



# Program Impact Pathway of the Positive Deviance/Hearth Interactive Voice Calling Program in a Peri-Urban Context of Cambodia

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## ABSTRACT

**Background:** Positive Deviance/Hearth (PDH) is an internationally recognized nutrition rehabilitation program. However, nutritional improvements are inconsistent across contexts. It is unclear if variations are due to differences in program design, implementation, utilization, or other contextual factors. Furthermore, few PDH programs have addressed the high time and work burdens of caregivers and volunteers. To address this, the study integrated interactive voice calling (IVC) with PDH.

**Objectives:** A program impact pathway (PIP) analysis was used to evaluate the secondary outcomes of facilitators, barriers, and contextual factors that influenced the design, implementation, and utilization of a Positive Deviance/Hearth-Interactive Voice Calling program to improve the nutritional status of children in Cambodia.

**Methods:** A PIP analysis was done on data collected through in-depth interviews with caregivers ( $n = 32$ ), key informant interviews with volunteers ( $n = 16$ ) and project staff ( $n = 3$ ), and surveys of project staff ( $n = 5$ ).

**Results:** In the design phase, facilitators included quality training, technical support and design tools, community mobilization, and linkage to existing health services. Barriers included poor community mobilization. For the implementation phase, facilitators were good volunteer knowledge, follow-up tools and guidance, supervision, and spot checks of volunteers. Barriers were lack of time and overworked older caregivers. For the utilization phase, facilitators included family and volunteer support and access to phones, whereas barriers were lack of support, time, and financial resources; low levels of education and old age of caregivers; and inconsistent phone use. Contextual factors included food insecurity and increased childcare responsibilities of grandmothers due to migration of mothers.

**Conclusions:** The PIP analysis identified facilitators, barriers, and contextual factors that may affect the design, intervention, and utilization of IVC interventions for health and nutrition behavior change and elements to consider when designing and implementing them. When implementing child nutrition programs in Cambodia, supporting interventions addressing mental health and time and resource constraints of elderly caregivers should also be included. This trial was registered at clinicaltrials.gov as NCT03399058. *Curr Dev Nutr* 2022;6:nzac045.

**Keywords:** Positive Deviance Hearth, interactive voice calling, mobile health, COVID-19 innovation, urban, Cambodia, nutrition, qualitative, mental health, grandmothers

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Manuscript received May 17, 2021. Initial review completed February 14, 2022. Revision accepted March 24, 2022. Published online March 28, 2022.

Supported by World Vision Hong Kong (to DB).

Author disclosures: The authors report no conflicts of interest.

World Vision Hong Kong participated in the design of the project.

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Abbreviations used: COVID-19, coronavirus disease 2019; DIQA, Design and Implementation Quality Assurance Tool; IDI, in-depth interview; IVC, interactive voice calling; IYCF, infant and young child feeding; KII, key informant interview; MoH, Ministry of Health; PDH, Positive Deviance/Hearth; PDH-IVC, Positive Deviance/Hearth-Interactive Voice Calling program; PIP, program impact pathway; SMS, short-message service/text; WAZ, weight-for-age z score; WV, World Vision; WVI, World Vision International; WVI-C, World Vision International—Cambodia.

## Introduction

Globally, 45% of deaths among children younger than 5 y of age are associated with undernutrition, with the highest number of associated deaths occurring in African and Asian countries (1). Evidence shows that child undernutrition is immediately caused by a child's dietary intake and exposure to diseases, both of which are influenced by the underlying causes of household food insecurity, inadequate care and

feeding practices, and unhealthy household environments. In the short term, undernutrition increases the risk of child mortality and morbidity. In the long term, it increases the risk of poor pregnancy outcomes, impaired cognition, and reduced economic productivity (2).

In Cambodia, Demographic and Health Surveys show that despite rapid economic growth, increased donor funding, and improvement in the quality of maternal and child health care services, the prevalence of stunting, wasting, and underweight among children under age 5 y

remains high, at 32%, 10%, and 24%, respectively (3). In the general population, 14.6% experience severe food insecurity. Poor households engaged in agriculture are the most food insecure, relying on markets and foraging for foods, leading to a homogeneous diet primarily consisting of rice (4–6). Most children in Cambodia consume watery rice porridge rarely enriched with nutrient-dense foods such as vegetables, meat, and fish (6).

The Cambodian national economy experienced substantial expansion from 2010 to 2016, accompanied by growth in paid employment opportunities in urban areas, driving an increase in migrant workers by ~140% (7). Women comprise about half of all migrants, the majority of whom go to Phnom Penh to work as factory workers, and who are mainly between the ages of 17 and 35 y (7), the prime childbearing and caring ages for women. Although the income boost brings benefits, it is also accompanied by poor breastfeeding and complementary feeding practices because of cost, time, and mothers quickly returning to work (6). Although Cambodia has one of the highest rates of exclusive breastfeeding in the Southeast Asian region at 79.9% among infants 0–1 mo of age, by the time a child is 4–5 mo of age, only 50.9% are exclusively breastfed, partly owing to mothers returning to work after a child is 3 mo old (4). About 40% of migrant laborers leave children in the care of grandparents, most of whom have limited education and care for 1–8 grandchildren each (7, 8). A recent report indicates that elderly caregivers in migrant households experience significantly higher anxiety and depression than caregivers in nonmigrant households (9). The report also indicated that caregivers over the age of 60 y have significantly poorer general mental health than caregivers <60 y of age, possibly due to the lasting effects of the trauma elderly caregivers experienced during the Khmer Rouge and Pol Pot regime of the 1970s (9).

World Vision International—Cambodia (WVI-C) and its partners are addressing the high prevalence of underweight children in Cambodia using the Positive Deviance/Hearth (PDH) approach. Positive Deviance is an asset-based, problem-solving, and community-driven approach. It is based on the observation made >30 y ago that in every community, there are certain individuals whose unique behaviors or strategies result in better nutritional outcomes than for peers who live in similar socioeconomic contexts (10). In the 1990s, the Positive Deviance approach was combined with “Hearth sessions,” which are small group sessions for delivering contextualized messages, feeding children a nutrient-dense meal, and practicing the behavior changes being promoted in a community setting, resulting in the Positive Deviance/Hearth Program (PDH) (11). Thus, PDH is a community-based intervention utilizing locally appropriate child feeding practices and a food-based approach to rehabilitate underweight children and promote behavioral changes in caregivers in health-care-seeking, child-feeding, caring, and hygiene practices. A 2011 systematic review of 17 peer-reviewed intervention trials and gray literature evaluations showed positive results from the PDH approach in specific settings, although improvements in nutritional outcomes were not always as dramatic as hoped (11). It is unclear if the variation in nutrition outcomes is due to differences in design, implementation, utilization, and/or contextual factors. Furthermore, few PDH programs have attempted to address the perennial concerns of high volunteer and caregiver work and time burdens, respectively, from implementing and participating in PDH programs (12, 13).

To increase scalability and reduce volunteer and caregiver work and time burdens in PDH programming, WVI-C integrated interactive voice calling (IVC) with PDH programming. Although there is some promising research suggesting short-message service/text (SMS) reminders and voice recordings may have a positive impact on infant and young child feeding (IYCF) (14–16), no prior research has investigated the implementation science of PDH nor the added value, opportunity costs, and effectiveness of replacing in-person household visits from PDH volunteers with IVC within PDH programs.

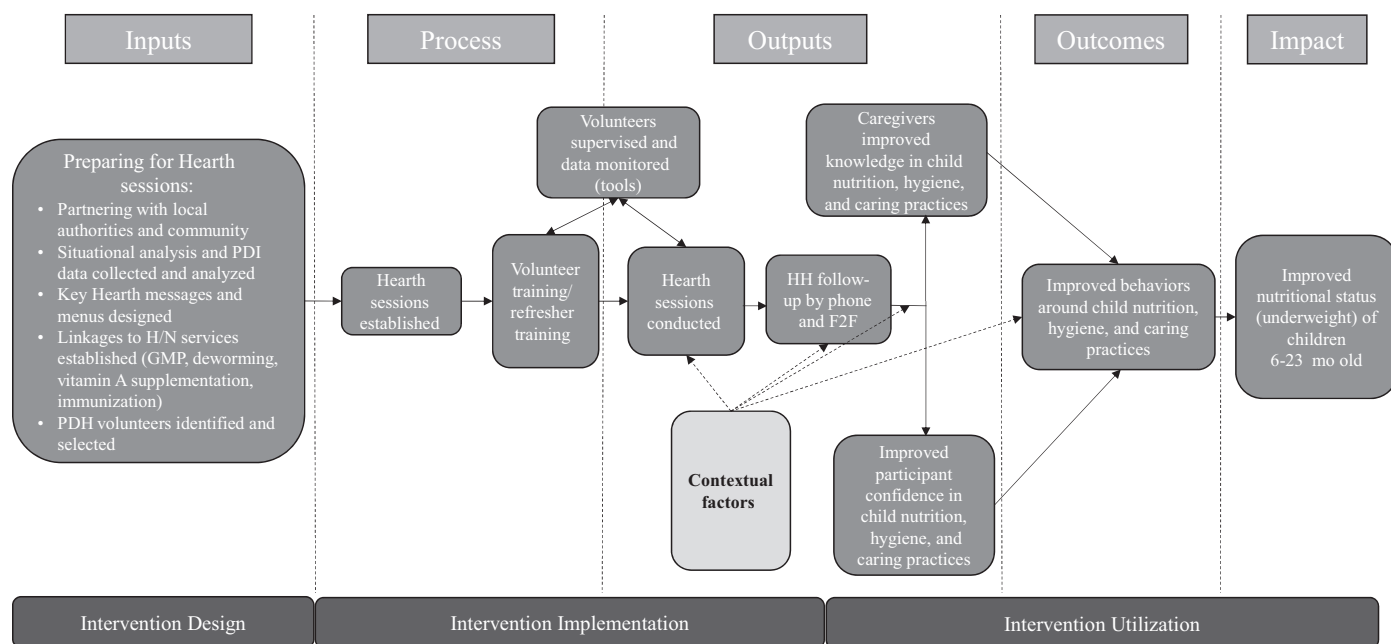
A program impact pathway (PIP) is a systematic way to assess the relations between planned interventions and intended results (17). PIPs can be used for process evaluations or final evaluations (17). PIPs incorporate the logic model components of program inputs, outputs, and outcomes, but they also identify the different pathways of the activities (planned, implemented, and utilized) and influencers (facilitators, barriers, and contextual factors) that may affect intervention effectiveness, thus providing researchers and implementers the ability to identify pathways or obstacles to program impact (18, 19). The objective of this article is to use a PIP to identify the secondary outcomes of facilitators and barriers that influence Positive Deviance/Hearth-Interactive Voice Calling program (PDH-IVC) design, implementation, and utilization in the context of improving the nutritional status of children in peri-urban Cambodia.

## Methods

### Study context

A longitudinal cluster-randomized controlled study (NCT03399058) was conducted in 3 districts located in the Kampong Chhnang and Kampong Speu provinces of Cambodia. The study’s overall purpose was to evaluate the impact of 2 modes for delivering a World Vision (WV) IYCF counseling program to reduce the prevalence of malnutrition in children 6–23 mo old. These 2 modes were 1) traditional PDH program with in-person home visits or 2) PDH-IVC which replaces some face-to-face interactions with phone calls, thus reducing volunteer and staff time and workload. The nutritional outcomes (weight-for-height, weight-for-age, and height-for-age *z* scores) in both groups were compared with a control group receiving the government’s basic health and nutrition package. WVI-C led the project with technical support from World Vision International (WVI), Emory University, and the National Institute of Public Health. Three area programs, Boribour, Rolea Pha Ea, and Samrong Tong, were purposively selected because of similar sociodemographic and health characteristics.

WVI-C used 107 Village Health Support Group members as front-line workers (hereafter referred to as volunteers) and 4 WV project staff overseeing the volunteers, including 1 project manager and 3 project coordinators, to implement the program for the study over 2 y. Data were collected using both qualitative and quantitative methods. A process evaluation was conducted in April 2018, 4 mo into the study, and an endline evaluation was conducted in June 2020. There was a slight delay in the endline evaluation because of the coronavirus disease 2019 (COVID-19) pandemic restrictions. Quantitative evaluations were conducted at the baseline, midline, and endline of the first year of the study period to assess program effectiveness, primarily focusing on primary outcomes, including improvements in child nutritional status, and the



**FIGURE 1** The program impact pathway for the PDH Interactive Voice Calling nutrition program. F2F, face-to-face; GMP, Growth Monitoring and Promotion; HH, household; H/N, Health and Nutrition; PDH, Positive Deviance/Hearth; PDI, Positive Deviant Inquiry.

overall study design and methodological approach. In summary, compared with the control group, the traditional PDH and PDH-IVC groups had a significant improvement in child nutrition after 3 mo with some evidence of sustained impact in only the PDH-IVC group after 12 mo. However, the improvements in child nutrition were modest and not as significant as results seen in other contexts. The detailed results of the impact evaluation are described elsewhere (20).

### PIP

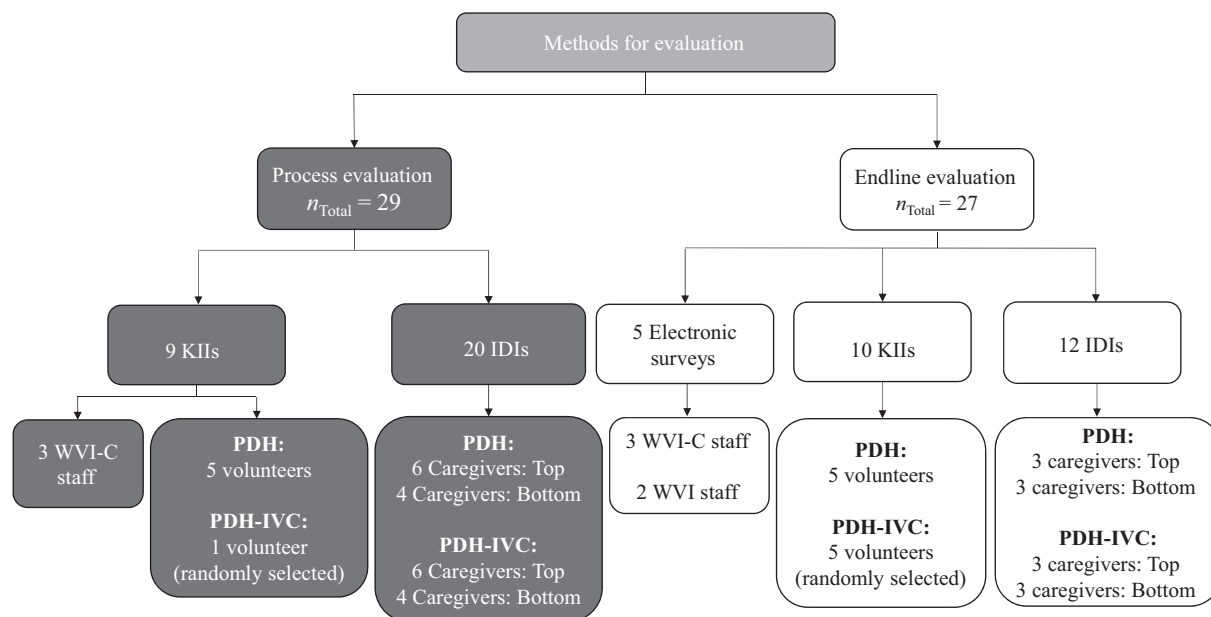
After the impact evaluation, we developed a PIP to better understand those results. The PIP was developed through an iterative process based on reviewing the project logic model (which includes hypothesized inputs, process, and outputs that ultimately contribute to the impact of improved nutritional status of children 6–23 mo old in the community); WV's PDH documents (WV's PDH Project Model document with theory of change), including the PDH essential elements; the process, midline, and quantitative endline evaluations; and discussing with the project team. To better understand the pathways or obstacles to program impact, we divided the PIP into 3 phases: intervention design, implementation, and utilization (Figure 1). The PIP guided the development of the data collection tools for the in-depth interviews (IDIs) with caregivers, key informant interviews (KIIs) with volunteers and project staff, and surveys with project staff as well as the data analysis to identify the secondary outcomes of facilitators, barriers, and contextual factors for each of the phases that are presented in this article.

Facilitators were defined as positive factors contributing to intervention design, implementation, and utilization whereas barriers would impede intervention design, implementation, and utilization for optimal nutrition outcomes. The same factors could be both facilitators and barriers. For example, strong family support could be a

facilitator in improving caregiver behaviors, which could then result in improved child nutrition, but poor family support could be a barrier to caregivers changing their behaviors and result in poor child nutrition. Contextual factors were defined as elements specific to the context of the program participants that enhance or constrain the effectiveness of the intervention, even when it is designed and implemented appropriately, thus revealing the necessity of other complementary interventions (17). For example, food insecurity due to drought during the intervention could be a contextual factor that constrains the effectiveness of the intervention even if the program design and implementation fidelity is high.

### Ethical approval

Approval for the study was obtained from the Cambodian National Ethics Committee and the Emory University Ethics Review Board. Oral informed consent was sought before starting the research and subjects were assured of confidentiality. All subjects authorized future use of their data in published research. For all 56 subjects, participation was completely voluntary. Project staff were notified that completion of the surveys did not affect their employment or compensation. Data were kept anonymized at the point of transcription and translation and identification numbers were used for each subject. Recordings were deleted as soon as transcription was completed. The first author was responsible for the security of the identifiable data. Participants did not benefit from participating in the interviews because they could be in the program without participating in the study. Participation in the study was optional and did not affect the families' access to or participation in other community health and nutrition services as well. The project team shared preliminary results of the study with the community through a community meeting where participation was optional.



**FIGURE 2** Participant flow diagram for the process and endline evaluations. IDI, in-depth interview; KII, key informant interview; PDH, Positive Deviance/Hearth; PDH-IVC, Positive Deviance/Hearth-Interactive Voice Calling program; WVI, World Vision International; WVI-C, World Vision International—Cambodia.

### Sampling and data collection

Primary data collection involved semistructured IDIs of primary caregivers ( $n = 32$ ), KIIs with volunteers ( $n = 16$ ) and project staff ( $n = 3$ ), and an electronic survey with project staff ( $n = 5$ ). The participants for the caregiver IDIs were selected from a list of the PDH participant children. For the process evaluation, the primary caregivers of the top 6 children with the greatest improvement in weight-for-age  $z$  scores (WAZs) and the bottom 4 children with the lowest improvement in WAZs at the 3-mo follow-up were selected from the PDH and PDH-IVC intervention groups for an interview. During the final evaluation, the caregivers of the top 3 children with the greatest and the caregivers of the bottom 3 children with the lowest change in WAZs were selected from the intervention groups for an interview. Volunteers at the time of the process and final evaluations were randomly selected from each intervention group using a number generator. All WVI-C project staff ( $n = 3$ ) were interviewed during the process evaluation. In the final evaluation, the project staff ( $n = 5$ ) completed an electronic survey evaluation to minimize in-person interaction during COVID-19. One WVI-C project staff member's final evaluation survey was excluded because it was incomplete. Two additional WVI technical nutrition specialists' surveys were included in the final evaluation because they played a key role in the design of the project but were not included in the process evaluation because it was conducted too soon after the project started to evaluate the design (Figure 2).

The KIIs and IDI tools included neutrally worded, open-ended questions for caregivers and volunteers and electronic multiple-choice and open-ended questions for project staff on intervention design, implementation, and utilization to understand facilitators and barriers for each phase. For design, adherence to preparation for the Hearth sessions by project staff and volunteers was examined by interviewing

project staff and volunteers. For implementation, the establishment of Hearth sessions, training and supervision of implementers, knowledge of implementers, intervention delivery mode including Hearth sessions conducted and household follow-ups, and fidelity of intervention delivery were examined by interviewing project staff, volunteers, and program recipients. For utilization, improvement in knowledge, level of confidence (self-efficacy), and behavior change were examined by interviewing staff, volunteers, and program recipients. Table 1 shows the data collection methods used and the study population included to examine each of the steps in the PIP for the PDH-IVC intervention.

All of the qualitative data were collected by trained interviewers not involved in the project in the local language. The interviewers recorded, transcribed verbatim at the end of each day, and translated into English for analysis. Group feedback, led by the field supervisor, was organized at the end of each data collection day, and then the field supervisors briefed the Primary Investigator daily throughout the data collection period. The study coordinators and supervisors reviewed the transcripts against the recordings to check the completeness of the transcripts and deleted the recordings afterwards.

### Data analysis

Qualitative data transcripts in English from the process and endline evaluations were uploaded to NVivo version 12.0 (QSR International) and analyzed using a mixture of deductive and inductive coding techniques. The different steps in the PIP under intervention design, implementation, and utilization determined the deductive codes (Figure 1). Two authors identified inductive codes from reviewing 22 transcripts and then agreed on the final codebook. The final codebook was shared with 2 additional data analysis team members to code the

**TABLE 1** Methods to study the steps in the PIP of the PDH interactive voice calling intervention<sup>1</sup>

Steps in the PIP	Data collection method used	Study population
Intervention design		
Partnering with local authorities and community members	KII, survey	WV project staff
Situational analysis and Positive Deviance Inquiry data collected and analyzed	KII, survey KII	WV project staff Volunteers
Key Hearth messages and menus designed	KII, survey	WV project staff
Linkages to health and nutrition services established (Growth Monitoring and Promotion, deworming, vitamin A supplementation, immunization)	KII, survey	WV project staff
PDH volunteers identified and selected	KII	Volunteers
Intervention implementation	KII, survey	WV project staff
Hearth sessions established	KII	Volunteers
Volunteers received Hearth session training	KII, survey KII	WV project staff Volunteers
Volunteers received participant follow-up training	KII, survey KII	WV project staff Volunteers
Volunteers supervised and data monitored (tools)	KII, survey KII	WV project staff Volunteers
Hearth sessions conducted (in-person and/or mobile phones)	KII, survey KII IDI	WV project staff Volunteers Caregivers
Intervention utilization		
Participants received and understood key Hearth messages	KII, survey KII IDI	WV project staff Volunteers Caregivers
Follow-up of participants conducted (in-person and/or mobile phones)	KII, survey KII IDI	WV project staff Volunteers Caregivers
Improved participant confidence in child nutrition, hygiene, and caring practices	KII, survey KII IDI	WV project staff Volunteers Caregivers
Improved behaviors around child nutrition, hygiene, and caring practices	KII, survey KII IDI	WV project staff Volunteers Caregivers

<sup>1</sup>IDI, in-depth interview; KII, key informant interview; PDH, Positive Deviance/Hearth; PIP, program impact pathway; WV, World Vision.

electronic survey data and the process evaluation report. Facilitators, barriers, and contextual factors for each step of the PIP were identified based on the codes that emerged. The PDH Design and Implementation Quality Assurance Tool (DIQA) was used to assess program adherence.

## Results

### Sample characteristics

Table 2 presents the characteristics of the participants in the process and qualitative evaluations. Chi-square test for independence showed that the characteristics of participants were similar in both evaluations, except for age. There were significantly more respondents in the 35- to 44-y age group in the final evaluation.

### Evaluation results

The results are presented as facilitators, barriers, and contextual factors contributing to the 3 intervention phases: design, implementation, and utilization (Table 3).

### Design.

Analysis of the surveys, IDIs, KIIs, and DIQA results indicated that there was good adherence. Some of the facilitators for the high adherence included the involvement of nutrition advisors, use of design tools, and community mobilization.

*Nutrition advisors and design tools.* The data from the electronic surveys of project staff and IDIs with volunteers identified that involving nutrition advisors and using design tools, like the menu calculator, helped to simplify the technical steps of the design phase and enabled a thorough review of the formative research, development of the key hearth messages, and menu design, thus facilitating adherence to the essential elements of PDH:

It was important for a technical nutrition specialist to help support the situational analysis data analysis and to help identify the major challenges in the communities contributing to malnutrition. (Project staff, 35 y, electronic survey)

*Community mobilization.* All project staff expressed that it was important to invest in community mobilization:

**TABLE 2** Characteristics of participants in process and final evaluations<sup>1</sup>

	Process evaluation (n <sub>Total</sub> = 29)	Final evaluation (n <sub>Total</sub> = 27)	P value <sup>2</sup>
Sex			0.45
Male	3 (10%)	2 (8%)	
Female	26 (90%)	25 (92%)	
Age, y			0.02
25–34	11 (38%)	4 (15%)	
35–44	2 (7%)	11 (41%)	
45–54	11 (38%)	8 (29%)	
>54	5 (17%)	4 (15%)	
Area program			0.93
Samrong Tong	9 (31%)	8 (32%)	
Rolea Pha Ea	13 (45%)	12 (48%)	
Boribour	7 (24%)	5 (20%)	
Intervention group			0.47
PDH	17 (59%)	12 (50%)	
PDH-IVC	12 (41%)	13 (50%)	
Type of respondent			0.24
Mother	9 (31%)	8 (30%)	
Father	2 (7%)	N/A	
Grandmother	9 (31%)	4 (15%)	
Volunteer	6 (21%)	10 (37%)	
Project staff	3 (10%)	5 (18%) <sup>3</sup>	

<sup>1</sup>Values are n (%) of respondents unless otherwise indicated. IVC, interactive voice calling; N/A, not applicable; PDH, Positive Deviance/Hearth.

<sup>2</sup>P value for difference between process and final evaluations. Significant difference indicated by  $P < 0.05$ .

<sup>3</sup>Two additional female Global Technical Advisors between the ages of 35 and 44 y were interviewed and were not from a specific intervention group or area program.

During this study, intensive community mobilization to involve the community leaders, health facility staff, local authorities, and community members was necessary for a successful project. (Project staff, 35 y, electronic survey)

Project staff mentioned that community mobilization activities such as PDH orientations and feedback sessions, community involvement in volunteer selection, and linking participant children to basic Ministry of Health (MoH) health and nutrition services were particularly important facilitators. Interestingly, project staff and volunteers also mentioned that poor community mobilization resulted in poor acceptance of the program by both the community and MoH and that this would be a significant barrier for the next step of implementation:

If not all levels of stakeholders are involved, it can hinder the continuity of services and linkages to MoH's health and nutrition services and proper referrals and follow-ups of severely wasted children. (Project staff, 61 y, electronic survey)

Thus, in-depth community mobilization was critical during the design phase.

### Implementation.

The data from the electronic surveys, KIIs, and IDIs also illustrated that intervention implementation was influenced by facilitators and barriers (Table 3). A few key facilitators and barriers directly affecting PDH-IVC included the following.

*Volunteers retained knowledge and skills after training.* The final evaluation data indicated that 70% of volunteers could recite all 6 key Hearth messages and the ingredients for PDH menus. Volunteers mentioned the facilitators for this were the quarterly refresher trainings that included all the information needed for them to lead Hearth sessions, and counseling for conducting follow-up visits or phone calls.

*Follow-up monitoring, tools, and guide.* A caregiver of a PDH-IVC participant child mentioned:

The follow-up phone calls from PDH volunteer are helpful. (Female volunteer, 53 y, KII)

Volunteers expressed that follow-up monitoring tools like the Household Observation Checklist were helpful to guide their follow-up sessions, which was a facilitator for program implementation. However, all the volunteers said they did not have a guide for follow-up phone calls, which was a barrier, and that they would have liked one in addition to the Household Observation Checklist:

No, I did not have [a guide for the follow-up phone calls]. It would have been helpful to have one. (Male volunteer, 34 y, KII)

*Supervision, spot checks, and coaching.* Supervision of volunteers was conducted by checking the monthly phone bills for the call duration and to whom the calls were made. Also, spot checks were done with the caregivers and volunteers. With the caregivers, project staff called random caregivers to ask when was the last time they spoke with the volunteer, how long they spoke for, and what were the key messages the volunteer shared with them. With the volunteers, to ensure quality phone calls were being made, 1 WV project staff member said:

I [project staff] asked the volunteer to call to educate mothers/caregivers while I am nearby and listen to him/her call, after that, I would correct and provide feedback from one step to one step. (Project staff, 34 y, electronic survey)

Such coaching and feedback sessions were conducted regularly at the beginning of the program implementation, which was a key facilitator. All project staff and volunteers mentioned during the final evaluation that monthly or bimonthly volunteer feedback meetings and checking monitoring data for nutritional status of children were invaluable to identify changes needed in the program and to immediately make adjustments during implementation, such as making changes to the menu to consider the seasonality of foods available and improving the delivery mode of the key Hearth messages to make it more interactive for caregivers:

Follow-up feedback sessions with volunteers were held quarterly and data was monitored and analyzed to see how the sessions and follow-ups could be improved regularly. This was important because we improved the menus, addressed high levels of food insecurity during lean seasons with coping mechanisms... improved the Hearth messages and the delivery modes of the messages... to ensure the Hearth sessions and follow-ups were closely aligned to high program fidelity. (Project staff, 35 y, electronic survey)

*Lack of time and work overload.* A significant barrier expressed by all volunteers and caregivers was the lack of time and resources for both,

**TABLE 3** Key facilitators and barriers identified in the PIP phases<sup>1</sup>

PIP phases	Facilitators	Barriers
Design	<ul style="list-style-type: none"> <li>• <i>Quality training</i> using WV PDH Training Manual for Facilitators and Volunteers</li> <li>• <i>Trained staff</i></li> <li>• <i>Immediate implementation</i> after trainings</li> <li>• <i>Technical support</i> for formative research analysis, design of messages and menu</li> <li>• Tools developed to simplify technical steps of PDH (menu calculator)</li> <li>• <i>Community mobilization</i> (community members, health facility staff, district health staff) <ul style="list-style-type: none"> <li>◦ Community involved in volunteer selection</li> <li>◦ Community feedback sessions (results of formative research shared and key messages shared to be promoted with the entire community)</li> </ul> </li> <li>• <i>PDH program linkage with health and nutrition services</i> (partner with MoH to provide vitamin A, deworming, and immunization for PDH participant children)</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Poor community mobilization</i> results in poor acceptance of the program by the community and MoH</li> </ul>
Implementation	<ul style="list-style-type: none"> <li>• <i>Volunteers retain knowledge and skills</i> after training</li> <li>• <i>Quarterly volunteer refresher trainings</i></li> <li>• Improved recognition and valued role of volunteers</li> <li>• <i>Strong volunteer support</i> inspires families to change behaviors</li> <li>• <i>Regular Growth Monitoring and Promotion</i> sessions identify PDH participant children easily</li> <li>• <i>Monitoring tools</i> to simplify volunteer work (during Hearth and household follow-up) <ul style="list-style-type: none"> <li>◦ Paper-based</li> <li>◦ Guides for phone calls</li> </ul> </li> <li>• <i>Supervision tools and spot checks</i> (ensure calls made and quality of phone calls)</li> <li>• <i>Coordination</i> between volunteers and caregivers agreeing on time and place for Hearth sessions</li> <li>• <i>Volunteer feedback meetings and monitoring data check</i> (monthly): helps to identify changes needed in the program and to immediately make changes during implementation (menus, alter messages during the food-insecure period, and improve the delivery mode of messages)</li> <li>• <i>Using phones</i> helps save time and travel costs and gives one-on-one counseling time during Hearth for both volunteers and caregivers</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Work burden of caregivers</i></li> <li>• <i>Elderly volunteers</i> had a hard time absorbing new skills and translating those skills to community</li> <li>• <i>Poor linkages with Health and Nutrition services</i> (poor deworming, vitamin A, and vaccination coverage)</li> <li>• <i>Poor supervision and guidance for volunteers</i></li> <li>• <i>Lack of time</i> of caregivers resulting in poor attendance of caregivers</li> <li>• <i>Volunteer time constraint</i> and <i>financial burden</i></li> </ul>
Utilization	<ul style="list-style-type: none"> <li>• <i>Family support</i> in household chores and/or childcare responsibilities</li> <li>• <i>Volunteer support</i></li> <li>• <i>Phone calls</i> are flexible, save time and cost for both volunteers and caregivers, and still personal enough (attendance higher in the PDH-IVC group)</li> <li>• Caregivers seeing weight gain and other positive changes in their children</li> <li>• <i>Access to mobile phones</i></li> <li>• <i>Regular access to the phone network</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lack of support</i></li> <li>• <i>Lack of time</i> of caregivers and volunteers</li> <li>• <i>Lack of financial resources</i></li> <li>• <i>Primary caregiver</i> (grandmothers') <i>low level of education</i></li> <li>• <i>The old age of caregivers</i></li> <li>• <i>Work burden of elderly caregivers</i></li> <li>• <i>Elderly caregivers' inconsistent phone use</i></li> <li>• <i>phone network poor</i> in some areas</li> <li>• <i>Volunteers cannot observe children</i> when only relying on phone calls</li> </ul>

<sup>1</sup> MoH, Ministry of Health; PDH, Positive Deviance/Hearth; PDH-IVC, Positive Deviance/Hearth-Interactive Voice Calling program; PIP, program impact pathway; WV, World Vision.

which would affect volunteer work burden and caregivers' attendance at Hearth sessions:

Some caregivers come late and sometimes leave early, because they are busy with housework, washing cloth[es], and no one else cares for the home. (Female volunteer, 50 y, KII)

During home visit, caregiver do not have much time to discuss with me, at the same time, she does her housework and talk. (Female volunteer, 50 y, KII)

I [grandmother] have to prepare food cooking by using ingredients learned from Hearth session only one time per week, because, I have no much money and am busy with my small business. (Grandmother, 57 y, IDI)

Volunteers also felt time constraints and financial burdens:

Underweight children are far from my house. It takes much time for home visit and money is expensive for gasoline. (Female volunteer, 57 y, KII)

Volunteers mentioned using phones helped save time. Phone logs of volunteers indicated, and caregivers verified during interviews, that calls would average ~15 min for Hearth Days and ~7 min for Hearth Follow-up Days, but in-person sessions would take ~2 h and ~1 h, respectively. Volunteers mentioned that calling took less time, was less burdensome, and freed up one-on-one counseling time during Hearth sessions for both volunteers and caregivers:

I spent about 10–15 minutes on phone calls for each household and for face-to-face home visits, it took around 1 hour. (Female volunteer, 57 y, KII)

Phone call is easy, I do not spend much time, I am not too tired. (Female volunteer, 50 y, KII)

Phone calls allow them to have one-on-one sessions with the volunteers. That one-on-one time is difficult to get during Hearth sessions because there are many caregivers and children and it could get hectic. So they [caregivers] mentioned that they liked the private conversations over the phone which allowed them to be open and ask difficult or embarrassing questions they would otherwise not be able to ask during a group session. (Project staff, 35 y, electronic survey)

Caregivers prefer the Hearth session phone call because they have time to do housework. I prefer using a phone call to follow-up, it is easy, the caregiver gets the information faster. (Female volunteer, 50 y, KII)

Overall, volunteers expressed that they preferred to use a combination of mobile phone calls and in-person visits, rather than mobile phone calls alone. This allowed the volunteers to physically see children eating, gaining weight, or improving in their clingy behaviors, which could not be well understood if only relying on providing support over the phone:

Hearth session face-to-face is still important because... you can see how much a child eats, the child is happy, and caregivers can exchange their knowledge and practice at home. Hearth session face-to-face help caregivers to understand on how to cook and remember the key message of Hearth session. (Female volunteer, 57 y, KII)

Just using mobile phone calls without face-to-face Hearth sessions, caregivers could change their behavior on feeding and

child care, but it is not fully effective like [face-to-face] Hearth session. (Female volunteer, 57 y, KII)

I preferred to receive phone calls for Hearth session. It saves time as we can do housework and talk to a volunteer at the same time. Even if I am not at home or in the village, I still get counseling from a volunteer. (Mother, 35 y, IDI)

*Poor phone network.* Volunteers and caregivers mentioned that the poor phone network connection in some areas was another barrier:

It is not easy for this area; sometimes, phone service is poor. (Female volunteer, 57 y, KII)

### **Utilization.**

The utilization of the intervention in improving caregivers' knowledge, level of confidence, and behavior change to improve the nutritional status of children was also influenced by multiple facilitators and barriers (Table 3).

*Family and volunteer support.* Among the children with the greatest improvement in WAZ, a common facilitator for caregivers was familial support with household chores and/or childcare responsibilities, allowing participation in Hearth sessions, improved behavior change, and increased confidence in caregivers in child-feeding and caring practices:

In my family, we support each other even my husband he helps to cook so I don't have any challenges [in changing my behaviors learned during Hearth sessions]. (Mother, 35 y, IDI)

Project staff mentioned that they believed mobile phone calls from volunteers without face-to-face Hearth sessions would not have as great an impact on behavior change:

I think Caregivers still need some face to face interactions [rather than using mobile phones alone]. It may not be as much as what is currently in place for PDH, but I think for behavior change to take place, caregivers need to have a relationship with other caregivers and the volunteer and that is best achieved by meeting face to face a few times. The phone calls would have to be individualized and couldn't be just a robot calling, but truly interactive where the caregiver and the volunteer are discussing and brainstorming together what are their challenges to behavior change and possible solutions. (Project staff, 38 y, electronic survey)

Several caregivers mentioned that they liked the combination of face-to-face and mobile phone calls because it saves them travel time. The face-to-face interaction at the beginning of Hearth sessions helps to build the trust and relationship with the volunteers, but the phone calls allow them to have one-on-one sessions with the volunteers. That one-on-one time is difficult to get during Hearth sessions... (Project staff, 35 y, electronic survey)

*Inconsistent use of phones.* The volunteers also expressed inconsistent use of phones by caregivers was a barrier. Volunteers would have difficulty reaching grandmothers over the phone because they were unused to carrying phones with them:

Using the mobile phone to call to caregivers is not easy for this area. Some caregivers have gone to the rice field and keep the phone at home. (Female volunteer, 57 y, KII)



### Contextual factors.

There were several contextual factors for peri-urban Cambodia that influenced the intervention implementation and utilization and limited caregivers from changing their behaviors to improve children's nutritional status. One contextual factor that continually emerged included the migration of mothers for work and the primary caregiver's responsibilities falling on grandmothers. One caregiver mentioned:

I am [a grandmother who] is busy with housework, I take care of other grandchildren, and sometimes I go to the rice field. For the mother, she goes to work at the factory from Monday to Saturday. (Grandmother, 53 y, IDI)

Many times, these grandmothers were older and overworked, had a low level of education, experienced high levels of prolonged food insecurity, and lacked the support, time, and financial resources to care for multiple grandchildren and aging husbands:

Everyday, I take care of 3 grandchildren. (Grandmother, age unknown, IDI)

I am old and taking care of 2 grandsons, and I'm so tired to cook the nutritious food for the baby. I feel overwhelmed when I feed my grandchild as I need to use active feeding; if I don't do it my grandchild will not eat. Sometimes, I call for my husband to help as I was so tired, but he is old too. (Grandmother, age unknown, IDI)

Volunteers also expressed that due to a lack of time, mental capacity, the burden of caring for multiple children simultaneously, and low energy, elderly caregivers had difficulty absorbing the messages during Hearth sessions and attending the whole Hearth session, making the Hearth meals at home and practicing the food preservation techniques, and growing home gardens:

Sometimes, some caregivers are not remembering the six key messages because most of the caregivers are old and take care of a lot of grandchildren. During Hearth session, grandma cannot concentrate well on the key messages. (Female volunteer, 57 y, KII)

The first challenge is the mother is working and leave their child with a caregiver who is old when we provide health education, elders seem to have difficulty in absorbing the messages. (Project staff, 34 y, survey)

Time constraint is another barrier as grandma or working mothers usually complain about not having enough time to prepare proper food for their children. (Project staff, 60 y, survey)

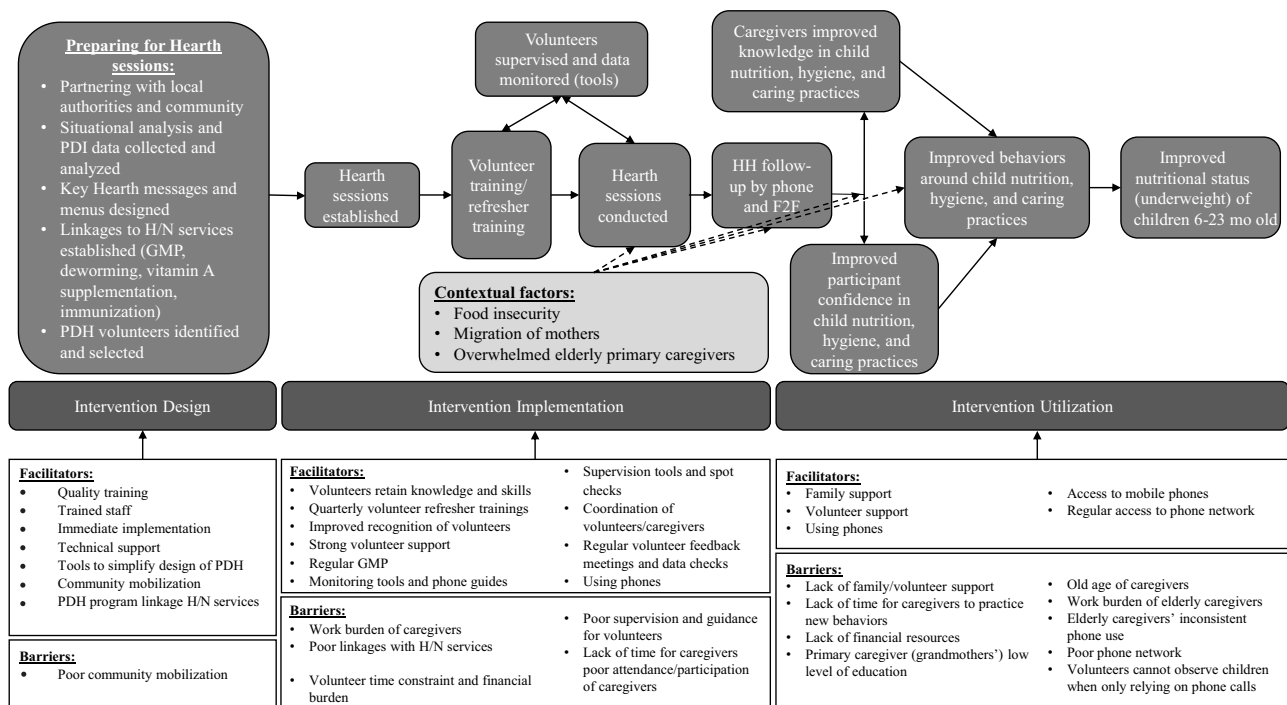
## Discussion

Le Port et al. (21) stated, "PIP analysis can help identify successes and bottlenecks or constraints to effective implementation that may affect the impact on key outcomes." A strength of our analysis is that it builds on the quantitative results to further understand the primary outcomes (20). Our study used a PIP analysis to identify the facilitators, barriers, and contextual factors along the PIP pathway of the PDH-IVC intervention in Cambodia that could have influenced the nutrition outcomes from the impact evaluation that was conducted in the first year (20). The PIP analysis also helped to identify ways in which other similar programs could be strengthened in design and implementation to

maximize the nutritional outcomes and impact. To our knowledge, this study is the first to apply a PIP analysis to a PDH program with an IVC component.

Within the PIP pathway, the study identified the key facilitators to be quality training with immediate implementation afterward, nutrition advisor support and tools to simplify menu design, community mobilization and linkage to existing health and nutrition services, volunteers retaining knowledge and skills after training, follow-up tools and guides, supervision and spot checks of volunteers, family support, and availability of resources (Figure 3). The PIP analysis also identified barriers along the pathway that may have contributed to less than optimal nutritional outcomes, including lack of time and overworked volunteers and caregivers, poor phone network, lack of resources, low level of education and old age of primary caregivers, and inconsistent phone use among grandmothers (Figure 3). Some of our project staff and volunteers reported that certain factors like community mobilization were facilitators, but others said those factors could also become barriers if not given sufficient attention. Thus, these factors should be given particular attention as powerful influencers of program implementation. Many of the facilitators and barriers, such as family support and lack of time for caregivers, align with the findings from another PIP analysis which sought to identify critical steps in the implementation and utilization of a behavior change communication intervention promoting infant and child feeding practices in Bangladesh (19).

Our study was also able to identify contextual factors that influenced intervention utilization along the PIP (Figure 3). In the peri-urban Cambodian context of this study, at the household level, it was clear that contextual factors including food insecurity, frequent migration of mothers to work in garment factories, and the primary caregiver role being left to grandmothers highly limited the behavior change of caregivers. In 2019, the International Organization for Migration reported that the prevalence of depression and anxiety for caregivers in Cambodian migrant households was 45% and 53%, respectively, significantly higher than among caregivers in nonmigrant households (9). They also reported that older age (>60 y of age) could be a risk factor for poor mental health (9). Their study also found that primary caregivers still showed symptoms of distress stemming from trauma experienced during the Khmer Rouge regime, with elderly caregivers having a higher level of distress than younger caregivers (9). Although little research has been published on the association between grandmothers' mental health and grandchildren's growth and development, there is evidence that the mental health of mothers influences the growth and development of children (22). This impact is likely to be similar regardless of whether the grandmother or the mother is the primary caregiver (23). Our study did not evaluate the mental health of program recipients. However, the contextual factors that surfaced during the IDIs and KIIs with caregivers and volunteers hinted there was a mental health component because the grandmothers shared that they felt overwhelmed and overworked with limited energy, caring for multiple grandchildren. Additional supporting interventions addressing elderly caregivers' mental health and their lack of time and resources should be included in the overall program to have the greatest impact. Given that such contextual factors can restrict program utilization, it is likely that without additional complementary interventions there will be limited improvements in nutrition outcomes, even with good program design and intervention fidelity. These contextual factors may have contributed to the modest



**FIGURE 3** Facilitators, barriers, and contextual factors identified for the design, implementation, and utilization phases within the PDH-IVC program's program impact pathway. F2F, face-to-face; GMP, Growth Monitoring and Promotion; HH, household; H/N, Health and Nutrition; IVC, interactive voice calling; PDH, Positive Deviance/Hearth; PDI, Positive Deviant Inquiry.

improvements in child nutritional status at the 12-mo follow-up (20). Our findings align with another study by Schneiders et al. (24), which observed that, in migrant households, grandparents are the primary caregivers for children and tend to their nutritional needs. The study also highlighted that to improve child nutrition, interventions need to be designed in ways to support and enable grandparent caregivers in Cambodia.

Volunteers expressed that having the first few initial in-person Hearth sessions helped with behavior change because it helped to develop a relationship and trust with the program recipients before providing messages through phone calls. The volunteers and caregivers said they preferred having the option of using a mixture of in-person and IVC sessions and follow-up. Volunteers mentioned that they would have to make multiple household visits if caregivers were not home, but with phone calls, they could call again during a different time of day if program recipients did not answer the first time, which was time-saving. Several caregivers also mentioned that they appreciated phone calls because they could attend to other chores and work while on the phone and the one-on-one time with volunteers was valuable to ask questions difficult to ask in group settings. Project staff expressed that key factors to consider when implementing IVC included the following: ensuring volunteers are given proper training and coaching focused on how to communicate the messages and provide counseling clearly over the phone, providing checklists and guides when sharing key messages and counseling program recipients, closely supervising and conducting feedback sessions with volunteers, and making spot checks with program recipients.

Although prior SMS-based behavior change interventions have reported high levels of satisfaction, their overall effectiveness is highly dependent on users' literacy level, age, educational status, and frequency of mobile phone use (25, 26). However, IVC messages may be more appropriate than SMS-based approaches among low-income and primarily illiterate populations. Studies in addition to our own provide evidence that receiving and listening to tailored IVC messages are associated with significant improvements in maternal knowledge and infant care and feeding practices (27, 28). Our study also found volunteers and caregivers preferred the blended approach of IVC and in-person sessions because phone calls were flexible, more accessible, and time-saving compared with in-person sessions, and there was still sufficient personal connection when talking over the phone. IVC may be an effective strategy that can be quickly scaled up because most people in peri-urban populations use simple mobile phones daily. Also, it does not require the complex skills needed for picture messaging, use of smartphones or tablet applications, ensures the right person receives the information, and it does not require high literacy levels or the availability of local scripts on phones, which another study in Cambodia found was a barrier (29).

Our study has some limitations. First, we had a limitation in utilization and uptake of behavior change because the contextual factor of elderly caregivers' mental health was not identified during the formative research step in the design process. Thus, the study did not include additional complementary interventions to address the resource, time, and health constraints caregivers faced. Second, the final qualitative evaluation had to be conducted in the context of COVID-19 so

a survey had to be used with program staff and IDIs and KIIs done with masks and social distancing, making it difficult to build rapport with interviewees and interpret body language. Thirdly, the PIP analysis does not allow for causal inference. However, it helps to map and measure the different elements of a program to assess implementation fidelity and utilization of the interventions by beneficiaries, as it did in our study (17). Moreover, the PIP also aided in identifying and testing key assumptions and exploring critical linkages between design, implementation, utilization, and contextual factors (17). Fourthly, there is potential for response bias for each category of respondent. The caregivers, volunteers, and project staff could have amplified the benefits of the PDH-IVC compared with the traditional PDH program because it is an innovative program using technology. However, measures were taken to minimize response bias such as standardizing the interviews as much as possible by training the interviewers to use neutral wording for interviews and surveys; keeping questions open-ended; probing for both positive aspects and areas of improvement for the program; using facilitators for the KIIs, IDIs, and surveys who were not involved in the project; assuring all participants of confidentiality; and ensuring project staff surveys were kept anonymous and not contingent on their employment. Response bias could have been a limitation, but the study was able to get a variety of responses for both positive aspects and areas of improvement for the program from each category of respondents.

In conclusion, the study's findings highlight various facilitators and barriers that need to be given special attention during the design and implementation phases of PDH and PDH-IVC. The mental health, time, and resource constraints of elderly caregivers should also be addressed for a context like Cambodia when implementing child-focused health and nutrition programs. We highly recommend for future PDH and PDH-IVC programs to thoroughly understand contextual factors including family dynamics in the design phase because it can influence the targeting and identify necessary program adaptations or additional complementary interventions for optimal results. Also, IVC is a new, innovative approach using mobile technology that may be effective in providing targeted health, nutrition, and hygiene messaging and counseling to replace the majority of in-person visits to save time and reduce the workload of frontline workers. IVC may especially be useful when a quick scale-up approach is needed to continue to provide health and nutrition services during times like a pandemic when social distancing is needed in peri-urban contexts of low- and middle-income countries. We recommend further research be done to determine if video calling or other innovative approaches using mobile phones effectively provide public health messages and counseling, contributing toward behavior changes for remote areas.

### Acknowledgments

We thank World Vision International—Cambodia staff (Mut Singa, Khim Sonea, Ros Chanty, Sopheap Ouk, Vannary Hun, Bunsor Khou, David Raminashvili, Sreyneang Teu, Uk Usa, and Grana Selvi), World Vision Taiwan staff (Holly Ya-Fan Chung), World Vision International staff (Sarah Bauler, Bridget Aidam), Emory University Rollins School of Public Health students (Lucas Gosdin, Paige Rogers, and Larelle Bookhart), and National Institute of Public Health Staff (Invong Wudhika) for their assistance in logistics, project support, implementing, and/or evaluating this project. The authors' responsibilities were as

follows—DB, KR, CC, MFY, and HH: were involved in the study design; HH, DB, and KR: provided oversight for implementation; DB and KR: wrote the manuscript; MFY: provided significant feedback and comments; DB: had primary responsibility for the final content; and all authors: supported data collection and analysis and read and approved the final manuscript.

### Data Availability

Data described in the article, questionnaires, analysis, final qualitative evaluation, and code book and data collection tools from the process will be made publicly and freely available without restriction at <https://doi.org/10.6084/m9.figshare.13524170.v1>.

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