


Determinants of adherence to micronutrient powder use among young children in Ethiopia

Aregash Samuel¹  | Inge D. Brouwer² | Nindya P. Pamungkas² | Tosca Terra² | Azeb Lelisa³ | Amha Kebede¹ | Saskia J. M. Osendarp²

¹Food Science and Nutrition Research Directorate, Ethiopian Public Health Institute (EPHI), Addis Ababa, Ethiopia

²Division of Human Nutrition and Health, Wageningen University, Wageningen, The Netherlands

³Nutrition International, Ethiopia, C/O Ethiopia-Canada Cooperation Office (CIDA-ECCO), Addis Ababa, Ethiopia

Correspondence

Aregash Samuel, Food Science and Nutrition Research Directorate, Ethiopian Public Health Institute (EPHI), Patriots Street, P.O. Box 1242 or 5645, Addis Ababa, Ethiopia.
Email: aregashhabebo@gmail.com

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Abstract

In Ethiopia, home fortification of complementary foods with micronutrient powders (MNPs) was introduced in 2015 as a new approach to improve micronutrient intakes. The objective of this study was to assess factors associated with intake adherence and drivers for correct MNP use over time to inform scale-up of MNP interventions. Mixed methods including questionnaires, interviews and focus group discussions were used. Participants, 1,185 children (6–11 months), received bimonthly 30 MNP sachets for 8 months, with instruction to consume 15 sachets/month, that is, a sachet every other day and maximum of one sachet per day. Adherence to distribution (if child receives ≥ 14 sachets/month) and adherence to instruction (if child receives exactly 15[± 1] sachets/month) were assessed monthly by counting used sachets. Factors associated with adherence were examined using generalized estimating equations. Adherence fluctuated over time, an average of 58% adherence to distribution and 28% for adherence to instruction. Average MNP consumption was 79% out of the total sachets provided. Factors positively associated with adherence included ease of use (instruction), child liking MNP and support from community (distribution and instruction) and mother's age > 25 years (distribution). Distance to health post, knowledge of correct use (OR = 0.74, 95% CI = 0.66–0.81), perceived negative effects (OR = 0.73, 95% CI = 0.54–0.99) and living in Southern Nations, Nationalities and People Region (OR = 0.59, 95% CI = 0.52–0.67) were inversely associated with adherence to distribution. Free MNP provision, trust in the government and field staff played a role in successful implementation. MNP is promising to be scaled-up, by taking into account factors that positively and negatively determine adherence.

KEYWORDS

adherence, determinants, Ethiopia, micronutrient powder, young children

Abbreviations: CSpro, Census and Survey Processing System; CBN, community-based nutrition; EPHI, Ethiopian Public Health Institute; GEE, generalized estimating equations; Hb, haemoglobin; HDA, health development army; HEW, health extension worker; KAP, knowledge, attitude and practice; MI, micronutrient initiative; MNP, micronutrient powder; NRERC, National Research Ethics Review Committee; SNNPR, South Nations, Nationalities and Peoples Region; TPB, theory of planned behaviour; UNICEF, United Nation Children's Fund; WHO, World Health Organization; VIF, variation of inflation.

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1 | INTRODUCTION

In 2016, the World Health Organization (WHO) published a recommendation about the use of micronutrient powders (MNPs) as an effective way of improving the micronutrient status of infants and young children (WHO, 2016). Home fortification of complementary foods with MNP has several advantages over other fortification methods as described elsewhere (Christofides et al., 2006; Schauer & Zlotkin, 2003; WHO, 2016; WHO/FAO, 2006). Several studies including a meta-analysis of 17 trials conducted so far showed that MNPs are effective in improving micronutrient intakes in children (6–59 months of age) and in significantly reducing iron deficiency in developing countries (Adu-Afarwuah et al., 2007; Rah et al., 2012; Salam, MacPhail, Das, & Bhutta, 2013). MNP has been successfully used in programmes for infants and young children in countries such as Zambia, Sierra Leone, Rwanda and Madagascar; globally, the number has tripled since 2011 (UNICEF, 2017).

Findings from the evaluations of these programmes suggest that MNPs were well accepted by infants, and fewer dislikes of the product were reported compared with other supplements (Adu-Afarwuah et al., 2008; Michaux et al., 2014; Rah et al., 2012; Tripp et al., 2011). Similar findings were also reported in Kenya and Ghana, although in Ghana, 16% of the mothers experienced negative effects and problems in giving MNP to their children (Adu-Afarwuah et al., 2008; Suchdev et al., 2010). Potential barriers identified, among others, were limited knowledge and experience with MNP. Additionally, several studies revealed that mothers preferred a less structured dosing regimen compared with a rigid one (Hyder, Haseen, Rahman, Tondeur, & Zlotkin, 2007; Sharieff et al., 2006).

Adherence refers to the extent to which a person follows suggested guidance or advice, in terms of health and medication (WHO, 2003). It also implies the person's belief and autonomy to freely choose whether or not to practice the recommendation (Brawley & Culos-Reed, 2000; Horne et al., 2005). Numerous documentation from efficacy trials has confirmed the perceived ease of use (Agostoni, Riva, & Giovannini, 2007; Geltman et al., 2009; Zlotkin et al., 2003) and high adherence to MNP (Sharieff et al., 2006) ranging from 32% to 90% (De-Regil, Suchdev, Vist, Walleser, & Peña-Rosas, 2013). However, evidence on adherence from large-scale programme settings is scarce (Rah et al., 2012). In addition, adherence to MNP was measured either at the start or end of the intervention (Adu-Afarwuah et al., 2008; Serdula et al., 2013) not taking into account changes in adherence over time. Assessing (change in) adherence and its determinants help to understand the (lack of) effectiveness of programme interventions (Angdembe, Choudhury, Haque, & Ahmed, 2015; De-Regil et al., 2013).

In Ethiopia, the ongoing programmes to improve the infant and young child nutrition include interventions such as routine vitamin A supplementation, deworming and nutritional screening services, and so forth. The health development army (HDA) refers to a group of community volunteers who engage on participatory actions to improve health of their communities. The HDA plays a vital role as a service provider and an intermediary between the

Key messages

- Increasing frequency of distribution and providing consistent instructions are important to enhance adherence of MNP intake.
- Intake adherence could be improved by improving social support, such as empowering husbands and health workers to be more involved in the programme.
- Future programmes scaling up MNP interventions should take into account factors associated with adherence in their programme design, for instance, taking into account factors that positively and negatively determine adherence.

community and the health system. HDAs see themselves as representatives of their communities. A functional HDA requires health development teams that comprise up to 30 households living in the same neighbourhood (Wang, Tesfaye, Ramana, & Chekagn, 2016). MNPs were introduced in Ethiopia for the first time (in September 2015) in the context of a UNICEF-Nutrition International (NI)-led programme on local production of complementary foods through rural Grain Banks (hereafter referred to as the Grain Bank programme). This programme focused on increasing the availability, demand and nutritional adequacy of the complementary foods by piloting a bartering system in rural areas and central production by women's groups in semi-urban areas. The focus was on an improved grain/legume blend as the base for complementary foods. The objective of the programme was to increase the number of infants and young children with sustained consumption of complementary food adequate in macronutrient and micronutrient contents to improve their growth. Later, this pilot was extended and rolled out in some of the community-based nutrition (CBN) *woredas* (districts) through collaboration with the NI (Roche, Sako, Osendarp, Adish, & Tolossa, 2017). As a new programme in Ethiopia, assessment of adherence to MNP and analysis of the drivers for correct use are essential to provide evidence-based information for course correction of programme design and implementation and to further inform scale-up interventions, thus eventually contributing to enhanced effectiveness of the programme.

Our aim was to explore the determinants of intake adherence over time, by utilizing the framework of theory of planned behaviour (TPB) to summarize the core elements that predict behaviour of adherence (Ajzen, 1991; Ajzen, Joyce, Sheikh, & Cote, 2011). Furthermore, the aim of the study also composed of assessing the use of MNP among 6- to 23-months old children in two regions of Ethiopia: Oromia and Southern Nations, Nationalities and Peoples Region (SNNPR), during an 8-month intervention period.

2 | METHODS

2.1 | Study design

A mixed method design was used comprising quantitative and qualitative methods. Quantitative data were collected using a knowledge, attitude and practice (KAP) questionnaire. Qualitative data were collected through semi-structured interviews and focus group discussions (FGD).

2.2 | Study subjects

Subjects were selected from districts (*woredas*) in Oromia and SNNP regions implementing the Grain Bank programme (Roche, Sako, Osendarp, Adish, & Tolossa, 2015; Roche, Sako, Osendarp, Adish, & Tolossa, 2017). Both regions were selected based on their large population size and their similar characteristics on food security, child health and nutrition status and infant feeding practices. This study was part of a larger effectiveness study (Samuel et al., 2018), evaluating the effectiveness of MNP intervention combined with the Grain Bank programme (Roche, Sako, Osendarp, Adish, & Tolossa, 2017).

Kebele is the smallest administrative unit in Ethiopia; each *kebele* will have at least one health post. The grain banks were situated in the health post. For this study, the five intervention districts implementing the Grain Bank programme were selected. From each selected district, three to four villages (*kebeles*) were then purposively chosen, as described elsewhere (Samuel et al., 2018). As a result, 17 villages were selected each containing at least 65 eligible households. They were eligible to participate in the study after they had met the inclusion criteria including the child was 6–11 months of age on the recruitment day, the child had never been provided with MNP before, the child was free of chronic illness, the family was not planning to move out of the study area during the study period and the mother was willing to sign the informed consent form. From these villages, in total, 1,185 children were enrolled in the effectiveness study (Samuel et al., 2018). The current study assessed intake adherence over time among these 1,185 children.

2.3 | Intervention with supplementation

The intervention period was from September 2015 to April–May 2016. The micronutrient powder (MNP), MixMe®, was manufactured by DSM Nutritional Products in South Africa. Each sachet of MixMe® contained 6 mg of iron in the form of encapsulated ferrous fumarate and 14 other essential vitamins and minerals. The MNP package was designed specifically for use in Ethiopia (Samuel et al., 2018), labelled in local (Amharic) language and briefly pre-tested among project senior staff.

We had hired data collectors (study field staff) and field supervisors who have health background and lived in the study districts for the duration of the study. MNP was distributed via the health post in

each village by study field staff. If mothers could not come to the health post, the data collectors would visit the subjects at their home. Mothers received 30 sachets every 2 months for feeding a maximum of 15 sachets MNP per month to their children every other day, a total of 120 MNP sachets during the study period of 8 months (Samuel et al., 2018). Mothers were instructed by the field staff, in the local language, on preparation and correct use of MNP (Reerink et al., 2017) at the time of distribution (see additional file 2) and if needed during every data collection time. Since the study was embedded in to the MNP effectiveness study (Samuel et al., 2018), the data collectors visited the mothers every 15 days on appointed dates for morbidity assessment and every 30 days for follow-up of the MNP utilization (KAP questionnaires).

The dosing scheme aimed to provide approximately one-half of the recommended nutrient intakes (RNIs) of micronutrients every day through regular MNP intake. We instructed mothers to give child one sachet of MNP every other day. They were also explained how to prepare MNP correctly before giving it to their child. During intervention period, data collectors would remind mothers of the correct instruction when they noticed that mothers made any mistake in using MNP.

2.4 | Data collection and measurements

A KAP questionnaire was used to collect data on adherence and its determinants, administered a month after the start of the intervention and continued monthly during the study for a total of seven rounds. The questionnaire was adapted from the manual of the Home Fortification Technical Advisory Group (HF-TAG, 2013) and translated into Amharic language. We used three different versions of the KAP questionnaire for data collection. Quarterly, at months 4 and 7, five questions were added to get more information on the experienced level of social/community support (including husbands, HDA and health extension workers [HEWs]) and experience with using MNP. Since this support was not considered to change frequently, these questions were only asked twice (months 4 and 7). The data collectors were trained intensively on interview techniques and instruments before the start of the study.

2.4.1 | Adherence to MNP intake

Adherence was measured monthly by counting the empty sachets of MNP. Mothers were categorized either as adherent or non-adherent based on the minimum number of MNP they gave to the child per month. Mothers were expected to give a maximum of 15 sachets MNP per month. Nevertheless, bimonthly MNP distribution scheme of 30 sachets made it possible for mothers to give >15 sachets and finish all 30 sachets in a month. To account for this condition, adherence was defined according to two definitions:

1. Adherent to distribution: if mother gave the child ≥ 14 sachets MNP per month ($\geq 95\%$ out of recommended 15 sachets per

month). Following this definition, the consumption of 30 sachets per month was also categorized as adherent to distribution.

- Adherent to instruction: if mother gave the child exactly 15(\pm 1) sachets MNP per month.

The outcome variable, adherence, was defined by counting the empty sachets of MNP during monthly visits and, in case the sachets were missing, based on the number of MNP per month the mother reported to have given to her child. When mothers responded 'do not know' or refused to answer the question asking for the number of sachets of MNP the child consumed during the last month, the data were considered missing.

Knowledge of correct use of MNP was measured through seven questions on dose of the MNP, type of food that MNP could be added into, preparation of the food and timing for feeding the MNP-mixed food to the child. Each correct answer was scored as one. The final score of total correct answers therefore ranged from 0 to 7. The responses to questions on attitude (including ease of use and child liking) towards MNP were dichotomized as 'yes' and 'no'. The multiple responses on the questions about what positive and negative effects mothers perceived after the child consumed MNP were categorized as perceived no positive effects versus perceived \geq 1 positive effects and perceived no negative effects vs perceived \geq 1 negative effects. The questions on mother's confidence and whether mothers felt being supported or not, in providing MNP to their child, were asked only in months 4 and 7. For these questions, a score of 1 to 5, represented strongly disagree (score 1) to strongly agree (score 5), was given and was analysed as a continuous variable.

2.5 | Qualitative data collection

Semi-structured interviews and FGD were conducted in the study sites, by trained project staff (T. T.) including the principal investigator (A. S.). The FGDs and in-depth interviews were conducted with field staff responsible for distribution of MNP and the field supervisors. We have also conducted key informant interviews with mothers. The qualitative data collection took place at two different time points: 1 month and 3 months after the intervention started.

A summary of the qualitative data collected is shown in Table 1. In total, 25 interviews (14 in-depth interviews and 11 key informant

interviews) and five semi-structured FGDs were held in local languages and anonymised before analysis. Within the FGD, experience on the programme was shared with an emphasis on usage and adherence of MNP among mothers. For the interviews with mothers, mothers who were at the health post for the monthly follow up were selected randomly, irrespective of adherence or non-adherence. All interviews were recorded and later transcribed in English by two of the project staff and analysed along with notes captured during the interview. The responses were coded and categorized according to the theoretical framework of the TPB (Maxwell, 2013) (see Data S1). According to the TPB, behaviour is a conscious effort mediated by intention being a function of three independent determinants, namely, the attitude towards the behaviour (reflecting the persons judgement of a behaviour), the subjective norm (reflecting social influence) and the degree of perceived behavioural control (reflecting the perceived difficulty of performing the behaviour) (Ajzen, Joyce, Sheikh, & Cote, 2011). We defined attitude as a perceived belief on the benefit of MNP as has been mentioned in adherence to medical treatments (Ajzen, 1991; Quittner, Modi, Lemanek, levers-Landis, & Rapoff, 2007; WHO, 2003).

2.6 | Statistical analysis

Quantitative data (from KAP questionnaires) were entered using CSPro6.0 (Census and Survey Processing System), U.S. Census Bureau Suitland, MD, USA, and analysed in SAS version 9.4, SAS Institute, NC, USA (SAS & Version, 2003), and IBM Corporation, SPSS Statistics version 22, Armonk, NY, USA (IBM, 2013).

Baseline characteristics were presented by percentage for the categorical variables and mean \pm SD for the continuous variables. The associations between adherence, socio-demographic characteristics and other determinants were assessed separately for each month using chi-square tests for categorical variables and Mann-Whitney *U* tests for continuous variables. Adherence was analysed separately for adherence to distribution and adherence to instruction. Variables that were significantly associated with adherence were included in the final model using generalized estimating equations (GEE). Two different GEE models were performed to compare associated factors with adherence to distribution and adherence to instruction as dependent variables. The independence among variables analysed in GEE was also checked using multi-collinearity test with a cut-off point of

TABLE 1 Summary of qualitative data collection

Method	Planned	Conducted
Semi-structured FGD with field staff (n of participants)	5	5 (4–6) ^a
In-depth interview with field staff (n)	17	10
In-depth interview field supervisors (n) ^a	4	2 (2) ^b
Key informant interview with mothers (n)	10	11
Total IDI/KII conducted		25

Abbreviations: FGD, focus group discussions; IDI, in-depth interview; KII, key informant interviews.

^aA total of five FGD were conducted with four to six participants.

^bTwo field supervisors were interviewed twice.

variation of inflation (VIF) less than 10 (see Tables 5 and 6). A Cochran's Q proportion test was performed to determine if there are differences in the proportion of mothers who perceived the identified benefits of MNP over the 7 months period. A two-sided significance level of $P < 0.05$ was applied.

2.7 | Ethical considerations

The study was approved by the Ethiopian National Research Ethics Review Committee (NRERC), Ministry of Science and Technology, reference number 3.10/865/07. Prior to the study, a support letter from the Ethiopian Public Health Institute (EPHI) was provided to each District Health Office, and meetings were held with officials and focal persons to inform them about the study and seek verbal consent. Written informed consent was obtained from the mothers/caregivers of all subjects, data collectors, project staff and field staffs by signing or fingerprinting consent form prior to study activity.

3 | RESULTS

The characteristics of study participants per region and age-group are summarized in Table 2. In total, 1,185 children, 6–11 months of age, were enrolled at baseline, out of which half (50%) were residing in Oromia region. At baseline, the mean age of children was 8.2 (SD + 1.7) months and that of mothers was 25.3 (SD + 5.6) years. Half of the mothers did not get primary education, and the majorities were married and housewives. About 80% of subjects lived in <60-min walking distance from the local health post.

TABLE 2 Socio-demographic characteristics of subjects

Characteristics	<i>n</i> = 1,185
Region (Oromia %)	50.3
Child's age in months, mean ± SD	8.2 ± 1.7
Child's gender (male %)	50.4
Mother's age in years, mean ± SD	25.3 ± 5.6
Education status of mothers	
No primary education (%)	50.2
Married mothers (%)	94.9
Main occupation of mothers	
Housewife (%)	78.4
Farmer (%)	16.1
Petty trader (%)	3.3
Daily labourer and others (%)	2.2
Walking time from home to health post	
<30 min (%)	377 (41.5)
30–60 min (%)	356 (39.2)
60–90 min (%)	49 (5.4)
>90 min (%)	126 (13.9)
Do not know (%)	277 (23.4)

3.1 | MNP consumption and intake adherence

The overall MNP consumption (% of MNP consumed out of a total of 120 sachets) and the monthly MNP consumption (% of MNP consumed out of 15 sachets in a given month) during the intervention period are shown in Figure 1. On average, the children consumed 79% of the total MNP provided during the 8 months of intervention. The monthly consumption fluctuated over time with the highest consumption during the second month (129%) and the lowest during the sixth month (77%). Figure 1 also shows that in the first, the second, the fifth and the seventh month; more than 100% of the 15 recommended MNP servings per month (110%, 129%, 107% and 119%, respectively) were consumed.

Adherence of mothers to distribution (if mother gave the child ≥ 14 sachets MNP per month) and adherence to instruction (if mother gave the child exactly $15[\pm 1]$ sachets MNP per month out of recommended 15 sachets) by month (%) during the intervention period is shown in Figure 2.

The average (mean) percentage of mothers' adherent to distribution was 58% over the course of the project (Figure 2), with the lowest percentage observed in the sixth month (36%) and the highest in the last month of the intervention (76%). Only 28% were adherent according to instructions (gave exact $15[\pm 1]$ sachets per month) with the lowest adherence to instruction in the second month (11%) and the highest in the seventh month (37%).

3.2 | Perceived benefits of MNP

MNPs were quite well accepted by the mothers and liked by children (Table 3). Every month, $\geq 80\%$ of mothers reported that the child liked to consume the MNP and at least 90% reported that MNPs were easy to use. Almost all mothers (97.3%) perceived at least one positive effect after their children had consumed MNP. For example, mothers reported as 'MNP make my child healthy', 'MNP make child stronger' and 'MNP increased my child's appetite'. The percentage of mothers experiencing at least one positive effect increased over time from 94.6% to 98.6%. In the first month, 15% of the mothers reported to have experienced negative effects of MNP, and this number decreased in the following months. Nausea, vomiting, loose stool and black stool were the most frequently reported adverse effects. In general, on average, only 4.9% of mothers perceived one or more negative effects of MNP during the study. With regard to the instructions to use MNP, most of the mothers (94%) did not report any problems in giving one sachet MNP every other day to their child.

3.2.1 | Determinants of adherence: quantitative measures

Determinants of adherence, using summarized data from all seven monthly rounds of data collection, are presented in Table 4. The determinants of adherence to distribution and instruction differed

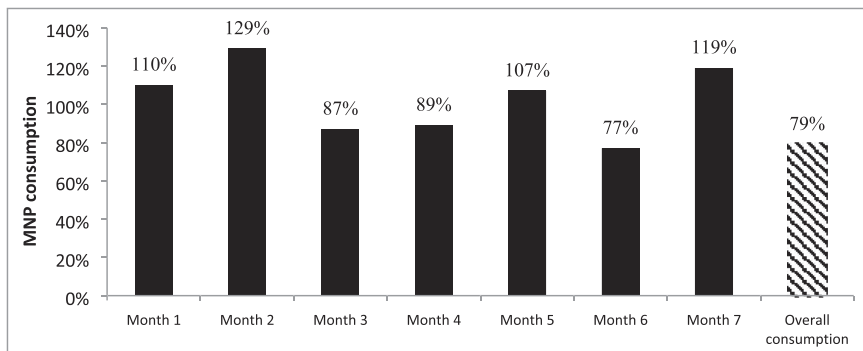


FIGURE 1 The percentage of sachets of MNP consumed by children out of the total number provided for each month and the overall consumption. The monthly percentage reflects the percentage of MNP consumed out of recommended 15 sachets per month. The overall percentage reflects the total MNP consumed out of total 120 sachets provided during the study

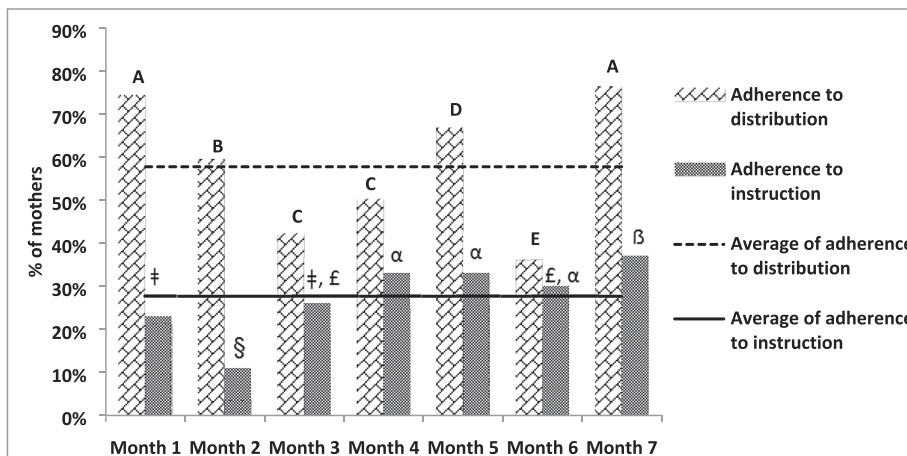


FIGURE 2 Adherence of mothers in giving MNP to their child during 8-month intervention. Adherence to distribution: mother gave ≥ 14 sachets per month ($\geq 95\%$ of recommended 15 sachets per month). Mother who gave > 15 sachets MNP per month were considered adherent to distribution. Adherence to instruction: mother gave exactly $15(\pm 1)$ sachets MNP per month. Average adherence was calculated by taking the mean of the monthly percentage. Different letter or symbol indicates significant difference based of McNemar proportion test with P value < 0.05

TABLE 3 Perceived benefits of MNP among mothers during the eight-month intervention

Indicator, % ^a	Month 1 (n = 1,053)	Month 2 (n = 1,040)	Month 3 (n = 1,045)	Month 4 (n = 996)	Month 5 (n = 1,027)	Month 6 (n = 1,018)	Month 7 (n = 1,019)	Average
Child liked MNP	88.4	83.9	86.7	91.8	90.4	88.1	95.0	89.2
MNP was easy to use	89.3	95.3	94.4	98.8	96.6	96.3	96.0	95.2
No problem to give MNP every other day	83.3	94.2	91.9	96.1	96.8	97.4	97.1	93.8
Perceived ≥ 1 positive effects	94.6	96.1	97.2	97.7	98.6	98.6	98.6	97.3
Perceived ≥ 1 negative effects	15.0	11.8	3.1	1.9	0.8	0.6	1.0	4.9

Abbreviation: MNPs, micronutrient powders.

^aIn all indicators, the percentage over time was significantly different, based on the Cochran's Q proportion test, with two-sided significance level, we rejected null hypothesis if the proportion is different for at least one group. P value < 0.05 . Average was calculated by taking mean of all the reported frequencies for each month. Positive effects include child liking MNP, increased appetite, increased energy and activity, increased immunity (child gets less sick), mental development, make child healthy, good physical growth and makes child stronger. Negative effects include nausea, vomiting, less energy, loose stool and black stool.

slightly per month (see Tables 5 and 6). About 70% of mothers responded that they were reminded by HDA/community health volunteers, and 18% were reminded by health facility staff to collect MNP (data not shown).

The child liking to consume MNP was a strong factor positively associated with adherence to distribution (OR = 1.57, 95% CI: 1.34–1.84) and to instruction (OR = 6.03, 95% CI: 4.48–8.12).

Similarly, mothers who felt being supported by their environment were also more adherent (OR = 1.34, 95% CI: 1.20–1.51 for adherence to distribution; OR = 1.17; 95% CI: 1.01–1.36 for adherence to instruction). The odds of being adherent to instruction was higher among mothers reporting that MNPs were easy to use (OR = 1.42, 95% CI = 1.01–1.98) and of being adherent to distribution was higher among mothers older than 25 years (OR = 1.17, 95% CI = 0.76–0.96).

TABLE 4 Determinants of mother's adherence to give MNP to the child

Variables	Adherence to distribution	Adherence to instruction
	OR ^c (95% CI)	OR (95% CI)
Region (SNNPR ^a)	0.59 (0.52–0.67)**	0.16 (0.14–0.19)**
Child's gender (female)	1.01 (0.91–1.12)	-
Mother's age (>25 years)	1.17 (0.76–0.96)*	1.05 (0.89–1.23)
Mother's educational status (literate)	1.10 (0.98–1.23)	0.86 (0.73–1.01)
Marital status (married)	1.04 (0.83–1.31)	0.87 (0.59–1.27)
Walking distance from home to health post		
<30 min (reference)	1.00	1.00
30–60 min	0.89 (0.79–0.99)*	0.85 (0.72–0.99)*
60–90 min	0.71 (0.55–0.92)*	0.70 (0.51–0.95)*
>90 min	0.82 (0.70–0.92)*	0.97 (0.78–1.21)
MNP was easy to use	1.17 (0.90–1.53)	1.42 (1.01–1.98)*
Had no problem to use MNP every other day	0.85 (0.68–1.08)	0.93 (0.73–1.21)
Knowledge score of correct use of MNP	0.74 (0.66–0.81)**	0.96 (0.87–1.08)
Child liked MNP	1.57 (1.34–1.84)**	6.03 (4.48–8.12)**
Perceived ≥1 positive effects	1.51 (1.04–2.19)*	0.87 (0.50–1.52)
Perceived ≥1 negative effects	0.73 (0.54–0.99)*	0.73 (0.48–1.11)
Confident to give MNP to the child ^b	0.92 (0.31–2.77)	2.82 (0.38–21.13)
Being supported to give MNP to the child ^b	1.34 (1.20–1.51)**	1.17 (1.01–1.36)*

^aReference category.

^bAs these variables were only asked in months 4 and 7, they were analysed using data of month 4 and month 7 only.

^cOdds ratios were calculated for every mentioned category of the given determinant, using the alternative values as reference. For instance, the OR for mother's age gives the odds of being adherent for mothers >25 years, reference to mothers younger or equal than 25 years.

* $P < 0.05$. ** $P < 0.001$.

Perceiving one or more positive effects of MNP was positively associated with adherence to distribution (OR = 1.51, 95% CI = 1.04–2.19) but not with adherence to instruction (OR = 0.87, 95% CI = 0.50–1.52).

The distance from home to health post was negatively associated with both types of adherence. Mothers who lived with in the shortest distance (<30 min) were more adherent than those living further away from the health posts. Knowledge of correct use of MNP was negatively associated with adherence to distribution (OR = 0.74, 95% CI: 0.66–0.81) but not to adherence to instruction (OR = 0.96, 95% CI: 0.87–1.08). Mothers became less adherent to distribution (OR = 0.73, 95% CI = 0.54–0.99) but not to adherence to instruction (OR = 0.73, 95% CI = 0.48–1.11) when they perceived one or more negative effects after their children consumed MNP. Living in SNNP region as compared with Oromia region was associated with a lower odds for adherence (OR = 0.59, 95% CI: 0.52–0.67 for adherence to distribution; OR = 0.16, 95% CI: 0.14–0.19 for adherence to instruction).

3.3 | Positive or negative effects experienced by mothers: qualitative measures

From the qualitative interviews, it appeared that without a clear knowledge about the ingredients and composition of the MNP,

some mothers speculated MNP was a medicine rather than a food supplement. Some of the mothers who prepared the MNP in front of their child experienced a rejection of the food by the child. According to them, the powder like nature of the MNP supported the child's perception that MNP is a medicine, making him/her reject the food.

In contrast, according to other interviewed mothers, their children liked the MNP because it made them happy and active. One mother explained:

My child likes the MNP very much; she even asks me: where is the sugar? She thinks MNP as a sugar... It makes her happy and active. (Mother)

Very few mothers experienced negative effects. Of the few negative effects reported, one mother complained about a metallic taste of the food, causing the child to reject it. One of the field staff explained this:

The mother prepared the food with MNP but waited too long before giving it to the child; the food got a metal taste... That is why the child rejects the food. (Field staff)

TABLE 5 Association between adherence to distribution with socio demographics characteristics and other determinants analysed from the monthly data

Variables	Month 1		Month 2		Month 3		Month 4		Month 5		Month 6		Month 7	
	N adherent /non-adherent ^a	P	% adherent/non-adherent	P	% adherent/non-adherent	P	% adherent/non-adherent	P	% adherent/non-adherent	P	% adherent/non-adherent	P	% adherent/non-adherent	P
Region	746/260	0.880	615/421	<0.001	443/592	0.001	495/492	<0.001	684/341	0.001	365/646	<0.001	760/237	0.002
Oromia	44.8/45.4	0.880	39.3/56.8	<0.001	55.7/44.9	0.001	57.7/33.9	<0.001	51.6/40.5	0.001	78.0/30.3	<0.001	43.1/54.9	0.002
Child's age ^b														
<8 months	43.8/48.2	0.265	49.0/42.2	0.066	46.9/44.4	0.452	46.6/43.9	0.421	45.7/42.9	0.438	46.1/44.0	0.558	46.7/42.9	0.341
>8 months	56.2/51.8	0.433	51.0/57.6	0.046	53.1/55.6	0.666	53.4/56.1	0.566	54.3/57.1	0.047	53.9/56.0	0.690	53.3/57.1	0.829
Child's gender														
Male	51.3/48.5	0.081	47.1/53.4	0.003	50.0/51.4	0.249	51.6/49.8	<0.001	47.7/54.3	0.825	50.7/49.0	<0.001	50.3/51.1	0.001
Mother's age														
<25 years	42.8/44.0	0.099	37.9/50.6	<0.001	40.8/46.8	0.053	37.6/49.0	<0.001	43.8/41.8	0.544	39.1/46.3	0.028	45.8/33.5	0.001
>25 years	57.2/56.0	0.081	62.1/49.4	0.003	59.2/53.2	0.249	62.4/51.0	<0.001	56.2/58.2	0.825	60.9/53.7	<0.001	54.2/66.5	0.001
Mother's education level														
No primary education	50.9/44.6	0.081	46.2/55.6	0.003	49.1/50.9	0.249	56.9/43.5	<0.001	49.7/50.4	0.825	62.5/44.0	<0.001	46.3/58.8	0.001
Literate	49.1/55.4	0.081	53.9/44.4	0.003	52.7/47.3	0.249	43.1/56.5	<0.001	50.3/49.6	0.825	37.5/56.0	<0.001	53.7/41.2	0.001
Marital status														
Married	94.9/96.1	0.418	95.3/94.5	0.605	95.8/94.4	0.341	93.3/97.1	0.005	96.0/93.8	0.117	94.8/96.0	0.377	96.0/93.1	0.122
Walking distance from home to health post														
<30 min	40.2/46.1	0.397	45.6/28.2	<0.001	43.8/38.8	0.496	37.7/46.0	0.014	45.2/30.0	<0.001	36.5/41.2	0.499	42.4/35.2	0.336
30-60 min	41.0/35.3	0.397	38.8/42.6	<0.001	37.0/40.3	0.496	38.2/37.4	0.014	35.1/47.7	<0.001	41.0/40.1	0.499	37.6/44.1	0.336
60-90 min	5.4/5.8	0.397	4.3/6.6	<0.001	5.1/6.4	0.496	5.2/5.2	0.014	4.2/7.8	<0.001	5.9/5.0	0.499	5.3/5.0	0.336
>90 min	13.3/12.9	0.397	11.3/22.5	<0.001	14.1/14.6	0.496	18.8/11.4	0.014	15.5/14.5	<0.001	16.6/13.7	0.499	14.8/15.6	0.336
MNP was easy to use (yes)	91.2/89.4	0.391	94.8/96.1	0.314	96.2/94.4	0.195	98.9/99.0	0.569	98.8/92.1	<0.001	95.1/96.9	0.141	95.4/97.5	0.160
Had problem to use every other day (no)	11.7/22.7	<0.001	7.3/3.6	0.011	7.2/7.8	0.742	6.7/1.2	<0.001	4.4/1.2	0.009	6.0/0.8	<0.001	3.2/1.2	0.402
Knowledge score of correct use of MNP (median)	6/6	<0.001	7/7	<0.001	7/7	0.004	7/7	0.021	7/7	0.654	7/7	<0.001	7/7	<0.001
Child liked MNP (yes)	91.8/77.1	<0.001	77.0/94.1	<0.001	84.8/88.3	0.099	97.0/86.7	<0.001	90.2/90.6	0.834	94.5/84.4	<0.001	94.3/96.6	0.164
Perceived >1 positive effects (yes)	97.2/90.4	<0.001	96.7/95.7	0.664	98.9/95.9	0.005	97.8/98.0	0.836	99.0/97.9	0.181	99.2/98.6	0.553	99.1/97.5	0.982

(Continues)

TABLE 5 (Continued)

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7
N adherent /non-adherent^a	746/260	615/421	443/592	495/492	684/341	365/646	760/237
	% adherent/ non- adherent	% adherent/ non- adherent	% adherent/ non- adherent	% adherent/ non- adherent	% adherent/ non- adherent	% adherent/ non- adherent	% adherent/ non- adherent
Variables	P	P	P	P	P	P	P
Perceived >1 negative effects (no)	87.7/78.8	<0.001	93.1/81.0	<0.001	0.007	98.2/98.2	0.989
Confident to give MNP to the child (yes)	96.9/92.3	0.002	-	-	98.8/99.6	0.287	-
Being supported to give MNP to the child (median)	-	-	-	4/3	-	-	<0.001

Note: Chi-square tests were performed for categorical variables and Mann-Whitney tests for continuous variables. Two-sided significance level of P value < 0.05 was applied.

^aSample size might vary due to missing data.

^bThis variable is not associated with adherence in any months so it was not included in the GEE model.

^cThis variable was not asked in the KAP questionnaire in the corresponding months.

According to the field staff, dislike among mothers in using MNP was because mothers were getting bored of using MNP or children started to reject the food with MNP after some time. One of the field staff said that when the mothers use MNP repeatedly, the likability and intake would no longer increase but decrease.

3.4 | Determinants of adherence: qualitative measures

3.4.1 | Attitude

All of the interviewed mothers reported experiencing a positive effect on their child after feeding the MNP. They said that their child has become more active, got a shiny face and a more beautiful skin. When asked how the mothers knew that the child became more active, one mother responded:

There is a great difference between my child and other children of his age, especially in growth and strength ... he can pick up anything and throws it away. (Mother)

Beneficiary effects were mostly mentioned as observational changes. From the interviews, it appeared that mothers who were non-adherent at the start of the study, became adherent when they saw a change in the appearance of their child and were more motivated to continue using the MNP. The most frequently mentioned beneficial effect after MNP use was seeing a change in the appearance of their child.

3.4.2 | Subjective norm

When asked if the mothers received any social support from their environment, most mothers reported that they did not get any social support with the preparation of MNP. The mothers also explained that in their culture, it was the mother's responsibility to feed the child. However, some felt supported by their husband since 'he' bought the flour and grain to make the porridge. One mother explained:

My husband supports me; he buys the flour I make porridge to mix the MNP for my child. He says: "the thing you brought from the health post is good for our child, are you giving it regularly? Do not forget to bring it." (Mother)

Furthermore, it appeared from the interviews that mothers asked for approval from their husband before feeding the MNP to their child. According to some non-adherent mothers, their husbands did not allow them to come to the health post to collect MNP. The fathers did not want their child to use the MNP as they thought it would make the child sicker.

TABLE 6 Association between adherence to instruction with socio-demographics characteristics and other determinants analysed from the monthly data

Variables	Month 1		Month 2		Month 3		Month 4		Month 5		Month 6		Month 7	
	N adherent / non-adherent ^a	P	% adherent / non-adherent	P	% adherent / non-adherent	P	% adherent / non-adherent	P	% adherent / non-adherent	P	% adherent / non-adherent	P	% adherent / non-adherent	P
Region	236/770	0.427	47.2/44.3	<0.001	267/768	<0.001	322/665	<0.001	337/688	<0.001	306/705	<0.001	371/626	<0.001
Oromia														
Child's age ^b														
<8 months	46.7/44.4	0.567	40.8/46.8	0.264	46.4/45.2	0.745	46.3/44.7	0.665	43.1/45.5	0.485	46.7/43.9	0.438	49.2/43.7	0.115
>8 months	53.3/55.6		59.2/53.2		53.6/54.8		53.7/55.3		56.9/54.5		53.3/56.1		50.8/56.3	
Child's gender														
Male	48.9/51.0	0.571	51.3/49.5	0.718	49.1/51.4	0.515	51.2/50.5	0.815	50.0/49.8	0.948	52.0/49.0	0.376	53.8/48.5	0.106
Mother's age														
<25 years	40.8/43.8	0.407	41.9/43.2	0.783	50.6/40.9	0.006	49.1/40.5	0.011	39.3/45.0	0.085	39.1/45.6	0.056	39.5/44.9	0.904
>25 years	43.8/56.2		58.1/56.8		49.4/59.1		50.9/59.5		60.7/55.0		60.9/54.4		60.5/55.1	
Mother's education status														
No primary education	52.4/48.3	0.278	61.5/48.5	0.008	56.2/49.4	0.057	57.8/46.5	0.001	65.5/42.4	<0.001	64.1/44.8	<0.001	58.6/43.6	<0.001
Literate	47.6/51.7		38.5/51.5		43.8/50.6		42.2/53.5		34.5/57.6		35.9/55.2		41.4/56.4	
Marital status														
Married	94.4/95.4	0.528	90.6/95.5	0.022	95.1/94.9	0.876	93.1/96.2	0.033	94.6/95.6	0.482	94.1/96.2	0.142	93.0/96.3	0.020
Walking distance from home to health post														
<30 min	53.2/38.1	<0.001	40.0/38.7	0.022	35.7/42.7	0.105	36.1/44.3	0.001	33.1/43.0	<0.001	41.9/38.8	0.122	40.6/40.9	0.017
30-60 min	36.2/40.5		28.9/41.7		39.0/38.8		34.7/39.0		35.9/40.9		34.2/42.7		33.7/41.8	
60-90 min	5.0/5.7		5.6/5.1		6.2/5.7		5.9/4.9		6.0/5.2		5.9/5.1		5.8/4.9	
>90 min	5.5/15.7		25.6/14.5		19.0/12.8		23.3/11.8		25.1/10.8		18.0/13.4		19.9/12.4	
MNP was easy to use (yes)	87.4/91.7	0.050	97.4/95.1	0.264	95.1/95.2	0.976	98.1/99.1	0.196	99.1/95.3	0.002	98.4/95.3	0.019	95.7/96.1	0.722
Had problem to use every other day (no)	16.6/13/9	0.300	8.5/5.4	0.175	8.2/7.3	0.613	10.2/0.9	<0.001	7.4/1.2	<0.001	2.0/3.0	0.356	3.5/2/6	0.424
Knowledge score of correct use of MNP (median)	7/6	<0.001	7/7	0.001	7/7	<0.001	7/7	<0.001	7/7	<0.001	7/7	<0.001	7/7	<0.001
Child liked MNP (yes)	93.2/86.4	0.006	86.3/83.7	0.459	96.6/83.4	<0.001	98.1/88.8	<0.001	97.6/86.8	<0.001	2.9/15.9	<0.001	94.6/95.2	0.669
Perceived >1 positive effects (yes)	96.2/95.2	0.524	95.7/96.1	0.801	100/96.2	0.001	98.8/97.4	0.180	99.1/98.4	0.568	99.0/98.7	0.239	96.7/98.7	1.00

(Continues)

TABLE 6 (Continued)

Variables	Month 1		Month 2		Month 3		Month 4		Month 5		Month 6		Month 7	
	N adherent / non-adherent ^a	P	N adherent / non-adherent	P	N adherent / non-adherent	P	N adherent / non-adherent	P	N adherent / non-adherent	P	N adherent / non-adherent	P	N adherent / non-adherent	P
Perceived ≥ 1 negative effects (no)	86.0/85.2	0.754	76.9/89.7	0.186	98.5/97.0	0.145	99.1/97.7	0.284	99.7/99.0	0.374	99.0/99.6	0.101	99.7/98.6	0.101
Confident to give MNP to the child (yes)	94.8/96.0	0.447	c	-	-	0.768	99.1/99.2	-	-	-	-	99.1/96.6	0.012	0.012
Being supported to give MNP to the child (median)	-	-	-	-	-	<0.001	2/3	-	-	-	-	-	3/4	<0.001

Note: Chi-square tests were performed for categorical variables and Mann-Whitney tests for continuous variables. Two-sided significance level of P value < 0.05 was applied.

^aSample size might vary due to missing data.

^bThis variable is not associated with adherence in any months so it was not included in the GEE model.

^cThis variable was not asked in the KAP questionnaire in the corresponding months.

Additionally, some mothers (in their follow up visit or a bi-monthly visit to collect MNP) gathered together and discussed the programme. This made them feel supported and more motivated. According to the field staff, this gathering had several advantages:

When the mothers gather together, they were able to ask each other questions about the MNP and preparation. They help each other in reminding to give and collect the new MNP from the health post. (Field staff)

3.4.3 | External factors

Free provision of MNP was, according to the field staff, an important factor in adherence and acceptability of the MNP. The field staff reported that the mothers were used to getting supplements for free from the government. Furthermore, factors such as drought and migration were named to negatively affect adherence. Especially one of the study districts suffered from drought and food shortage during the intervention period. Mothers in this district complained that they were unable to feed their child with MNP since they had no or limited access to food. Drought-led migration was observed in this area. The field staff of one of the study districts described this issue as follows:

Drought is also a big problem. Already a lot of mothers had migrated out of the area because of the drought. It is affecting the study because MNP needs to be mixed with food, and they do not have enough food. They ask us for additional food to mix the MNPs with. (Field staff)

Complaints about external circumstances included allocation of time for collecting MNP and workload for MNP preparation. Mothers complained that they had no time to prepare the MNP because they were too busy with other responsibilities.

3.4.4 | Self-efficacy and trust in the government

Interviewed mothers reported feeling confident in giving the MNP to their child. The main reason mentioned was that the project was performed in cooperation with the government. One mother explained:

I know you are from the government and you know it is good for him that is why we use it. You brought it and you know it is good. I trust the government; they won't give us anything that is bad for us. (Mother)

The field staffs reportedly were involved in consulting the mothers on MNP use, correcting them when they made mistakes in preparation or feeding and monitoring the health of their child. All field staff

reported having a good relationship with the mothers. The field staff of one study district reported:

They accept things when I say and listen to me ... The relationship is very good. They are nice to me and invite me for coffee when I come by their house. They accept things from me and trust me. Since this is a remote area, and they need medical education; so when you go there and tell them your health provision and say I am here to help you. They are eager to do things like that. They trust me completely. (Field staff)

4 | DISCUSSION

This study investigated determinants of adherence to MNP use among 6–11 months of age children and their caregivers, living in two regions in Ethiopia. Two definitions of adherence were used based on distribution and dosing instructions. By examining the adherence per month of intervention, it was found that adherence fluctuated over time, with an average of 58% for adherence to distribution and 28% for adherence to instruction. Following the instructions of one sachet every other day, mothers were expected not to give more than 15 sachets of MNP per month to their children. However, the bimonthly distribution scheme was thought to lead to the observed fluctuations in adherence over time and low adherence to distribution on average. These issues with adherence could have been avoided if MNP were distributed more frequently, for example, on a monthly basis. Moreover, mothers were instructed not to give MNP when their child was sick; thus, 8% of the mothers reported suspending MNP during the sick days. After the illness, mothers had also been taught to compensate for the missing days by providing MNP daily for some time, which turned out to be a difficult instruction to follow. In addition, inconsistency between on-pack, 'do not give more than one sachet MNP per day', and oral dosing instructions 'give MNP every other day' may have caused mothers to use more than the instructed 15 sachets per month, resulting in the low observed adherence and confirms the need for a proper pre-test of the packaging. The issue with inappropriate packaging was previously also experienced in Kenya, which, in part, caused a nearly 70% drop in MNP uptake from 99% to 30% during 17 months of provision (Kodish, Rah, Kraemer, de Pee, & Gittelsohn, 2011). In addition, a recent review of the literature on factors affecting adherence to MNP programmes identified issues with administration regimen, related to caregivers' capacity to remember to give MNP, as an important programme design feature affecting adherence (Tumilowicz, Schneck, Neufeld, & Pelto, 2017).

Overall, we found marginal adherence to MNP that is consistent with the findings of other studies. Low adherence was previously reported in Peru (MNP consumption, every other day for 6 months) and in Aboriginal children in Canada (with consumption of sprinkles containing 30 mg Fe/day for 6 months), which was explained by disliking the taste of the MNP (49%) and forgetting to give the MNP to the child (60%), respectively (Christofides, Schauer, Sharieff, & Zlotkin,

2005; Creed-Kanashiro, Bartolini, Abad, & Arevalo, 2016). Similar to the study in Canada, we also observed on average 5% of mothers forgetting to give MNP (data not shown) according to instructions.

The study showed that acceptability of MNP and total consumption out of 120 sachets provided overtime was good. This is consistent with other studies published (Adu-Afarwuah et al., 2008; Christofides, Schauer, Sharieff, & Zlotkin, 2005; Tripp et al., 2011). In contrast, a meta-analysis of previous studies in other developing countries reported that the consumption of MNP has generally been >83% (Dewey, Yang, & Boy, 2009). However, most of these studies were trials that were conducted in controlled settings, which can explain their slightly higher consumption as compared with our intervention embedded in a programme setting.

Like other studies (Bilukha, Howard, Wilkinson, Bamrah, & Husain, 2011; Jefferds et al., 2010; Kodish, Rah, Kraemer, de Pee, & Gittelsohn, 2011; Osei et al., 2014), every month more than 90% of mothers in this study reported at least one positive effect such as increased health, activity, strength, appetite, growth, energy, more beautiful skin and shiny face of the children. The 'child liking MNP' was a strong factor positively associated with adherence to distribution and adherence to instruction, similar to the findings in Nepal (Mirkovic et al., 2016). Following the TPB (Ajzen, 1991), mothers would have a more positive attitude towards MNP and therefore an increased intention to use MNP when they observed their child liking the MNP. Similar to our findings, a recent review paper of literature on factors affecting adherence also concluded that caregivers' perception of positive changes, caregivers' perceived child acceptance of food with MNP and forgetfulness were the most important factors affecting adherence (Tumilowicz, Schneck, Neufeld, & Pelto, 2017).

In addition, our study also found that social/community support was positively associated with intake adherence. Mothers who received support from their surrounding such as husbands were more likely to adhere than those who did not. Other studies also showed approval of husbands having a significant role for decision making (Hogan, Berhanu, & Hailemariam, 1999; Kamal, 2000). In the TPB, social support constructs a subjective norm factor that refers to the perceived social pressure to or not perform the required behaviour (Ajzen, 1991). HDA, HEWs, and husbands were the most frequently reported persons who gave support to mothers during the intervention by reminding them to go to health posts and collect MNP every 2 months. Our findings of the positive association of social support to adherence were also in line with the study in Mexican children (Ramakrishnan, Neufeld, Flores, Rivera, & Martorell, 2009) and the systematic review of iron supplementation (Nagata, Gatti, & Barg, 2012). This suggests that family members have a significant role in acceptability and use of MNP.

The factor of perceiving one or more positive effects of MNP influenced adherence differently depending on the definition of adherence used. It increased the adherence to distribution but decreased the adherence to instruction. A plausible explanation for this finding might be that when mothers had a positive attitude to MNP they would give MNP to the child more frequently, and subsequently, the consumption would be more than 15 sachets per month.

Adherence to distribution was lower when negative effects were perceived, despite the fact that only 4.9% of mothers reported any negative effects.

An inverse association was found between knowledge and adherence, though almost all mothers (>95%) answered correctly all questions about how to use MNP. This implies that level of knowledge may not simply relate to performing a behaviour, and in the present study, mothers might not make knowledge-based decisions for performing behaviour of adherence. It is generally known that knowledge has been consistently non-influential in predicting behaviour performance (Ajzen, Joyce, Sheikh, & Cote, 2011; Wallace, 2002).

The current study showed that mothers who were living in SNNP region were less adherent than mothers in Oromia region. This may be due to the contextual factors that may differ from region to region. Those factors include a commitment from the local staff, local programmes or social and cultural differences (Macfarlane, 2005), which should be considered when planning a tailor-made MNP programme. Therefore, it is important to locally tailor the MNP implementation programmes to address the regional variation by enforcing additional inputs such as preparing context-specific behaviour change intervention materials and providing regional-level training.

An important strength of our study is that it was conducted within the context of a large-scale programme setting involving a large number of subjects, thus portraying a 'real-life' situation. Furthermore, adherence and determinants were assessed every month that allowed for demonstrating the trends of adherence and associated factors over time. This enabled us to forward recommendations that should be taken into account while designing strategies in the intervention programme. Finally, it is the first evidence-based data on adherence to an MNP programme in Ethiopia to use as a reference.

This study has some limitations that need to be acknowledged. First, MNPs were distributed to children free of charge. Consequently, adherence might be higher compared with a situation where mothers would have to pay for the MNP. Mothers' willingness to pay for MNP was not considered in this study; however, this willingness could influence the continuity of MNP consumption. A second limitation of our study is that the analysis did not take into account factors associated with the health workers that may have impacted mothers' adherence to the intervention (Kodish, Rah, Kraemer, de Pee, & Gittelsohn, 2011; Nanjappa, Chambers, Marcenes, Richards, & Freeman, 2014; Rowe et al., 2007). In particular, information on the level of education, job experience and satisfaction, knowledge, skills, and perception of health workers on MNP, their expectation from the programme and the level of support health workers provide to mothers was not measured. It is important to note that our study used hired project staff for distributing MNP, which can be different from the regular government programmes that rely on the HEWs. However, the HEWs and the HDAs were also very cooperative on the study. A third limitation is the use of self-reported adherence. It is important to realize that mothers might give different responses because they report to their data collector instead of to an independent interviewer. In addition, the fact that interviewers asked the same questions every month

might have led to social desirability bias (Adams et al., 2005) and an overestimation of adherence (Quittner, Modi, Lemanek, Ievers-Landis, & Rapoff, 2007); however, several repeated questions were asked to check the reliability of the responses. Another limitation is adherence data were collected from mother's recall plus used sachet. While in most cases we collected used sachets, there were at least two to three mothers reporting that they lost while coming to the health post and a mother also had reported that she lost (was stolen) with other items. The use of two approaches might lead to biases in the information captured.

Recommendations for future programmes and research include aligning the instruction on the packaging with the distribution and consumption schedule. Monthly distribution helps to better monitor the consumption and also reach the desired programme adherence. The benefit of frequent distribution has been experienced in previous studies (Adu-Afarwuah et al., 2008; Sharieff et al., 2006) in Haiti (96%) (Menon et al., 2007) and Lao (100%) with a monthly and weekly distribution, respectively (Kounnavong et al., 2011). A frequent distribution is believed to encourage more interactions between mothers and health workers (Mirkovic et al., 2016). However, using more frequent distribution might increase operational cost especially in the long-term and in large-scale programme. Therefore, in order to maintain the high adherence, a less rigid instruction and definition can be used altogether. For example, to give 60 sachets of MNP in a flexible administration over 3 (or 4) months or 90 sachets in 6 months as per WHO 2016 guideline (WHO, 2016), with the instruction to not exceed consumption of one sachet per day. Such a flexible scheme can be an option especially when MNPs are included in longer term, large-scale programmes where intensive supervision cannot be guaranteed. Moreover, giving autonomy to mothers to choose when and how often to use MNP would make it easier for them to adapt to and thus adhere to the programme (Hirve et al., 2013; Ip, Hyder, Haseen, Rahman, & Zlotkin, 2009). Since social support was a significant determinant of intake adherence among mothers, empowering husbands and health workers (HDA and HEW) to be more involved in the programme seems essential (Creed-Kanashiro, Bartolini, Abad, & Arevalo, 2016; UNICEF/CDC, 2010). However, this may increase the workload especially for HEW; thus, consideration should be taken into account to adjust this recommendation with the existing capacity and health system in the country and/or by using other delivery channels that may be more relevant for husbands or male influencers, such as agricultural workers (Potter & Brough, 2004). The use of health posts for the delivery of MNP gave the mothers trust and made them confident that the product was good for their child's health. From the interviews, it appeared that mothers themselves were not knowledgeable about the effects of MNP but trusted the field staff when they were told to use it. This suggested that trust in the government and field staff played a big role in successful implementation of the programme.

The adherence of mothers in giving MNP fluctuated over time during an 8-month intervention, with a low overall adherence: 58% for adherence to distribution and 28% for adherence to instruction. The main reason for the low adherence was the bimonthly

distribution scheme that was misaligned with the instruction of use. Nevertheless, average consumption of 79% of received MNP was observed, and the acceptability was good both among mothers and children.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONTRIBUTIONS

AS was responsible for the design of study, data collection, data preparation, data analysis and interpretation and manuscript preparation and has full responsibility for the final manuscript. SO and IB were responsible for the conception, design, overview of the study, overview of data analysis and interpretation and contributed to the final manuscript. NP and TT contributed to data analysis and interpretation and the final manuscript. AL and AK facilitated study implementation and contributed to final paper. All authors have contributed to and approved the final manuscript.

ORCID

Aregash Samuel  <https://orcid.org/0000-0001-9758-2462>

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SUPPORTING INFORMATION

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

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