

Micronutrient powder programs: New findings and future directions for implementation science

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1 | BACKGROUND

This MCN supplement on the implementation of programs that distribute micronutrient powder (MNP) comes almost 20 years after the concept of adding a powder of micronutrients to foods prepared at home, so-called *home fortification* or *point-of-use fortification*, was developed by Stanley Zlotkin and colleague (Zlotkin, Arthur, Antwi, & Yeung, 2001). Initially, MNP was intended to combat iron-deficiency anaemia among young children who could not swallow iron tablets and iron syrups were bulky and stained their teeth.

The early research and development of MNP focused on composition, i.e. how much iron and of what form and in combination with how much of which other micronutrients, on how frequently to provide them and for how long, on the required quality of the packaging to ensure stability over a long enough period under hot and humid conditions, etc.

When MNP had been found to be efficacious for combating iron-deficiency anaemia (Giovannini et al., 2006; Zlotkin et al., 2001; Zlotkin et al., 2005), attention moved to its delivery, including aspects such as specifying required storage conditions, developing package design, formulating appropriate behaviour change messages and materials for interpersonal communication and mass media, and trying out different distribution strategies and platforms (de Pee et al., 2008).

In 2011, the World Health Organization (WHO) issued a guideline on the use of MNP for combating iron-deficiency anaemia that recommended inclusion of at least three micronutrients (iron, vitamin

A and zinc) and provision of 60 sachets (one per day) every 6 months (World Health Organization, 2011), based on the proven impact on reducing iron-deficiency anaemia (De-Regil, Suchdev, Vist, Wallester, & Peña-Rosas, 2011). Around the same time, the Home Fortification Technical Advisory Group published programmatic guidance on behalf of the Global Alliance for Improved Nutrition, Helen Keller International, Micronutrient Initiative, Sight and Life, Sprinkles Global Health Initiative, University of California Davis, UNICEF and World Food Programme that recommended the use of MNP to complement diets of young children that are characterized by low diversity in order to prevent a range of micronutrient deficiencies (Home Fortification Technical Advisory Group, 2011). That guidance recommended provision of 90 (range: 60–180) sachets per 6 months, depending on the likely dietary gap, and inclusion of 15 micronutrients at the level of 1 RNI.

As programmatic guidance had been harmonized, and a number of suppliers had started producing MNP, agencies and governments started implementation at larger scale. Between 2011 and 2015, the number of countries implementing programs with MNP increased from 22 to 65 and they reached over 10 million children by 2015 (UNICEF, 2017).

In 2016, WHO updated the MNP guideline, which now recommends provision of 90 sachets every 6 months to children aged 6–23 months and 2–12 years where prevalence of anaemia among young children is 20% or higher and inclusion of iron, vitamin A and zinc with or without other micronutrients at level of 1 RNI (World Health Organization, 2016). With regard to dosing, no more than one sachet should be used per day and some programs choose

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to recommend flexibility around dosing, e.g. 15 per month without specifying the days, whereas others recommend daily use until finished. The idea of the former was that it will be less likely that caretakers get discouraged by a sense of failure when they have forgotten a dose, whereas there are also reports of daily use being easier to remember (Roschnik et al., 2019).

2 | THE CURRENT STUDIES

By now, after 5–10 years of use of MNP at a considerable scale, the focus of program development has shifted towards sustainability, i.e. ensuring supplies are available, uptake is good and use is appropriate and sustained. In order to facilitate further uptake of MNP at scale where this intervention is deemed the most appropriate for addressing micronutrient deficiencies among young children, there is a need for documented experience and identification of factors that can enhance uptake, appropriate use and sustained adherence. The papers in this supplement make a critical contribution to that body of evidence and experience.

Use of MNP is a long-term preventive intervention that requires continued and sustained practice. Programs should hence both promote new behaviours and sustained practice (D'Agostino et al., 2019) for caretakers to adopt a complex series of behaviours and maintain them (Ford et al., 2019, Locks et al., 2019, Tumilowicz, Habicht, et al., 2019). The behaviours include obtaining sachets initially and over time (coverage) and initiating and continuing to prepare and serve food with MNP to children (sustained intake). Programs need to identify ways to achieve this that can also be scaled up to larger programs with fewer resources.

Some of the papers in this issue have systematically assessed the different steps going from hearing about MNP (i.e. awareness), ever receiving it (i.e. active or passive *obtainment*), ever feeding it (experience with using it), correctly using it and continuing to use it. The most systematic of these (Tumilowicz, Vossenaar, et al., 2019) applied the Tanahashi model of health service delivery, distinguishing the following steps (and their indicators): availability coverage (i.e. ever heard of MNP), accessibility coverage (ever received MNP), contact coverage (ever fed MNP) and effective coverage (recently fed MNP, indicating sustained use). For correct use the researchers assessed answers to questions about how to prepare and feed it. They found that the first step, i.e. ensuring people heard about it, and the step to go from initial use to continued use, was the most difficult to achieve. Importantly, they also identified factors that were related to the different phases. Frequent contact with frontline workers was found important for continued use as it provided an opportunity to discuss issues with the caregiver, obtain a new supply and be aware off and prepared for dealing with possible challenges or side effects such as children rejecting the food or having dark stools. Most of the studies in the supplement used some version of a *program impact pathway* (PIP) such as this Tanahashi model, an important tool that deserves systematic use in future research and program design, monitoring and evaluation.

Key messages

- Although the efficacy of micronutrient powder has been established, many factors affect the uptake, use, and sustained adherence.
- For this reason, continuous improvements in programme design and implementation are needed during initial implementation and scale up.
- The systematic use of strong impact pathways and various forms of practical implementation research are two of the strategies for achieving this, bearing in mind the specific needs, constraints, and timetables of implementers and policy makers.

Table 1 summarizes the main findings and conclusions from the papers in this supplement and highlights particularly noteworthy aspects of the studies according to the authors of this editorial. Overall, these papers bring out important lessons for future scale-up of programs that provide MNP.

Impact of MNP on taste/sensory characteristics are frequently reported—this is contrary to the typical statement that MNP is a virtually tasteless powder that can be mixed with a child's food without children being able to distinguish between foods with and without MNP (Sutrisna et al., 2018) and is very important to acknowledge, whether it is proven or not. The issue should be addressed technically, i.e. by trying to find ways to minimize this impact, which can also vary by type of foods that MNP is mixed with, and it should be addressed in programs by telling caretakers that this may happen and suggesting ways to minimize it. Furthermore, as children's taste evolves as they grow older and they enter a neophobic phase in their second year of life (Pelto et al., 2019), acceptance issues may also arise among children who were already accustomed to eating foods with MNP.

It is important to communicate that side effects may occur—caretakers who are aware that there may be some side effects as children start to use MNP (e.g. change of stool colour or consistency or noticing a different taste) will be less worried when it happens and feel better equipped to deal with it (Jefferds et al., 2010). Other authors have reported that the influence of negative side effects depends on the counselling that was received (Loechl et al., 2009; Tripp et al., 2011).

Caretakers need to be supported to try different strategies to provide their child the MNP—as children may be able to distinguish between foods with and without MNP, caretakers should be provided with suggestions for how to try to mitigate this, such as mixing with flavourful foods, mixing with good quantity of food and adding it to food without the child knowing it (Jefferds et al., 2010).

Continued use requires continued reinforcement and access to *experts* in the community—a number of studies found that involving community-based workers in the MNP distribution was positively

TABLE 1 Key findings

Authors, country	Main aim of the study	Key findings and conclusions	Noteworthy
1. Pelto et al., Ethiopia	Identifying factors that facilitated and inhibited appropriate use and continued use of MNP (linked to Tumilowicz et al, Ethiopia)	<p>Appropriate use</p> <ul style="list-style-type: none"> - interpersonal communication and cooking demonstrations by health extension workers (HEW) very important for mothers' knowledge and confidence - organoleptic changes (colour, taste, smell, and texture), caretakers attributed that to preparation techniques - continued exposure overcame children's initial rejection of food with MNP and mothers used various strategies <p>Continued use</p> <ul style="list-style-type: none"> - continuing users report positive changes in their children (better health, more appetite, more active, weight gain) - positive statements from others encouraged continuation - having been informed about side effects made that they were not deterred when those occurred - expressed frustration when they were not able to overcome challenges of feeding the MNP - negative effects lead to discontinuation by some <p>Obtaining a new supply</p> <ul style="list-style-type: none"> - mothers reported confusion on how to get a refill or experienced problems doing so 	<p>Mothers noted that children apparently noticed differences between foods with and without MNP</p> <p>Informing women that children may experience signs or symptoms when using MNP enables them to deal with them and seek advice if necessary</p>
2. Tumilowicz et al., Ethiopia	Identifying the main bottlenecks to initiating and continuing use of MNP and factors related to these (linked to Pelto et al study)	<p>Main bottlenecks between hearing about, receiving, using, continuing to use: hearing about and going from initial use to continued use</p> <p>Initial use—important to counsel on MNP use and IYCF</p> <p>Continued use—important to have multiple contacts with frontline workers (discuss issues, obtain new supply, and prepare for side effects); perceiving positive outcomes in child; fewer perceived challenges</p> <p>Reasons for discontinuing use: not obtaining additional supply; perceived child rejection of food with MNP; negative side effects without proper counselling</p> <p>Feeding during child's second year of life was more challenging, related to progressing through developmental stages that affect feeding behaviours (reference to neophobic phase); experiencing illness and poor appetite; stopping routine attendance at health services so that getting a new supply required a special trip</p>	<p>Tanahashi model was used to study the components of the system that was implemented for MNP delivery and adherence—i.e. examination of sequential program outcomes and their correlates using cross-sectional data: very insightful, including the graphics—good that it was applied in multiple places because context specific factors were also identified</p>
3. Ford et al., Uganda	Identifying factors important for achieving good coverage and adherence, so as to focus on those when program is scaled-up	<p>59% high coverage (at least 60 sachets every 6 mos); 65.4% recent intake (during 2 weeks prior to survey, used as proxy for sustained use); 43.5% high coverage and recent intake</p>	<p>Explore factors associated with organoleptic changes to foods that MNP is mixed with (type, preparation, product quality, packaging integrity etc)</p> <p>Ease of obtaining sachets was important</p>

(Continues)

TABLE 1 (Continued)

Authors, country	Main aim of the study	Key findings and conclusions	Noteworthy
4. D'Agostino et al., Uganda	Comparing facility-based and community-based distribution of MNP	<p>Factors positively associated with high coverage: having MNP ration card; organoleptic changes to foods cooked with soda ash (had been specifically addressed in information campaign, i.e. can occur, but can continue to feed); heard of anaemia; know correct use of MNP; currently breastfeeding. Negative association: older age.</p> <p>Factors positively associated with recent intake: having MNP ration card; heard MNP radio jingle; ease of obtaining sachets; know correct use of MNP; child does not dislike MNP</p> <p>Interventions that increase caregiver knowledge, skills, demand and a focus on older children could improve coverage and intake.</p>	Includes emphasis on sustained use—reporting high uptake
4. D'Agostino et al., Uganda	Comparing facility-based and community-based distribution of MNP	<p>High awareness in both delivery arms</p> <p>Predictors of adherence: counselling (i.e. more frequent contact); receipt of communication materials; perceived positive effects; MNP knowledge; child liking MNP</p> <p>Main success factors: community sensitization; continued and effective counselling; increased support for distributors</p> <p>Distributors need refresher trainings and training of replacement staff and opportunity to share problem-solving tactics</p> <p>SBCC needs to be regular and consistent and be able to evolve as the program matures and new issues can emerge (e.g. when child is perceived cured, caregivers may discontinue)</p>	<p>Village health teams played a key role, e.g. by explaining about MNP to husbands and being accessible to discuss any misinformation or concerns</p> <p>Any community member seen as reliable health information provider needs to be equipped to answer questions about MNP</p>
5. Roschnik et al., Mali	Describing how MNP distribution was set-up in malaria-endemic area and assess outcomes and contributing factors	<p>ECD centres and multidisciplinary community volunteers (ECD teachers, midwife, health agent, women leaders, and two committed men) offer supporting environment and delivery mechanism for complementary interventions on good nutrition practices and child development, including MNP</p> <p>Mothers were asked to provide suggestions on how to introduce and communicate about MNP</p> <p>Choice of food vehicle that is already given daily to add MNP to promotes adherence and prevents sharing (as child has own bowl)</p> <p>Factors contributing to high levels of acceptance and adherence: perceived positive changes; selected food vehicle; daily routine to provide MNP 4 mos/y</p>	<p>Different distribution schedule to avoid MNP use during malaria season, i.e. 4 months daily</p> <p>Broad cross-section of community leaders involved</p> <p>Good strategy to identify food vehicle and formulate messages</p>

(Continues)

TABLE 1 (Continued)

Authors, country	Main aim of the study	Key findings and conclusions	Noteworthy
6. Tumilowicz et al., Mozambique	Assessing uptake and adherence to MNP as distributed using a novel method	<p>Concurrent delivery of other popular interventions was supportive</p> <p>Community-based and -led delivery of MNP is feasible and can lead to high uptake and acceptability</p> <p>Non-users had lower dietary diversity—not necessarily causal, but points to vulnerability</p> <p>Vouchers provided at health centres and in communities, to be redeemed at participating local commercial shops</p> <p>Voucher system was novel and complex, but that impeded delivery of MNP to caregivers as parallel supply chains had to be set-up, function well, and be aligned. Issues: incorrect number of vouchers, redemption system with codes on cell phones did not work; MNP stock outs at vendors (ordered late and/or received late). Thus, the transfer of messages, vouchers and product between different actors of the delivery system did not work well.</p> <p>Resourceful program implementers found a way to circumvent the issues with redemption of vouchers by collecting on beneficiaries' behalf</p> <p>Initiation of feeding by many, continued use much less</p>	<p>Interesting findings on complication of concurrently setting up two systems for distribution</p> <p>Attention is required to improve access and support continued use—frontline workers are key to support the latter (e.g. they developed a way to bypass the vouchers)</p>
7. Locks et al., Nepal	Assessing coverage and related factors in two districts after scale-up of the program (post-pilot)	<p>Two districts: two-thirds had received, higher among mothers of younger children; 25% and 50% of mothers had received MNP at least twice (defined as high intake); half of the mothers who had tried MNP reported positive effects (better health, growth, immunity, appetite, energy/activity, mental development); one-third reported negative effects (black or loose stool, constipation, nausea, vomiting)</p> <p>Factors associated with coverage: hearing MNP radio messages; health worker and FCHV counselling; shorter travel time</p> <p>FCHV counselling stronger association than health worker counselling with: coverage, maternal knowledge of appropriate use, high child intake of MNP—group counselling more associated than individual (peer support aspect)</p>	<p>Lower coverage than in the pilot program, may be related to now having fewer resources per district</p> <p>FCHV contacts were key—reliable channel for delivery and information and to support sustained use</p> <p>Authors emphasize importance of investing in program equity and to make an extra effort to ensure coverage of more vulnerable community members</p>
8. Schnefke et al., Ethiopia	Designing a caregiver ethnographic interview	<p>Setting up a program advisory group that represents different expertise and knowledge, of the topic, research methods and the context; can make an important contribution to the design of a focused ethnographic assessment</p>	<p>The strategy ensured good contributions. Now that these papers have been published, they could provide a good source of first insights</p>

Note. MNP, micronutrient powder.

related to continued use, as it helped address supply issues, answer questions, discuss issues and provide continued reinforcement (D'Agostino et al., 2019; Locks et al., 2019; Roschnik et al., 2019; Tumilowicz, Habicht, et al., 2019; Tumilowicz, Vossenaar, et al., 2019). Furthermore, Lock et al. also found that group and group-plus-individual counselling was related to repeat coverage and high intake, but individual counselling alone was not. This emphasizes the importance of skills-building, social support and continued positive reinforcement, which are essential for maintaining changes in health behaviour and should be provided in the community (Locks et al., 2019).

The social and behaviour change strategy should include nonhealth workers/volunteers—it is important not only to work with health workers or volunteers that are present in the community but also to ensure that other respected members of the community are aware, supportive and can provide basic information about MNP and how to provide it to children. The best example of this was described for the program in Mali (Roschnik et al., 2019) where the ECD platform was used to introduce MNP in the community and a multidisciplinary group of community volunteers were involved, which had actually been a suggestion from women that were asked for suggestions for program design.

Distribution through nonhealth systems is innovative but challenging—the idea to distribute vouchers for MNP that can be redeemed at a shop (Tumilowicz, Habicht, et al., 2019) reduces the commodity storage and management requirements for the health system and is also being attempted for other health and nutrition products. It could provide a way to give certain consumers access to MNP for free, as they receive a voucher, whereas other (more wealthy) consumers would be able to buy it. The experience described for Mozambique indicates that introducing two new distribution systems at the same time (MNP and vouchers) can be challenging. It also reveals the resourcefulness and commitment of health workers who can find solutions to logistical problems when they have the flexibility to do so.

Distribution schemes can be adapted to circumstances—the WHO and Home Fortification Technical Advisory Group recommended frequency of dosing of MNP is 90 sachets, one per day, over a period of 6 months, which would result in an average daily intake of 50% of the RNI. However, programs may choose alternative dosing schemes in case that better fits their circumstances, such as the provision for daily consumption during 4 months outside of the malaria season (Roschnik et al., 2019).

3 | MNP THROUGH THE LENS OF IMPLEMENTATION SCIENCE

This collection of eight papers focusing on factors affecting adherence provides an opportunity to assess current practices for generating knowledge concerning MNP implementation, using the frameworks recently developed by the Society for Implementation Science in Nutrition (Tumilowicz et al., 2018). In doing so we also consider a broader systematic review of factors affecting MNP adherence (Tumilowicz, Schneck, Neufeld, & Pelto, 2017) and the broader

consultations and reviews of MNP program experiences (Nyhus Dhillon et al., 2017) conducted at approximately the same period of time. The SISN frameworks outline (a) five categories of factors that can affect implementation quality, (b) the range of methods for assessing and addressing those factors in a given context and (c) three forms of knowledge that, together, make up a practical and useful science of implementation. This commentary uses these frameworks to assess current practices for generating implementation knowledge in relation to MNP, but they are applicable to the full range of interventions, policies and innovations in nutrition.

As a point of departure Table 2 summarizes some key features of the eight papers in this supplement. In broad terms this summary shows (for studies 1–7)¹ that the programs studied here are operating at modest scale (district or multiple districts) and with relatively short duration (4–15 months in most cases); the studies focus primarily on coverage and adherence and factors affecting it, with some variation across studies in how these outcomes are quantified; MNP are most commonly being delivered through health centres and community health workers, but there are also some experiences with pre-schools and local shops; caregivers are the primary study participants, with community leaders, health workers, community health workers, and/or program managers being included in three of the studies; research design and data collection are most commonly based on cross-sectional analysis of endline surveys, complemented (in five of the studies) by focused ethnographic studies or other forms of qualitative research; and data analysis typically involves descriptive statistics on coverage and adherence, logistic regression on determinants and thematic analysis of qualitative data. In all of the studies the choice of outcomes and the analyses were explicitly or implicitly guided by some version of a PIP, which strengthens the analysis and facilitates broad comparisons across studies. All of the studies made recommendations on how to address the factors that affect adherence, primarily by strengthening SBCC strategies. Only one was formally testing ways to do so (the comparison of facility vs. community delivery in Uganda; D'Agostino et al., 2019) and one was gaining experience (with no comparison group) with a novel distribution method (vouchers redeemable at shops in Mozambique; Tumilowicz, Vossenaar, et al., 2019).

Although the small number of studies in this set limits the generalizations that can be drawn, the broader systematic review of factors affecting adherence revealed similar tendencies (Tumilowicz et al., 2017). In that review, which included 35 published studies and 6 grey literature reports, there were 23 studies with only quantitative methods (randomized designs and cross-sectional surveys), 8 studies with only qualitative methods, and 4 with both; all 41 studies included caregivers as study participants and only 3 included health workers, community leaders, or other types of participants; only 4 of the studies explicitly compared innovations in regimen (e.g. daily versus flexible administration) or delivery (e.g. public-private hybrid). The authors suggest that the emphasis on caregiver knowledge and perceptions, as factors that affect adherence, may reflect a bias towards

¹Study 8 has a different focus than the others and is discussed separately.

TABLE 2 Methodological aspects

Paper/location	Scale and duration	Outcomes	Delivery and study participants	Overall design	Method collection	Method analysis
1. Pelto/ Ethiopia	11 districts in two regions; 7 mos 2016	Appropriate use, continued use	CHW and health centres/caregivers	Focused ethnographic study	In-depth, open-ended interviews focused on appropriate use and continued use	Thematic analysis
2. Tumilowicz/ Ethiopia	11 districts in two regions; 10 mos, 2016–2017	Ever-heard, ever-received, ever-fed, recently-fed	CHW and health centres/caregivers	Endline survey (and FES reported in separate paper)	Endline survey with outcomes, caregiver, child, IYCF practices and perceived change in the child	Descriptive statistics and multivariate models guided by the PIP
3. Ford/ Uganda	One district; 12 mos 2016	Coverage, recent consumption	Clinics, VHWs/caregivers	Endline survey, multi-stage cluster sample	Endline survey, IYCF and MNP knowledge and practices and exposure to intervention	Univariate and multivariate analysis of predictors
4. D'Agostino/ Uganda	One district 9 mos 2016	Ever-heard, coverage, consumption, adherence	Facility: community/parents, VHWs, HWs	Six subcounties randomized to facility or community delivery	Systematic monthly spot-checks; midline and endline KI; endline survey; bias-check survey after endline	Endline differences; logit models; triangulation guided by PIP
5. Roschnik/ Mali	60 rural villages; 4 months in 2014 and in 2016	Coverage, adherence, acceptability, vehicles	Preschools/parents and community leaders	60 villages randomized to MNP vs control	Quantitative baseline and endline surveys and a midline qualitative study	Descriptive statistics; logistic regression; thematic analysis
6. Tumilowicz/ Mozambique	Two districts 15 mos 2016–2017	Ever-heard, voucher coverage, sachet coverage, bottlenecks	Delivery and study participants	Overall design	Method collection	Method analysis
7. Locks/Nepal	Two of 26 scaled-up districts; 3 years 2014–2016	Ever-received, maternal knowledge of appropriate use, repeat coverage, adherence	Health centres (vouchers) and local shops (sachets)/caregivers, managers, implementers	Endline survey and focused ethnographic study	Endline survey and interviews with staff (in-depth, semi-structured and close-ended)	Descriptive statistics guided by the PIP; thematic analysis
8. Schnefke/ Ethiopia	N/A	Guidance for designing interview protocols for implementation research	CHWs and health centres/caregivers	Endline survey	Endline survey with outcomes, perceptions and experiences	Descriptive statistics; multivariate analysis of predictors
			Researchers, expert advisory group	Expert consultation	Pre-testing/mock interviews with experts	Expert consultation

Note. MNP, micronutrient powder; N/A, not applicable.

these factors among researchers and a broader socio-ecological perspective is needed to better understand the barriers and facilitators acting at various points along the PIP.

When examined in relation to the SISN frameworks (Tumilowicz et al., 2018), these observations suggest that the current research on MNP adherence is primarily focusing on factors related to caregivers (with an emphasis on their knowledge and perceptions), which is only one of five categories in the SISN framework. The other categories, which are much less studied, relate to implementing organizations and staff, the enabling environment, planning and implementation processes and characteristics of the intervention itself. It further reveals that a limited range of quantitative and qualitative research designs and methodologies is being used. This is important because the current research documents numerous implementation problems and challenges, and makes recommendations for improvement, but has not yet generated as much knowledge on how to implement and test recommendations and innovations to address the widely recognized challenges. This is illustrated vividly in the many suggestions summarized above, all of which would require changes in counselling practices, workloads, training and supportive supervision for health workers and community volunteers. Finally, the published papers do not discuss whether or how the study findings have been used to design or modify implementation strategies in the study countries, or the nature of any efforts to facilitate this, such that its contribution to decisions and implementation quality within the study countries is unclear.

In contrast to the present 8 studies and the 41 studies in the systematic review, which focused largely on caregiver-related factors affecting adherence, a year-long consultation during the same period (Nyhus Dhillon et al., 2017) attempted to synthesize knowledge and experience on broader aspects of MNP programming, specifically: planning processes and supplies (Schauer et al., 2017), MNP delivery (models, platforms and channels), SBCC and training (Reerink et al., 2017) and monitoring, process evaluation and supportive supervision for continuous quality improvement (Vossenaar et al., 2017). This effort engaged 49 experts, from 19 countries and 25 organizations, with experience in MNP interventions, included an extensive review of published and grey literature and conducted 47 key informant interviews relative to implementation experiences in over 35 countries. The literature review identified 66 peer-reviewed articles containing some program-specific learning and 45 reports, presentations, or other grey literature. Two features of this work are especially notable for present purposes. First, it revealed a paucity of published or documented experience on these broader programmatic aspects, especially for programs at-scale. In the words of the authors:

Most existing documentation on MNP programme learning focuses on formative research and acceptability trials—learning usually generated early on and often only in pilot programmes. Although intensively examined pilots have their value for context-specific implementation, systems-based learning from large programmes (integration, national coordination, monitoring, supervision, sustainability and supply) is

better placed to inform sustainability and scale-up. (Dhillon et al., p6).

Second, in the absence of published sources on these important system-level aspects, the consultation was able to assemble a rich body of operationally useful learnings and guidance by drawing upon the experiential knowledge from the key informant interviews and the participants in the consultation, with appropriate caveats about the challenges of doing so.

This consultation is instructive for those interested in building and applying a science of implementation in nutrition, with implications well beyond MNP programs. It highlights that current research and formal documentation often addresses only a limited range of factors that affect implementation (viz. the five categories in SISN's framework) and it remains largely based on pilot-scale experiences. As such, decision makers confront large gaps in research-based knowledge and must rely upon other forms of guidance. The consultation highlights that an enormous body of experiential knowledge exists, which can be tapped for guidance in such circumstances, but great care and more guidance is needed on how to gather, systematize, share and use such knowledge. Experiential knowledge corresponds to one of the three forms of implementation knowledge in SISN's framework, which often is overlooked or discounted, is tacitly used in all cases (even when interpreting, adapting and using findings from formal research within a particular country or programmatic context) and is required for the building and applying a science of implementation in nutrition. This is an area that needs more development and testing as the implementation science field matures.

The need to recognize multiple forms of knowledge in implementation science—and the care required in generating that knowledge—provides the segue to the important eighth study in Tables 1 and 2 (Schnefke et al., 2019). Two of the direct contributions of that paper are the carefully-designed and -vetted protocol for a caregiver interview for use in the evaluation of an MNP trial and an illustration of the value of engaging an expert stakeholder group in protocol development more generally. The time, effort and expertise invested in the development and documentation of this process and the protocol itself are exceptional. Also, exceptional and important is the authors' decision to disclose some tensions that arose in the process:

The study results illustrate the ways in which some of the fundamental features of ethnography are different from survey-type research. The discovery that some PAG members were uneasy with, or even negative about, some of the features of good qualitative interview techniques was surprising. It is an important finding and raises larger issues that require exploration to identify the reasons for the tensions related to methodological approaches and what can be done to ameliorate them.

The authors are correct that the tensions that arose in this case raises larger issues related to methodologies in implementation science and how they are to be resolved. Tensions also can arise related to choice of research design (e.g. whether to include comparison groups; if so what type; whether and how to randomize), choice of indicators, forms

TABLE 3 Author affiliations

Paper	1	2	3	4	5	6	7	8	Totals
National coauthors									
Govt	1	1	1	1		1	1	2	8
NGO		2			3		1	1	7
University		2	1					1	4
Other research									0
National subtotal									19
International organization coauthors									
Govt (CDC)			5			1	3		7
NGO/UN	4	4	1	8	2	6	2	6	33
University	1	3		1	5	1	1	1	13
Other Research	2 ^a	2 ^a		2 ^a		4 ^a		3 ^a	13
International sub-Total									65
Grand Total									84

Note. NGO, nongovernmental organization.

^aConsultants in studies 1, 2, 4, 6, and 8; DHS in study 4; RTI in studies 1 and 8.

of analysis, study duration, external validity, etc.. Although there may be disagreements about such issues even in conventional research, they can be especially difficult in implementation research for practical reasons (e.g. cost and timeliness in relation to decision-makers' needs), for ethical and political reasons and because conventional norms and incentives for academic research may not align well with the needs of decision-makers. Ultimately, researchers, implementers and (sometimes) policy makers must find ways to communicate, develop mutual understanding and resolutions, but even this is challenging because of the limited time and opportunity for in-depth deliberation. Finding constructive ways to resolve such issues is indeed a priority for the nutrition community, including researchers and stakeholders alike.

Finally, the eight studies in this supplement allows us to open another conversation within the nutrition community, namely, how to promote and support the capacities for and the practice of implementation science at national level in low- and middle-income countries and within university systems in all countries. This was done by tabulating the institutional affiliations of the coauthors of the eight studies (Table 3). The tabulation shows a preponderance of coauthors from outside the study countries (59 out of 75) and the low representation of coauthors from universities in the study countries (4) or from other countries (8). The interpretation of these numbers is not straight forward, because of the small number of studies and because coauthorship may not reflect other forms of participation in the studies, but the disparities do suggest the need for a more systematic examination and development of strategies to mainstream implementation science within countries and universities, as well as within nutrition programs themselves.

4 | CONCLUSION

Development of MNP and implementation of programs that distribute it provide a classic illustration of the varied tasks required to bring

nutrition-specific interventions to scale, beginning with product or intervention development, establishing efficacy and safety under varied circumstances, studying consumer acceptability and adherence in different contexts, documenting implementation experience with varied modes of delivery at pilot scale, integration into existing delivery systems at-scale and creating a supportive enabling environment of policies, finances and stakeholder support. The studies in this supplement make important contributions in the midrange of this process by advancing our understanding of the many factors affecting uptake, use and sustained adherence and providing or illustrating valuable tools and methodologies for similar studies in other settings. They also reveal some of the changes and continuous improvements in program design and implementation that will be required to strengthen uptake, use and adherence in the future and at larger scale. Those changes, in turn, will pose new challenges and opportunities for implementation science to support the effort by studying various aspects of the implementation systems themselves and doing so in ways that meet the needs and timetables of implementers and policy makers. Some excellent examples of the latter are available in a recent supplement focused on the challenges of integrating and sustaining nutrition interventions within health platforms in low- and middle-income countries (Pérez-Escamilla & Engmann, 2019).

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

CONTRIBUTIONS

SDP drafted the first section of the paper, DP drafted the second section and both reviewed the final draft.

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