Using participatory methods to build an mHealth intervention for female entertainment workers in Cambodia: the development of the Mobile Link project

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Background: The HIV epidemic in Cambodia is strongly and disproportionately concentrated among key populations. One important hard-to-reach key population is the expanding community of female entertainment workers (FEWs). HIV as well as other sexual and reproductive health (SRH) outcomes including sexually transmitted infections (STIs), contraception, and gynecologic health are also substandard among FEWs. To address these concerns, a mobile health intervention (mHealth) using short message service (SMS) and voice message (VM) services—the Mobile Link project—was constructed. This paper aims to describe the development of this mHealth intervention that used participatory methodologies and to illustrate how these findings can be useful in future mHealth projects.

Methods: This intervention development process used an iterative, participatory approach. Twenty-seven focus group discussions (FGDs) covering SRH topics were designed and conducted and implemented across four provinces in Cambodia. Additionally, six in-depth interviews (IDIs) were conducted with FEWs living with HIV in Siem Reap and Phnom Penh. Data from the FGDs and IDIs were analyzed using content and matrix analysis methods to identify prioritized themes for messages. Two data validation workshops were organized to present the prioritized themes to FEWs and outreach workers (outreach workers) for validation. The workshops included activities stimulating participation such as listening to sample messages in order to determine health priorities as well as message tone and style.

Results: The findings from the qualitative research provided guidance on how to tailor the intervention to the FEW community in terms of the tone, timing, content and delivery mode of the messages. Participants preferred a friendly, professional female voice for VM. Participants revealed that health priorities such as gynecologic issues (vaginal infections/irritation) and cervical and breast cancer, were emphasized more than HIV and family planning. Participants also reported a number of misconceptions about contraception, particularly around oral contraceptives and intrauterine devices, and STI transmission. Participants expressed the need to build trust in outreach workers and linkages, affirming the emphasis on the link within the Mobile Link project. Lastly, from the IDIs, FEWs living with HIV highlighted wanting supportive/messages to address depressive feelings that may stem from their perceived stigma.

Conclusions: Utilizing participatory methodologies was demonstrated to be useful in intervention content creation and program implementation. As a result of this intervention development process, the research team gleaned lessons that may be applicable to future mHealth projects including the idea of adding some layers of choice to mHealth interventions for further tailoring at the individual level and the importance of human contact and trusting relationship.

Introduction

Mobile phone use is becoming ubiquitous as a means of communication in developing countries. Mobile health (mHealth) interventions are now a viable medium to collect and distribute health information in the developing world. Recent studies have demonstrated success in utilizing mHealth interventions in developing countries, to collect health data (1,2), increase access to health knowledge (3,4), and to increase medication adherence (5,6). Mobile phone-based health studies in Cambodia have shown promising results when used for post-operation follow-up (7), diabetes self-management (8), and pharmacovigilance (9). Also in Cambodia, organizations are using mobile phones to reach hard-to-reach populations with health messages and service linkages such as post-abortion family planning (10).

One hard-to-reach population in Cambodia is female entertainment workers (FEWs). FEWs are women who work in entertainment venues, such as karaoke bars, massage parlors, restaurants, or beer gardens, and whose roles range depending on the venue but include serving food and alcohol, accompanying clients in karaoke rooms, or for women who work in massage parlors, providing massage (11). Not all FEWs exchange sex for money, but due to the implementation of the 2008 "Law on Suppression of Human Trafficking and Sexual Exploitation", which banned brothel-based sex work, there has been a growing number of FEWs who exchange sex for money with clients they meet at the entertainment venue (12). The number of FEWs in general is also growing as women working in garment factory jobs transition into the entertainment industry for better wages (13,14).

FEWs are considered a high-risk population for HIV, sexually transmitted infections (STIs), and poor sexual and reproductive health (SRH) outcomes (15). The most recent figures suggest that about 40,000 FEWs resided in Cambodia in 2013 of which 24,000 resided in Phnom Penh (16). Recent studies suggest that the HIV prevalence among venue-based entertainment workers (9.8%) is lower than street-based sex workers (37.3%) and brothel-based sex workers (17.4%), but still remains a national concern (16). In addition, the movement of brothel-based sex workers away from brothels and into entertainment venues as a result of the ban on brothels has created additional barriers to reach FEWs and connect them with health services (12,16). The use of mHealth interventions might be an answer to this, by providing links to health services through mobile phone devices.

Despite the current evidence supporting the use of mHealth interventions with high-risk populations, more studies are needed to understand how best to implement mHealth interventions in order to maximize their utility for beneficiaries (17). This article aims to provide detailed information about the Mobile Link intervention design and implementation and is influenced by the World Health Organization's call to report more detailed information about intervention design and development when reporting on the effectiveness of mHealth interventions (18).

The Mobile Link intervention is an operational mHealth implementation research project that aims to engage FEWs in Cambodia and link them to the existing prevention, care, and treatment services available in the country. The overall goal of the Mobile Link study is to deploy and rigorously evaluate the efficacy of Mobile Link, an innovative intervention for communicating with FEWs in Cambodia through frequent short message services (SMS) and voice messages (VM), linking them to existing services which include:

(I) A package of clinic-based HIV and sexual and reproductive health services (HIV testing, STI screening/treatment, contraception counseling and provision, gynecological exams);

(II) Outreach sessions to FEWs at their place of work led by FEWs trained as peer facilitators who use behavior change communication techniques to promote condom use, STI/HIV testing, family planning and reproductive health services;

(III) Community health volunteers offering community-based finger prick HIV tests to FEWs at their place of work as well as pre and post counseling services and case management for people living with HIV;
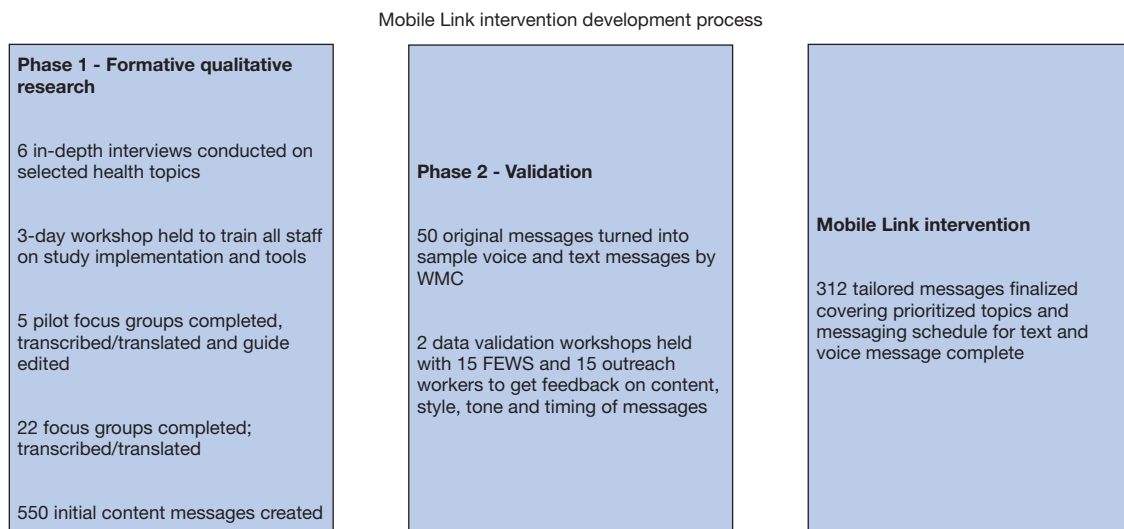
Mobile Link intervention development process

Phase 1 - Formative qualitative research

6 in-depth interviews conducted on selected health topics

3-day workshop held to train all staff on study implementation and tools

5 pilot focus groups completed, transcribed/translated and guide edited

22 focus groups completed; transcribed/translated

550 initial content messages created

Phase 2 - Validation

50 original messages turned into sample voice and text messages by WMC

2 data validation workshops held with 15 FEWS and 15 outreach workers to get feedback on content, style, tone and timing of messages

Mobile Link intervention

312 tailored messages finalized covering prioritized topics and messaging schedule for text and voice message complete

Figure 1 Mobile Link intervention development process.

(IV) A drop-in vocational training skills center for FEWs seeking new professions that provides training on tailoring, make-up artistry and hairdressing. The drop-in centre also provides a place where entertainment workers can meet and provide peer support in a safe environment.

The added components of the Mobile Link intervention include:

(I) Medically-accurate and engaging health information for FEWs through mobile phones;

(II) Linkage to outreach workers (outreach workers) for HIV/STI testing by mobile phone;

(III) Linkage to outreach workers for escorted referral to other health and non-health services by mobile phone.

The primary outcome measures of the Mobile Link trial include HIV testing, condom use at last sex, frequency of condom use (always, sometimes, rarely, never) with clients, frequency of condom use (always, sometimes, rarely, never) with boyfriends, STI screening when experiencing symptoms, STI treatment when diagnosed, modern contraceptive use, and abortion.

The objective of the intervention development process was to utilize qualitative and participatory methodologies to create highly-tailor, appropriate and relevant health-related SMS and VM services for FEWs in Cambodia and to inform intervention implementation. This paper will further describe how focus group discussions (FGDs), in-depth interviews (IDIs), and data validation workshops were

conducted and how they influenced message design. The resultant protocol for the Mobile Link operational research study is published elsewhere (19).

Methods

Study design

The intervention development process used a two-step approach:

Phase I: formative qualitative work

The exploratory qualitative research was carried out using FGDs with FEWs and IDIs with FEWs living with HIV and pregnant/parenting FEWs, to inform message creation and program implementation and integration. Afterwards, the data were analyzed and an initial message bank was developed.

Phase 2: validation

Data validation workshops were held to gather feedback on the themes pulled from the qualitative data, and sample messages from the initial master list of messages were tested among representative participants. Based on the results of the validation workshops, the final messages were developed. *Figure 1* describes this process.

Study sites and recruitment

The intervention development process including data

collection, analysis and data validation workshops, was conducted from August—December 2017 with 3 weeks of concurrent data collection, transcription, and translation. The study sites included the capital city of Phnom Penh, as well as three other provinces, Banteay Meanchey, Battambang, and Siem Reap. These provinces are considered areas with high burden of HIV and a large proportion of FEWs.

In total, 27 FGDs and 6 IDIs were conducted across the four study sites with a total of 165 venue-based FEWs (working in a KTV, massage parlor or beer garden), or non-venue based FEWs (street-based or on-call). The FGDs included five pilot groups, 15 venue-based groups (five karaoke, five massage parlors, five beer gardens), two groups with "on-call" FEWs, three FGDs with street-based sex workers and two groups with parenting/pregnant FEWs. All of the IDIs were conducted with FEWs living with HIV. The recruitment design involved a two-stage cluster design whereby venues were randomly selected by venue type (KTV, massage, beer gardens) from each operational district and a convenience sampling or snowball sampling procedure was used to recruit participants. The IDIs were conducted in the two largest operational districts in Phnom Penh and in Siem Reap. The data validation workshops were held in Phnom Penh and Battambang to ensure representation from urban and peri-urban/rural areas.

Eligibility requirements for participation in the study included: (I) working at an entertainment venue in Cambodia OR self-identifying as an entertainment worker OR actively exchanging sex for money/gifts; (II) being aged between 18–30; (III) being currently sexually active, defined as having engaged in oral, vaginal or anal sex in the past three months; (IV) owning a personal and private mobile phone; (V) knowing how to retrieve VM or retrieve and read SMS on mobile phone (Khmer or Khmer with English alphabet), and (VI) being able to provide informed consent.

Procedures

Instrument development

Prior to the pilot study a literature review was conducted and a study protocol, operations manual, and FGD/IDI guides were developed. The FGD guide covered a wide range of SRH topics as well as gender-based violence and substance use. Based on the data from the pilot study, the tools were revised to prioritize some topics over other topics, and to explore new topics that arose in the pilot. Also, the tool set was expanded to include a specific interview

guide for FEWs living with HIV, and pregnant/parenting FEWs. All FGD guides were translated into Khmer. Lastly, after the pilot, a topic module implementation schema was designed to ensure that all topics would be covered across all venue types and provinces. As the FGDs progressed, and a threshold of knowledge around experience with mHealth programming, mobile phone use, and literacy levels were met, more of the focus of the FGDs were focused on gathering specific information on the knowledge and behavior of participants related to rotating health topics, to inform message development and prioritization.

Data collector training

A two-day training was conducted for seven data collectors and five community lay health workers, and data transcribers. The transcribers, who were research assistants hired by KHANA, were included to ensure they had a deeper understanding of the data. The training provided an overall overview of the project, how to use the discussion guides, and basic skills in facilitating FGDs and conducting interviews, especially with vulnerable populations. All data collectors were women.

Data collection
Phase 1: formative qualitative research

Before starting the FGDs, health topic cards with pictures were hung around the room to give participants the opportunity to process the health topics upon arrival. The data collector read the informed consent to the participants as it was written in Khmer and each participant was given a signed copy of the consent form. Each FGD lasted around 90 minutes and covered a variety of topics including: STIs, HIV, modern contraception, gynecological health, condom use, cervical cancer, pregnancy, gender-based violence and substance use. Within each topic area, questions explored participants' understanding, known myths/misconceptions, practices related to the topic, and the ways in which health information and linkages could be utilized to improve outcomes related to that issue. Women were encouraged to share experiences and stories to generate conversation. After the FGD was completed, the data collectors completed an FGD summary form together, which was then submitted to the project coordinator providing contextual and environmental information related to the FGDs, to inform the analysis.

Based on the topic preferences identified during the FGDs, an initial bank of 550 content messages covering a wide range of subtopics within the larger topic areas was

created from the thematic coding and supplemented with medically accurate information from health information resources for prioritized topics. The research team collaborated with a non-profit media organization, Women's Media Center of Cambodia (WMC) to craft sample voice and text messages from the initial messages in the most approachable and relevant language for the population of interest. Messages were created to fit within an SMS format, staying roughly within 178 characters in English, recognizing there may be differences when translated into Khmer. From the initial bank of 550 potential messages, 50 sample messages across topic areas were chosen to test with participants. The 50 sample messages included content with a wide range of both comprehension level and subject sensitivity.

Phase 2: validation

Data validation workshops, were held with 15 FEWs and 15 outreach workers in Phnom Penh and Battambang. The three main objectives of the workshops were: (I) health topic feedback, (II) SMS and VM sample feedback, and (III) exploration of linkages to outreach workers and mobile program monitoring. Phnom Penh and Battambang were selected to include representation from both an urban and semi-urban area.

To collect health topic feedback, posters with a picture of the health topic and the title in Khmer were hung around the room. Pictures as well as text were used to accommodate participants with low literacy. Participants were asked to place post-it notes on the health topics to vote for the topics that fell among the following categories:

(I) "The health topic that is most important to you in your life";

(II) "The health topic that you think is most important to your peers";

(III) "The health topic that you already know the most about";

(IV) "The health topic that you don't know very much about";

(V) "The health topic that is least important to you".

To obtain VM sample feedback, 50 audio-recorded messages were played for participants for their feedback. The VM review component was led by the WMC. Each outreach worker and FEW was given a score sheet and moderators reviewed each scoring option with participants prior to beginning. WMC played the messages via a laptop with a recorded mp3 file and a speaker. Each message lasted around 30 seconds. The scoring of the first few messages was heavily facilitated, but as the participants became more familiar with the tool, they needed less support to complete

it. After 10 messages, the facilitator would ask for reactions in general to the past 10 messages, to identify which types of messages participants favored. One limitation of the process was the potential for group-think. However, we found meaningful variability in the responses across participants both in scoring messages and in validating the health information.

The scorecards consisted of several dimensions on which the messages were rated. The dimensions included:

(I) Comprehension ("Do you understand this message?");

(II) Trust ("Do you trust the information in the message?");

(III) Engagement ("Would you like to receive this message?");

(IV) Likeability ("Do you like the voice of the person recorded in this message?");

(V) Preferred gender of the voice ("Do you want to hear this message in a man's or woman's voice?");

(VI) Preferred style formal/informal ("Do you want to hear this message from a health professional or a peer?");

(VII) Preferred delivery mode ("Do you prefer this message as an SMS or a VM?").

Lastly, to explore the implementation of how the Mobile Link project can facilitate linkages to services, separate discussions with outreach workers and with FEWs were facilitated to explore the linkage component of the Mobile Link project, specifically related to workflow (outreach workers) and trust and linkage to care (FEWs). Data was recorded on data recording forms by notetakers. The whole process took around a half-day and included multiple stretch breaks, snack breaks and lunch.

Data analyses

Phase 1

All FGD recorded audio files were uploaded into a locked Dropbox managed by the project coordinator. Transcribers, accessed the audio files, transcribed the data into Khmer and then uploaded Khmer transcripts into a second Dropbox folder. The transcribers then accessed the Khmer transcripts to translate into English to upload into the final Dropbox folder. The transcription and translation were time-intensive, and the authors did consider note-taking instead. Ultimately, we chose verbatim transcription and translation because of personnel considerations, which actually may have made note-taking more time-intensive.

Detailed note-taking in this case would have required funding (food, hotel, per diem, and salary costs) the staff to travel around the country with the data collectors to take notes. Additionally, there was concern that even with training on note-taking for qualitative research, data could have been lost, and with limited time, capturing all information was more prudent. Lastly, while detailed notes can allow for quotes to be captured as well, so many of the messages were built off of stories and experiences shared, and questions posed, by participants, and it would have been challenging to capture all of those details through note-taking. We think that the level of detail that we were able to capture makes the Mobile Link program uniquely engaging and relevant to the population to which it is tailored.

Using QSR International's NVivo 12 software (20), data were analyzed using *in vivo* coding as the primary coding method, followed by two rounds of thematic coding as the secondary coding method. The first round of thematic coding was identification of the health topic area (i.e., HIV, contraception, etc.). The second round of thematic coding was related to whether the code was: (I) knowledge-seeking, (II) behavior change or (III) experience sharing. Next a table was created which included an *in vivo* code for each health area that fit into the categories listed above for the second round of thematic coding. After group review, the data was reorganized into 3 frames: (I) health access, (II) health rights, and (III) health promotion/prevention. That table was then shared with the media partner, WMC who built off the table to create messages in Khmer that linked to the identified themes and actual words of the participants.

Phase 2

Data collected during the validation workshops were related to participant feedback on (I) health topic prioritization and (II) message development. For health topic prioritization, frequencies of each health topic within each rating category (as described above) were tabulated by geographic area, to identify the most salient responses. Feedback related to message development was analyzed by category (as described above) for each individual message and across messages. Responses to each question were tabulated for each message to assess whether similar types of messaging should be used. Additionally, responses were tabulated across messages to draw larger inferences of participant preferences around categories as a whole, for example, gendered voice or SMS *vs.* VM.

Ethical considerations

The intervention development process was included in the ethical review application for the larger study. This study was approved by the National Ethics Committee for Health Research (NECHR, No. 142NECHR) within the Ministry of Health in Cambodia and the Touro College Institutional Review Board (No. PH-0117). All key personnel involved in this study completed the online the National Institute of Health (NIH) research ethics course on the protection of human research participants. All participants were informed about the study aims and procedures and completed a written informed consent. The study topics included personal information about extremely sensitive topics. During the formative research activities, research staff offered all participants escorted referrals to counselors and health services upon request and referral to a local women's center for those who have experiences of violence. Out of respect for participants' time and travel, we offered a $5 incentive for participation.

Although this was not the intention of the sampling strategy, it was possible that participants ended up in focus groups with friends, acquaintances, or even relatives. The research team was careful when asking participants to reveal things that could have affected these relationships by giving participants the chance to decline to answer any questions that came up. In addition, for HIV⁺ participants, we conducted one-on-one interviews instead of focus groups to protect privacy.

Results

Phase 1: exploratory qualitative study

A number of health topics were discussed during the FGDs, both through responses to pre-planned questions, as well as those that arose organically in conversation. Aside from the specific topic areas explored, as described above, breast and cervical cancer and infertility emerged as particularly salient themes across venues and geographies. Overall there were no major differences in the themes raised based on provinces or venues, therefore the results will be presented across provinces and venue types. Major findings and responses to each finding are described in *Table 1*.

Program implementation and integration

Most participants were in favor of mHealth programming

Table 1 Major findings and responses from the FGDs and IDIs

Finding	Response
1. Participants were most knowledgeable about HIV testing frequency, but less knowledgeable about transmission and treatment	Messages focused on gaps in knowledge about transmission, especially mother-to-child transmission. Example message: "Pregnancy will not make HIV worse, but it is possible that you can transmit HIV to your baby during pregnancy—It is very important adhere to your medication during pregnancy."
2. STIs are a major concern for many women, but there was a lack of clarity on prevention, treatment and transmission	Messages focused on dispelling myths and misunderstandings. Example message: "Taking vaginal ovules will only help if you have some infections. But if you have an STI, vaginal ovules will not help. Make sure to talk to a provider if you have vaginal itchiness before you take medication."
3. Participants wanted more information related to prevalent cancers. While the FGD guide asked questions related to cervical cancer, the responses from the participants illustrated a desire for broader information on cancer including breast cancer, as well as abnormal growths	Additional messages covered breast cancer warning signs. Example message: "Breast Cancer Warning Sign #3: Do you have skin on the breast that is pulled in, or looks rough and pitted like orange or lemon peel? Go see a health provider or outreach worker!"
4. Participants knew about different types of contraceptive methods but expressed several myths and misconceptions which may prevent them from seeking a particular method	Messages focused on those methods that were most misunderstood—intrauterine device (IUD) and emergency contraception known as the 72-h pill. Example message: "An IUD is a 99.5% effective in preventing pregnancy. It is also very safe—it DOES NOT lead to cervical cancer! It must be inserted and removed by a trained health professional so if you want an IUD talk to a Mobile Link field staff."
5. Participants reported using condoms with clients and but not with more consistent partners; they reported having to employ various strategies for condom negotiations for partners and clients	Messages focused on negotiation technique with different types of partners. Example message: "Talking to your sweetheart about condoms is hard. One tip is to say you use condoms just for pregnancy prevention; even though you know you are protecting yourself from STIs at the same time!"
6. Most FEWs were not allowed to work while they were pregnant, but often hid the pregnancy if possible	Messages focused on issues of pregnancy and work. Example message: "If you are pregnant but it is hard to reduce or stop drinking alcohol at work you can get confidential support to make a plan. Talk to a Mobile Link field staff today."
7. Women reported experiencing infertility and wanted more information on medical reasons for infertility	There was an increased focus on root causes of infertility. Example messages: "There are many reasons for infertility but one major cause is untreated STIs. Get tested often and adhere to treatment, and encourage your partners to test, too!"
8. There was a lack of clarity around legality of abortion	In Cambodia, abortion is legal within the first 12 weeks. Messages tried to dispel myths about the law. Example message: "There is no law about husbands needing to sign any document prior to an abortion! If a provider tells you that you have to sign something, that is not true! You should seek care somewhere else."
9. Substance use was a major health issue faced by women in the entertainment industry, but many women saw it as a necessary part of their job	Messages focused on strategies for avoiding excessive alcohol consumption. Example message: "Sisters, let's talk to each other and share tips to help avoid being drunk and stay safe. Our first tip for you: Eat a lot of rice or noodles before you drink even if you feel a little sick. You need something in your stomach to soak up the alcohol!"
10. Women reported various forms of gender-based violence across venues and reported limited resources for support	This topic was prioritized as it came up in many focus groups. Example message: "No person asks for or deserves violence in their lives. If someone is hurting you, it is not your fault and there is help available. Talk to a Mobile Link field staff today."
11. Some participants expressed feelings of sadness and hopelessness but lack emotional support services	Positive mental health messages were woven into health topics. Example message: "If you had a miscarriage and are feeling sad and grieving don't worry this is normal. Sometimes it is helpful to have a ritual such as a water ceremony to work through your loss."
12. FEWs living with HIV wanted supportive messages but also feared discrimination and stigma from family, community, and workplace	Messages tried to engage HIV+ FEWs in support and services. Example message: "HIV is not a curable disease. However, now there are medicines you can take which will prolong and greatly improve your quality of life! If you are HIV+ no fear, just get on medication today."

FGDs, focus group discussions; IDIs, in-depth interviews; STIs, sexually transmitted infections; FEWs, female entertainment workers.

for basic health information. There was fairly mixed reporting of technology utilization for health information. Some participants cited using the Internet in general, Facebook, or YouTube to search for information. A few participants said that they had participated in an mHealth information service but could not remember the name. Participants also referred to literacy levels as an influencing factor on their ability to see and access health information.

"I think giving the information is also a good idea because some people are busy with their work, so they can read the message in their phone without going directly to see the doctor." —Siem Reap, massage parlor

"Even the ones who can't read can listen to the voice messages. And ones who can read, just read every detail. In conclusion, mHealth is really good." —Banteay Meanchey, KTV

One benefit of SMS, which was mentioned across FGDs was the ability to save and go back to it later, whereas with a VM that would not be possible.

"Just like you said, we pay minimally with SMS and also we can know everything while we cannot save voice calls." —Banteay Meanchey, pilot

However, there is also a limitation to the depth of information that participants would want on the phone. Additionally, some participants said that they would not want to receive more sensitive information, like HIV-related information. Participants were more interested in basic health information and support messaging, rather than detailed explanations of issues. Other limitations may include losing or sharing phones or SIM cards.

"Health community workers visit us and ask for my telephone number. They send us health messages. Since I have lost my phone, I lost the contact." —Siem Reap, pilot

Phase 2: data validation workshops

The data validation workshops allowed for further refinement and clarification of both the message content and delivery.

Health priorities

The results from the revision workshops are summarized in *Table 2*. Vaginal/gynecological health issues and cervical cancer were the most important health topics to FEWs themselves, while condom use and STIs were indicated as most important to their peers. The participants reported to already know most about HIV, family planning, and STIs, and had the least knowledge about miscarriage, infertility and cervical cancer. Health topics related to support and encouragement and substance use were reported as least important. Based on these findings, 312 final content messages were created following a basic format of a health rights message, a piece of health information and then a health promotion/prevention action. While the mHealth program is an HIV-focused program, the results from the FGDs and the revision workshop were important in highlighting the need for a broader scope of messaging to address the diversity of women's health needs. For example, the final messages included a strong focus on topics such as cancer and substance use, which were not included in the original focus of the project. The messages cover the following finalized topics: HIV, STIs, family planning, cancer and tumors (cervical, breast, fibroids), vaginal/gynecological health, substance use, infertility and miscarriage, pregnancy, and gender-based violence.

VM sample messages

Of the sample audio messages that were played, the audio scorecards showed that there were overall good comprehension levels across most but not all messages. Trust in the person giving information on the audio messages was also high. Participants generally preferred a female voice rather than a male voice; however, for some messages, especially in regards to medical messages around HIV, many participants said they preferred a male voice versus a female voice. Results from the feedback session with FEWs and outreach workers are presented in *Table 3*. The total number of feedback possibilities was representative of all 50 messages, across 30 participants.

Message content was finalized based on input from the validation stage. Messages were friendly, informational and invitational; messages were delivered in the tone of a friendly female health professional. Examples of initial and revised messages are included in *Table 4*.

Message schedule

Based on the above results, a map of informational message, linkage to outreach workers, and mobile monitoring survey questions was developed and is diagrammed below (*Figure 2*). The message schedule diagram was designed with the intention that women should be able to choose the level of engagement that they want to have with the Mobile Link, ranging from very low (only receiving messages and monitoring survey, but not engaging with the Mobile Link staff) to very high (receiving messages and frequently connecting to Mobile Link staff on a range of topics). When
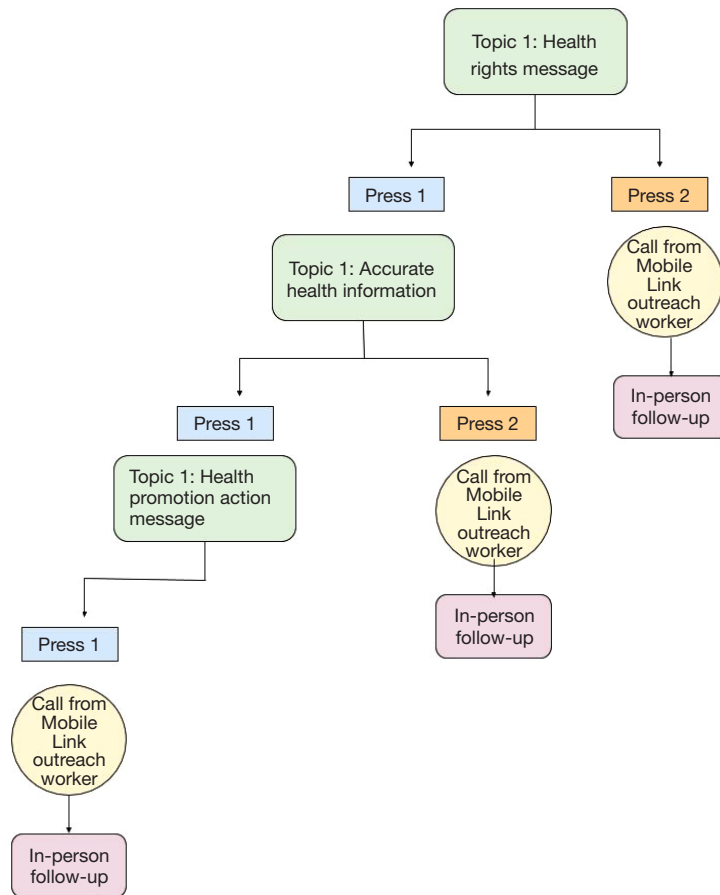
Figure 2 Message schedule diagram.

participants receive messages from Mobile Link, they are prompted to press 2 if they want to have an outreach worker contact them. The platform refers their contact information to the corresponding Mobile Link field staff member who directly contacts the individual. This diagram was used as a basis for intervention development.

Discussion

This intervention development process took a participant-centered approach to designing an mHealth intervention tailored to and relevant for FEWs across Cambodia. The research team was intentional about including the beneficiaries in multiple steps of the program design phase. Literature suggests that involving users in the design and development of new technologies increases functionality and usability by meeting users' requirements, and therefore improving the system's quality and increasing the likelihood of achieving intended health outcomes (21). The process

described in this article provided insight into the specific needs and health priorities of FEWs to inform message creation, program implementation and integration.

Overall, women in this study were in favor of the Mobile Link project and indicated that the messages could be a valuable addition to current programming. A technology platform such as Mobile Link could serve as a meaningful tool to provide important and difficult to access health information, linkage to services, and aid in monitoring data. In support, previous studies have shown that mobile phone messages can be successful in supporting utilization of key reproductive health services with young women in the US (22), India (23) and Kenya (24).

The FGDs provided essential information for content development, in particular priority topics, tone and the myths and misconceptions about specific health issues that can be directly addressed within the messages. Moreover, the data collected during the FGDs and IDIs provided important insight into the life experiences of

Table 2 Health prioritization by study site

Questions	Most common responses	Phnom Penh (n=30)	Battambang (n=30)
What is the health topic most important to you?	Vaginal/gynecological issues	60%	38%
	Cancer	29%	36%
What is the health topic that is most important to your peers?	Condom use	56%	n/a
	STIs	n/a	50%
What is the health topic that you know most about?	HIV	65%	47%
	Family planning	23%	n/a
	STIs	n/a	32%
What is the health topic that you don't know much about?	Miscarriage and infertility	34%	n/a
	Cancer	n/a	58%
What is the health topic that is least important to you?	Support/encouragement	58%	40%
	Substance use	16%	30%

STIs, sexually transmitted infections; n/a, not available.

Table 3 Feedback on audio messages from workshops

Feedback category (n=1,500)	Phnom Penh	Battambang
Comprehension (Do you understand this message?)	Yes: 84% (n=1,367)	68% (n=1,130)
Trust (Do you trust the information in the message?)	Yes: 84% (n=1,366)	67% (n=1,130)
Engagement (Would you like to receive this message)	Yes: 85% (n=1,367)	68% (n=1,130)
Likeability (Do you like the voice of the person recorded in this message?)	Yes: 86%, (n=1,366)	69% (n=1,130)
Preferred gender (Do you want to hear this message in a woman's or man's voice?)	Woman's voice: 72% (n=1,350)	64% (n=1,108)
Preferred style (Do you want to hear this message from a health professional or a peer?)	Health professional: 66% (n=1,350)	57% (n=1,108)
Preferred Delivery Mode (Do you prefer this message as an SMS or a VM?)	VM: 59% (n=1,351)	58% (n=1,108)

SMS, short message service; VM, voice message.

Table 4 Examples of initial and revised messages from three health topics

Topic	Initial message	Revised message
Contraception	Walking around after sex will not prevent you from getting pregnant! That sperm is very small and swims fast. Protect yourself with contraception today! Talk to a SmartGirl outreach worker to find a method that works for you!	Withdrawal or pulling out method is not very effective against pregnancy. In fact, did you know half of women who use this method will get pregnant? Find a contraceptive method that works for you!
STI symptoms	Don't let anyone make you feel dirty about having an STI. Everyone who has sex, especially without a condom, is at risk for having an STI. It is just a reality of having sex. Get tested today!	Don't guess! If you have vaginal irritation it could be from an STI and you just need easy treatment to feel better soon. Talk to a Mobile Link field staff member
Vaginal Health	Vaginas should only be cleaned on the outside and not the inside. Vaginas have lots of good bacteria that keep it clean and putting products in your vagina will kill good bacteria. Neither you nor any medical person should clean inside your vagina.	Sisters, we have the power to keep our bodies clean and healthy. The best way to keep our vaginas clean is to wash only on the outside with clean water. Never clean inside, or allow a doctor to clean inside your vagina

STIs, sexually transmitted infections.

women working across multiple entertainment venues in Cambodia. The data validation workshops were critical in illustrating the health priorities of women and validating the notion that the messages could be more effectively used to link women into services, rather than providing in-depth technical health information.

With regard to the health priorities, the results showed that gynecological issues and cervical cancer surpassed concerns over HIV, STIs, and family planning. While current health programs for FEWs are mainly focused on SRH and HIV prevention, these results indicate that they may not address the priorities of the women themselves. That is to say, the health priorities of FEWs are limited to sexual health, which is more often the focus of programs and funding, but rather include a wider range of health issues.

There were some health issues raised in the FGDs and IDIs where information, support or encouragement was preferred from a person, whether it is someone who visits them in person or on direct phone call, rather than an automated message. This is an area where the Mobile Link could play an important role by providing a supportive platform when needed, and connecting women with a person by phone or face-to-face. In addition, Mobile Link would allow FEWs to speak confidentially about their health issues without the fear of discrimination. Many FEWs in the current study continue to feel that the stigma around STIs, including HIV, at medical facilities contributed to a delay in being tested and seeking treatment.

As a result of this intervention development process, the research team gleaned lessons that may be applicable to future mHealth projects:

(I) Choice was critical for individual-level tailoring, continued engagement and buy-in. Women in the revision workshops indicated that they would like to have the option to get voice or SMS messages and to be able to switch if needed. They also wanted to be able to have the option to connect with the Mobile Link staff depending on the topic and the severity of the issue.

(II) Tailoring all aspects of the delivery of the mHealth intervention is essential. For example, messages were sent within a specified window of time as defined by participants. In the case of our study participants, that was between 12 pm–17 pm.

(III) It was critical to ensure timely and consistent follow-up in response to any technical or personal issues that are reported by the participants. This is an important part of building participants' trust in the intervention and the staff.

(IV) It was important to ensure that all project staff were fully trained to provide basic information across all health topics. While ideally the Mobile Link staff served as a linkage or referral for other services, the service would be more effective if any staff member that participants encountered could at least provide some accurate health information over the phone.

(V) Any mHealth intervention should also be supported by options for human contact. While the messaging services were well-accepted by the participants, women wanted to be able to directly reach out to a staff member at their own convenience. Based on this feedback, expectations around responsiveness was detailed in the outreach worker job description, and they had dedicated hours for which they were "on-call".

(VI) Trust of the program and trust of outreach workers was a priority issue, which needed to be addressed during all aspects of the program roll-out. It was helpful to brand the Mobile Link program and have Cambodian government buy-in so that women know that the program they are signing up for is medically accurate and trustworthy.

(VII) The importance of monitoring the formation and implementation of mHealth cannot be understated. The Mobile Link project developed systems for data collection, management, and dissemination structure and flow to be able to capture all program data points. As a result, the team has been able to catch and address issues such as spikes in drop-outs, frequency of dropped SMS or VMs, and when we had a need for more outreach workers.

Limitations

There are a few limitations that are important to note. First, in order to capture a wide variety of opinions and to generate rich dialogues, we utilized FGDs among FEWs; however, we recognized that for issues such as gender-based violence and substance use, FGDs may not promote enough confidentiality and privacy to allow for full disclosure of experiences. There may be issues that women are reluctant to discuss in a group, but may feel comfortable opening up about in an interview setting. However, after seeing the quality data that were collected, the group setting did not seem to significantly hinder open discussion in most groups.

Because there were so many topics to cover, all topics

could not be explored within all groups. We addressed this limitation by creating a schedule of topic module implementation to ensure that all topics were covered at least once within the province and at least once across all the groups.

Lastly, it is important to note that the women who attended the FGDs and the data validation workshops may be more invested in the project or who have closer connections to the outreach workers, and therefore may not represent the entirety of views reflected in the FGDs.

Conclusions

In response to an identified gap in the reporting of mHealth interventions (18), this article describes the Mobile Link intervention development process in great detail in order to support reporting transparency, to share learning within the field and to contribute to an evidence base for policy-makers.

The Mobile Link intervention development process used FGDs, IDIs, and data validation workshops to develop SMS/VM messages based on health content prioritized by the key population. The results suggest that many FEWs were in favor of the Mobile Link program because it would enable them to consult with someone anonymously about their health issues and use the messages to gain access to healthcare services without fear of discrimination. The program's efficacy will be determined by the delivery of basic health information based on the priorities of women themselves, successful referral to the existing health services and monitoring the linkage utilization and follow-up database.

While there has been success in reducing and preventing HIV transmission in the general population in Cambodia, that same level of attention and resources should be maintained to ensure that key populations, including FEWs receive equitable and tailored women's health promotion and treatment services. Additionally, the health priorities of women, which may not always align with researchers and funders, need to be prioritized. This intervention will serve as a platform to increase access to sexual and reproductive health-related information and linkage to existing healthcare services, and to monitor health-seeking among FEWs. Future research is needed to examine the health benefits and the incremental cost effectiveness of implementing the Mobile Link program.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: This study was approved by the National Ethics Committee for Health Research (NECHR, No. 142NECHR) within the Ministry of Health in Cambodia and the Touro College Institutional Review Board (No. PH-0117). All participants were informed about the study aims and procedures and completed a written informed consent. The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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