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Research

Availability, acceptability, and utilization of micronutrient fortification for children 6-23 months in three districts in Ghana

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Background

Micronutrient deficiencies result from multiple factors, including inadequate intake of micronutrients (vitamins and minerals) from nutrient-rich diverse diets. Point-of-use fortification with a nutritional supplement powder is recommended to address micronutrient deficiencies and anemia among infants and young children (6-23 months), particularly, in low-income countries. In Ghana, about a quarter of children aged 6-59 months are anemic, or deficient in iron and vitamin A. World Vision Ghana (WVG) implemented the integrated Improved Feeding Practices (IFP) project between 2020 and 2023 in three districts in Ghana to improve diet quality and practices of women of reproductive age, and young children below age two years. One component of the project involved the distribution of a nutritional supplement powder (KOKO Plus). This is the second in a series of four papers that document the implementation and outcomes of the IFP project; the other papers are published in this journal. The current paper assessed the availability, acceptability, and utilization of KOKO Plus to households who participated in the IFP project as well as lessons learned from implementing the intervention.

Methods

A mixed-methods design was used, triangulating primary and secondary data. Secondary data originated from review of IFP project documents, including project mid-year and annual reports, and implementation plans across the three interdependent components of the IFP project. Primary data were obtained from interviews in six purposively selected communities. Key informants included WVG staff, community volunteers, and local government agency staff from health and agriculture sector agencies, and beneficiaries of the intervention. Interview respondents answered questions on the project's mechanism for KOKO Plus distribution, participant experiences of purchasing and using KOKO Plus, perceived benefits of using KOKO Plus, and lessons learned about KOKO Plus from the IFP project. Beneficiaries also provided information on their perceptions of KOKO Plus acceptability and adverse outcomes.

Results

The project distributed KOKO Plus free of charge to almost 14,000 (13,942) children, more than its target (4,900). In addition, Village-Based Entrepreneurs (VBE) sold 192,092 sachets of KOKO Plus in the project communities. The KOKO Plus value chain involved WVG purchasing the KOKO Plus from the Ghanaian manufacturer and supplying it to VBE's either in their respective communities, or at distribution centers in their respective WVG district office. KOKO Plus promotion and marketing was led by trained VBE's, VBE supervisors, and Community Based Organizations across multiple settings (homes, child welfare clinics, markets, community durbars, and religious gatherings). There was high acceptability of KOKO Plus. Mothers attributed their acceptance of KOKO Plus to its

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potential health and nutrition benefits for children. They also attributed increased child weight, and less frequent illness, to feeding meals that included KOKO Plus to their young children. KOKO Plus was added to the diverse local meals fed to young children. Diarrhea was the only mentioned adverse report, albeit rarely. At the end of the IFP project, WVG established a fund to ensure sustainable distribution of KOKO Plus in the project communities.

Conclusions

The IFP project established a KOKO Plus value chain, increasing availability, accessibility, acceptability, and utilization of KOKO Plus in the project communities. VBE's successfully distributed KOKO Plus with support from community volunteers, and health care workers. This approach to KOKO Plus distribution is feasible and sustainable and is recommended for similar contexts.

INTRODUCTION

Up to 2 billion people are affected by micronutrient deficiencies, globally (WHO et al., 2007); particularly deficiencies of iron, vitamin A, Iodine, and Zinc. Micronutrient deficiencies are linked with diseases, deaths, and disabilities across the entire lifecycle. Globally, an estimated 2 million children die each year because of micronutrient deficiencies (Black et al., 2013). Beyond deaths, there is a high burden of disease in terms of disability-adjusted life years (255 million DALYs) attributable to dietary risk factors, especially in low-income settings (Han et al., 2022). Pregnant women and children have the greatest burden of micronutrient deficiencies, and deficiency disorders.

Micronutrient deficiencies result from multiple factors, including inadequate intake of micronutrients-rich diets (UNICEF, 2019). Micronutrient requirements can, typically, be met through consumption of diverse nutrient-rich diets. However, there are multiple barriers to accessing and consuming micronutrient-rich diets at household and community levels including poverty, food preferences, dietary taboos, and inadequate knowledge of nutrient-rich foods. Proven strategies such as dietary diversification, supplementation, food fortification, and biofortification are recommended to ensure adequate micronutrient intake at the population level (Bhutta et al., 2008, 2013; Keats et al., 2021; Dewey K, 2003).

Home fortification, using micronutrient powders is an effective strategy for addressing micronutrient deficiencies. Micronutrient powders (MNPs) typically contain multiple (about 15) vitamins and minerals recommended by WHO and can be added to prepared food without substantially changing its appearance or taste (WHO, 2016). MNPs are less costly, easy to use and store, and can be distributed easily to hard-to-reach geographical locations. Although home fortification with MNPs is not currently implemented routinely in Ghana, the government has approved MNPs as one of the strategies for addressing micronutrient deficiencies among young children. MNPs are available in specific districts where they are distributed as part of projects implemented by non-government stakeholders. In addition, the Ghana Health Service (GHS) has successfully piloted the distribution of micronutrient powders as part of its monthly child welfare clinics and observed improvements in the micronutrient status of children (Kyei-Arthur et al., 2020).

The Micronutrient situation remains suboptimal in Ghana. A national micronutrient survey in 2017 found the prevalence of anemia, iron deficiency, and vitamin A deficiency to be 35.6, 21.5, and 20.8%, respectively, among children 6-59 months. In addition, folate deficiency of 58.8% was reported among non-pregnant women of reproductive age (GroundWork et al., 2017). MNP use is well documented in Ghana with several studies reporting its efficacy in addressing anemia, and iron deficiency among other micronutrient deficiencies (Adu-Afarwuah et al., 2007, 2008; Ghosh et al., 2019).

World Vision Ghana (WVG) implemented the integrated 'Improved Feeding Practices for the first 1,000 days' (IFP) project, which aimed to improve the feeding practices of women of reproductive age (pregnant and lactating women), and children below 2 years. The IFP project intended to achieve its aim by increasing access to innovative nutritional supplements, promoting household-level nutrition-sensitive agriculture, and increasing access to nutrition messaging. This paper reports on the component of the project focused on increasing access to essential micronutrients for young children, using MNPs. Communities in selected districts were targeted for distribution of the MNPs, using a social enterprise approach. The project promoted a brand of MNP known as KOKO Plus. KOKO Plus is a protein and micronutrient powder that contains 8 essential amino acids, 13 vitamins and 8 minerals for children aged 6-24 months. KOKO Plus has been rigorously tested and is produced locally in Ghana (Furuta et al., 2021; Ghosh et al., 2019; Tano-Debrah et al., 2019).

The main objective of the current study was to document how promotion and distribution of KOKO Plus influenced its availability, acceptability, and utilization in the three districts where the IFP project was active. The study focused on (a) describing the mechanisms used in supplying MNPs to participants, (b) documenting the quantity of micronutrient powder sachets distributed in the project, (c) describing how the micronutrient powders were used by beneficiaries, including what informed usage, (d) describing beneficiaries' perceptions and experiences of using MNPs, (e) identifying adverse responses of using the MNPs, and (f) describing the lessons learned from the project's implementation. The findings of this study are intended to inform scale up of MNP distribution in Ghana and elsewhere.

METHODOLOGY

A mixed-methods approach was used in the current study. Secondary data from various project documents were

triangulated with primary qualitative data gathered through in-depth interviews. Project documents were reviewed to identify relevant information on implementation of the IFP project, including monitoring and tracking information on KOKO Plus procurement, supply to village-based entrepreneurs (VBE's), and distribution. Kushitor et al, 2024 provide a full list of the documents that were reviewed in this analysis. The number of beneficiaries targeted and successfully reached with the KOKO Plus was obtained from records kept by project officers in charge of KOKO Plus supplies. Relevant secondary data on availability, acceptability, and utilization of KOKO Plus were also obtained from IFP project records.

Primary data were collected from two sources:

1. Interviews with stakeholders involved in the implementation of the project (including WVG Staff, community volunteers, GHS staff, and Staff of the Department of Agriculture). A total of 61 stakeholders in the 3 implementation districts and WVG staff were engaged in in-depth interviews. The list of participants included in the in-depth interviews is provided in supplementary Table 1.
2. Interviews with project beneficiaries. Beneficiaries of two communities from each of the three districts were selected for interviews regarding project implementation.

All interviews were audio-recorded and subsequently transcribed, verbatim. Where it was necessary for interviews to be conducted in a local language, a translator was engaged to provide this service. Field notes were taken during interviews.

DATA ANALYSIS

Descriptive statistics were used to summarize the quantities of KOKO Plus procured, distributed, received, or sold; the number of children reached in the project from each district; and reported adverse events. Transcripts were cleaned and imported into ATLAS.ti for analysis. All transcripts were read to understand the data, develop codes, and identify emerging themes. The organizing themes focused on marketing and distribution mechanisms, KOKO Plus utilization (frequency, quantity, type of food, time of addition etc.), perceived adverse responses, experiences with KOKO Plus in young child feeding, and project sustainability strategies. These have been summarized, along with quotes from participants/stakeholders to support discussions and to enhance clarity.

ETHICS

Ethical approval for this study was obtained from the Institutional Review Board of the Noguchi memorial institute for medical research (073/22-23). Permissions to interview target groups were obtained from the appropriate institutional and community-level authorities.

RESULTS

SUPPLY AND DISTRIBUTION OF KOKO PLUS

The IFP project was implemented in 70 communities in three districts in the Ashanti, Bono East, and Upper East regions. The project included (1) improving access to innovative nutritional supplements (KOKO Plus), (2) improving dietary diversity through household level agriculture and (3) the provision of nutrition education and messaging to trigger behavioral change related to maternal and child nutrition. Two other intervention strategies are discussed elsewhere (Konlan et al., 2024; Kushitor et al., 2024).

The project's component #1 aimed to improve access to proven and effective nutritional supplements in targeted communities through the development of an innovative, and sustainable business model. The project leveraged the existence of village savings and loans associations (VSLAs) to select 140 VBEs. These VBEs, mostly based in remote areas, were tasked to be the last mile of distributors/retailers of KOKO Plus, thus bringing the product to community dwellers.

This situation enabled mothers to access nutritious products more readily and regularly for their 6–23-month-olds. VSLAs are a group of people who collectively support a structured process of saving money together and offering loans at a local level. The activities of the group run in one-year cycles, after which the accumulated savings and the loan profits are distributed back to members. The purpose of a VSLA is to provide simple savings and loan facilities in a community that does not have easy access to formal financial services.

VBEs, two from each of the 70 villages included in the IFP project and who were already members of established VSLAs, were nominated by the respective associations on account of already having an established channel for selling other products from a vending point or door-to-door. Preference was given to women residing in the community who had business skills, including the ability to identify the Ghana cedi and trade with it. The VBEs were later verified and confirmed using criteria already established by WVG. The VBEs were trained to sell KOKO Plus, by consultants hired by WVG who used a social enterprise approach and sustainable business model in areas of entrepreneurship, sales, and marketing. The training included skill and capacity building in business development such as pricing, costing, working capital management, record keeping, entrepreneurship, franchising, practices and principles in marketing and sales. General training approaches utilized included role playing, adult learning and experience sharing to ensure effective knowledge transfer. They were provided with a manual focused on the VBE concept and practical approach to implementation, soft skills for marketing, entrepreneurship, working capital management, and other business practices.

To initiate the implementation of the VBE model, WVG negotiated with the KOKO Plus Foundation to procure 200,000 sachets of KOKO Plus for distribution. These were delivered to the Jema office of WVG for distribution to the various districts and further to VBEs. To commence the sales of the products, each VBE was provided with a quantity of KOKO Plus to sell, based on the population of the community and the strength of the VSLA and VBE. Figure 1 below illustrates the flow of distribution.

The VBEs adopted diverse marketing approaches to facilitate awareness and sale of KOKO Plus and to make it readily available and accessible to communities. The point-of-sale vending shop and house-to-house approach was the most common vending reported by VBEs.

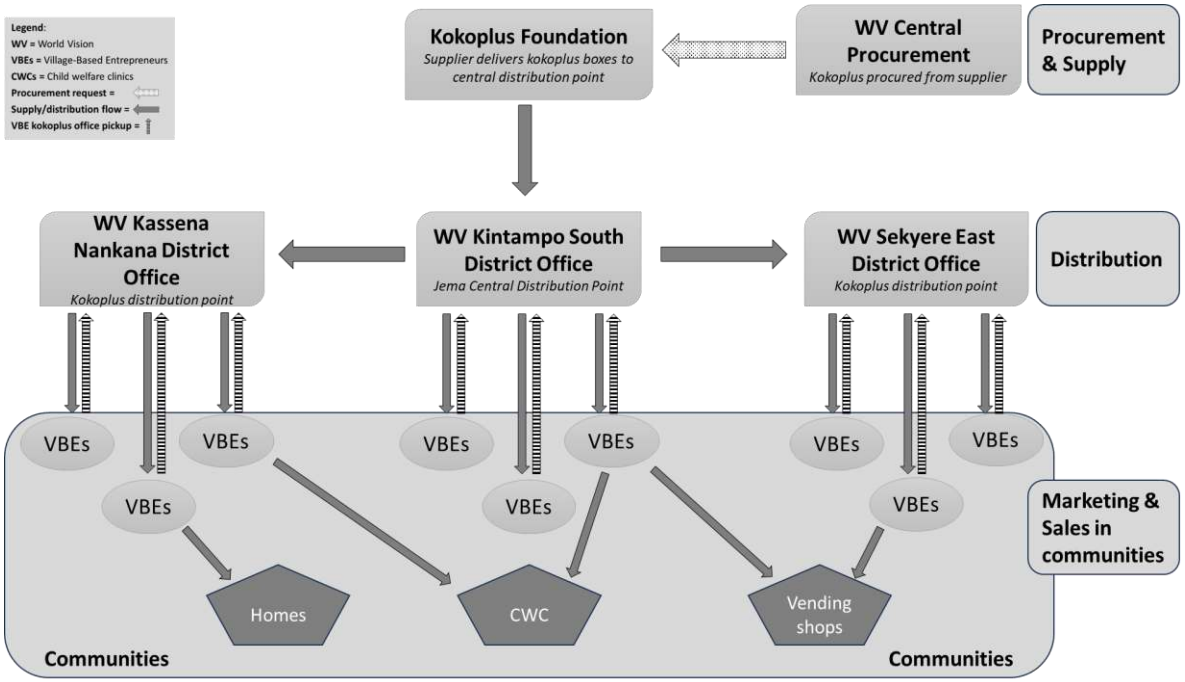

Figure 1: Flow diagram of the process for distribution of KOKO Plus

Other approaches including promotional messaging at child welfare clinics, designated KOKO Plus market days, knowledge and information communication at community information centers and church gatherings were utilized. VBEs indicated that community health nurses promoting KOKO Plus at CWCs as well as house-to-house distribution were the best marketing approach:

"The house-to-house sales. I make a lot of sales through that. I also make a lot of sales when facilitators visit the community for training sessions or some other programme. When they educate the mothers, they believe in the efficacy of the products and buy them because when we go round, they think we're just out to make sales. And the sales are also good at the weighing centres" **KS_Akora_VBE**

"I sell the Koko Plus supplement to nursing mothers. Like I mentioned, I go from house to house educating the nursing mothers on the health and nutritional benefits of the product and encourage them to buy it for their babies." **KS_Akora_VBE**

"We were told to undertake a house-to-house sale of the product, sell them at the weighing (post-natal health checks) centres, churches etc. and educate nursing mothers on the benefits and nutritional value of the product." **KS_Akora_VBE**

The KOKO Plus was supplied to VBEs at a subsidized price of 40 pesewas [equivalent of 3 cents US]/sachet and the VBE selling price was 50 pesewas/sachet. Upon selling the KOKO Plus, the VBEs deposited 40 pesewas from each sachet sold into the VSLA's savings box and kept the 10 pesewas as their gross profit. Price hikes subsequently resulted in a doubling of the price price/sachet. This price increase was occasioned by a general shortage in KOKO Plus, following which the supplier increased the price. This shortage lasted between 1 and 2 months:

"Yes, there are [shortaged] but that doesn't happen often. I remember a time when we couldn't find some to sell, I visited the Manager at the office and he told me that they were experiencing a shortage of the product but not long after, we received supply in abundance." **KS_Akora_VBE**

Price hikes had an adverse consequence on affordability, sales, and use of KOKO Plus. VBEs reported a reduction in the number of sachets they sold, resulting in a reduction in income. Also, caregivers couldn't afford the usual quantity they used to purchase:

"It used to be 50 pesewas per sachet but now it's sold for 1 Ghana Cedi [100 pesewas] per sachet. The increment has made it expensive for us. So, I don't buy as many as I used to buy because I now have to spend twice as much on the product and my baby would usually want it thrice daily, once in the morning, once in the afternoon and once in the evening." **KS_Akora_Beneficiary**

"The patronage of the product has reduced considerably due to the price change. The full package used to be 5 Ghana Cedis and many of my customers used to buy that weekly but now that the price per sachet is 1 Ghana Cedis, they'd often buy maybe just one or two sachets per week. They often complain of financial difficulties and the price hike is not helping matters." **KS_Akora_VBE**

"I can't buy it every day. If I buy it today, then I will skip the next day and alternate like that, depending on when I have money." **KNW_Bembesi_Beneficiary**

To resolve the shortage issue and create continuous demand, continued sensitization on the health benefit of the supplement, food demonstrations at CWCs, promotional activities during market days, discussions on

community information centers and church gatherings were utilized to educate community members and mothers on the reason for the price increment (high cost of production material). The strategy also focused on drawing the attention of beneficiaries to the affordability of KOKO Plus, compared to other supplements on the market. Furthermore, the sensitization also outlined the general price increment of goods and services in the country due to a general economic downturn in the country.

KOKO PLUS DISTRIBUTED AND AVAILABLE AT COMMUNITY LEVEL

A total of 1,250 boxes of KOKO Plus were procured for distribution over the period of the project. Each box of KOKO Plus contained 200 sachets, resulting in a total of 250,000 KOKO Plus sachets being procured for the IFP project. Initially, 750 boxes (i.e., 150,000 sachets) were procured for distribution and sales. Subsequently, another 500 boxes (100,000 sachets) were procured. KOKO Plus was distributed to the three districts by WVG via a centralized distribution point at Jema in the Kintampo South district. About 13,942 children were reached with the 192,092 sachets of KOKO Plus sold by VBEs. The remaining sachets of KOKO Plus remain with VBEs who are continuing to sell to caregivers, in 2023. Table 1 summarizes information on KOKO Plus procurement and distribution.

Table 1: KOKO Plus procurement and distribution across districts

Indicator	Total	Districts		
		Kassena Nankana	Sekyere East	Kintampo South
Number of KOKO Plus sachets purchased for the project	**250,000**	80,400	86,800	82,800
Number of supplements sold by VBEs	**192,092**	54,875	64,617	72,600
Number of children reached with nutritional supplement in targeted households	**13,942**	2,778	4,584	6,580

KOKO Plus boxes were distributed to the districts (Kassena Nankana, Sekyere East and Kintampo South) based on need and requests originating from the respective districts. The distribution of KOKO Plus to VBEs was through two channels: WVG district office pick up or community level delivery. VBEs typically placed their requests to their respective distribution office, and when it had been processed, they picked it up in-person, either during VBE regular meetings at the district office, or by scheduling a trip to the district office. The second channel required placing an order through a WV field supervisor. This order was delivered to the VBE in the community. Order requests were placed when needed and based on the level of stock a VBE had.

UTILIZATION OF KOKO PLUS AND REASONS THAT INFORMED USAGE

Caregivers generally reported acceptance of KOKO Plus based on knowledge and belief about its health benefits. Acceptance was motivated by knowledge sharing and promotion techniques of health professionals at child welfare clinics (CWCs), growth monitoring sessions (GMs) and food demonstration sessions, the knowledge gained by caregivers, the raw materials used in the preparation and the perceived positive impact on children. The perceived impacts on children included weight gain, reduced frequency of common illnesses, ability to walk relatively early compared to siblings or peers, and increased appetite. The following are a few quotes on acceptance of KOKO Plus, and perceived impact on children:

"When we went to weighing [child welfare clinics], they prepared food with it for us to feed our children, so I saw the name and when I went to Effiduasi I saw some hanging in a shop somewhere, so the man asked me what it was used for, and I said the food used to feed the child, so I purchased some." **SE_Ahensan_Beneficiary**

"Initially they weren't, we kept talking and emphasizing on it and we also were using it, so they saw us using it, so it became better." **KNW_community health nurse**

"It improves the health and nutrition of babies. When I for instance completed my six (months) exclusive breastfeeding, my baby refused to take any foods I introduced him to and wanted just the breast milk but Koko Plus got him to start eating after I was introduced to it by the health professionals at the weighing (post-natal health) centre. It is very healthy for babies because it gives them increased cognitive abilities and improves their overall health and general wellbeing." **KS_Akora_VBE**

"It has really benefited us since we partnered with them, and we have also received education on something we were ignorant about. They took some time to teach us, which really helped us. I even purchase KOKO Plus instead of Cowbell [milk powder product] because they had taught us how nutritious the koko plus is comparing to the cowbell" **SE_Ahensan_Beneficiary**

"I can't speak much about that because it's usually my wife who feeds the children, but I know it improves the weight of children. I know this because whenever they miss it for about a month, the children start experiencing weight loss." **KS_Akora_MaleHusband**

Caregivers used KOKO Plus in diverse ways and quantities. Although the information provided on how to use KOKO Plus required caregivers to mix only one sachet per day in meals for children, caregivers reported that KOKO Plus quantities used varied from one to four sachets per day. A few of the quotes from caregivers and community health professionals are:

"I used to use one sachet thrice daily. I would incorporate it in my child's food in the morning, afternoon, and evening. But now, my baby has gotten used to it, so I use one sachet of Koko Plus in the morning and afternoon and open a second sachet in the evening." **KS_Akora_Beneficiary**

"About five (5) at most and four (4) at the very least" **KS_Akora_Beneficiary**

"I use 3 in a day" **SE_Ahwerewa_Beneficiary**

Caregivers reported that they wanted to ensure that the entire sachet of KOKO Plus is 'not wasted' in a single meal, so they will often split up a sachet of KOKO Plus into multiple portions and use it across meals in a day. Some caregivers reported using it from three to seven times a week based on their ability to afford it. A few of the caregivers explained their practices as follows:

"My baby would usually want it thrice daily, once in the morning, once in the afternoon and once in the evening." **KS_Akora_Beneficiary**

"Twice daily. Once in the morning and once in the evening. I am often not at home in the afternoons, so I usually don't give it to him in the afternoon. I usually give him one (1) sachet in the morning and one (1) sachet in the evening, but when I am home in the afternoons, then I would divide the sachet in the morning and give him half of the content and give the remaining to him in the afternoon. I used to give him one (1) sachet daily when he was very little and didn't eat much but now his appetite has increased so he takes two (2) sachets daily." **KS_Akora_Beneficiary**

"In a week, I normally buy one package, but the other ones normally eat them, so I use 7 in a week, but it is more than that on a line, just that the other [children] eat them" **SE_Ahwerewa_Beneficiary**

Some caregivers mentioned that they felt the urge to also consume the KOKO Plus because they found the meals containing KOKO Plus to be appealing and attractive. Other caregivers also reported that other household members and older children consumed KOKO Plus:

"I consume much myself compared to what I even give to my child because it is very sweet when mixed with mashed kenkey [local dish made from fermented boiled corn meal] compared to mixing it with milk powders" **SE_Ahensan_Beneficiary**

"In a week, I normally buy one [a package of multiple sachets], but the other ones normally eat them, so I use 7 in a week, but it is more than that on a line, just that the other ones eat them" **SE_Ahwerewa_Beneficiary**

Caregivers and other health professionals were aware of the varying reasons that informed KOKO Plus use by caregivers. Despite initial hesitancy in acceptance and utilization, the promotional activities on KOKO Plus including food demonstrations and communication by community health nurses and project implementers appeared to stimulate usage. Some caregivers reported that the knowledge they gained from the messages on KOKO Plus and its benefits led them to using the KOKO Plus. These are explained in the following quotes:

"The reason why I give it to my child is due to the nutrients it possesses. When I give the raw koko [fermented corn porridge] to my child he will not have any nutrients, it only contains starch but when you put in koko plus the child will gain nutrients." **SE_Ahensan_Beneficiary**

"With the lessons we get, it made me understand that you don't divide it, you only have to measure the child's food and put some inside. If in the afternoon, you mash kenkey for the child, you can put some inside. If it's soup, you can put some inside. It's not used for porridge solely" **SE_Ahwerewa_Beneficiary**

"I was encouraged to use the KOKO Plus in meals I prepare for my child and ever since I started practicing it, it's been very helpful." **KS_Akora_Beneficiary**

"It was delicious. When it was not in existence, we used to prepare soup with seasoning but when they came to educate us that it can be used to prepare soup, when I am preparing soup, I use it as well as grind some and add it to my stew." **SE_Ahensan_Beneficiary**

PERCEIVED ADVERSE EFFECTS

Diarrhea was the most frequently reported adverse effect reported by caregivers as a result of using KOKO Plus. However, there weren't widespread reports of this adverse outcome. VBEs believed that although diarrhea was reported, it is not due to using KOKO Plus, but rather poor hygiene practices. VBEs further indicated that whenever they heard such reports, they promoted proper hygienic practices to demonstrate that the adverse events were unrelated to the use of KOKO Plus. A few of the quotes from VBEs related to adverse reports are here:

"Some complain of stomach upset or diarrhea when their babies take the product, and some say their babies simply cannot take it. In such situations, I just explain to the mothers to incorporate the supplement in home cooked foods for their babies and not foods they have purchased from food vendors. That could potentially give the baby a running tummy if the meals are not well cooked and not because of the supplement. Even when food is left uncovered and flies keep hovering over the foods, that could also give the child diarrhea, so I educate them on all these things." **KS_Akora_VBE**

"It is only one woman who complained that whenever her child took the KOKO Plus, she had a runny stomach, so I told her that, it is not the KOKO Plus, but it might be the Porridge which perhaps was not properly cooked" **KNW_Bembesi_VBE**

SUSTAINABILITY

To promote the sustainability of the VBE model for KOKO Plus distribution, and the continuous supply of KOKO Plus in communities, VBEs were linked up with regional and district KOKO Plus supply agents by WVG. This linkage is expected to facilitate the continuous flow of KOKO Plus along the supply chain. VBEs were also expected, from the beginning of the project, to keep 20% of the sales revenue as their gross profits, and to save 80% with the VSLA. This amount is intended to be used as a revolving fund to support/maintain KOKO Plus distribution at the end of the IFP project when there will no longer be facilitated distribution of KOKO Plus. This fund will enable VBEs to sustain their KOKO Plus businesses. The following quotes explain how stakeholders presume sustainability:

"So, you know they taught us to always leave the sales in the

box for the sake of tomorrow. So that when World Vision is no more here, we can use that as capital to continue the business." **KNW_Pungbesi_VBE**

"We've been informed that before the project comes to an end, we'll be directed to new places where we can access the product so when that happens, we'll go to those places to buy the product and come and sell it." **KS_Akora_VBE**

DISCUSSION

The use of MNPs is recognized as an effective strategy to address the problem of anemia and iron deficiency among infants and young children (6-23 months) (WHO, 2016). This study assessed the availability, acceptability, and utilization of a micronutrient in selected communities through the improved feeding practices for the first 1000 days project. KOKO Plus was not available prior to the implementation of the IFP project. The IFP project successfully introduced it to the communities and caregivers of children less than 2 years old. A deliberate process of community social marketing, led by VBEs, resulted in establishing its widespread availability within the selected communities. The project supported community and household-level distribution and sales mechanisms, leading to the acceptance and use of KOKO Plus.

The positive remarks observed from various beneficiaries suggest the VBE model implemented in the IFP project is an effective approach that could be adapted for use in other settings. In this project, large quantities of the KOKO Plus were purchased and supplied to communities; investments were made directly by WVG to ensure the constant supply of KOKO Plus, including subsidizing the price to keep it stable against market dynamics. Nevertheless, the subsidies were not enough to address the rapid increase in the retail price of KOKO Plus. The delivery approach used by IFP project implementers was culturally accepted and appropriate, meeting the needs of the community. In a review of MNP distribution approaches in Kenya, Kyrgyzstan, Mongolia, Ghana, and Vietnam, similar distribution approaches were reported to have increased coverage (Reerink et al., 2017). Nevertheless, there were temporary shortages of KOKO Plus which were eventually largely remedied by the project. This means that whichever distribution approach is used, it must be monitored constantly to ensure that it is not adversely affected much by market forces. Because KOKO Plus was well accepted, whenever there was a supply deficit, some mothers/caregivers explored alternative sources of the product including visiting nearby community markets.

There was high acceptability of KOKO Plus and this could be attributed to several factors. First, KOKO Plus was relatively inexpensive compared with infant formula and other infant commercial food products. Even when the price was increased, it remained lower in price than other dairy powder products. Secondly, the use of trained VBEs in marketing the KOKO Plus to the mothers in the community, coupled with the integrated support in the form of information and communication about the benefits of KOKO Plus by community health workers and project partners, provided trusted information. Moreover, the perceived health and nutrition benefits observed in their children may have encouraged mothers to accept and use KOKO Plus for their infants. Some mothers indicated that the KOKO Plus improved their children's weight. They were told by health workers that KOKO Plus reduced anemia and hospital visits. Other benefits reported included perceived improved child intelligence, "increased appetite" and children being "more active". Finally, the addition of KOKO Plus to meals was considered an easy process involving adding the KOKO Plus to commonly consumed foods. These findings are consistent with a similar study in Ghana (Kyei-Arthur et al., 2020) and other studies elsewhere (Creed-Kanashiro et al., 2016; De Barros & Cardoso, 2016; Laher et al., 2022; Roschnik et al., 2019). However, rapid increases in the price of KOKO Plus can offset the high acceptability of the product.

The use of KOKO Plus, together with food that was produced as part of nutrition-sensitive agriculture (Habib et al., 2024), increased opportunities for children to enhance the quality of their diet. Several of these food vehicles were used by mothers/caregivers as vehicles for giving the MNPs to their children. In addition, a variety of food vehicles were used along with KOKO Plus, including porridge, soup, stew, gari and soft kenkey. These are common local foods, and thus mothers found it easy and inexpensive to prepare them as a vehicle for adding KOKO Plus for their infants. Further, the use of the KOKO Plus was motivated by community cooking demonstration campaigns, as well as KOKO Plus market day campaigns. The variety of marketing and promotional activities were critical to KOKO Plus distribution and should be considered an integral part of distribution of nutritional supplements for young children.

Most mothers utilized KOKO Plus as indicated in promotional messages and on the label. There were a few instances of not using KOKO Plus as recommended, either giving more or less than amount than is recommended. These deviations from the promoted approach were linked to mothers/caregivers' perception of child preference for the product. The physical appeal and taste of the product also influenced consumption by caregivers and other family members. Although the product was developed for children, it may be useful to examine its effects on mother's nutrition and health.

Sustained use of MNP requires ensuring uninterrupted accessibility and reinforcement. Studies in Mali, Uganda, Nepal and Ethiopia, have shown the utility of involving community volunteers and community health workers; these community actors helped to address issues of misconceptions by providing answers to caregiver questions, and enabling information sharing and discussion (D'Agostino et al., 2019; Locks et al., 2019; Roschnik et al., 2019; Tumilowicz et al., 2019). In this study, VBEs provided opportunities for building trust, and encouraged use of KOKO Plus among mothers/caregivers. Husbands of the mothers/caregivers were also actively involved in the KOKO Plus education through men's group meetings that facilitated information sharing. The men provided an additional layer of support and motivation for using KOKO Plus. This is similar to a study in Mali where a diverse group of community members were involved in MNP promotion (Roschnik et al., 2019). This approach and strategy have been shown to enhance sustained usage of MNP (Pelletier & DePee, 2019).

Perceived adverse effects of MNPs such as diarrhea, darkening of stools and constipation have been reported among children in some studies (D'Agostino et al., 2019; Hannah & Max, 2017; Kyei-Arthur et al., 2020; Roschnik et al., 2019). In this study, reports of adverse reactions to KOKO

Plus by caregivers (diarrhea) were rare. However, it may be possible that the adverse outcomes were due to the food vehicle rather than KOKO Plus, given that environmental hygiene is not optimal in many of the communities. As was done in this project, water, sanitation, and hygiene communication should be part of the messaging component of integrated interventions. Such messages can allay the fears of caregivers regarding the safety of MNPs (Locks et al., 2019).

The findings of this study unearthed some key lessons to guide future programs. First, the involvement of GHS staff is important for ensuring trust and sustained behavior change communication through health systems. The tools and training provided to health care staff can be made available throughout the health system, expanding the reach of the behavior change aspect of the intervention. Second, the practical demonstrations used in activities such as cooking demonstrations were much appreciated and helpful for correcting misperceptions about child feeding and the use of KOKO Plus. Thirdly, a community-centered approach was utilized in this intervention that prioritizes community ownership, increases the prospects of an intervention being accepted by beneficiaries and its sustainability. The use of community groups also contributed to an increased sense of community ownership. Finally, the VBE approach contributes to sustainability, since it enables the communities to continue to access KOKO Plus using the savings made through the VSLA.

The current study used a mixed-methods approach, increasing the richness of the evidence from diverse viewpoints of stakeholders, WVG staff, and beneficiaries. The main evidence was, however, qualitative, and largely based on mothers/caregivers reports which could be subject to social desirability bias. Another limitation is that implementation data curation was sub-optimal and limited the extent of analysis of the implementation data. As a result, it is not possible to determine how much KOKO Plus was consumed by each child throughout the intervention. Further, pre-existing relationships of the project implementers with the community and networks could have also influenced MNP acceptance and utilization in ways that may not be replicable in other settings. Nonetheless, findings show high acceptability of the KOKO Plus and utilization in the project implemented communities.

CONCLUSION

The implementation of the IFP project may have improved availability, acceptability, and utilization of KOKO Plus in the project's index communities. The KOKO Plus was readily available, and mothers/caregivers could afford it. VBEs acted as distribution agents with support of other community volunteers and health care workers. Several marketing channels were used to market the KOKO Plus including house to house sales, community gatherings and during religious meetings. Adverse reactions (only diarrhea) were rarely reported. We recommend future MNP supply interventions to use community-based and community-led approaches as used in the current study not only to increase access, availability, and utilization of MNP to improve child feeding practices but to ensure sustainability. It is also pertinent to monitor the utilization of purchased MNPs, as purchase may not translate to usage, particularly by the target children.

AUTHOR CONTRIBUTIONS

WESD and RA contributed to the study design. Data collection tools were designed by WESD and RA. Initial analysis and coding were conducted by WESD and IB. WESD and IB wrote the first draft of the manuscript with routine critical reviews by RA. All authors then critically reviewed the following versions. All authors have read and approved the final version of the paper and its submission

CONFLICT OF INTEREST

This research was funded by World Vision Ghana Country Office through the Improved Feeding Practices for the First 1000 Days Project. Professor Richmond Aryeetey was a member of the National Steering Committee of the Improved Feeding Practices Project. Priscilla Babae and Christian Duut were project manager and project coordinator of the Improved Feeding Practices Project respectively. The authors declare that they have no other potential conflicts of interest.

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