Title: Program Impact Pathway of the Positive Deviance/Hearth Interactive Voice Calling Program in a Peri-Urban Context of Cambodia[1,2,3,4]

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[2] Abbreviations used: Area Program (AP), Coronavirus Disease 2019 (COVID-19), Design and Implementation Quality Assurance Tool (DIQA), F2F (Face-to-face), Growth Monitoring and Promotion (GMP), Health and Nutrition (H/N), Household (HH), In-Depth Interviews (IDI), International Organization for Migration (IOM), Interactive Voice Calling (IVC), Infant Young Child Feeding (IYCF), Key Informant Interview (KII), Ministry of Health (MoH), National Institute of Public Health (NIPH), Positive Deviance/Hearth (PDH), Positive Deviant Inquiry (PDI), Positive Deviance/Hearth-Interactive Voice Calling program (PDH-IVC), Primary Investigator (PI), Program Impact Pathway (PIP), Village Health Support Group (VHSG), Weight-for-age z-score (WAZ), World Vision (WV), World Vision International (WVI), World Vision International – Cambodia (WVI-C)

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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 from differences in program design, implementation, utilization, or other contextual factors. Furthermore, few PDH programs have addressed the high time- and work-burden of caregivers and volunteers. To address this, the study integrated interactive voice calls (IVC) with PDH.

OBJECTIVES: A program impact pathway (PIP) analysis was used to evaluate the secondary outcomes of facilitators, barriers, and contextual factors that influence PDH-IVC design, implementation, and utilization to improve the nutritional status of children in Cambodia.

METHODS: The study was registered at clinicaltrials.gov[NCT03399058]. 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 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 while 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 on grandmothers due to migration of mothers.

CONCLUSIONS: The PIP analysis identified facilitators, barriers, and contextual factors that may affect the design, intervention, and utilization and elements to consider when designing and implementing IVC interventions for health and nutrition behavior change. When implementing child nutrition programs in Cambodia, supporting interventions addressing mental health and time and resource constraints of elderly caregivers should also be included.

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

Teaser Text: *Interactive voice calling by frontline workers is an innovative approach to replace the majority of in-person health and nutrition counseling and messaging, reducing time and work burden.*

INTRODUCTION

Background and Context

Globally 45% of deaths among children younger than five years 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 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

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 are fed 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 about 140% (7). Women comprise about half of all migrants, the majority of whom go to Phnom Penh to work as factory workers, and are mainly between the ages of 17-35 years (7), the prime child-bearing and caring ages for women. While 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). While Cambodia has one of the highest rates of exclusive breastfeeding in the Southeast Asian region at 79.9% among babies 0-1 month of age, by the time a child is 4-5 months of age, only 50.9% are exclusively breastfed partly due to mothers returning to work after a child is three months (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 compared to caregivers in non-migrant households (9). The report also indicated that caregivers over the age of 60 have significantly poorer general mental health compared to caregivers less than 60 years 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 over 30 years ago that in every community, there are certain individuals whose unique behaviors or strategies result in better nutritional outcomes compared to peers who live in similar socio-economic 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 grey literature evaluations showed positive results from the PDH approach in specific settings, though 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, to implement and participate in PDH programs (12,13).

To increase scalability and reduce volunteer and caregiver work and time burden in PDH programming, WVI-C integrated interactive voice calls (IVC) with PDH programming. While 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 relationships 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 paper is to use a PIP to identify the secondary outcomes of facilitators and barriers that influence 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 was conducted in three districts located in the Kampong Chnang and Kampong Speu Provinces of Cambodia. The study's overall purpose was to evaluate the impact of two modes for delivering a World Vision IYCF counseling program to reduce the prevalence of malnutrition in children 6-23 months. These two modes were: 1) traditional PDH program with in-person home visits or 2) PDH-IVC program 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, height-for-age z-

scores) in both groups were compared to 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 (NIPH). Three Area Programs (APs), Boribour, Rolea Pha Ea, Samrong Tong, were purposively selected due to similar socio-demographic and health characteristics.

WVI-C used 107 Village Health Support Group (VHSG) members as frontline workers (hereafter referred to as volunteers) and four WV project staff overseeing the volunteers, including one project manager and three project coordinators to implement the program for the study over two years. Data was collected using both qualitative and quantitative methods. A process evaluation was conducted in April 2018, four months 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 overall study design and methodological approach. In summary, compared to the control group, the traditional PDH and PDH-IVC group had a significant improvement in child nutrition after 3 months with some evidence of sustained impact in only the PDH-IVC group after 12 months. 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).

Program Impact Pathway

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 months in the community); World Vision's PDH documents,[5] including the PDH essential elements; the process evaluation, 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 three phases: intervention design, implementation, and utilization (**Figure 1**). The PIP guided the development of the data collection tools for the IDIs with caregivers, 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 paper.

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 both be facilitators or 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

[5] World Vision's PDH Project Model document with theory of change

156 factor that constrains the effectiveness of the intervention even if the program design and
157 implementation fidelity is high.

158 *Ethical Approval*

159 Approval for the study was obtained from the Cambodian National Ethics Committee and
160 the University of Emory Ethics Board. Oral informed consent was sought before starting the
161 research and subjects were assured of confidentiality. All subjects authorized future use of their
162 data in published research. For all 56 subjects, participation was completely voluntary. Project
163 staff were notified that completion of the surveys did not affect their employment or
164 compensation. Data was kept anonymized at the point of transcription and translation and
165 identification numbers were used for each subject. Recordings were deleted as soon as
166 transcription was completed. The first author was responsible for the security of the identifiable
167 data. Participants did not benefit from participating in the interviews because they could be in the
168 program without participating in the study. Participation in the study was optional and did not
169 impact the families' access or participation in other community health and nutrition services as
170 well. The project team shared preliminary results of the study with the community through a
171 community meeting where participation was optional. The study was registered at
172 clinicaltrials.gov as NCT03399058.

173 *Sampling and Data Collection*

174 Primary data collection involved semi-structured in-depth interviews (IDIs) of primary
175 caregivers (n=32), key informant interviews (KIIs) with volunteers (n=16) and project staff
176 (n=3), and electronic survey with project staff (n=5). The participants for the Caregiver IDIs
177 were selected from a list of the PDH participant children. For the process evaluation, the primary
178 caregivers of the top six children with the greatest improvement in weight-for-age z-scores

(WAZ) and the bottom four children with the lowest improvement in WAZ at three months follow-up were selected from the PDH and PDH-IVC intervention groups for an interview. During the final evaluation, the caregivers of the top three children with the greatest and the caregivers of the bottom three children with the lowest change in WAZ and were selected from intervention groups for an interview. Volunteers at the time of the process and final evaluation from each intervention group were randomly selected 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's final evaluation survey was excluded because it was incomplete. Two additional WVI nutrition technical 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, the adherence to preparation for the Hearth sessions by project staff and volunteers were 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 was 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 (PI) daily throughout the data collection period. The study coordinators and supervisors reviewed the transcripts against the recording to check the completeness of the transcripts and deleted the recordings afterwards.

Data Analysis

Qualitative data transcripts in English from the process and endline evaluation were uploaded to NVivo Version 12.0 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 two additional data analysis team members to code the 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. A design and implementation quality assurance tool[6] (DIQA) for PDH was used to assess program adherence.

RESULTS

Sample Characteristics

[6] PDH Design and Implementation Quality Assurance Tool

Table 2 presents the characteristics of the participants in the process and qualitative evaluation. 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 35-44 age group in the final evaluation.

Evaluation Results

The results are presented as facilitators, barriers, and contextual factors contributing to the three 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 years, electronic survey)

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

"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 years, electronic survey)

Project staff mentioned that community mobilization activities such as PDH orientations and feedback sessions, community involvement in the 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 years, electronic survey)

Thus, in-depth community mobilization is 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 include the following:

Volunteers retain knowledge and skills after training. The final evaluation data indicates that 70% of volunteers could recite all six key Hearth messages and the ingredients for PDH menus. Volunteers mentioned the facilitator 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 years, 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 years, 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 the last time was 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, one 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 years, 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 bi-monthly volunteer feedback meetings and checking monitoring data for nutritional status of children was 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 years, 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 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 years, 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 years, 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 years, IDI)

Volunteers also felt time constraint and financial burden:

"Underweight children are far from my house. It takes much time for home visit and money is expensive for gasoline."

(Female Volunteer, 57 years, KII)

Volunteers mentioned using phones helped save time. Phone logs of volunteers and caregivers verified during interviews that calls would average approximately 15 minutes for Hearth Days and 7 minutes for Hearth Follow-up Days, but in-person sessions would take approximately 2 hours and 1 hour, respectively. Volunteers mentioned that calling takes less time and is less

burdensome and gives 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 years, KII)

"Phone call is easy, I do not spend much time, I am not too tired."

(Female Volunteer, 50 years, 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 years, 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 years, KII)

Overall, volunteers expressed that they prefer 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:

346 "Hearth session face-to-face is still important because…you can see how much a child
347 eats, the child is happy, and caregivers can exchange their knowledge and practice at home.
348 Hearth session face-to-face help caregivers to understand on how to cook and remember the key
349 message of Hearth session".

350 (Female Volunteer, 57 years, KII)

351 "Just using mobile phone calls without face-to-face Hearth sessions, caregivers could
352 change their behavior on feeding and child care, but it is not fully effective like [face-to-face]
353 Hearth session."

354 (Female Volunteer, 57 years, KII)

355 "I preferred to receive phone calls for Hearth session. It saves time as we can do
356 housework and talk to a volunteer at the same time. Even if I am not at home or in the village, I
357 still get counseling from a volunteer."

358 (Mother, 35 years, IDI)

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

361 "It is not easy for this area; sometimes, phone service is poor."

362 (Female Volunteer, 57 years, KII)

363 **Utilization**

364 The utilization of the intervention in improving caregivers' knowledge, level of
365 confidence, and behavior change to improve the nutritional status of children was also influenced
366 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 years, IDI)

Project staff mentioned that they believe mobile phones calls from volunteers without face-to-face Hearth sessions would not have as great of an impact in 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 years, 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 years, 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 are unfamiliar with 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 years, KII)

Contextual Factors

There are 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 years, IDI)

Many times, these grandmothers are older and overworked, have a low level of education, experiencing high levels of prolonged food insecurity and lack 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, 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 years, 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 years, 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 years, survey)

DISCUSSION

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 program 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 also 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 influence 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, International Organization for Migration reported that the prevalence of depression and anxiety for caregivers in Cambodian migrant households was 45 percent and 53 percent, respectively, significantly higher than among caregivers in non-migrant households (9). They also reported that older age (>60 years of age) could be a risk factor for poor mental health (9). Their study also found that primary caregivers still showed the symptoms of distress stemming from post-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 if it is the grandmother or the mother as 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 reveal that interviews with caregivers and volunteers hint there is a mental health component as the grandmothers share that they feel overwhelmed and over worked 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 improvements in child nutritional status at 12-month follow-up (20). Our findings align with another study by Schneiders et al. (24), which observed in migrant households, grandparents are the primary caregiver 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 helps to develop a relationship and trust with the program recipients before providing messages through phone calls. The volunteers and caregivers said they prefer 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 do not answer the first time, which is 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 include: 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

498 and conducting feedback sessions with volunteers, and making spot checks with program
499 recipients.

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

514 Our study has some limitations. First, we had a limitation in utilization and uptake of
515 behavior change because the contextual factor of elderly caregivers' mental health was not
516 identified during the formative research step in the design process. Thus, the study did not
517 include additional complementary interventions to address the resource, time, and health
518 constraints caregivers faced. Second, the final qualitative evaluation had to be conducted in the
519 context of COVID-19 so a survey had to be used with program staff and IDIs and KIIs done with
520 masks and social distancing, making it difficult to build rapport with interviewees and interpret

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

537 **CONCLUSION**

538 The study's findings highlight various facilitators and barriers that need to be given
539 special attention during the design and implementation phases of PDH and PDH-IVC. The
540 mental health, time, and resource constraints of elderly caregivers should also be addressed for a
541 context like Cambodia when implementing child-focused health and nutrition programs. We
542 highly recommend for future PDH and PDH-IVC programs to thoroughly understand contextual
543 factors including family dynamics in the design phase as 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 to 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.

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Authorship

The authors' responsibilities were as follows— DB, KR, CC, MFY, and HH: were involved in the study design; DB, KR, CC, MFY, SO, and HH: supported data collection and analysis; HH,

DB, and KR: provided oversight for implementation; DB and KR: wrote the manuscript; MFY: provided significant feedback and comments and DB: had primary responsibility for final content. All authors read and approved the final manuscript.

Data Sharing

Data described in the manuscript, questionnaires, analysis, and code book, will be made publicly and freely available without restriction at https://doi.org/10.6084/m9.figshare.13524170.v1

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List of Figures

Table 1. Methods to Study the Steps in the PIP of the PDH-IVC Intervention

Steps in the Program Impact Pathway	Data Collection Method Used	Study Population
Intervention Design		
Partnering with local authorities & community members	KII, Survey	WV project staff
Situational analysis and Positive Deviance Inquiry data collected & analyzed	KII, Survey	WV project staff
	KII	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
	KII	Volunteers
PDH Volunteers identified & selected	KII, Survey	WV project staff
Intervention Implementation		
Hearth sessions established	KII, Survey	WV project staff
	KII	Volunteers
Volunteers received Hearth session training	KII, Survey	WV project staff
	KII	Volunteers
Volunteers received participant follow-up training	KII, Survey	WV project staff
	KII	Volunteers
Volunteers supervised & Data Monitored (tools)	KII, Survey	WV project staff
	KII	Volunteers
Hearth sessions conducted (in-person and/or mobile phones)	KII, Survey	WV project staff
	KII	Volunteers
	IDI	Caregivers
Intervention Utilization		
Participants received & understood key Hearth messages	KII, Survey	WV project staff
	KII	Volunteers
	IDI	Caregivers
Follow-up of participants conducted (in-person and/or mobile phones)	KII, Survey	WV project staff
	KII	Volunteers
	IDI	Caregivers
Improved participant confidence in child nutrition, hygiene, & caring practices	KII, Survey	WV project staff
	KII	Volunteers
	IDI	Caregivers
Improved behaviors around child nutrition, hygiene, & caring practices	KII, Survey	WV project staff
	KII	Volunteers
	IDI	Caregivers

Abbreviations: *IDI – In-depth interview; IVC – Interactive Voice Calling; KII – Key informant interview; PDH – Positive Deviance/Hearth; PIP – Program Impact Pathway; WV – World Vision*

Table 2. Characteristics of Participants in Process and Final Evaluation

	Process Evaluation (n_{Total}=29)	**Final Evaluation** (n_{Total}=27)	**p-value**
	Respondents, *n* (%)	**Respondents, *n* (%)**	
Sex			0.45
Male	3 (10%)	2 (8%)	
Female	26 (90%)	25 (92%)	
Age			0.02[a]
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[b] (18%)	

[a] *p-value for significant difference between process and final evaluation*

[b] *Two additional female Global Technical Advisors between ages 35-44 were interviewed and were not from a specific intervention group or area program*

Abbreviations: *IVC – Interactive Voice Calling; PDH – Positive Deviance/Hearth; p-value – probability value*

Table 3. Key Facilitators and Barriers Identified in the Program Impact Pathway Phases

Program Impact Pathway Phases	Facilitators	Barriers

Design	• **Quality Training** using WV PDH Training Manual for Facilitators and Volunteers
	• **Trained staff**
	• **Immediate Implementation** after trainings
	• **Technical support** for formative research analysis, design of messages and menu
	• Tools developed to simplify technical steps of PDH (menu calculator)
	• **Community Mobilization** (community members, health facility staff, district health staff)
	  o Community involved in volunteer selection
	  o Community feedback sessions (results of formative research shared and key messages shared to be promoted with the entire community)
	• **PDH program linkage with Health and Nutrition Services** (Partner with MoH to provide Vitamin A, deworming, and immunization for PDH participant children)
		• **Poor community mobilization** results in poor acceptance of the program by the community and MoH

Implementation	• **Volunteers retain knowledge and skills** after training
	• **Quarterly volunteer refresher trainings**
	• Improved recognition and valued role of volunteers
	• **Strong volunteer support** inspires families to change behaviors
	• **Regular Growth Monitoring** and Promotion sessions identify PDH participant children easily
	• **Monitoring tools** to simplify volunteer work (during Hearth and household follow-up)
	  o Paper-based
	  o Guides for phone calls
		• **Work burden of caregivers**
		• **Elderly volunteers** had a hard time absorbing new skills and translating those skills to community
		• **Poor linkages with Health and Nutrition services** (poor deworming, Vitamin A, and vaccination coverage)
		• **Poor supervision and guidance for volunteers**

Program Impact Pathway Phases	Facilitators	Barriers
Implementation	• **Supervision tools and spot checks** (ensure calls made and quality of phone calls) • **Coordination** between volunteers and caregivers agreeing on time and place for Hearth sessions • **Volunteer feedback meetings and monitoring data check** (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) • **Using phones** help save time and travel costs and gives one-on-one counseling time during Hearth for both volunteers and caregivers	• **Lack of time** of caregivers resulting in poor attendance of caregivers • Volunteer **time constraint** and **financial burden**
Utilization	• **Family support** in household chores and/or childcare responsibilities • **Volunteer support** • **Phone calls** are flexible, save time and cost for both volunteers and caregivers, and still personal enough (attendance higher in PDH-IVC group) • Caregivers seeing weight gain and other positive changes in their children • **Access to mobile phones** • **Regular access to the phone network**	• **Lack of support** • **Lack of time** of caregivers and volunteers • **Lack of financial resources** • **Primary caregiver (Grandmothers') low level of education** • **The old age of caregivers** • **Work burden of elderly caregivers** • **Elderly caregivers' inconsistent phone use** • **Phone network poor** in some areas • Volunteers cannot observe children when only relying on phone calls

Abbreviations: *IVC – Interactive Voice Calling; PDH – Positive Deviance/Hearth; MoH – Ministry of Health; WV – World Vision*