



# Facility- and community-based delivery of micronutrient powders in Uganda: Opening the black box of implementation using mixed methods

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## Abstract

Micronutrient powders (MNP) have the potential to increase micronutrient intake, yet documentation of implementation lessons remains a gap. This paper presents results of a pilot in Uganda comparing community- and facility-based delivery of MNP and documenting experiences of caregivers and distributors. The pilot's mixed method evaluation included a cross-sectional endline survey, monthly household visits, and midline and endline interviews. Primary outcomes were ever-covered (received  $\geq 1$  MNP packet), repeat-coverage (received  $\geq 2$  MNP packets), and adherence (consumed no more than 1 MNP sachet per day, consumed MNP with food, and consumed MNP 3+ days in past week). An adjusted Wald chi-square test compared differences in programme outcomes between arms, and logit regression identified predictors to adherence. Key informant interviews were coded thematically. Most programme outcomes in the endline survey were statistically significantly higher in the community arm, although in both arms, adherence was lower than other outcomes (adherence 31.4% in facility vs. 58.3% in community arm). Counselling, receipt of communication materials, perceived positive effects, MNP knowledge, and child liking MNP were consistent predictors of adherence in both arms. Qualitative findings corroborated survey results, revealing that social encouragement and advocacy facilitated use and that forgetting to give MNP was a barrier. Facility arm caregivers also cited distance, time, and transportation cost as barriers. Distributors had positive experiences with training and supervision but experienced increased workloads in both arms. MNP programme design is context-specific but could benefit from strengthened community sensitization, continued and more effective counselling for caregivers, and increased support for distributors.

## KEYWORDS

anaemia, delivery channels, evidence-based practice, infant and child nutrition, micronutrient powders, social and behaviour change

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## 1 | INTRODUCTION

Anaemia and iron deficiency are major public health problems (Black et al., 2013), with iron deficiency anaemia being the leading cause of disability among children globally (Global Burden of Disease Paediatrics Collaboration et al., 2016). Micronutrient powders (MNP), a mixture of micronutrients in single-dose sachets that are mixed into young children's food, are an intervention aimed at increasing micronutrient intake (De-Regil, Suchdev, Vist, Walleser, & Peña-Rosas, 2013). Although the impact of MNP on nutritional status is well-established (De-Regil et al., 2013), much less is known about how to implement an MNP programme.

A recent systematic review on MNP programming exposed the scarcity of documentation, not only for scale-up but also at the pilot stage (Reerink et al., 2017). Although the authors were able to identify MNP coverage and adherence data from seven countries using a health platform to deliver MNP free of charge, among these experiences, there were only two peer-reviewed published papers. One was a pilot in Nigeria where MNP were delivered at maternal and child health days (Korenromp et al., 2015), and the other was a pilot in Nepal comparing community- and facility-based delivery (Jefferds et al., 2015). Around the same time, a review was published highlighting the need to assess MNP programmes along a pathway to better understand factors that contribute to caregivers' adherence (Tumilowicz, Schnefke, Neufeld, & Pelto, 2017). The lack of documented evidence on MNP implementation is a major barrier to achieving population-based nutritional impact (Menon et al., 2014; Pelletier, Porter, Aarons, Wuehler, & Neufeld, 2013).

The purpose of this paper is to fill the implementation research gap by presenting the results of an MNP pilot in Uganda, using a mixed-method approach. SPRING designed a 9-month pilot study to compare the distribution of MNP through facility- and community-based delivery channels. First, we evaluate programme coverage and adherence between the facility- and community-based MNP delivery channels. Second, we describe perceptions of barriers and facilitators to behavioural outcomes along a programme impact pathway (Figure 1). To our knowledge, this is the first pilot in sub-Saharan Africa to compare MNP delivery channels.

## 2 | METHODS

### 2.1 | Programme description

In 2012, due to the high prevalence of anaemia among Ugandan children, the Ministry of Health established a technical working group to explore the introduction of MNP. The working group built on the Infant and Young Child Feeding (IYCF) Policy Guidelines (2012) for Uganda and the Uganda Nutrition Action Plan (2011–2016), both of which provide policy-level support for MNP, as well as other strategies to improve micronutrient intake for young children. The United States Agency for International Development (USAID)-funded Strengthening Partnerships, Results, and Innovations in Nutrition

### Key messages

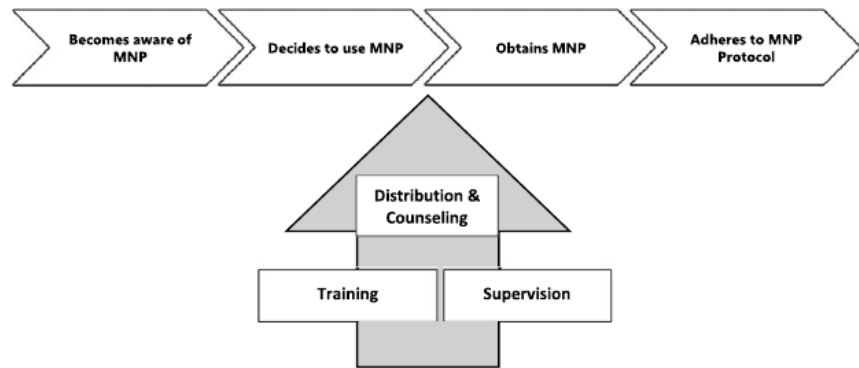
- Use of mixed methods (quantitative and qualitative) provided a comprehensive and nuanced understanding about MNP use along a behaviour pathway.
- Community-based MNP distribution in Namutumba District, Uganda, resulted in better programme outcomes compared with facility-based MNP distribution.
- Sustaining MNP programmes requires continual assessment and updating during implementation and a greater focus on behavioural continuity.
- Further research on behavioural supports for the different stages of programme participation (awareness, decision to use, obtainment, and sustained use) is a future area for implementation research.

Globally (SPRING) project, the World Food Programme (WFP), and UNICEF served as implementing partners for the MNP working group. The working group identified the need for formative research and pilots to inform national guideline development. First, formative research was conducted to assess acceptability, inform the package design, and identify key messages for MNP decision makers, including mothers, fathers, and grandmothers (SPRING, 2014). Stemming from this work, a series of strategy design workshops were held to determine MNP composition and packaging, design a social and behaviour change communication (SBCC) strategy, and develop training and monitoring plans (Uganda Ministry of Health, SPRING Project, World Food Programme, and UNICEF, 2015). Subsequently, the implementing partners piloted MNP distribution in different locations to inform national MNP implementation guidelines. The UNICEF pilot took place in five districts in Southwest Uganda (2015–2016), the WFP pilot was in two districts in Northern Uganda (2015–2016), and the SPRING pilot was in one district in the East Central region of Uganda (2016). The focus of this paper is on the results of SPRING pilot.

The SPRING pilot conducted blanket distribution of MNP to all children ages 6 to 23 months in Namutumba district, Uganda. The pilot took place over a 9-month period, beginning in February 2016 and ending in November 2016. Namutumba district is composed of six sub-counties. There are no hospitals in the district, but there is one health centre IV, providing inpatient and outpatient services with a doctor MD on staff; eight health centres III, providing outpatient services, lab services, and a maternity ward; and 25 health centres II, outpatient clinics providing treatment of common diseases and antenatal care, spread across the sub-counties and provide limited clinical services. In Namutumba District, the HCIIIs serve one to two parishes, covering at least six to 12 villages. Malaria is endemic, but the government and nongovernmental organizations carry out indoor residual spraying activities and distribute bednets during campaigns



**FIGURE 1** Caregiver behaviour adoption pathway. The caregiver behaviour adoption pathway flowchart presents the key determinants of effective behaviour change interventions identified by Fabrizio et al., 2014. It details the steps required of a caregiver to ensure that micronutrient powders (MNP) have their intended nutritional impact, which includes the following: becomes aware of MNP; decides to use MNP; obtains MNP; and adheres to MNP protocol. The flowchart also has a new component of distributor experiences, which includes distribution and counselling, training, and supervision.



throughout the year. Tests, as well as antimalarials, are provided at health centres across the district. According to the 2016 Uganda Demographic and Health Survey, over three quarters of households in the Busoga region, of which Namutumba is a part, have at least one mosquito net (Uganda Bureau of Statistics (UBOS) and ICF, 2018).

Two delivery channels for MNP distribution were piloted. In the “facility” arm, male and female health workers and facility-based village health teams (termed “HWs”) distributed MNP as part of routine activities at facility or outreach events. MNP were delivered at all types of health facilities (HC II-IV). Routine activities included postnatal care clinic days, antenatal care clinic days, and immunization activities. In the “community” arm, male and female village health teams (termed “VHTs”) distributed MNP to the caregivers, often at their home. Going forward, the general term “distributor” refers to health staff in both the facility and community arms, though their role was broader than distribution alone (e.g., providing MNP counselling) and included providing non-MNP related health services. HWs were health centre staff, most of whom were trained nurses, or facility-based community volunteers trained by health centre staff. VHTs were community-based volunteers trained by health centre staff.

National-level master trainers conducted trainings for over 450 distributors (VHTs and HWs) from both arms of the pilot, and district-level trainers provided ongoing capacity building. All health workers received training at the start of the intervention, and clinics that reported difficulty or showed low performance through routine data received coaching as needed throughout the pilot. Clinic staff gave VHTs in the facility arm on-the-job training about MNP. VHTs in the community arm received training at the beginning of the programme and at 2-month intervals during routine data collection meetings.

The MNP used in this pilot included 15 micronutrients<sup>1</sup> and were produced and packaged by DSM Nutritional Products, Ltd (South Africa). MNP were stored at a central facility in the district, and SPRING managed monthly deliveries to facilities. Facilities managed the delivery of stock to health workers or VHTs for further distribution to caregivers. To avoid contamination, facilities in the community arm did

not provide any MNP to health workers, and those in the facility arm did not provide any to VHTs. Caregivers requesting the product were encouraged to seek out the correct distributor for their arm.

Distributors were instructed to provide the caregiver one packet of 30 MNP sachets every 2 months, enough for the child to consume one sachet every other day. This dosing schedule provides half of the child's daily recommended nutrient intake (Home Fortification Technical Advisory Group, 2013). After 2 months, caregivers in the facility arm had to travel to health facilities or outreach events to receive a refill. Caregivers in the community arm reached out to the VHT for a refill or received refills from their VHT during a home visit. In most cases the caregiver was the mother of the eligible child, but in some cases MNP were provided to other adult family members who acted as primary caregiver to the child.

Recognizing the central role of behaviour change for the successful implementation of an MNP programme, SPRING implemented actions to support and encourage positive caregiver and distributor behaviours through robust communication and training activities. The SBCC strategy included having distributors counsel and provide communication materials, like calendars and stickers, to caregivers. Counselling was provided on MNP use and recommended IYCF practices, with reinforcement from reminder materials on how to mix the MNP with food, when to give the MNP, and when to get refills (Figure 2). As part of an IYCF strategy, MNP materials and counselling focused on key behaviours, including ensuring appropriate consistency of complementary foods, providing a variety of foods to complement the MNP, mixing MNP into food, supporting children to eat the full serving of food, and continued breastfeeding.

In addition to interpersonal counselling, the SPRING pilot included mass media and community mobilization activities to motivate caregivers to obtain and use MNP, address questions and concerns about the MNP, and reinforce the positive results of MNP. Radio advertisements and interviews with local politicians about MNP ran regularly throughout the period of the pilot. From the second month of implementation to the end of the pilot, drama troupes performed short skits about MNP use and misconceptions at markets, specifically identifying the role of husbands in encouraging MNP use. Recordings of the drama performances were shown in local cinemas during sporting events. The counselling, materials, and media campaign were the same

<sup>1</sup>The composition for this study included the following micronutrients: iron (10 mg), vitamin A (400 mcg), zinc (4.1 mg), vitamin C (30 mg), folic acid (90 mcg), vitamin D (5.0 mcg), vitamin E (5.0 mg), vitamin B1 (0.5 mg), vitamin B2 (0.5 mg), vitamin B3 (6 mg), vitamin B6 (0.5 mg), vitamin B12 (0.9 mcg), copper (0.56 mg), iodine (90 mcg), and selenium (17 mcg).





**FIGURE 2** Materials provided to caregivers, English version. The materials include (1) sticker with pictorial instructions for micronutrient powder (MNP) use; (2) adherence calendar for MNP use; and (3) enrolment card for MNP use. The materials were developed by Uganda Ministry of Health, SPRING project, World Food Programme, and UNICEF in 2015.

across both arms, with the type of distributor and location of the distribution as the only significant difference between interventions. A launch was held in the district seat at the beginning of the pilot, and local launches were held in each subcounty.

## 2.2 | Design and data collection

All sub-counties in Namutumba district were randomly assigned to either the facility- or community-based MNP delivery channel. The six sub-counties of the district are divided into 37 parishes. Three sub-counties were assigned to the facility arm and three sub-counties to the community arm. SPRING's previous work in Namutumba included annual household surveys that examined socio-economic and health-related characteristics across the district and found little differences between sub-counties (SPRING, 2016).

A mixed-method approach was used to evaluate the pilot programme, comparing caregiver and distributor experiences between the facility arm and community arm. Data was collected throughout the 9-month duration of the pilot (Table 1). Process evaluation data included midline qualitative interviews and monthly spot check data. Programme outcome evaluation data included endline key informant

**TABLE 1** Data sources and collection time

Type of data	Data source	Collection time frame
Qualitative	Informant interviews	Midline: May 2016 Endline: December 2016
Quantitative	Spot checks	April–October 2016
Quantitative	Endline survey	December 2016

interviews and a cross-sectional survey. All three sources of data are used to triangulate results in this study.

Starting in the first month of the pilot, SPRING staff made monthly spot check visits to one randomly selected village per parish. There are 18 parishes in the community arm and 19 in the facility arm. Once in the village, staff used a random walk until they identified a household with eligible children. One house was visited per village. During the spot checks, selected households participated in a short interview about exposure to MNP messaging, experience using MNP, and any difficulties using MNP. The interview ended with an open-ended question about their overall experience. Staff observed MNP materials, counted remaining sachets, and answered basic questions on MNP. These were not counselling visits, however, and staff referred caregivers to VHTs or health workers—depending on study arm—for more complicated questions. Interviews were carried out by SPRING staff, compiled monthly, and used to share experiences with programme managers and distributors.

Semistructured key informant interviews were conducted at midline and endline with caregivers of children aged 6 to 23 months. An equal number of caregivers were selected who were users (child taken MNP in last week), former users (child stopped taking MNP), and nonusers. Key informant interviews with fathers were added during endline data collection, though resources allowed for interviews with only half as many fathers ( $n = 16$ ) as caregivers ( $n = 32$ ). An equal number of HWs ( $n = 16$ ) and VHTs ( $n = 16$ ) were selected from both arms of the study. At midline, caregivers were selected to participate in interviews using the random walk method to identify households with eligible children. Once identified, interviewers would determine the category of user and either complete the interview or move on to the next randomly selected household, depending on which category





was prechosen for the interview. At endline, survey staff preidentified households for participation in the qualitative portion of the survey, as well as whether the household caregiver or father would be interviewed. If the survey identified that the household was the necessary category of user to fulfil the predesignated quotas, the interview took place after the survey. During both rounds, VHTs were randomly selected from a list to participate in interviews, and upon arrival to health facilities, the health worker with the most involvement in the MNP programme was selected to participate in interviews. Interviews with clinic staff took place in English, whereas interviews with community members and VHTs took place in one of the local dialects. No respondents participated in more than one interview, and all interviews were audio recorded and transcribed in English.

A cross-sectional endline household survey asked caregivers of children aged 8 to 23 months questions on socio-economic status, care-seeking practices, exposure to MNP messaging, feeding practices, foods to which the MNP were added, and MNP use. Caregivers of children aged 8 to 23 months were selected for endline household surveys to ensure all infants had an opportunity to receive at least one packet (2 months) of MNP. Sample size was calculated using a design effect of two, 95% confidence interval, power of 0.8, a 90% response rate, and assuming coverage rates of 50% and 60% for the facility and community intervention arms, respectively.

We used a two-stage cluster-sampling strategy to select participants. One hundred and seventy-six clusters (half in each study arm) were randomly selected using population-proportional-to-size sampling based on village-level population estimates from the 2014 National Population and Housing Census Provisional Result Report ("National Population and Housing Census", 2014). A listing of eligible households in the selected clusters was provided by local VHTs, and 10 households were randomly selected for inclusion.

The survey team intended to reach 1,760 (880 households per arm), and there was no replacement of clusters or households. During fieldwork, the household listings were found to be incomplete. The listing included households that could not be located in the cluster and ineligible households (no child aged 8 to 23 months in the household). The final survey included 1,060 households. There was a comparable amount of missing data between the two survey arms. To assess potential bias in the endline survey household listing, a full census activity was conducted in the district in a random selection of 10 clusters (five clusters per study arm), and household demographic characteristics were compared for those households who were and were not included in the endline survey household listings. Analysis of this issue is detailed elsewhere (Schott et al., 2018) and suggests negligible bias for comparisons between households, though households included in the endline were wealthier than their community.

## 2.3 | Data analysis

Coding and initial thematic analysis of key informant interviews was conducted in Nvivo (version 10) using queries and Excel-based coding

matrices to analyse responses. All coding and analysis results were independently reviewed by two researchers.

Spot check data were pooled across all months and analysed by study arm in MS Excel using descriptive statistics. The process evaluation indicators were defined as "ever heard of MNP" and "received and taken MNP."

Endline survey results were used to assess programme outcomes using Stata (version 12.0; College Station, TX). Weights were applied for nonresponse in each study arm. The Taylor linearization method was used to obtain unbiased estimates that incorporated the weight, strata, and cluster. Programme outcome variables included from the endline are presented in Table 2. Differences in population characteristics and programme outcomes between study arms were calculated using a Wald chi-square test adjusted for survey design. Logit models, adjusted for survey design, were performed to predict the programme exposure factors that could potentially be associated with adherence to protocol (Table 6). These factors were determined a priori and included topics related to social and behaviour change, perceptions and knowledge of MNP, and changes in food. This model was adjusted for child sex, age category (8–11 months, 12–17 months, 18–24 months), household wealth (being in the poorest 40% or richest 60%), and maternal education (not completed primary or completed at least primary).

Ethical approval for the study was provided by the Makerere University School of Public Health and the John Snow, Inc. institutional review boards. All participants provided written consent.

## 2.4 | Development of a behaviour pathway

During analysis of midline interviews, a pathway began to emerge from caregiver experiences with MNP. To support development of this framework (Figure 1), we identified several existing frameworks from

**TABLE 2** Outcome variable definitions

Outcome variable	Definition
Ever heard of MNP	Caregiver has heard of MNP
Ever-covered	Child received $\geq 1$ MNP packets during the course of the pilot
Repeat coverage	Child received $\geq 2$ two packets of MNP during the course of the pilot
Ever consumed MNP	Child has consumed food mixed with MNP
Consumed in last week	Child consumed MNP sachet in the last 7 days
Adhere to protocol <sup>a</sup>	Child met all three required practices derived from three indicators: Last time child took MNP; he/she consumed 1 sachet in that day, it was mixed with food or porridge; child took MNP $\geq 3$ days in the last 7 days

Note. MNP: micronutrient powder.

<sup>a</sup>Logit model presented for this outcome variable.



MNP (or similar nutrition interventions) process evaluations in Ethiopia, Haiti, and Nigeria and adapted them based on the findings in our pilot (Kim et al., 2015; Korenromp et al., 2015; Loechl et al., 2009). The caregiver behaviour pathway features two key elements of effective behaviour change interventions identified by Fabrizio, van Liere, and Pelto (2014)—use of formative research and assessment of intermediary stages in a programme impact pathway—and delineates steps required of a caregiver to ensure that MNP have their intended nutritional impact. Distributor feedback on the counselling process, in addition to training and supervision, is a novel component embedded in the adapted framework to help evaluate the role of distributors in the behaviour pathway.

### 3 | RESULTS

#### 3.1 | Respondent characteristics—Key informant interviews

Key informant interviews were held with a total of 64 caregivers, 16 fathers, 32 VHTs, and 32 HWs. Most caregivers interviewed were between the ages of 20 and 30 years. Respondent households had

**TABLE 3** Spot check process evaluation indicators, by delivery arm<sup>a</sup>

Indicators	Facility arm	Community arm
	Proportion (n)	Proportion (n)
Percent of respondents who had ever heard of MNP	79.4 (104)	96.9 (124)
Of those who had heard of MNP, the percent whose children had received and taken MNP	61.5 (64)	87.1 (108)

<sup>a</sup>MNP: micronutrient powders.

**TABLE 4** Characteristics of endline survey population, by delivery arm<sup>a</sup>

Characteristics	Facility arm (n = 524) Proportion [95% CI]	Community arm (n = 548) Proportion [95% CI]	P-value
Child characteristics			
Child female	51.7 [46.5, 56.8]	53.1 [48.0, 58.1]	0.694
Age category			
8–11 months	25.4 [20.5, 31.0]	14.3 [11.2, 18.1]	0.000
12–17 months	44.4 [39.2, 49.7]	44.2 [39.9, 48.7]	
18–23 months	30.3 [25.9, 35.0]	41.4 [36.9, 46.1]	
Minimum dietary diversity <sup>b</sup>	23.9 [19.2, 29.4]	29.8 [24.6, 35.6]	0.122
Household characteristics			
Mother's education <sup>c</sup>	21.2 [17.3, 25.7]	19.1 [15.8, 22.8]	0.438
Wealth quintile (poorest 40%)	44.6 [39.6, 49.8]	38.0 [34.1, 42.0]	0.276
Urban	12.4 [6.3, 22.8]	0 [NA]	0.004

<sup>a</sup>MNP: micronutrient powders; NA: not applicable.

<sup>b</sup>Minimum dietary diversity: Proportion of children 6–23 months of age who receive foods from four or more food groups.

<sup>c</sup>Have not completed primary education.

an average of four to five children under 18 years old living in the household. Only two households had more than one child within the age range eligible for MNP. On average, VHTs had been in their position nearly 7 years with little difference between study arms. HWs in both study arms had an average of 5 years of experience in their position.

#### 3.2 | Respondent characteristics—Spot check data

A total of 259 spot checks were conducted in separate villages across 37 parishes. Two thirds of spot check respondents were between ages 20 and 30, with 10% under the age of 20. Twenty-two percent reported receiving education beyond the primary level, and 15% reported no formal education. Process evaluation indicators are presented in Table 3.

#### 3.3 | Survey sample characteristics and comparison of programme outcomes between arms—Endline survey

A total of 1,060 households participated in the endline survey. Some characteristics of surveyed children and households in the facility arm and community arm were statistically significantly different (Table 4). Children were older in the community arm, whereas there was a higher proportion of urban residents in the facility arm. Despite this age difference, programme outcomes remained statistically significantly different from each other after adjusting for sex, age, education, wealth, and maternal education in logit regression models (data not presented). All programme outcomes were statistically significantly higher in the community arm compared with the facility arm, except “ever heard of MNP,” which was similar across both arms (Table 5).



**TABLE 5** Programme outcomes, by delivery arm<sup>a</sup>

Outcomes	Facility arm (n = 524) Proportion [95% CI]	Community arm (n = 548) Proportion [95% CI]	P-value
Ever heard of MNP	98.5 [97.0, 99.3]	99.1 [97.8, 99.6]	0.966
Ever-covered	83.7 [0.781, 0.881]	96.6 [94.4, 97.9]	0.000
Repeat coverage	44.4 [38.9, 50.0]	87.5 [83.8, 90.4]	0.000
Ever consumed MNP	82.3 [76.3, 87.1]	96.7 [94.6, 98.0]	0.000
Consumed in last week	34.6 [28.6, 41.2]	63.6 [0.582, 0.687]	0.000
Adhere to protocol			
Consumed 1 sachet last time	78.5 [72.2, 83.8]	95.1 [92.0, 97.0]	0.000
Consumed MNP w/food	82.1 [75.9, 86.9]	96.6 [94.5, 98.0]	0.000
Consumed MNP 3+ days in last week	34.0 [28.2, 40.3]	61.1 [55.8, 66.2]	0.000
Practices combined	31.4 [25.7, 37.6]	58.3 [52.9, 63.5]	0.000

<sup>a</sup>MNP: micronutrient powders.

### 3.4 | Experiences across the behaviour pathway

In the following sections, we discuss factors that contribute to the desired behavioural outcomes along the behaviour pathway, which include differences between the community arm and facility arm. The findings triangulate endline survey data, spot check data, and key informant interviews in each section. In the last stage of the pathway, predictors of adherence to protocol are presented, as this downstream indicator will ultimately determine whether nutritional impact of the programme is achieved.

### 3.5 | Awareness of MNP

On the basis of the endline survey and spot check data, nearly all caregivers had heard of MNP, and this did not differ by arm (Table 5). However, spot check data found more respondents in the community arm were aware of MNP compared with respondents in the facility arm (Table 3). Key informant interviews with caregivers supported the finding that awareness was high across both delivery arms.

Over half of respondents in the endline survey reported hearing about MNP on the radio (Table 6). On the basis of key informant interviews, many caregivers remembered the radio advertisement content vividly and found it engaging.

*It excited me, the way the advert was made, and I also had to think about giving MNP to my child. User, facility arm.*

During key informant interviews, distributors confirmed awareness was high among respondents in general, saying they appreciated the widespread awareness, which “simplified” the “work of explaining [MNP] to them” (HW, facility arm). However, many respondents could not give a precise description of MNP and often conceptualized MNP by comparing it with familiar products that are added to food. One caregiver said her child called MNP “band” (user, facility arm), referring to Blue Band margarine, whereas another said that community leaders told her that MNP were like Royco (user, facility arm), referring to a brand of curry powder that comes in small sachets.

### 3.6 | Decision to use MNP

In the endline survey, 77% of caregivers reported that they were the ones who made the decision to provide MNP to their child, followed by their spouse for 21% of children (data not shown). Other family or household members were identified as the decision maker in less than 1% of cases (data not shown). However, a large proportion of caregivers reported they consulted someone, such as a husband, friend, religious leader, or health worker, about MNP before deciding to use MNP (59.3% facility arm and 66.8% in the community arm, Table 6).

Key informant interviews supported the finding that the caregivers were the decision maker. However, nearly all caregivers indicated they had to consult their husband and ensure he did not disapprove. In nearly all situations where a husband's disapproval was a barrier to MNP, caregivers reported they were able to overcome his opposition. They often accomplished this by asking distributors or community leaders to speak with their husbands about MNP and encourage his support.

*My husband did not know about them. He asked me what they were and where I got them. I told him it is for the children and I got them from the health centers. Former user, facility arm.*

Key informant interviews with caregivers suggested that social encouragement and advocacy by respected community members were highly influential in the caregiver's decision to provide MNP to their child, especially those who were initially hesitant.

*The director's wife asked me whether my child eats MNP. I told her that I do not know about them, she showed me a packet... When I came back home, I went [to the VHT]. User, community arm.*

Caregivers reported that concerns of negative side effects existed in the community, but no caregiver reported that the rumours affected their decision to give MNP. Seeing others use MNP dispelled rumours of negative effects, and encouragement from trusted community members moved caregivers from thinking about MNP to using it.



**TABLE 6** Prevalence and odds of factors associated with adherence to protocol<sup>a</sup>

Factors	Facility arm (n = 524)		Community arm (n = 535)	
	Proportion [95% CI]	Odds ratio [95% CI]	Proportion [95% CI]	Odds ratio [95% CI]
Heard of MNP from radio	53.4 [47.3, 59.4]	0.8 [0.5, 1.4]	60.9 [55.7, 65.8]	1.85 [1.3, 2.7]
Consulted someone about MNP	59.3 [53.1, 65.1]	2.9 [1.7, 5.0]	66.8 [60.7, 72.4]	1.4 [0.8, 2.2]
Counselled on MNP <sup>b</sup>	81.1* [75.2, 85.8]	2.9 [0.6, 14.9]	97.1* [94.9, 98.3]	NA
Received SBCC calendar	80.4* [74.1, 85.5]	7.6 [1.6, 36.7]	93.1* [90.2, 95.2]	1.5 [0.5, 4.7]
Received SBCC sticker	59.3* [52.8, 65.6]	1.4 [0.8, 2.5]	81.2* [77.1, 84.8]	2.1 [1.2, 3.5]
Knowledge of MNP <sup>c</sup>	34.6 [28.5, 41.3]	2.0 [1.2, 3.3]	38.5 [33.2, 44.0]	2.2 [1.4, 3.4]
Child likes MNP	75.4* [69.5, 80.5]	1.0 [0.4, 2.4]	91.0* [87.8, 93.4]	3.2 [1.4, 7.3]
Perceived ≥1 positive effect	75.6* [69.6, 80.7]	2.4 [1.0, 6.0]	92.9* [90.0, 95.0]	1.2 [0.4, 3.2]
Perceived ≥1 negative effect	28.7 [24.3, 33.5]	1.0 [0.6, 1.5]	28.5 [24.4, 33.0]	0.7 [0.4, 1.2]
Child bothered by changes in food				
Colour	4.8 [2.2, 10.1]	1.0 [0.3–3.1]	4.3 [2.5, 7.3]	1.6 [0.5, 5.2]
Taste	16.5 [11.4, 23.2]	1.2 [0.4, 3.4]	16.8 [12.1, 22.7]	1.0 [0.4, 1.6]
Smell	5.5 [3.1, 9.8]	1.0 [0.2, 4.3]	1.8 [0.7, 4.3]	4.1 [0.6, 25.9]

<sup>a</sup>MNP: micronutrient powders; NA: not available (nearly all caregivers received counselling first time and none of those not being counselled first were adhering to protocol); SBCC: social and behaviour change communication; Odds ratios presented adjusted for potential confounders sex, age, education, wealth, and maternal education (Odds ratios of confounders not shown).

<sup>b</sup>First time received.

<sup>c</sup>Know age child should start and stop consuming MNP and frequency MNP should be taken.

\*Indicates difference in proportions between the community and facility arm at the  $P < 0.05$  level.

*Some people misled us, [saying] that when you give MNP to a child, he can die. When I saw other people going to pick up MNP, I also decided to get it for my child. User, community arm.*

From the key informant interviews, caregivers who stated they did not give MNP to their child often reported that they felt they “did not have enough information” to make an informed decision.

### 3.7 | Obtaining MNP

In the endline survey, nearly all caregivers had obtained a packet of MNP (Tables 3 and 4). Additionally, key informant interviews did not cite any barriers to obtaining the first batch of MNP. Thus, data in this section on obtaining MNP is focused primarily on obtaining refills.

The endline survey showed that caregivers in the community arm reported getting an average of 2.8 packets of MNP (equivalent to 5.6 months of MNP use) compared with 1.5 packets of MNP (equivalent to 3 months of MNP use) in the facility arm over the pilot period (Table 5). Key informant interviews with caregivers corroborated the differences in caregivers' ability to obtain MNP between the two arms. Caregivers in the community arm perceived MNP as easier to obtain, with most receiving the MNP from the VHTs during a home visit. There remained barriers to obtaining MNP even in the community arm, however. Some caregivers reported incidents where VHTs ran out of stock. Spot check data supports a periodic delay in VHTs' restocking of MNP from the facility. In addition, during key informant

interviews, a few caregivers and VHTs mentioned that it was sometimes difficult to find a time when they could meet for the distribution.

*In one area [the caregivers] told us that they were not getting MNP, so I followed up with that VHT. He told me that it is very hard to find those mothers at home as they are in the garden. HW, community arm.*

In contrast to the community arm, key informant interviews identified the burden—in time and money—associated with travelling to facilities as a barrier to obtaining MNP in the facility arm.

*I keep telling [the VHT] that it is very tiresome for me to move to the health facility to get MNP because it is very far. Former user, facility arm.*

Spot check data supports this, with caregivers reporting that they were too busy to pick up the MNP packet. Caregivers explained that they often waited to get refills until they were at the facility for an unrelated reason or when the health facility conducted an outreach activity in the community. A few HWs reported that although it was not part of distributor protocol, they started adjusting refill dates to coincide with the next planned health facility visit or community outreach activity, even if it was before the 2-month supply was finished, to ease the burden of travelling to facilities.

### 3.8 | Adherence to MNP protocol

In the endline survey, adherence to protocol (all three practices followed) was 31.4% in the facility arm and 58.3% in the community





arm (Table 5). The endline survey showed that most caregivers followed the first two components of adherence to protocol, not giving the child more than one MNP sachet per day and mixing the MNP with food; these two practices were slightly higher in the community arm (Table 5). The third component of adherence to protocol, consumed MNP 3+ days in past week, was much lower compared with the other two components, but performance remained better in the community arm (Table 5).

Likewise, during spot check and key informant interviews, caregivers were able to explain how they prepared the food to be mixed with MNP and noted the importance of having foods that were not too hot and of appropriate thickness. In a few cases, though, caregivers reported sharing MNP with a noneligible child in the household. As was the case in the endline survey, caregivers reported the most common impediment to adherence to the protocol was the third component. The main reason cited by caregivers in the community and facility arm was forgetting to give MNP. This was often because of deviations from routine, which happened when travelling, or when the primary caregiver was absent. However, other caregivers reported this was overcome by household members providing reminders and giving the MNP to the child in the absence of the caregiver.

*They go for funeral rites and they leave the [MNP] at home. They stay there for some 2–3 days. There comes the problem. VHT, facility arm.*

*Whenever I was not around, [my daughter] would help me give the child MNP. If I was around, she would remind me. She used to ask me, 'Mother, aren't [you] giving him MNP?' Former user, community arm.*

Identifying at least one positive effect of MNP was a significant predictor of adherence to protocol (all three practices followed) in the facility but not the community arm, where nearly all caregivers reported a positive effect (Table 6). This was substantiated in key informant interviews, where caregivers reported that positive health effects motivated them to continue using MNP. In contrast, some caregivers discontinued use, assuming the product did not work when their expectations, such as seeing immediate and visible physical improvement in their child, were not met. Similarly, distributors reported that some caregivers who saw improvements in the child's health, separate from any side effects associated with the MNP use, assumed that MNP had "cured" the child and were no longer needed, so they discontinued use. Discontinuing MNP for these reasons was more pervasive in the facility arm, where caregivers had less interaction with distributors. This suggests caregivers had fewer opportunities for misinformation to be corrected.

*Some caregivers who are using [MNP] say they do not see any changes. They thought they would notice the changes immediately ... They expect their children to look good after one packet when they use MNP, and it does not happen. HW, facility arm.*

Negative side effects were not a statistically significant predictor of adherence to protocol (all three practices followed) in the endline survey in the facility or community arms (Table 6). However, some caregivers did report the child passed loose (19.7% community arm, 17.5% facility arm) or dark stool (5.4% community arm, 6.2% facility arm) in the endline survey (data not shown, other side effects also reported). In the key informant interviews, some caregivers also reported diarrhoea occurred after starting MNP. Those who continued MNP use despite diarrhoea said that a VHT or HW had set an expectation for this negative side effect before MNP use began, or that they had sought advice from a VHT or HW and received counselling to continue giving MNP.

*[My daughter] had some diarrhea at the start. I went and asked the health workers and they told me to continue giving her MNP. They told me the diarrhea will stop eventually and that is what happened. User, community arm.*

Having a child who likes MNP was a statistically significant predictor of adherence to protocol (all three practices followed) in the community but not the facility arm (Table 6). Almost no caregivers reported the child rejected food mixed with MNP (3.1% community arm, 3.9% facility arm). Over half of caregivers reported changes in the food characteristics (colour, taste, and smell) when mixed with MNP (56.9% community arm, 58.4% facility arm; data not shown). A small proportion of caregivers reported the changes bothered the child, but changes were not associated with adherence to protocol in either arm (Table 6). Similarly, a few caregivers in the key informant interviews reported changes in the flavour or colour of the food and child's refusal to eat food mixed with MNP as the reason they discontinued use. However, most reported even with changes, the child did not refuse the food.

*He doesn't refuse it. When you are cooking, before you finish, he carries the packet, so you can add it for him. User, community arm.*

Exposure to the SBCC activities and materials predicted adherence to protocol (all three practices followed) in both arms (Table 6). More caregivers received counselling, stickers, and calendars in the community arm and when provided these materials, caregivers were more likely to adhere to protocol in both arms (Table 6). Key informant interviews supported these findings, citing the materials as a helpful reminder of the appropriate steps, and distributors described them as a useful counselling tool.

*First you look at [the sticker] and see how the woman is feeding her child and then you can also follow the steps when feeding yours ... it was helpful in that it would remind me of the steps whenever I prepared MNP for my child. User, community arm.*

However, some caregivers and distributors suggested that the pictorial instructions were not clear. There were also some cases in which SBCC materials and counselling on IYCF confused caregivers who



thought MNP could only be used with foods or recipes that were promoted as “ideal” foods for young children.

*The issue [of not having the right foods for MNP] was resolved when they were told they could mix MNP with any food so long as it was well-prepared, lukewarm, and they followed all the guidelines as they had been taught. HW, facility arm.*

### 3.9 | Distributors' experiences with training and MNP delivery

All VHTs and HWs found the MNP training to be complete, giving them the skills to conduct their programme activities, including answering questions and addressing caregiver concerns. Distributors found that training added to their knowledge on IYCF, making them better equipped to provide counselling on nutrition and feeding to caregivers. They also reflected that the programme contributed to strengthening relationships between the distributors and the caregivers.

*A bond is created between the health worker and the caregiver when there is a change in the baby who is eating the MNP. HW, community arm.*

The MNP pilot faced a common challenge: Most distributors noted the need for refresher trainings during the programme and for training replacement staff. In the facility arm, staff turnover resulted in distributors being replaced by staff untrained in MNP. Many HWs highlighted the importance of on-the-job mentoring and informal training, in addition to the initial training, because all staff received questions about MNP from community members with young children.

*I never attended any training, but I was taught by the health center in-charge... She used to teach me during our free time, or ... when someone had come to pick MNP. HW, facility arm.*

Overall, distributors had positive experiences with programme supervision by Ministry of Health staff and appreciated when supervisors shared current information about issues or challenges coming up in the programme. They reflected that this feedback loop helped resolve problems before they got worse and improved performance.

*When they supervise us, it just motivates us to work harder, and even the caregivers know that the people who gave them the MNP are interested in knowing what is going on. HW, community arm.*

Nearly all distributors in both arms reported that MNP distribution created additional work for them. This was true even for staff who were not expected to distribute MNP (facility staff in the community arm and VHTs in the facility arm), reporting they spent time counselling MNP users in their catchment areas or communities. In addition, facility staff in the community arm had to manage the distribution of stock to the VHTs, which they cited as a disruption to their regular

activities. Many reported they should receive compensation to accommodate for the added workload, though these facility staff did not suggest discontinuing the activity. The majority of HWs mentioned that they felt an allowance should be added for the additional burden, and some in the facility arm mentioned that asking VHTs to share their work burden or training new staff would help.

*[For] health education we were spending 45 minutes for a group but now we are spending an hour because one [person asks] a question and another also has a question ... I have become a bit busy and active. HW, facility arm.*

*Sometimes you are busy, and a VHT comes and they tell you that they want the mineral powder. So, you leave this work here to go and serve the VHT. Then another one will come. HW, community arm.*

VHTs also noted additional challenges beyond those cited by HWs related to completing programme activities, mainly due to competing obligations and transport difficulties. The most common barrier to VHT motivation, as communicated by VHTs and corroborated by facility staff, was not compensating them for the extra work through reimbursement of travel fees, provision of a stipend, or provision of supplies like boots or umbrellas.

The additional workload often affected caregiver experience when obtaining MNP packets at the facilities. Households in the facility arm reported long wait times at facilities to receive MNP, in addition to the time they had already spent travelling to the facilities. Facility staff corroborated this, describing significant time needed to distribute and counsel caregivers. In some facilities, staff streamlined this process by gathering caregivers for group instead of individual counselling and enlisting volunteers to help with the counselling process.

*We have expert clients who work at the [antiretroviral therapy] clinic, so on very busy days sometimes they come in ... [to] help us with the documentation. Then with time we also taught them how to counsel mothers. HW, facility arm.*

## 4 | DISCUSSION

To our knowledge, this is the first study conducted in sub-Saharan Africa comparing facility- and community-based distribution for an MNP programme. By exploring the experiences of caregivers and distributors across a behaviour pathway, we were able to identify factors that influence MNP programme outcomes. We found that generating awareness and building support for the decision to use MNP were achieved independent of delivery channel. Sustaining continual MNP use was difficult in both arms, with proportions dropping drastically between ever-covered, repeat coverage, and adherence to protocol, although programme outcomes were significantly enhanced with community-based distribution. This research suggests that MNP can be included in existing health activities, but work burden challenges



did emerge, indicating that it may be necessary to better integrate messaging and materials across topics rather than simply layering MNP efforts on top of existing programmes. The findings also suggest that the selection of a facility distribution model may result in lower programme fidelity but would also likely require less intensive programmatic inputs than a community distribution model.

The main facilitators to adherence to protocol in our study were caregivers' perceptions of positive effects and greater exposure to SBCC, whereas remembering to give MNP was a major barrier. A recent review of 41 documents identified these same factors but also found child not accepting food with MNP to be a barrier, which was not seen in our study (Tumilowicz et al., 2017). Although similar facilitators and barriers were found between arms in key informant interviews, lower programme outcomes suggest that these barriers had a more pronounced effect on caregiver behaviours in the facility arm. Additionally, users in the facility arm were more likely to report not receiving SBCC materials, suggesting that project fidelity is lower when implemented through facilities, possibly due to the time constraints of providing MNP along with other services. These results were similar to a study in Nepal, which showed community distribution performed better than facility distribution on coverage and adherence indicators (Jefferds et al., 2015). Our study and the Nepal study indicate the important role of communities and community-based distribution in the successful implementation of an MNP programme. Additionally, although this study was not able to measure the effect of MNP on IYCF behaviours, additional analysis of these data elsewhere does suggest a correlation between MNP compliance and improved IYCF practices (Schott et al., 2018).

Despite substantial programme inputs with a strong SBCC strategy and high receipt of counselling and SBCC materials, MNP knowledge remained low, and this was associated with caregiver's adherence to protocol. This may be the result of the narrow definition of MNP knowledge (know age child should start and stop consuming MNP and frequency MNP should be taken) or could indicate there needs to be improvements in SBCC inputs. In addition, qualitative findings indicated SBCC inputs need to remain regular and consistent, but also able to evolve as the programme matures to be able to address new issues that emerge. For example, caregivers who discontinue MNP because they believe that improvements in the child's health indicates a "cure" should be counselled on the continued need for micronutrients in the child's diet and the risk of decline in their child's growth and development with inadequate micronutrients. The role of noncaregiver family members in deciding whether to give MNP and playing a role in MNP collection and use suggests that future programming consider wider audiences for MNP messages.

Further, our findings revealed the need to strengthen ongoing training and supportive supervision for distributors, so they can help caregivers sustain MNP use. Namutumba District was undergoing a drought and famine during much of the MNP pilot. During discussions with SPRING staff, distributors said that when food availability was poor, they needed a way to encourage MNP use with the food that was available. SPRING staff worked with distributors to identify messages that could address this issue, sharing the updated messages with

distributors throughout the district. These findings are also similar to other studies that identify the importance of continued capacity building for distributors (Creed-Kanashiro, Bartolini, Abad, & Arevalo, 2015; Jefferds et al., 2015; Korenromp et al., 2015) and difficulty providing supportive supervision (de Barros & Cardoso, 2016; Kim et al., 2015). Distributors in this study benefitted from the chance to discuss the community response with their peers, sharing problem-solving tactics. It is possible that integrating this topic into other trainings or events where multiple distributors are present, data collection meetings, for example, would alleviate some of the training issues faced in this study.

Similarly, consideration of staff turnover, workload, and sustaining motivation to perform programme activities without compensation are system-level problems that affect other nutrition interventions (de Barros & Cardoso, 2016; Kim et al., 2015; Korenromp et al., 2015; Loehl et al., 2009). Whether programmes rely on community distributors or facility staff—or some other channel—to deliver MNP to households, any community members seen as reliable health information providers should expect to receive questions about the product. Therefore, at a minimum, these cadres should be identified by programme implementers, made aware of the product's introduction into their area, be prepared to encourage its use, and be able to direct caregivers to someone who can answer questions about it.

A major strength of this study is our ability to triangulate quantitative and qualitative data. However, during the endline survey data collection, the research team discovered that the household listings were not complete in many of the clusters. To better understand this bias, we conducted an additional round of data collection by going door to door in 10 randomly selected clusters within the study district and administering a shortened version of the endline survey questionnaire. We found the programme outcomes were lower in both the facility and community arms in these clusters compared with the endline survey. This result indicates a bias in our sample, which, we hypothesize, is the result of harder to reach households not being included in the endline survey. Nevertheless, the differences in programme outcomes between arms remained statistically significant in this subset of clusters, so we can be reasonably confident that our conclusions would be the same if this bias had not occurred. In addition, our endline survey findings were corroborated by our spot check and key informant interviews.

Our study showed that sustaining MNP as a long-term preventive intervention has challenges; the use of MNP does not rely on one-time actions but requires continued and sustained practice. Therefore, programme activities must be updated frequently to maintain a balance between promotion of new behaviours and their sustained use. Ensuring that programmes are designed to facilitate continued use of MNP is important from the outset but may require a shift in strategy after the programme is established, calling for additional inputs in communications, counselling, capacity building, and supervision. Sustaining the programme also means considering the added workload for distributors, as each interaction with caregivers requires time for counselling. Longer term studies on the behavioural supports needed at different stages of implementation (initiation of pilot through



transition to scale) to maintain sustained use is an urgent area of implementation research.

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## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

## CONTRIBUTIONS

AD, AC, WS, SN, HM, MG and DS did the primary drafting of this paper. AD, FS, HM, AC, RN, KO, DS, WS, DK, MG and SMLN contributed to data collection, data analysis, and interpretation of the data as well as revising the draft critically. All authors contributed to the conception and design of the paper and reviewed and approved the overall paper.

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