterns, outcomes and associated costs for treating acute malnutrition cases among a cohort of children in Burkina Faso. This study is a secondary analysis of a proof-of-concept trial, called Optimizing treatment for acute Malnutrition (OptiMA), conducted in Burkina Faso in 2016. A total of 4958 eligible children whose mid-upper arm circumference (MUAC) was less than 125 mm or with oedema were followed weekly and given ready-to-use therapeutic foods (RUTF). We evaluated the service utilization and outcomes among patients and estimated resource use and variable cost per patient, and examined factors driving variation in resource use. Children with lower initial MUAC level grew faster but required more time to recover than those with higher initial MUAC level. They also had higher rates of death, default and nonresponse. The simplified OptiMA approach for treating acute malnutrition achieved high rates of recovery overall (84%), especially among less severe cases, with modest quantities of RUTF. The average overall variable cost per child admitted was US $38.0 (SD: 20.5) half of which was accounted for by the cost of RUTF. Cost per recovered case was correlated with case severity, ranging from US$35.1 to US$132.8. If simplified integrated programmes using severity-based RUTF dosing can increase access to treatment at earlier, less severe stages of acute malnutrition, they can help avoid more serious and costlier cases.

KEYWORDS

chronic malnutrition, evaluation, low income countries, malnutrition, policy, public health

1 | INTRODUCTION

Childhood malnutrition is a widespread global health problem. About 45 million children under the age of 5 are wasted, of which 14 million are severely wasted (United Nations Children's Fund [UNICEF], et al., 2021), and 149 million are stunted. Malnutrition is associated with nearly 45% of childhood deaths (World Health Organization [WHO], 2021).[1] Evidence based on incidence rates suggest that the actual number of children affected could be much higher (Isanaka et al., 2021). The prevalence of stunting in West Africa where Burkina Faso belongs to is 27.7% and it is higher than the world average of 21.3% (UNICEF et al., 2021). Less than 30% of children with acute malnutrition have access to the treatment globally (Micha et al., 2020), despite the proven efficacy of a package of nutritional supplementation and treatment of comorbid infections, plus intensive monitoring.

Under standard practice, acute malnutrition is divided into moderate (MAM) and severe acute malnutrition (SAM). Traditionally, different organizations treat cases of MAM and SAM, using different protocols and different treatment products (Burkina Faso Ministry of Health, 2014; Lenters et al., 2016). Programmes to treat malnutrition often face substantial financial constraints, making it imperative to design effective and efficient protocols that can maximize impact for every dollar invested (Chui et al., 2020).

The Optimizing Treatment for Acute Malnutrition (OptiMA) approach was designed to improve efficiency of resource use by merging and simplifying the protocols for treating MAM and SAM. See Daures et al. (2020) for the detailed description of the OptiMA study. In Burkina Faso, OptiMA made three changes to the existing national nutrition protocol; (1) screening for acute malnutrition was done at home by caretakers trained to use mid-upper arm circumference (MUAC) bracelets, rather than in health facilities and by health workers, (2) the case definition was simplified by omitting weight-for-height *Z*-score as a criterion and using only MUAC < 125 mm and/or oedema, and (3) only one product—ready-to-use therapeutic food (RUTF)—was used for treatment, with dosage that was reduced as the child's weight and MUAC status improved. Under the OptiMA approach, treatment of MAM and SAM was combined in a single protocol, with a focus on early detection, using only MUAC as the anthropomorphic measure for diagnosis and discharge, and applying an RUTF dosage schedule that tapers as the patient's condition improves.

This paper analyses the clinical outcomes and resource utilization patterns for patients participating in the single-arm proof-of-concept OptiMA trial in Burkina Faso in 2016 (OptiMA is also being tested in the Democratic Republic of Congo, Mali and Niger). It examines the patterns of resource use as malnourished children moved through treatment under the OptiMA protocol, and estimates the average treatment costs per child admitted to the study and assesses the main drivers of variation in costs.

Key messages

- This paper evaluates utilization patterns, outcomes, and associated costs for treating acute malnutrition cases among a cohort of children in Burkina Faso.
- Children with lower initial mid upper arm circumference (MUAC) level grew faster but required more time to recover than those with higher initial MUAC level.
- The average cost per child admitted was US$38.0 half of which was accounted for by the cost of ready to use therapeutic foods (RUTF).
- If simplified programs can increase access to treatment at earlier, less severe stages of acute malnutrition, they can help avoid more serious and costlier cases.

2 | METHODS

2.1 | OptiMA study, study population and data

This study is a secondary analysis of the OptiMA proof-of-concept trial conducted in Yako Health District, Burkina Faso (Daures et al., 2020). Data were collected among 4958 children aged 6–59 months with a MUAC less than 125 mm or with oedema without medical complication and who presented to any of the 54 outpatient clinics in the district. Progress was monitored through the course of treatment on an approximately weekly basis. MUAC, weight and height were recorded at the health centre, as well as the prevalence of any sickness (e.g., lack of appetite, fever, diarrhoea, malaria), medications prescribed and the quantity of RUTF sachets provided. At the first visit to the health center, information on socio-demographic status was also collected, including age, sex and whether mothers of the children were alive or not. If children were admitted for inpatient treatment, their progress in terms of health conditions, medications and the quantity of RUTF consumed was recorded daily.

Once enrolled in the study, children received weekly supply of RUTF sachets based on MUAC and weight. Children were considered recovered if they achieved MUAC ≥ 125 mm without oedema for 2 consecutive weeks, were in good clinical health, with had been in the programme for at least 4 weeks, at which point they were discharged from the study. The other mutually exclusive health outcomes included: death, default and nonresponse. Default was triggered once children were absent for three consecutive visits. Nonresponse indicated failure to achieve recovery after 12 weeks in the programme. A small number of patients nevertheless continued on treatment beyond 12 weeks, based on clinical assessment, and about half of

[1] Wasting is defined as children with low weight for height, with acute malnutrition also including children with low mid-upper arm circumference (MUAC) and/or bilateral pitting oedema, while stunting or chronic malnutrition refers to children with low height for age (WHO, 2019; WHO & UNICEF, 2009).

TABLE 1 Unit price for utilization and medications

Category	Unit price in US dollars (2020)	Data source
Utilization		
Inpatient visit cost (primary level hospital) per day	5.13	WHO-CHOICE (2011)
RUTF (one sachet)	0.33	UNICEF (2019)
Outpatient visit cost (Health centre, no beds) per visit	1.38	WHO-CHOICE (2011)
Medications		
Bacterial infection		
Amoxicillin 250 mg	0.29	MSF supply (2020)
Deworming		
Mebendazole 100 mg (for children ≤2 years) or	0.93	MSF supply (2020)
Albendazole 400 mg (for children >2 years)	0.04	MSF supply (2020)
Dehydration		
ReSoMal (Rehydration Solution for Malnutrition) 84 g/2 L	0.95	MSF supply (2020)
Candidiasis		
Oral Nystatin	1.43	MSF supply (2020)
Malaria		
Malaria RDT	0.54	MSF supply (2020)
AL (antimalaria) 20/120 mg 5–14 kg	2.30	MSF supply (2020)

Abbreviation: AL, artemether-lumefantrine; RDT, malaria rapid diagnostic test.

these patients ultimately recovered. However, in this analysis, we focus on outcomes at 12 weeks.

2.1.1 | Cost evaluation method

To measure costs, we used various data sources (see Table 1). We divided resource use into four categories: outpatient clinic visits, inpatient stays (hospitalization), RUTF provided and medication. Unit costs for outpatient clinic visits and inpatient stays were estimated using WHO-CHOICE estimates of country-specific service delivery costs (WHO, 2011), which include labour and capital costs, but not costs for medications, lab tests, or other procedures, or costs that have been incurred by patients' families (e.g., for transportation to clinic). We estimated medication cost during hospitalization from data from a similar pilot study in Niger that was recently conducted by the same organization. Our analysis mainly focuses on variable costs. Our estimates do not include programme-specific overhead or start-up costs (e.g., for management/supervision or training for health staff and caregivers) and omit supply-chain costs for RUTF above clinic-level (e.g., transportation, warehousing, supply chain labour).

2.2 | Data analysis

Data analysis was conducted using Stata SE15.1.

Since we hypothesized that nutrition outcomes and resource use were likely to be correlated with disease severity and duration of treatment, as a proxy for malnutrition severity we divided patients into four categories according to their MUAC at treatment initiation: 120 ≤ MUAC < 125, 115 ≤ MUAC < 120, 110 ≤ MUAC < 115, MUAC < 110.

The cumulative proportion of children who recovered, defaulted or died by a certain time in treatment was calculated according to the initial MUAC status. For each category, we examined the average duration of treatment, the number of clinic visits, inpatient days, RUTF sachets and medications used. Total treatment cost in the study was calculated by multiplying the quantity of each resource used by its unit cost and summing across resource categories.

3 | RESULTS

Table 2 Panel A presents the summary statistics of the children in the patient cohort, which are consistent with those previously reported for the Burkina pilot project by Daures et al. (2020). On average, children were about 15 months old, less than half of them (41%) were male, and mothers of most of children (97%) were alive. At the time of admission, the average MUAC of children was 118.7 mm, average weight about 7 kg and average height 71.8 cm. Children were younger, had lower weight and shorter height if the initial MUAC was lower, with these differences statistically significant (p-value <0.01; table not shown).

TABLE 2 Summary statistics and cumulative % recovery

	Initial MUAC				
	MUAC < 110	110 ≤ MUAC < 115	115 ≤ MUAC < 120	120 ≤ MUAC < 125	Total
N	189	627	1070	3064	4958
Panel A: Summary statistics					
Age (months)	12.0 (9.27)	12.7 (7.74)	14.5 (8.54)	15.7 (8.89)	15.0 (8.80)
Sex (male) (%)	39.2 (48.9)	39.9 (49.0)	39.3 (48.9)	42.8 (49.5)	41.5 (49.3)
Mother is alive (%)	95.2 (21.4)	95.5 (20.7)	97.0 (17.0)	97.3 (16.1)	96.9 (17.2)
Initial MUAC	101.5 (6.85)	111.9 (1.69)	116.8 (1.47)	121.7 (1.59)	118.7 (5.26)
Initial weight (kg)	5.24 (1.32)	6.15 (1.12)	6.75 (1.21)	7.35 (1.27)	6.99 (1.36)
Initial height (cm)	65.1 (8.34)	68.7 (6.77)	71.0 (7.07)	73.1 (7.27)	71.8 (7.50)
Panel B: Cumulative % recovery					
(1) Sample: All					
% recovery by 4 weeks	2.6	9.1	20.9	45.1	33.7
% recovery by 6 weeks	14.8	30.9	52.1	76.5	63.1
% recovery by 8 weeks	26.5	47.8	67.8	84.8	74.2
% recovery by 10 weeks	37.6	59.6	76.4	88.5	80.3
% recovery by 12 weeks	48.1	67.9	81.5	90.3	84.0
(2) Sample: Among those who recovered by 12 weeks					
% recovery by 4 weeks	5.5	13.4	25.7	50.0	40.1
% recovery by 6 weeks	30.8	45.5	64.0	84.7	75.1
% recovery by 8 weeks	55.0	70.4	83.1	93.9	88.4
% recovery by 10 weeks	78.0	87.8	93.8	98.1	95.7
% recovery by 12 weeks	100.0	100.0	100.0	100.0	100.0

Note: Total sample includes 8 observations with oedema and MUAC ≥ 125. Standard deviation in parentheses in Panel A. The total number of observations is 4958 which includes 8 observations that had MUAC 125 and above.
Abbreviation: MUAC, mid-upper arm circumference.

Table 2 Panel B presents the proportion of children recovered by a certain time, according to the initial MUAC level. Panel B1 shows the proportion of recovered children among the total sample in each MUAC category, while Panel B2 presents the proportion among only the children who recovered by 12th week. At any given time from the point of admission, children with lower initial MUAC had less likelihood of recovery than children with higher initial MUAC. For example, the proportion of all children who recovered was 48.1% if the initial MUAC was less than 110 mm, while the proportion was 81.5% if the initial MUAC was between 115 and 120 mm (Panel B1). We observed a similar trend when we restricted the sample to children who achieved recovery by Week 12 (Panel B2). For example, among these children, the proportion who recovered by 8th week was 55.0% if the initial MUAC was less than 110 mm, while the proportion was 83.1% if the initial MUAC was between 115 and 120 mm.

In general, the proportion of children in any subgroup who recovered increased over time. However, among children with the lowest initial MUAC (less than 100 mm), the proportion who recovered was still rising at 84th day (12th week), while the proportion gaining arm circumference plateaued by Week 12 among children with initial MUAC of 120–125 mm (Table 2 Panel B). On the other hand, the proportion of children with nonresponse was higher if the initial MUAC was lower, with the proportion of nonresponders dropping as the initial MUAC level rose (table not shown).

Table 3 presents the summary statistics on service utilization and treatment. On average, children visited health facilities for RUTF treatment 6.8 times, and the average amount RUTFs received throughout was 58 sachets. Some children received medications during their visits for the treatment of infectious diseases and related symptoms like diarrhoea and dehydration which exacerbate malnourishment. See Table 1 for the specifics. A large share of children received antibiotics for bacterial infection (amoxicillin) (78%) and Albendazole or Mebendazole for deworming (82%), while ReSoMal for dehydration and oral Nystatin for candidiasis were given only for children admitted to hospital (overall uptake of about 1%). Around 28% of children had positive malaria test results. Among children who received medication, most received it only once, regardless of the type of medication (table not shown). For example, 84% of children who received antibiotics for bacterial infection received it once, 15% twice or three times and the remaining 1% more than three times. Thus, the average child who received antibiotics for bacterial infection received it 1.2 times. For other medications, such as for dehydration and candidiasis, and malaria tests, we observed a similar pattern in that most children who received medication or testing received it only once.

TABLE 3 Utilization and medications (12 weeks and below)

	Mean	Std. dev.	CI	
Utilization				
Number of outpatient visits	6.76	2.39		
Number of RUTF sachets received	58.0	26.4		
Hospital stay (%)	13.7	34.4	12.8	14.7
Number of inpatient days per hospitalization (among hospitalized)	8.28	5.07		
Medications and tests				
Ever received medication for (%)				
Bacterial infection	77.8	41.6	76.6	78.9
Deworming	81.6	38.7	80.5	82.7
Dehydration	1.3	11.5	1.0	1.7
Candidiasis	1.2	10.9	0.9	1.5
Malaria test = positive	27.8	44.8	26.5	29.0

Note: The number of observations is 4958. The records on medications were only during the study period.

Abbreviations: CI, confidence interval; RUTF, ready-to-use therapeutic food; Std. dev., standard deviation.

The number of outpatient visits and of RUTF sachets received was highest among children with initial MUAC less than 110 mm (Table 4). Hospitalization, both frequency and duration, was also highest among children with the lowest initial MUAC. Among the 13.7% of total patients who were ever hospitalized during the study period, the average duration of hospital stay was 8.3 days. Among all children, the average duration was less than 1 day (0.99) (table not shown).

On average, it cost US$38.0 to treat one child admitted for acute malnutrition using the OptiMA protocols in Yako (Table 5). RUTF was the major cost driver, at US$19.3 (50.8% of total cost), followed by outpatient care (US$9.9, 25.9%) and hospitalization (US$7.3, 19.2%). The cost of hospitalization among those actually hospitalized was US $42.4 (table not shown). The average cost for treating other diseases was US$1.6 (4.1%). Cost per patient treated varied from US$31.7 in the group with initial MUAC 120–125 to US$63.9 in the group with initial MUAC less than 110.

When we account for overall recovery rate of 84%, the cost per recovered patient was US$45.2 but ranged widely by initial MUAC. For patients with the mildest cases—initial MUAC between 120 and 125 mm—of whom 90.3% recovered and average time to recovery was about 5 weeks, the average cost per recovered patient was US $35.1. Since the fraction who recovered declined and the duration of treatment increased with lower initial MUAC, the cost per recovered patient was substantially higher for the more severe cases. Among those with initial MUAC < 110, the cost per recovered patient was US $132.8—about four times higher than for the mildest cases. For these most severe cases, less than half recovered by 12 weeks, and many of those who did recover needed all 12 weeks to do so.

We also estimated the costs based on whether a child presented with the WHO definition of SAM (MUAC < 115 mm and/or WHZ < −3, and/or presence of oedema) or MAM (MUAC between

TABLE 4 Service utilization, by initial MUAC (12 weeks and below)

	Initial MUAC				
	MUAC< 110 (*N* = 189)	110 ≤ MUAC< 115 (*N* = 627)	115 ≤ MUAC< 120 (*N* = 1070)	120 ≤ MUAC< 125 (*N* = 3064)	Total (*N* = 4958)
Utilization					
Number of outpatient visits	9.11	8.39	7.37	6.09	6.76
Number of RUTF sachets received	86.6	80.5	64.4	49.5	58.0
Hospital stay (%)	45.8	26.7	16.7	7.2	13.7
Number of inpatient days per hospitalization (among hospitalized)	11.17	8.37	7.93	7.38	8.28

Note: The total number of observations is 4958 which includes 8 observations that had MUAC 125 and above.

Abbreviations: MUAC, mid-upper arm circumference; RUTF, ready-to-use therapeutic food.

TABLE 5 Cost estimate (USD 2020) of programme

	Overall			Cost by initial MUAC at admission				
	Mean	Std. dev.	Breakdown of total costs (%)	MUAC < 110 (N = 178)	110 ≤ MUAC < 115 (N = 595)	115 ≤ MUAC < 120 (N = 1038)	120 ≤ MUAC < 125 (N = 3015)	Total for all participants (N = 4958)
Total costs per patient	$38.01	20.52	100.0	$63.87	$53.26	$42.98	$31.69	$188,454
Outpatient care	$9.86	3.28	25.9	$13.18	$12.11	$10.71	$8.93	$48,886
RUTF	$19.30	8.72	50.8	$28.32	$26.68	$21.51	$16.54	$95,689
Hospitalization	$7.31	14.32	19.2	$20.80	$12.79	$9.07	$4.75	$36,243
Medications	$1.55	1.12	4.1	$1.56	$1.68	$1.69	$1.48	$7685
Percent recovered	84.0%			48.1%	67.9%	81.5%	90.3%	
Total costs per recovered patient	$45.25			$132.79	$ 78.44	$ 52.74	$ 35.10	

Note: The cost analysis by initial MUAC is based on 4834 (4826 with MUAC < 125, and 8 with MUAC ≥ 125) observations that have a valid information on the date of each visit. When we calculate the total costs for all participants, we included all the sample (*N* = 4958). The cost of hospitalization were incurred only among 13.7% of patients who were admitted for inpatient visits, but this cost was divided by the total number of patients regardless of inpatient status. Similar logic applies to medication costs.

Abbreviations: MUAC, mid-upper arm circumference; RUTF, ready-to-use therapeutic food; Std. dev., standard deviation.

TABLE 6 Cost estimate (USD 2020) of programme SAM versus MAM

	SAM (*N* = 1715)	MAM (*N* = 3243)
Total costs per patient	$45.40	$33.92
Outpatient care	$10.86	$9.30
RUTF	$22.40	$17.58
Hospitalization	$10.55	$5.51
Medications	$1.59	$1.53
Percent recovered	76.1	88.5
Total costs per recovered patient	$59.65	$38.33

Note: SAM is defined as having one of the following characteristics: MUAC < 115, oedema, or WHZ < −3. All patients in the study not meeting SAM criteria are assumed to be MAM.

Abbreviations: MAM, moderate acute malnutrition; RUTF, ready-to-use therapeutic food; SAM, severe acute malnutrition; WHZ, a weight-for-height z-score.

115 and 125 mm) in Table 6. On average, it cost US$45.4 to treat one child with SAM and US$33.9 to treat a child with MAM. While the cost of medication was similar (about US$1.5), the hospitalization costs for SAM children (US$10.6) were almost double that for MAM children (US$5.5). RUTF remained the major cost driver for both SAM and MAM, with higher amounts consumed on average among SAM (US$22.4) than among MAM patients (US$17.6). Factoring in the recovery rate, 76.1% for SAM and 88.5% for MAM, the cost per recovered patient was US$59.7 for SAM and US$38.3 for MAM.

4 | DISCUSSION

This paper used unique panel data which tracked 4958 malnourished children aged between 6 and 59 months in Yako District of Burkina Faso to analyse the progression of MUAC and other health outcomes. Combined with information on the unit costs associated with different components of the programme, we were able to calculate the average variable costs of the Burkina OptiMA trial per child and to analyse cost differences among the different types of participants, taking into account initial MUAC level upon starting therapeutic feeding.

On average, the recovery rate among all the patients by 12 weeks was 84%, with the rate increasing at higher levels of initial MUAC (severity of acute malnutrition). The overall average amount of RUTFs consumed by patients over the course of treatment was 58 sachets. As Daures et al. (2020) also pointed out, these high recovery rates and lower RUTF consumption levels are favourable compared to the results from other studies in Africa.

The average total cost of treatment among all the patients in the OptiMA study was US$38.0, half of which was for RUTF and a quarter for outpatient care. The average hospitalization cost was modest (US$7.3) because the proportion of hospitalized children was low. However, the hospitalization cost among children who were admitted to hospital was six times higher—about US$42 on average. The duration of stay under the OptiMA study among those hospitalized (8.3 days) was similar to what has been reported in other studies (6.5 ± 5.6 days) (Blaauw et al., 2019).

A limitation of our study is its reliance on secondary data sources for unit costs estimates for outpatient visits and inpatient hospital stays, which were obtained from a WHO analysis of data gathered across several countries, and not specific to acute malnutrition patients. Additionally, our costing omits some indirect features of the OptiMA programme, such as training of health workers and caretakers and other start-up and programme-specific management/supervision costs. We did not collect data on out-of-pocket costs potentially incurred by patients themselves, such as for transportation to clinics. These omitted costs underestimate the overall costs.

Finally, OptiMA in Burkina Faso was implemented without a control group, thus preventing us from calculating the costs of OptiMA relative to current standard programming. Although it is certainly true that MUAC increases gradually with age and normal growth in a well-nourished population of children, this cohort of children is from a malnourished population as evidenced by a prevalence of stunting of 42% (Daures et al., 2020) and the average treatment duration is only 4–5 weeks. Therefore, overestimation of the treatment effect due to normal growth is likely to be minimal.

These limitations may explain why costs calculated in this study are lower than in other studies of similar programmes. A study of 5-week MAM treatment in Mali comparing different nutritional products estimated a cost of US$27.8–38.1 per child treated (similar to the US$38.0 we report here under OptiMA) whereas it cost US $89.0–99.9 to wait and only treat those children who deteriorated to SAM (Isanaka, Barnhart, et al., 2019; Isanaka, Hanson, et al., 2019).

Several studies of community-based SAM treatment estimate higher cost per patient admitted than we found in Yako. These range from US$56 per child treated in India (Garg et al., 2018) to US $805 in Ghana (Abdul-Latif et al., 2014). Cost per child recovered varied from US$114 to US$1041 (Chui et al., 2020) compared to our estimate of US$45 under OptiMA and US$60 for those meeting the WHO definition for SAM at admission. Hospitalization costs for children with SAM also range from US$85 to US$230 (Chui et al., 2020), while another study found a US$25 average inpatient cost per child with SAM treated in Kaya, Burkina Faso (Zoungrana et al., 2019), whereas under OptiMA we found that it cost US$42 per hospital stay. High costs found in the literature can be due to various factors such as that studies included costs from project partners and societal costs, and that the target number of children was very small (Chui et al., 2020).

MUAC level at admission was strongly correlated with subsequent nutrition outcomes. The lower the MUAC of a child was at admission, the higher was the likelihood that the child would be hospitalized and would die. Treatment cost was also correlated with the initial MUAC level, with higher cost for more severe cases due to longer treatment duration and increased hospitalization, consistent with results from other studies (Isanaka, Barnhart, et al., 2019; Isanaka, Hanson, et al., 2019). A single protocol that allows for the effective treatment of children with MAM or SAM likely avoids a proportion of more severe cases, especially those that require hospitalization, and could have important implications for more efficient resource allocation and use in future programmes to combat SAM.

5 | CONCLUSION

Cost analysis for the MUAC-based nutrition programme using the OptiMA protocol points to the potential for conferring major benefits to children with acute malnutrition, including the possibility that the OptiMA protocol is more cost-effective than other prevailing approaches. Patient outcomes are better and treatment costs are substantially lower when RUTF-based treatment starts before acute malnutrition becomes severe. Further studies with more data and comparison groups are needed to confirm this finding and to explore cost-effectiveness.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Ryoko Sato and Stephen Resch did the design of study, data cleaning, statistical analysis, writing of manuscript. Robert Hecht advised on study design and analysis, did the detailed review and edits. Maguy Daures, Kevin Phelan, Susan Shepherd, Moumouni Kinda and Renaud Becquet advised on background, analysis, and reviewed and edits the manuscripts.

DATA AVAILABILITY STATEMENT

Research data are not shared.

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