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Dietary outcomes of moderately wasted children treated in a food voucher program in Cameroon's Far North: a three-month longitudinal study

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Abstract

Background Many interventions in Cameroon focus on addressing severe wasting rather than targeting moderate wasting, although the latter is more prevalent. The objective of the study was to evaluate dietary outcomes in a program designed to treat moderate wasting using a food voucher program (FVP) tested in the Far North, examining the factors associated with dietary outcomes.

Methods A three-month longitudinal study was carried out by an independent team of researchers within the context of a one-year humanitarian project designed to treat children with moderate wasting (middle-upper arm circumference [MUAC] measures 115–125 mm) by providing caretakers with a bi-weekly voucher to redeem for a predefined basket of foods together with essential hygiene and nutrition education. A sample of 474 children were randomly selected from the cohort enrolled in the program for inclusion in the study. Using a pre/post-test design, we evaluate the effect of the receipt of food vouchers on dietary outcomes using as indicators minimum dietary diversity (MDD) for children aged 6–23 months and dietary diversity scores (DDS) for children aged 24–53 months. Mixed logistic and linear regressions were used to identify factors from socio-demographic data and program activities (cooking demonstrations and nutrition education, perception of food safety, food basket sharing, and lasting) associated with these variables. Life table analysis was employed to assess the likelihood of achieving MDD among children aged 6–23 months.

Results The likelihood of children aged 6–23 months meeting MDD increased from 19.9% at the beginning of the study to 100% after 12 weeks. Among older children, average DDS increased from 3.2 at entry to 5.1 at the two-week mark and remained constant for the duration of the study. A negative perception among caregivers of the safety of redeemed food items was negatively associated with achieving MDD (adjusted RR = 0.50, $p = 0.012$). The consumption of food basket contents by other family members was negatively associated with DDS (adjusted coef. = 0.33, $p = 0.047$).

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Conclusion The FVP was effective in improving the dietary diversity of MAM children aged between 6 and 59 months in Cameroon's Far North.

Keywords Food voucher program, Moderate wasting, Minimum dietary diversity, Dietary diversity score

Background

In 2020, an estimated 45.4 million children worldwide suffered from wasting, defined as weight-for-height <-2 standard deviations [SD] from the World Health Organization (WHO) Growth Standards median [1], and the consequences of the SARS-COV-2 pandemic threaten to increase that number by as many as 9.3 million children [2]. Globally, nearly half (45%) of all child deaths are linked to malnutrition [3], and it is projected that by 2030, about 60% of all child deaths will occur in sub-Saharan Africa [4].

The 2018 Demographic and Health Survey (DHS) for Cameroon reported that the under-5 mortality rate is 80 deaths per 1,000 live births, with the Far-North region having among the highest rates (102) [5]. The survey also indicated that the prevalence of wasting among children under five was 10.1%, a level considered serious by WHO, with over two-thirds of those cases moderate (between −3 and −2 SD WHO Standards). The prevalence of stunting (height-for-age <-2 standard deviations [SD] of the WHO Child Growth Standards median) among children under 5 is also high at 37%. Infant and young child feeding practices were also found to be suboptimal, with only 18.3% of children 6–23 months receiving a diet of minimum dietary diversity (MDD, using the updated definition of at least 5 of 8 defined food groups the previous day) and only 9.8% receiving a minimum adequate diet (MAD) that reflects both MDD and minimum meal frequency [6]. According to a comprehensive food security analysis conducted by the World Food Program in 2017, the Far North also has the highest prevalence of poor and borderline household food consumption scores (FCS) at 36.2% and of household food insecurity at 33.6% [7]. Nevertheless, market surveys conducted by Helen Keller Intl found adequate supplies of a range of foods, suggesting income and insecurity were more significant barriers to nutritious diets for young children and other family members than availability.

Citing the lack of evidence for the effectiveness of formulated food supplements for the management of moderate wasting, the WHO has not defined a protocol for treatment other than providing general nutrition counseling to promote the feeding of locally available, nutrient-dense foods [8]. In situations of acute emergencies or food shortages, the World Food Programme, the United States, and other donors provide specially formulated fortified blended foods (FBF) or large quantity lipid-based nutrient supplements, also referred to as ready-to-use supplementary foods (RUSF) as treatment [9], but supplies are often limited for areas in prolonged crisis, like Cameroon's Far North. In such settings, effective alternative approaches are needed, and WHO has called for research to identify "an effective package of interventions to achieve nutritional and functional recovery of children with moderate wasting" [4]. A recent systematic review of the literature on the treatment of moderate wasting found food supplements were more effective in supporting child recovery than counseling either with or without micronutrient supplements [10]. Facing a shortage of specialized nutritious foods in Cameroon's Far North, where the population is coping with displacement, conflict, and food insecurity, Helen Keller Intl conceived of an approach involving the design of a paper voucher families could redeem in local markets to cover a basket of foods that would provide supplementary calories and essential nutrients to support the moderately wasted child's recovery. This paper reports on dietary outcomes; recovery outcomes were reported previously [11].

The use of food and cash vouchers in international humanitarian programming is growing rapidly, such that in 2019 it totaled $5.6 billion or almost one-fifth of the total programming budget, yet its use in the nutrition sector is less common [12]. These mechanisms are also used in high-income countries, such as in the United States' Women, Infants and Children (WIC) program, which is designed to safeguard the health of low-income families by providing paper vouchers, checks or electronic benefit transfer cards for the purchase of specific food items from authorized food vendors [13]. While there is mounting evidence documenting the effectiveness of conditional and unconditional vouchers on health-seeking behaviors and poverty reduction [14], as well as research comparing the effectiveness of cash transfers vs. vouchers in preventing malnutrition and in improving food consumption [15], we are aware of no research examining the impact of food voucher transfers as a treatment for acute malnutrition. In light of the promise of voucher programs and the need for evidence of the effectiveness of alternative treatment approaches for the management of moderate wasting, Helen Keller Intl first piloted a food voucher program (FVP) for the context of the protracted emergency in Cameroon's Far North region and then collaborated with researchers to evaluate the acceptability and effectiveness of the intervention. This paper reports the findings related to improvements in dietary diversity. A previous publication presented the recovery outcomes of enrolled children [16].

The primary purpose of the FVP evaluation study was to assess whether providing caretakers of children diagnosed with moderate wasting vouchers on a bi-weekly basis to cover the purchase of a predefined basket of diverse, nutrient-rich foods could support the recovery of those children and was acceptable to enroll households and the wider community. The objective of the present report is to examine the factors influencing a range of dietary outcomes of this intervention.

Methods

Study design

The overall research was a three-month longitudinal study using mixed models to evaluate changes in child nutritional status, fidelity of implementation to program design including influencing improvements in dietary diversity and quality among the treated children, and perceptions of participating families, health and community agents, and community leaders. The research was led by an independent team of investigators from the Universities of Bamenda and Yaoundé. The design was quasi-experimental without a control group due to ethical concerns over enrolling children without an alternative treatment option. As noted, global supplies of ready-to-use foods were insufficient to meet the needs at the time of the intervention, which was designed to fill the treatment gap.

Study population and sample size and

The overall study was conducted between March and August 2020 in 13 health areas in the district of Kaélé, in Cameroon's Far-North region, near the Chadian border. Enrollment criteria included being age 6–59 months with a MUAC between 115 mm and 124 mm. Children were excluded from the study if they were diagnosed with severe acute malnutrition (MUAC < 115 mm and/or edema), caretakers refused to give their approval for the study, or the child was or became severely ill during the study. For a household with more than one moderately wasted child, the youngest child was selected for the study. The sample size calculation for the overall study is reported elsewhere [11], based on a one-group pre-post treatment comparison. A total of 474 children were enrolled in the study and were selected using stratified sampling with probability proportional to the size of each of the 13 health areas comprising the study area.

Data collection

A structured baseline questionnaire was administered to consenting caregivers following enrollment in the voucher program, but before receipt of the first voucher, covering household demographic and socioeconomic characteristics, gender-disaggregated asset ownership, agricultural production, food security, health knowledge, child's recent illness and treatment, and infant and young child feeding knowledge and practices (Supplementary file 1). A 24-hour dietary recall was administered by the research team to the enrolled child before entry into the voucher program and at each bi-weekly follow-up visit (Supplementary file 2). Data were collected using the ODK application (www.getodk.org) installed on smartphones and stored on the ONA server (www.ona.io).

Food voucher program

The FVP was funded by the U.S. Agency for International Development and was designed and implemented by Helen Keller Intl and the Cameroon Ministry of Public Health. Community health workers (CHW) conducted a community-wide mass screening using middle-upper arm circumference (MUAC) measures to identify all children with moderate wasting. Suspected cases were referred to health centers where the children were re-examined by health agents, and confirmed cases enrolled in the FVP, in which they reported bi-weekly to their nearest health facility for physical examinations, counseling, and paper coupons with the child's unique identification number to redeem for the predefined list of foods from a pre-certified vendor. Vendors were subsequently reimbursed electronically for the value of the voucher upon presenting the redeemed coupons to Helen Keller staff. This design avoided theft and abuse of the vouchers. Children with MUAC < 115 mm were referred to health facilities for treatment of severe wasting. Mothers of enrolled children and others were also invited to participate in weekly cooking demonstrations of enriched porridge recipes using food voucher items, and discussions of essential nutrition and hygiene actions (ENA-EHA) using a Ministry of Public Health curriculum organized in their health area. The cooking demonstrations were conducted by key opinion leaders and women leaders from each community who were recruited and trained by the project. ENA-EHA discussions were facilitated by CHW.

The food basket covered by the voucher was designed to provide a substantial proportion of the micronutrient and macronutrient requirements of children 6–59 months of age, with extra quantities in anticipation that some food would be shared, and was prescribed as a supplement to the usual diet to support rehabilitation of moderate wasting. For example, for a child 6–23 months of age, a sample daily ration would exceed the normal daily requirements for calories, fat, protein, vitamin A, B1, niacin, B6, and vitamin E, as well as providing about 80% of the calcium requirements and between one-third and one-half of the requirements for zinc, iron, niacin, folate and vitamin D. The proportions of micronutrients varied as different fruits and vegetables were included according to market availability. Health agents

provided mothers of enrolled children with a voucher every 2 weeks for a ration consisting of 15 eggs (750 g), 750 g of fruits, 750 g of vegetables, 4.5 L of milk, 450 g of sugar, 450 g of edible oil, and 1.5 kg of flour, along with the names of the nearest vendor pre-qualified to redeem it. The value of each voucher was US$13. Under this voucher program, caregivers were instructed to return with the child to the health center every 2 weeks for a physical examination and a MUAC measurement. Children with MUAC ≥ 125 mm were considered recovered and exited from the program, and caretakers of children with MUAC between 115 mm and 124 mm were provided another food voucher. The treatment program ran for 3 months, corresponding to up to 6 health center visits.

Voucher utilization

As part of program implementation and monitoring, CHWs conducted a weekly visit to each household in between food voucher distributions to verify the appropriate use of food basket ingredients. They also conducted a 24-hour recall of the food consumed by the child, as well as a visual assessment of the voucher contents remaining in the household, and observation of the preparation of the enriched porridge. CHW also reinforced positive feeding practices conveyed through ENA-EHA discussions. At the end of every 2 weeks, study enumerators visited the household to administer a follow-up questionnaire with caregivers.

Diet quality outcomes

For children 6–23 months of age, minimum dietary diversity (MDD) was defined according to the updated WHO-UNICEF guidance [6] as the consumption in the previous 24-hour period of ≥ 5 or more food groups out of a possible 8; namely: (1) breastmilk; (2) grains, roots and tubers; (3) pulses, nuts and seeds; (4) dairy products; (5) flesh foods (meat, fish, poultry and organ meats); (6) eggs; (7) vitamin A-rich fruits and vegetables; (8) other fruits and vegetables. The indicator is intended as a proxy measure for dietary quality and the likelihood of meeting a child's daily energy and nutrient requirements. The recall questionnaire was administered according to the instructions in the WHO-UNICEF reference.

As no specific dietary indicator has been validated for children 24–53 months of age, we applied the individual dietary diversity score (DDS) developed by the Food and Agriculture Organization [17], also based on a 24-hour recall period, which defines 9 food groups: (1) starchy staples; (2) dark green leafy vegetables (3) other vitamin A-rich fruits and vegetables; (4) other fruits and vegetables; (5) organ meats; (6) meat and fish; (7) eggs; (8) legumes, nuts and seeds; and (9) milk and milk products. The scores were thus calculated as the sum of the number of food groups consumed.

Additional characteristics

The household survey included the Household Food Insecurity Access Scale (HFIAS) developed and validated by the Food and Nutrition Technical Assistance Project (FANTA) [18], as well as data on marital status, family size, age, and education level of the mother, and breastfeeding status of children between 6 and 23 months. During follow-up visits, closed-ended questions (yes/no) were asked to assess: (1) respondents' perception of the quality of the basket of ingredients redeemed; (2) family member sharing of the food voucher ingredients or enriched porridge; (3) attendance of cooking demonstrations; (4) attendance of ENA-EHA discussion sessions; (5) which if any food items were used up before the next distribution; and (6) receipt of home visits from the CHW.

Other data

The research team also collected qualitative data about experiences of the program from program participants. In addition, data were extracted from field reports from CHW home visits documenting vouchers redeemed, dietary recall, and voucher food utilization to estimate how closely households adhered to voucher instructions.

Data quality control

A pretest of the baseline and follow-up questionnaires was performed prior to actual data collection with 33 caregivers of moderately wasted children in the town of Guidiguis and Lara, and adjustments were made for a final French version. Contract enumerators, with good knowledge of local languages (Moundang, Fufulde, and Toupouri), were provided 3 days of intensive training on the objectives of the study, ethical considerations, questionnaire administration translated as necessary into the local language, and use of ODK collect and ONA storage software.

Statistical analysis

Continuous variables were summarized as the median and interquartile range (IQR) since they did not follow normal distributions, and categorical variables were summarized as percentages (%). Life Table analysis was done to assess the time to achieving MDD. A mixed effects logistic model was used to assess the bivariate and multivariate (adjusted for confounding factors) determinants of MDD. The random-effect model adjusted for the fact that children differed in their baseline scores. Similar analyses were conducted for DDS among children 24–59 months using a linear mixed model. The associations were quantified for linear models using the

estimated coefficient and for logistic regression using relative risk (RR), given the longitudinal design, with a 95% confidence interval (CI). Predictors with p-value < 0.2 in bivariate regression analysis were included in multivariable regression models. Statistical significance was set at p-value < 0.05. IBM-SPSS 26.0 (IBM Corporation, Armonk, NY, USA) and Stata 14 (StataCorp, College Station, TX: StataCorp LP) were used for the statistical analyses. GraphPad Prism 5.0 was used for Box plot and MS Excel 2019 for histograms and curves.

Ethical approval and consent to participate

The research protocol was approved by the Cameroon National Research Ethics Committee for Human Health under the number 2020/02/1207/CE/CNERSH/SP. Before data collection, administrative authorization was obtained by the research team from the Regional Delegation of Public Health of the Far-North of Cameroon. Each caregiver was fully informed of the nature and objectives of the study and possible risks associated with their participation. The informed consent text was read to caretakers at the first household screening visit and written consent was obtained from both parents for the child's enrollment. All caretakers were above 18 years of age. Participants had the opportunity to have their questions answered and to refuse any part of the study procedure or questions. All research was performed in accordance with the Declaration of Helsinki. The trial was included in the ISRCTN registry ID 12,287,685 on December 12, 2023.

Results

Participants' characteristics at enrollment

A total of 474 subjects were enrolled in the study (Fig. 1), of whom three-quarters were aged 6–23 months, a majority (59%) were female, and half were currently exhibiting signs of illness (Table 1). More than two-thirds (70.3%) of marriages of participating households were monogamous. Moderate food insecurity was reported by 59.8% of households and severe household food insecurity by 20.9%. Among the mothers of enrolled children, 44.7% had completed primary education while only 9.5% had no formal education. At baseline, one-fifth (19.9%) of children aged 6–23 months had adequate dietary diversity (MDD ≥ 5).

At baseline, the dominant food groups consumed were grains, roots, and tubers (70.0%), flesh foods (53.5%), vitamin A-rich fruits and vegetables (43.7%), and other fruits and vegetables (41.5%). Approximately 1 out of 20 (5.3%) consumed eggs the day before and 14.8% consumed no fruits or vegetables. Among children aged 24–59 months, the average DDS was 3.2 out of a possible 9 and showed low to no consumption of eggs, milk products, organ meats, and vitamin A-rich fruits and vegetables (Table 2).

Achievement of MDD by children 6–23 months of age

After enrollment in the program, children's dietary diversity increased, and this increase was sustained across their stay in treatment (Fig. 2). Life table analysis (Table 3) showed that between week 2 and week 12, the cumulative probability of achieving the MDD among children aged 6 to 23 months increased and was sustained throughout participation in the food voucher program. The median time to achieving MDD was 8 weeks.

Factors associated with MDD

The analysis explored significant determinants at the household, maternal, and child levels influencing the achievement of MDD by children under the FVP. In the multivariate model, only the perception of the safety of the food remained significant (Table 4). Mothers' negative perception of the safety of the redeemed food items was associated with a decrease in MDD compared to mothers with a positive perception (aRR = 0.50; 95% CI: 0.28, 0.87).

DDS of children aged 24–53 months

The average DDS also meaningfully increased between the enrollment and the first survey following the receipt of the first voucher, from 3.2 to 5.5 (Fig. 3). During treatment, DDS averaged around 5.1 (95% CI 4.6–5.7). Similar analyses to MDD were conducted to explore associations with independent variables (Table 5). In the multivariate regression model, having other family members sharing the food basket ingredients was significantly associated with a 0.33 point lower DDS, compared to households not sharing (β = – 0.33 (-0.66, 0.00); p = 0.047).

Food voucher utilization

Table 6 presents data on voucher redemption and utilization. Virtually all eligible households received all food basket items throughout the child's enrollment, and program data showed that 95% of vouchers for which children were eligible were redeemed, indicating that the caregivers were visiting health facilities and collecting vouchers as intended. Although children's time in treatment varied, on average, an enrolled child redeemed about 4.5 vouchers. According to the average of the 24-hour recall administered to each child at each biweekly visit by the research team, most children were consuming fruits, milk, and flour, while consumption of eggs was low and vegetables almost nil. Qualitative interviews with caretakers suggested.

children refused porridge with these ingredients. Slightly more than one-third of households reported sharing the food basket contents with other family members, in those cases with approximately 2 others, although sharing may have been underreported. Caretakers reported that many of the voucher items were used up

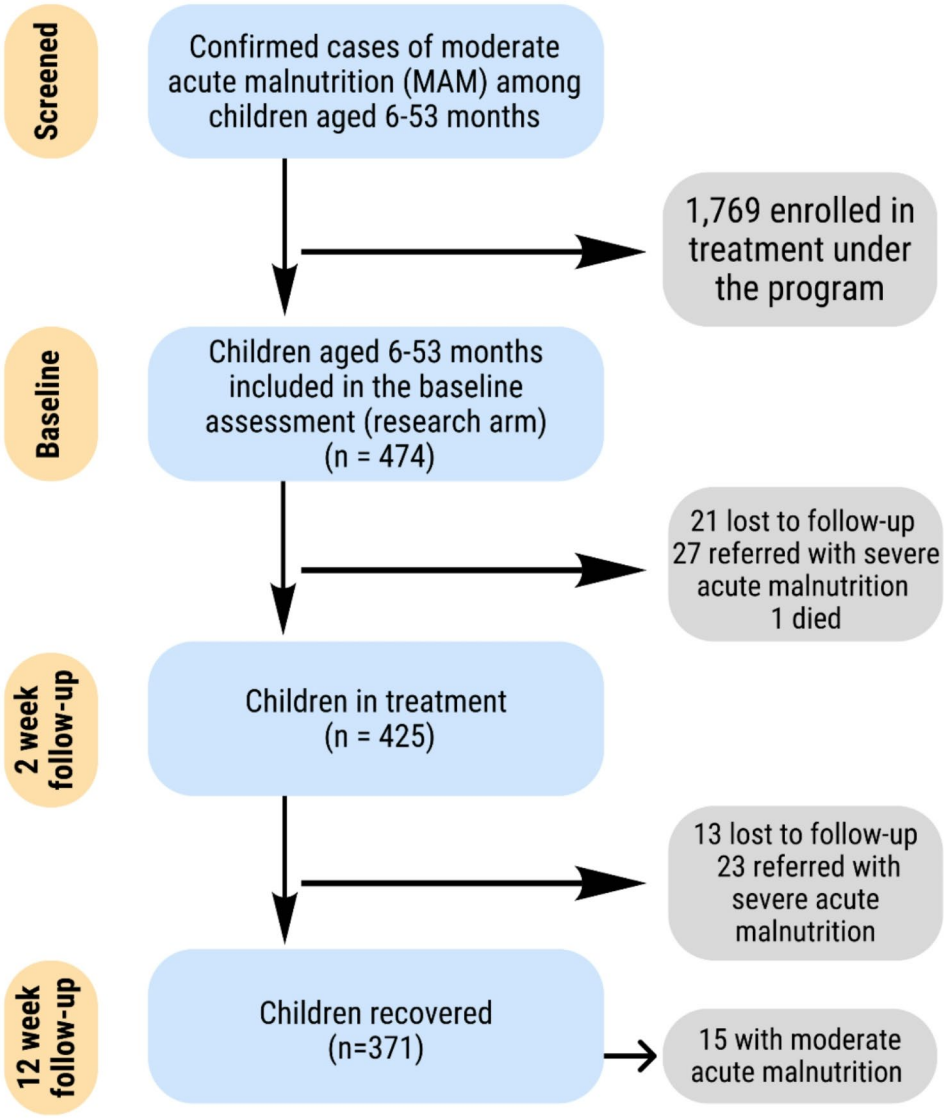

Fig. 1 Flowchart of recruitment and follow-up of children aged 6–53 months in the program [16]

before the end of the 2-week period they were intended for, notably vegetables, which lasted only 2 days, and fruit, which lasted about 7 days. As these were largely perishable items, it is not surprising that they were consumed quickly.

Discussion

The food vouchers were provided to moderately wasted children and evaluated for acceptability and effectiveness as an alternative treatment to imported food rations and ready-to-use supplementary foods. Utilization data indicate that this was highly acceptable to caretakers and feasible in this emergency context. The analysis presented here confirms that dietary diversity improved with entry into the program and was sustained for the duration of treatment. Beyond the vouchers themselves, the only factors we found to be significantly associated with meeting the minimum requirement for dietary diversity were the perception of the safety of food items among mothers of the younger children and not sharing rations with other family members for the older children. Sharing was reported by a minority of households, although may have been higher and not reported, as caregivers were instructed not to share. We anticipated pressure within households to do so and designed the voucher basket to allow for some sharing. Consumption data suggest that highly perishable items may be problematic for households to store for two weeks without refrigeration. Additionally, they indicate counseling may also be needed to convince mothers of the value of vegetables and eggs to child health and recovery and to troubleshoot ways to mix these into recipes children will eat.

Table 1 Baseline information of the households enrolled in FVP study ($n = 474$)

(a) Household characteristics	*N*	Percent
Marital status		
Monogamy	333	70.3
Polygamy	111	23.4
Single/separated/divorced/widowed	30	6.3
Family size (# of children)		
≤ 6	270	57.0
> 6	204	43.0
Number of children (0–18 years)		
≤ 4	306	64.7
> 4	168	35.3
Number of children (less than 5 years)		
≤ 2	392	82.7
> 2	82	17.3
Household food insecurity access scale (HFIAS)		
Secure	9	1.9
Mildly insecure	82	17.3
Moderately insecure	283	59.8
Severe insecure	99	20.9
Main current drinking water source		
Improved	131	27.6
Unimproved	343	72.4
Households treating drinking water from unimproved source N (%)	343	156 (45.5)
Round trip time to retrieve drinking water (minutes); Median (IQR)	474	15 (10–30)
Access to sanitation facility		
No	98	20.7
Yes	375	79.3
Person responsible for retrieving water		
Adult woman	298	62.9
Adult woman and child < 19 year	130	27.4
Others	46	9.7
Treatment of water before drinking		
No	263	55.5
Yes	211	44.5
(b) Maternal characteristics	**N**	**Percent**
Highest education		
No formal	45	9.5
Primary	212	44.7
Secondary or higher	178	37.6
Other	39	8.2
Occupation		
Wage labor	46	9.7
Agriculture	159	33.5
Own business	215	45.4
None	47	9.9
Other	7	1.5
Age (median (IQ)) in months	**470**	**27 (23–32)**
(c) Child characteristics	**N**	**Percent**
Sex		
Male	194	40.9
Female	280	59.1
Age (months)		
6–11	152	32.1

Table 1 (continued)

(c) Child characteristics	N	Percent
12–23	205	43.2
24–59	117	24.7
Child birth order		
1	93	19.6
2	100	21.1
≥ 3	181	59.3
Immunization		
Fully	268	56.5
Partially	206	43.5
Vitamin A supplementation		
At least one	450	95.5
Never	21	4.5
Deworming treatment		
At least one	280	60.9
Never	180	39.1
(d) Characteristic	***N***	**Percent**
Child currently suffering from any illness	237	50.0
Specific illness		
Diarrhea (acute)	39	17.7
Fever (acute)	27	12.3
Malaria	9	4.1
Difficult breathing (Respiratory disease)	1	0.5
Vomiting	5	2.3
Diarrhea (chronic)	7	3.2
Coughing	92	41.8
Skin infection	7	3.2
Others	33	15.0
Child currently receiving any treatment	180	76.0
Source of treatment		
Medical doctor or health worker	75	63.3
Self-medication	41	34.9
Traditional practitioner	2	1.8
Nature of treatment		
Modern medicine only	147	81.7
Traditional medicine only	16	8.9
Modern and traditional medicine	17	9.4

Many studies have evaluated other food voucher designs and their impacts on various aspects of child and household nutrition. A study in Ecuador compared the impact of cash transfers, food vouchers, and food transfers on household food consumption, and found that while all modalities significantly improved household food consumption, caloric intake, and dietary diversity, the food vouchers had the strongest positive influence on dietary diversity [19]. Vouchers also led to the most significant increases in household consumption of 9 out of 12 food groups examined.

Limited information is available on the impact of vouchers as a treatment for malnourished children. To evaluate the most effective strategy for the prevention of wasting in children 6–23 months of age, researchers in Niger compared the provision of one of three food supplements (high- or medium-quantity lipid-based nutrient supplements or Super Cereal Plus) with and without cash transfers, and compared to cash alone [20]. All households also participated in nutrition education discussions. The combination of food and cash was found to have a significantly greater impact on a reduction in the incidence of wasting than food or cash alone. A complementary qualitative evaluation of the program indicated that households receiving cash only used funds to purchase recommended food for young children (milk, meat, fruits), yet these purchases were less effective in preventing acute malnutrition than the combined food-cash transfer, as the cost of local foods of equivalent nutritional density was greater than the formulated food supplements. In our program, the voucher value was

Table 2 Baseline dietary intake, previous 24 h period

Children 6–23 mos. (*n* = 375)	***N*(%)**
Proportion achieving MDD	71 (19.9)
Food Group Consumption	***N*(%)**
Breast milk	73 (20.4)
Grains, roots, tubers	250 (70.0)
Pulses, nuts & seeds	112 (31.4)
Flesh foods	191 (53.5)
Other fruits & vegetables	148 (41.5)
Vitamin A-rich fruits or vegetables	156 (43.7)
Eggs	19 (5.3)
Dairy products	18 (5.0)
Children 24–59 mos. (*n* = 117)	**Mean (SD)**
Average DDS	3.2 (1.1)
Food Group Consumption	**N (%)**
Starchy staples	107 (91.5)
Legumes, nuts & seeds	49 (41.9)
Dark green leafy vegetables	40 (34.2)
Vitamin A-rich fruits & vegetables	9 (7.9)
Other fruits & vegetables	54 (46.2)
Organ meat	2 (1.7)
Meat & fish	78 (66.7)
Eggs	5 (4.3)
Milk & milk products	2 (1.7)

Table 3 Life table analysis of achievement of MDD by children aged 6–23 months

Interval start time (weeks)	Number assessed	Probability of achieving MDD	Cumulative probability of achieving MDD
2	271	0.77	0.77
4	49	0.67	0.52
6	12	0.40	0.21
8	6	0.50	0.11
10	2	0.00	0.00
12	1	0.50	0.00

calculated to cover the local costs of the recommended foods, but also to guide food choices.

Other experts have observed that overcoming malnutrition requires strategies that address the wider context of household vulnerability with a combination of income, food, and counseling support [21]. In Burkina Faso, unconditional cash transfers provided during the lean season improved the quality of diets of children aged 14–27 months compared to a control group, including their consumption of eggs, dairy, flesh foods, and iron-rich or iron-fortified foods [22]. The transfers did not, however, reduce the incidence of wasting, stunting, or morbidity in young children [23], possibly because, as recipients themselves reported, the cash was used to meet other household needs in addition to child nutrition during this stressful period. In summary, all these studies also showed a positive impact on child food intake, yet al.so highlight the challenges families face in navigating the related burdens of poverty and inadequate health and sanitation infrastructure in similar contexts.

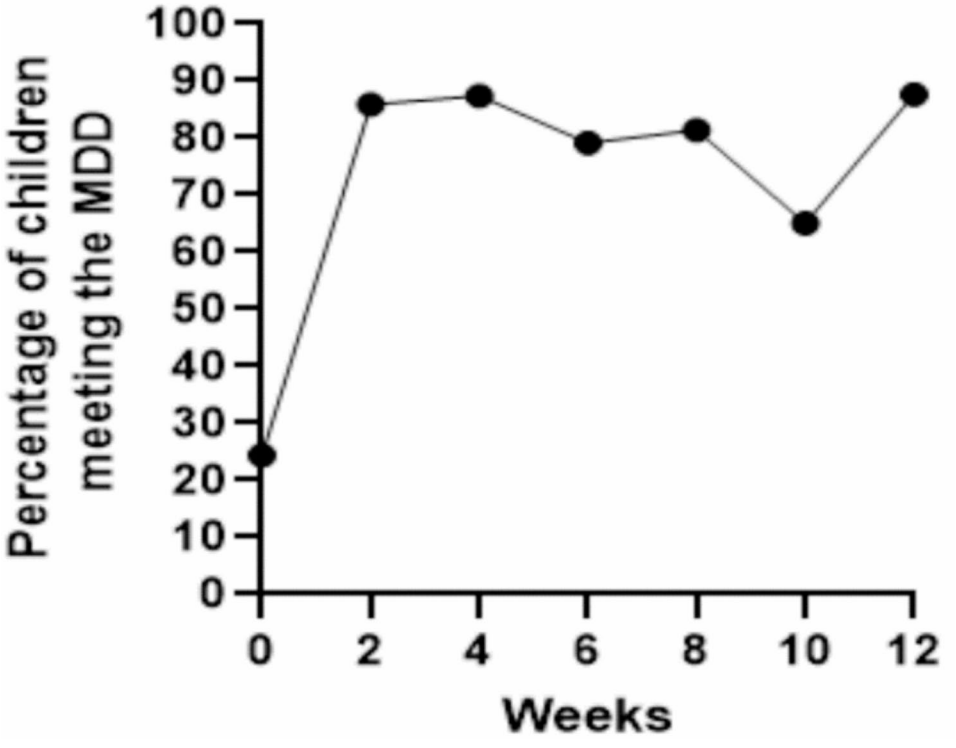

Fig. 2 Percent of enrolled children aged 6–23 months meeting the Minimum Dietary Diversity over time

Table 4 Variables evaluated for association with MDD of children aged 6 to 23 months using mixed effect logistic regression models

Characteristics	Univariate analysis		Multivariate analysis	
	RR (95%CI)	*p*-value	aRR (95%CI)	*p*-value
HOUSEHOLD				
Marital structure				
Polygamous	1.70 (1.06, 2.74)	0.028	3.23(0.65, 16.07)	0.151
Monogamous	1.40 (0.85, 2.33)	0.191	2.14 (0.45, 10.23)	0.341
Other (single, widowed, divorced)	1		1	
HFIAS				
Severely food insecure	1.34 (0.48, 3.82)	0.573	/	/
Mildly food insecure	0.80 (0.29, 2.20)	0.661	/	/
Moderately food insecure	0.83 (0.29, 2.36)	0.726	/	/
Food secure	1			
Family size	1.02 (0.99, 1.04)	0.215	/	/
MOTHER				
Age	1.00 (0.98, 1.01)	0.834	/	/
Education level				
Secondary education	0.83 (0.56, 1.22)	0.332	/	/
Primary education	0.84 (0.57, 1.24)	0.389	/	/
Other (koranic, professional school)	0.68 (0.37, 1.26)	0.222	/	/
No formal	1		/	/
CHILD				
Sex				
Female	0.85 (0.69, 1.05)	0.124	0.67 (0.39, 1.13)	0.131
Male	1		1	
Age (months)				
12–23	0.88 (0.72, 1.09)	0.248	/	/
6–11	1		/	/
PROGRAM PARTICIPATION				
Cooking demonstration				
Yes	0.64 (0.42, 0.96)	0.029	0.95 (0.54, 1.69)	0.878
No	1		1	
Mean no. demonstrations attended	0.75 (0.40, 1.40)	0.366	/	/
ENA-EHA discussion participation				
Yes	0.76 (0.53, 1.08)	0.124	0.78(0.37, 1.67)	0.528
No	1		1	
Number of visits every 2 weeks by CHW	1.05 (0.92, 1.19)	0.493	/	/
Positive perception of the safety of food basket items				
Yes	0.49 (0.30, 0.80)	0.005	0.50 (0.28, 0.87)	0.014
No	1		1	
Family members sharing food basket items				
Yes	0.69 (0.50, 0.96)	0.025	1.15 (0.70, 1.91)	0.58
No	1		1	
Food items finished before the next distribution				
Yes	1.16 (0.82, 1.64)	0.41	/	/
No	1		/	/

95%CI: 95% confidence interval; HFIAS: Household Food Insecurity Access Scale; RR: Relative risk; aRR: Adjusted relative risk; ENA-EHA: Essential Nutrition And Hygiene Actions; CHW: Community Health Workers

Research on food vouchers has consistently shown positive impacts on dietary intake. A meta-evaluation of five fresh food voucher programs, commissioned by Action Contre la Faim and implemented across multiple continents between 2009 and 2011, found increases in household dietary diversity in all settings, while also identifying program weaknesses for future improvement [24]. Additionally, a review of 38 primary studies evaluating the impact of the United Kingdom's Healthy Start and the United States WIC program revealed that pregnant women either increased their consumption of fruits and vegetables using vouchers or reduced other food

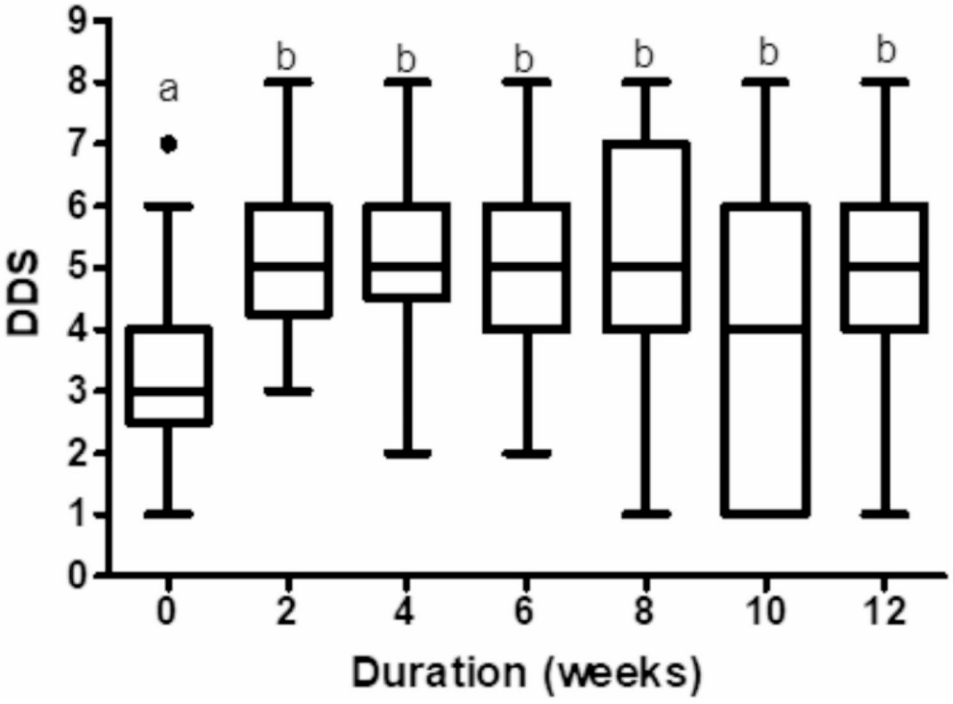

Fig. 3 Box plot of DDS of enrolled children aged 24–53 months over program duration. **Legend.** DDS: Dietary diversity score

expenditures to meet pressing household needs [25]. In France, a study found that vouchers for fruits and vegetables significantly increased consumption of these foods among low-income adults over a 3-month trial, with comparable increases achieved through nutritional counseling [26].

Given these positive outcomes, it is reasonable to expect similar benefits for children. It is well-established that dietary diversity and food variety are strong predictors of micronutrient density and dietary adequacy among children [27, 28]. Therefore, it is likely that these aspects also improved among the children enrolled in our program. However, reaching the recommended intake of certain nutrients, such as calcium, iron, and zinc, remains challenging in settings like ours [29]. While sharing voucher foods with other family members did occur, which may have diluted the benefits for the target children, the high recovery rates indicate the potential of this approach.

To better understand the cost implications of our program, it is important to note that the cost of our food vouchers was US$15.00 every two weeks, or $7.50 per week, which is higher than the cost estimate of $1.57 to $3.45 per week for specially formulated foods published in 2019 [30]. Despite the higher cost, our approach was justified by the lack of alternatives and the potential spillover benefits to the local economy from purchasing foods from local vendors. Future studies should conduct a comprehensive cost-benefit analysis to evaluate the viability of this approach.

The World Health Organization recently updated its guidelines on the prevention and management of wasting and nutritional edema (acute malnutrition) in infants and children under 5 years [31] The guidelines include a recommendation that children with moderate wasting should have access to a nutrient-dense diet to meet their extra needs for recovery and improved survival, health, and development. Our program financially enabled families to provide such a diet and potentially modeled this as a sustainable household practice, although further research is needed to confirm this impact. The guidelines also emphasize the importance of comprehensive medical and psychosocial evaluation and treatment. Future studies should adopt this holistic approach when evaluating children's moderate acute malnutrition status and determining appropriate referrals.

Our study contributes to the growing body of evidence supporting the effectiveness and suitability of food vouchers for children with moderate acute malnutrition, especially in contexts of high insecurity. The recovery rates achieved were comparable to those of ready-to-use supplementary foods and fortified blended foods. Future research should explore the long-term benefits of combining food vouchers with complementary nutrition demonstrations and discussions on child feeding practices. Given the disruptions and strains on global supply chains due to the COVID-19 pandemic and increasingly frequent climate shocks, local food voucher provisioning may offer more sustainable options for food sourcing. Future research should compare the cost-effectiveness

Table 5 Determinants of dietary diversity scores (DDS) of enrolled children aged 24 to 59 months using simple linear mixed-effects models

Characteristics	Univariate analysis		Multivariate analysis	
	Coef. (95%CI)	*p*-value	aCoef. (95%CI)	*p*-value
HOUSEHOLD				
Matrimonial regimen				
Polygamy	-0.08(-0.54, 0.38)	0.744	/	/
Monogamy	0.21(− 0.29, 0.72)	0.717	/	/
Other (single, widowed, divorced)	1			
HFIAS				
Severely food insecure	-0.94(-1.79, -0.08)	0.032	0.53(-0.58, 1.64)	0.352
Mildly food insecure	-0.80(-1.61, 0.01)	0.052	-0.09(-0.73, 0.54)	0.769
Moderately food insecure	− 0.69(-1.55, 0.17)	0.115	0.50(-0.45, 0.55)	0.845
Food secure	1	1		
Family size	0.03(-0.01, 0.06)	0.096	0.00(-0.05, 0.05)	0.993
CARETAKER				
Mother's age	0.01(-0.01, 0.02)	0.391	/	/
Mother's education level				
Secondary education	0.33(-0.08, 0.74)	0.116	-0.243(-1.19, 0.71)	0.614
Primary education	0.47(0.09, 0.86)	0.016	0.052(-0.73, 0.84)	0.052
Others (koranic, professional school)	0.66(0.10, 1.22)	0.020	-0.08(-0.95, 0.79)	0.854
No formal	1	1		
CHILD				
Sex of child				
Female	0.15(-0.09, 0.40)	0.217	/	/
Male	1		/	/
Age of child (months)				
37–59	0.40(0.11, 0.69)	0.007	-0.331(-0.82, 0.16)	0.186
24–36	1		1	
FOOD VOUCHER PROGRAM STEPS				
Cooking demonstration participation				
Yes	0.26(-0.06, 0.58)	0.108	0.30(-0.10, 0.69)	0.139
No	1	1		
Number of cooking demonstrations	-0.04 (-0.44, 0.37)	0.858	/	/
ENA-EHA discussion participation				
Yes	0.61 (0.28, 0.93)	0.000	-0.13 (0.79, 0.53)	0.693
No	1	1		
Number of visits every 2 weeks by CHW	0.10 (-0.04, 0.24)	0.168	-0.02 (-0.19, 0.14)	0.766
A good perception regarding the safety of food items redeemed				
Yes	0.27 (-0.10, 0.65)	0.151	-0.25 (-0.71, 0.21)	0.279
No	1	1		
A member of the family consuming the enriched porridge				
Yes	0.21 (-0.03, 0.45)	0.093	-0.33 (-0.66, 0.00)	0.047
No	1	1		
Food items finished before the next distribution				
Yes	0.29(-0.02, 0.61)	0.069	0.20 (-0.27, 0.66)	0.401
No	1		1	

95%CI: 95% confidence interval; HFIAS: Household Food Insecurity Access Scale; Coef.: Coefficient; aCoef: Adjusted coefficient; ENA-EHA: Essential Nutrition And Hygiene Actions; CHW: Community Health Workers

The letters indicate scores whose differences are statistically significant ($p < 0.05$)

of vouchers versus imported foods and investigate the impact of such FVPs on vendor incomes. The high adherence to the voucher program underscores the feasibility of collaborating with local vendors and the acceptability of this approach to caregivers. Notably, food safety emerged as a critical factor predicting MDD among voucher recipients, signaling the importance of understanding consumer valuation of food safety in food choice, an area with limited research in low-income countries [29].

Table 6 Food voucher redemption, food voucher basket utilization, consumption of the enriched porridge, ingredients management, and reasons and solutions for the depletion of ingredients

Parameter	Visit 1	Visit 2	Visit 3	Visit 4	Visit 5	Visit 6
Food voucher redemption						
HH received all the food basket items, n (%)	429 (100%)	411 (100%)	377 (100%)	311 (100%)	216 (100%)	119 (100%)
HH exchanged food voucher items for something else	0 (0.0%)	0 (0.0%)	1 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Child consumption of voucher contents per 24-hour recall						
Eggs	175 (39.0)	156 (35.7)	155 (38.4)	88 (25.9)	88 (24.4)	40 (31.7)
Fruit	261 (59.0)	273 (63.8)	307 (79.3)	274 (82.3)	179 (79.9)	107 (84.9)
Vegetables	3 (0.7)	10 (2.3)	6 (1.6)	6 (1.8)	3 (1.4)	2 (1.7)
Milk	382 (98.4)	397 (97.3)	322 (87.0)	274 (89.2)	163 (81.1)	108 (93.1)
Sugar	259 (57.7)	161 (36.8)	168 (41.6)	193 (56.9)	127 (56.7)	58 (46.0)
Oil	180 (40.2)	181 (41.4)	143 (35.5)	115 (33.8)	78 (34.7)	50 (39.7)
Flour	441 (99.1)	429 (99.3)	397 (98.5)	338 (100.0)	221 (98.7)	122 (96.8)
No. of ingredients, Mean ± SD	5.3 ± 1.0	5.2 ± 1.0	5.1 ± 1.1	4.9 ± 1.5	4.1 ± 2.1	5.2 ± 0.9
Consumption of the enriched porridge						
Enriched porridge consumed by other family members, n (%)	172 (38.3)	166 (37.9)	121 (30.0)	107 (31.5)	83 (36.9)	55 (43.7)
No. of adults in HH consuming, Mean ± SD	1.1 ± 0.5	1.2 ± 1.3	1.1 ± 0.7	1.1 ± 0.4	1.1 ± 0.5	1.0 ± 0.6
No. of other children consuming, Mean ± SD	1.7 ± 1.0	1.6 ± 0.8	1.6 ± 0.9	1.7 ± 0.8	1.5 ± 0.7	1.5 ± 0.7
No. of people in HH consuming, Mean ± SD	1.9 ± 1.1	1.8 ± 1.1	1.9 ± 1.2	1.8 ± 0.9	1.7 ± 0.7	1.6 ± 0.7
Food management						
HH finished any voucher food before the next provision, n (%)	310 (69.0)	351 (80.1)	293 (72.5)	276 (81.2)	193 (85.8)	97 (77.0)
Finished eggs	194 (43.1)	185 (42.1)	169 (41.1)	142 (39.2)	105 (37.2)	57 (45.2)
Days lasted, Mean ± SD	11.1 ± 3.1	11.5 ± 3.2	11.7 ± 2.9	11.9 ± 3.0	11.3 ± 3.1	11.8 ± 3.0
Finished fruits	140 (31.1)	168 (38.3)	128 (31.4)	130 (35.9)	73 (25.9)	48 (38.1)
Days lasted, Mean ± SD	7.0 ± 4.4	7.0 ± 4.2	7.0 ± 4.2	7.8 ± 4.5	8.2 ± 4.1	8.4 ± 4.6
Finished vegetables	163 (36.2)	197 (44.9)	163 (40.0)	206 (56.9)	139 (49.3)	76 (60.3)
Days lasted, Mean ± SD	2.3 ± 2.8	2.0 ± 1.9	1.9 ± 1.3	1.5 ± 1.9	2.0 ± 2.8	2.2 ± 2.7
Finished milk	101 (22.4)	102 (23.2)	99 (24.3)	77 (21.3)	56 (19.9)	29 (23.0)
Days lasted, Mean ± SD	13.4 ± 2.5	13.3 ± 2.6	13.0 ± 2.8	13.3 ± 2.3	13.0 ± 2.4	14.2 ± 1.2
Finished sugar	168 (37.3)	217 (49.4)	197 (48.3)	160 (44.2)	123 (43.6)	62 (49.2)
Days lasted, Mean ± SD	9.6 ± 3.4	9.2 ± 3.4	10.0 ± 3.3	9.0 ± 3.3	9.4 ± 3.4	9.2 ± 3.6
Finished oil	88 (19.6)	116 (26.4)	95 (23.3)	102 (28.2)	66 (23.4)	36 (28.6)
Days lasted, Mean ± SD	11.5 ± 3.2	11.9 ± 3.4	12.1 ± 3.3	11.3 ± 3.3	11.0 ± 3.4	11.2 ± 3.5
Finished flour	91 (20.2)	100 (22.8)	74 (18.1)	81 (22.4)	53 (18.8)	34 (27.0)
Days lasted, Mean ± SD	10.8 ± 3.9	10.0 ± 4.0	10.7 ± 3.8	10.6 ± 3.6	10.6 ± 3.9	11.9 ± 3.4
Reactions of mothers when voucher ingredients were finished						
Purchase of missing ingredients	84 (27.1)	134 (38.2)	77 (26.3)	91 (33.0)	75 (38.8)	48 (49.5)
Use of same home ingredients	18 (5.8)	19 (5.4)	19 (6.5)	22 (8.0)	5 (2.6)	13 (13.4)
No action taken	208 (67.1)	198 (56.4)	197 (67.2)	163 (59.0)	113 (58.6)	36 (37.1)
Reasons reported						
Quantity too small	232 (74.8)	307 (87.5)	263 (89.8)	259 (93.8)	180 (93.3)	91 (93.8)
Used for family ration	17 (5.5)	34 (9.7)	24 (8.2)	15 (5.4)	12 (6.2)	4 (4.1)
Used more than recommended	29 (9.3)	26 (7.4)	16 (5.4)	14 (5.1)	11 (5.7)	6 (6.2)
Some foods are spoiled or unusable	120 (38.7)	97 (27.6)	91 (31.1)	62 (22.5)	53 (27.5)	22 (22.7)
Shared with people, not family members	1 (0.3)	2 (0.6)	2 (0.6)	1 (0.4)	0 (0.0)	0 (0.0)

HH: Households

This study adds to this body of research evidence of food voucher effectiveness and suitability among children with moderate-acute malnutrition and in contexts of high insecurity, achieving recovery rates comparable to that of RUSF and fortified blended foods. Future research should explore whether the positive experience with the vouchers combined with the complementary nutrition demonstrations and discussions could also have some long-term beneficial impact on child feeding practices. The findings of this study conducted in an emergency context are also relevant in view of disruptions of and strains on global supply chains due to the COVID-19 pandemic and both the logistics and cost of transporting formulated foods. Local food voucher provisioning

may offer more sustainable options for sourcing food, and future research should compare the cost effectiveness of vouchers vs. imported foods. Moreover, procuring from local vendors also benefits those market players and local market systems. Future research should also investigate the impact of such FVPs on vendor incomes. The high adherence to the voucher program speaks to the feasibility of working with local vendors to provide foods and the acceptability of the approach to caregivers. Food safety emerged as the most important factor predicting MDD among voucher recipients. Limited research exists on the perception of food safety as a driver of food choice in low-income countries [29].

Limitations

Because we applied the simpler WHO and FAO guidance on dietary intake, we did not collect information on the amount of food consumed, and thus could not measure the full nutrient intake of the children treated. In addition, the study was conducted in one health district of the Far-North Region, and therefore findings may not be generalizable to other areas where food availability and dietary patterns are different. Importantly, the program functioned well despite considerable insecurity. In addition, because alternative treatment foods were not available and we felt it would be unethical to include a group that received only dietary counseling, we did not have a control group. Despite these limitations, this study adds valuable information and evidence that food vouchers can positively influence the dietary intake of children aged 6–53 months.

Conclusion

Our study suggests that the FVP was effective in improving MDD of children 6–23 months of age and DDS of children aged 24–53 months. Over 12 weeks, a substantial increase in the proportion of children meeting the (MDD) criteria was observed, reaching 100%. Additionally, the average DDS also showed significant improvement after two weeks and remained stable throughout the study period. Thus, as intended, the proportion of young children achieving improved dietary diversity increased with enrollment in the program, also confirmed by previously published findings of good recovery under the program. The perception that the food voucher contents were unsafe was also significantly and negatively associated with benefit, suggesting that addressing caregivers' concerns regarding food safety can further enhance the effectiveness of the intervention. For younger children, sharing of the enriched porridge among family members was associated with a decrease in dietary diversity, highlighting the importance of considering both individual and familial factors when designing such interventions. Additional research is needed to confirm these findings and to inform further strengthening of the approach.

Abbreviations

FVP	Food Voucher Program
MAM	Moderate acute malnutrition MAM
MUAC	Mid-upper arm circumference
RUSF	Ready-to-use supplementary foods
WHZ	Weight-for-height Z-score

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions

BUSF oversaw the research study and analysis and contributed to drafting the manuscript; IT oversaw the implementation of the program and contributed to data analysis and review of manuscript; JNN contributed to implementation monitoring and drafting and editing of the manuscript; YK contributed methodologically and statistically to data analysis; GNT contributed to data collection and analysis; CDN contributed to data analysis; DT contributed to data analysis and drafting of manuscript; DD contributed to the design and planning of the FVP; JO oversaw data collection and supported data analysis.

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Data availability

The datasets generated and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The ethical clearance for the study was obtained from Cameroon's *Comité National d'Ethique de la Recherche pour la Santé Humaine* (2020/02/1207/CE/CNERSH/SP), and administrative authorizations were obtained from the Far North representative of the Minister of Public Health (Regional Delegate).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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