RESEARCH ARTICLE

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Design and Process of Implementation Mobile Application Based Modular Training on Early Detection of Cancers (M-OncoEd) for Primary Care Physicians in India

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Abstract

Background: Early detection of curable cancers is a cost-effective way to address the cancer care burden of low- and middle-income countries and active engagement of primary care physicians using mobile technology can have a significant impact on cancer outcomes in a short time. Aims: To describe the process of mHealth study; Oncology Education and Training for Providers using Mobile Phones which developed a mobile application (M-OncoEd) to educate physicians on approaches to early detection of curable cancers. It also aims to describe how the insight gained through qualitative research by the researchers was used in the design and implementation of the project. **Methodology:** Qualitative research methods were used in all the phases of the study. Phenomenology was used in the formative phase with three expert meetings, two Focus Group Discussion (FGD) and five In-depth Interviews (IDI), and during the implementation stage with two FGDs, three IDI, and five informal discussions. **Observations:** The majority of curable cancers are detected at a late stage and poorly managed in India, and active engagement of primary care physicians can have a significant impact on cancer outcomes. There is a lack of knowledge and skills for early detection of cancers among consultants and physicians and this can be attributed to the training gap. M-OncoEd was a need-based well designed engaging learning platform to educate primary care physicians on Breast, Cervical, and Oral Cancer early detection. It was found to be very useful by the beneficiaries and made them more confident for early detection of cancers from the community. **Conclusions:** This research study could design a need-based, cost-effective mobile-based learning tool for primary care physicians using the expertise and experience of the experts in cancer care using qualitative methods.

Keywords: mHealth- early detection of cancer- oncology training- implementation research- primary care physician

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Introduction

Low and middle-income countries are experiencing a substantial increase in cancer incidence (Sung et al.. 2021). In India, many cancers are detected at a late stage and many of those cancers detected early are improperly managed. Inadequate knowledge and training of medical graduates could be one of the many reasons for the unmet need for early detection services. Active engagement of primary care providers can have a significant impact on cancer outcomes.

Mobile health technology (mHealth) plays a significant role in the overall development and personal development of human beings. It can serve as a tool for offering e-learning opportunities to physicians. Mobile application in the field of oncology and its use in training for early detection of cancer is truly relevant among widely dispersed physicians with limited time which can provide inexpensive and on-demand training.

This manuscript is one component of the mHealth project "*Oncology Education and Training for Providers using Mobile Phones*" which developed a mobile application (M-OncoEd). Device usability and interactive learning were the key features of the M-OncoED. The feasibility and acceptability of the application are based on the Reach Effectiveness Adoption Implementation

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Maintenance (RE-AIM) framework (Glasgow et al., 2019). The quantitative part of the project is published as "*Acceptability Utility and Cost of a Mobile Health Cancer Screening Education Application for Training Primary Care Physicians in India*" (Subramanian et al. n.d.)

Objectives: To describe the process of curating the M-OncoEd app; the current scenario of Cancer care and early detection services, formative training needs of physicians, their perspectives on mobile platforms, and experiences with app learning.

The research was conducted in three phases of which the observations from the Formative Phase and Experimental phase of the Mobile Application are covered in this manuscript (Figure 1). This article attempts to describe the optimal use of qualitative methods and findings for this successful implementation research project. Terminologies were used appropriately and can be used as examples to express qualitative study findings in medical research. As multiple methodologies were used in different phases, this will not fit the criteria for a typical qualitative study report.

Figure1 provides an overview of the process for developing the mobile application and evaluating feasibility, acceptability, and preliminary impact on physician behavior.

Materials and Methods

Research team

The Core research team comprised of a retired Epidemiologist with vast experience in cancer control activities and currently using his expertise and experience taking advisory roles in the international platform, A practicing senior surgical oncologist treating cancer patients at one of the apex centers in cancer care in the country, A senior health economist and researcher handling multiple projects at the international level, a field epidemiologist with wide experience in early detection programs in the community and an expert in qualitative research methodology. Representatives of decision-makers from the government health system, Government and private medical colleges, Doctor's organizations, NGOs, IT companies (for app development) were also part of the team. Researcher Reflexivity was strictly controlled by bridling. (Frogstuff 2012) Subjective interpretations are independently interpreted by another expert in qualitative research.

Methodology

Qualitative Methods with the hermeneutic phenomenology of research are conducted through empirical (collection of experiences) and reflective (analysis of their meanings) activities, to offer a pragmatic solution in the formative phase and its implementation in the experimental phase.

Theoretical Framework (Figure 2) and Research Paradigm is an adapted version of Grix's paradigmatic building blocks. (Brown and Dueñas 2020a) (Figure 3).

Methods

Formative Phase (FP)

To evaluate the current scenario and training need assessment three expert meetings, one FGD, and five IDI were conducted. Description of personal experiences of the experts was also included. Delphi method was used to finalize the contents of the modules by the experts (three expert meetings) were done. Another FGD was conducted among consultants before the finalization of the modules and the sociogram is given as Figure 4.

Experimental Phase (IP: Implementation Phase)

The mobile app was created and piloted among a group of selected providers. A focus group discussion was also conducted before the app's finalization to triangulate the findings and feedback obtained from the app. Two FGDs, three IDI, and five informal interviews were done. Direct feedback from the app, Inputs from two FGDs, informal discussions, social media platforms were also used. Summary of Methods and Participants is depicted in Figure 5.

Sampling strategy

To explore the multiple realities related to poor cancer care and training needs; max variation purposive sample was taken from Experts in Cancer care, Primary care physicians, private doctors, Consultants from government and private, Doctor organizations representatives Indian Medical Association (IMA), NGO representatives, and community members).

Data Sources

Meeting minutes, Questionnaire reports, Audio

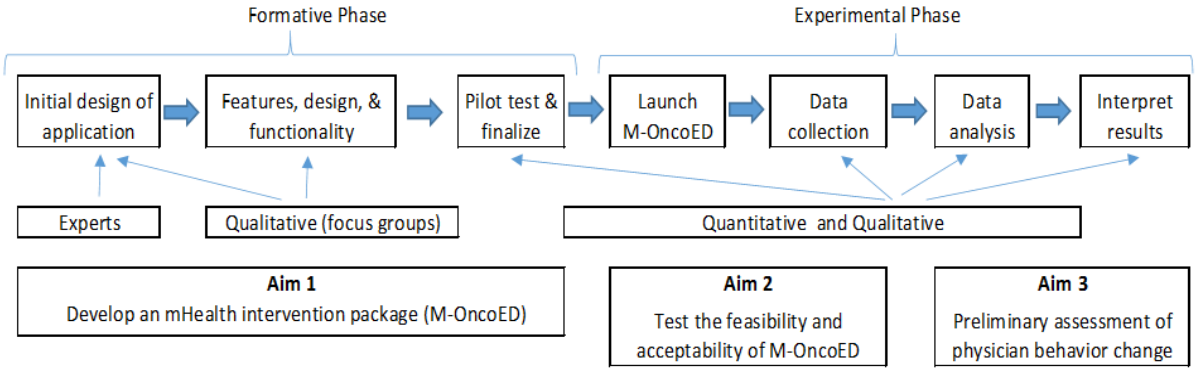

Figure 1. Framework for Developing and Evaluating M-OncoED

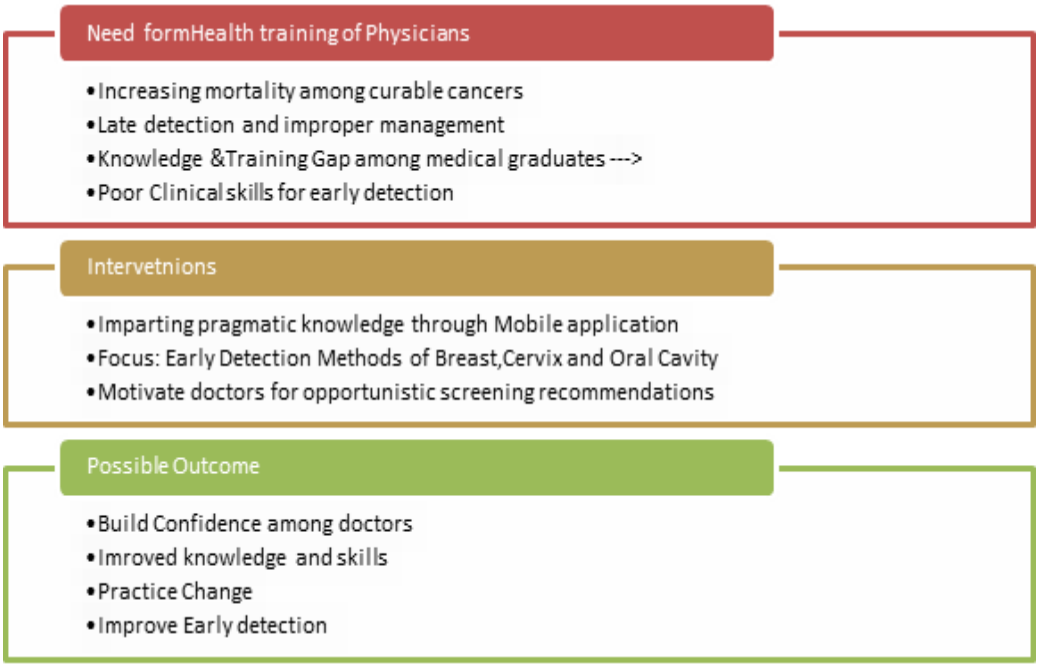

Figure 2. Theoretical Framework

Records and Transcripts of IDI and FGDs, Direct feedback from the mobile applications, Direct and Indirect feedback from social media platforms created for the purpose, Observation during the intervention as an interest to participate, compliance, and adherence.

Data Processing and Analysis

Thematic analysis is done with a combination of the inductive and latent approaches. Six steps of the thematic analysis process namely Familiarization, Coding, Generating themes, Reviewing themes, Defining and naming themes are used here (Braun and Clarke, 2006). The Rich textural data obtained is substantiated by quotations to get a subjective experience.

Ethical Dimensions

The protocol was approved by the Ethics Committees of RTI International and Sree Gokulam Medical college.

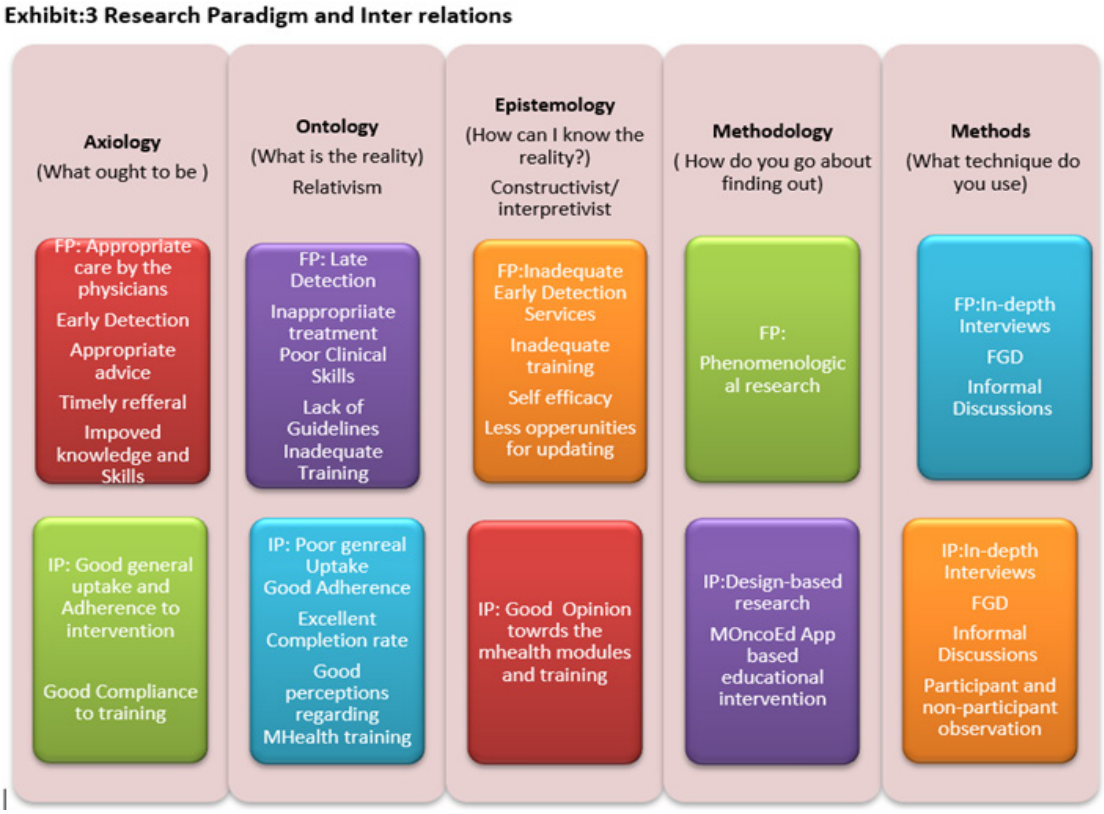

Figure 3. Research Paradigm and Interrelations

Permission from state health authorities was taken before approaching physicians during the formative phase and for personal communications via emails, SMS, and WhatsApp groups during the implementation phase. Informed consent was incorporated in the mobile application and all participants who gave consent were allowed to enter the modules. Feedback from participants was also obtained from the mobile application. Continuous technical support was ensured throughout the intervention.

Results

Thematic Representation of the Findings of formative and implementation phase

Formative phase: Develop the mHealth Intervention Package

The formative phase comprised of an analysis of the current scenario of cancer care, exploring the barriers to early detection from the physician perspective, and developing a mobile health intervention package (M-OncoED) to educate primary care physicians. The decisions on the design, features, contents and functionality, pilot testing, and fine-tuning of the mhealth platform were also taken at this stage. Reflections were made by the experts and the following themes and sub-themes have emerged.

Initial Design of the Application

Assessing the current scenario of Cancer Care

Everyone agreed to the fact that cancer incidence is on the rise and many cases are detected late leading to increased mortality. Late detection and improper management especially due to an inappropriate initial surgery were attributed to the high mortality among curable cancers.

"*Despite high literacy rate and good diagnostic health*

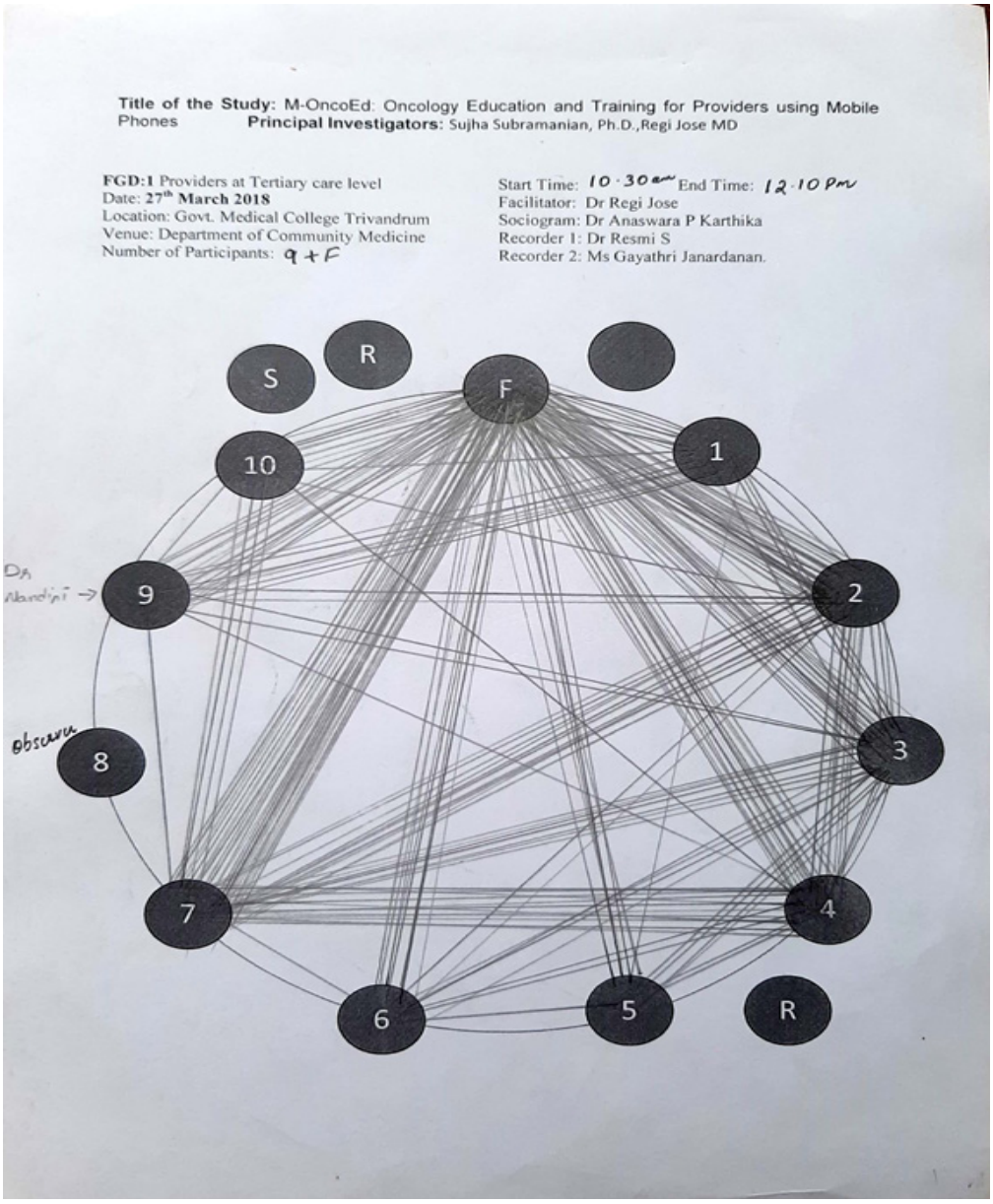

Figure 4. Sociogram of Focus Group Discussion Conducted at Government Medical College Trivandrum before the Finalization of Contents of the Module (Participants Consultants in tertiary care canters Surgeons, Gynecologists, Dental surgeons, Epidemiologists, Health System representatives)

Table:1 Summary of Methods and Participants		
Phase	**Methods**	**Respondents (number and description)**
Formative phase **Need Assessment** **Determining the Content and duration of M-OncoEd modules**	Expert panel meetings (1) IDI (5) FGD (2) Expert panel meetings (2) Delphi method by the expert panel Group Discussions doctors with Administrative levels and Medical College Teachers (2) IDI of Experts (4) Consultants (4) Informal Discussion with Subject experts and Primary care physicians (3)	Subject experts (5), and consultants (6), representatives from the target recruitment group Primary care physicians (8)
Experimental phase (Implementation Phase) **Targeted recruitment group**	FGD (2) Informal Discussion with Subject experts and Primary care physicians (5) Verbal feedback and participant observation of responses from WhatsApp groups	doctors from different administrative levels, representatives from target recruitment groups, both private and public sector (18)
Broad-scale recruitment group	Feedback from Mobile Application (participants) Verbal feedback from reminder phone calls (non-participants)	All participants who completed the module (130) non-participants:6

Figure 5. Summary of Methods

services and accessibility to medical care, cancers are detected at an advanced stage in Kerala thereby escalating the cost of cancer treatment. The cost of cancer treatment is above the national average and about 10-15 % of the entire health budget. Preventive steps and early detection are very important when it comes to battling cancer as it leads to about 95% cure rates and excellent quality of life." Consultant Cancer Epidemiologist (E1_IDI)

"Most of the patients are not being referred to higher centres at the earliest instance possible. Many undergo expensive investigations and consequent delay and wastage of resources due to inappropriate handling of the diagnostics and screening at the initial level. The patients would have to undergo repeat investigations and further delay at the higher centre."(E2_IDI)

"Every day 5-7 breast lumps come to OP, which accounts for approximately 40 breast cancers/month. They are mostly stage 3 cancers. Only educated patients come in early stages." Consultant Surgeon Tertiary Care Hospital (C1_FGD)

Early Detection Services

Kerala is a literate state with good health indicators, and most are aware of the importance of early detection, but limited interest is shown towards the adoption of early detection methods. There is high knowledge practice gap, a low perceived risk among the people, lack of proper guidelines and knowledge sources, limited access to quality services, inappropriate provider consultations, and missed opportunities for early detection at the peripheral level according to most participants.

No organized screening programs for the general population nor a country-specific screening guideline is implemented. No opportunistic screening methods are adopted by Hospitals and physicians. Educational intervention through mass media could attract few individuals from upper socio-economic status to approach hospitals for preliminary exams, wherein only radiology examinations are usually carried out without proper clinical examination. Most persons whose tests are found to be normal do not have follow-up examinations. Mass campaigns by voluntary organizations could spread awareness and offer cost-effective early detection methods and very few offer follow-up services. Female doctors are preferred by women, and this could lead to doctors who are less skilled/experienced in conducting the examinations.

"*Organized screening exists in developed countries. An organized screening by informed people is lacking in India. Fundamentally, early diagnosis with opportunistic screening is the most important, highly relevant approach which could downstage cancer at diagnosis." (E1_IDI)*

"In the PHC (Primary Health Centre), not much care is given to cancer screening. No service or very rudimentary service is rendered for detecting cancers. Examination and referral are done only if patients present with symptoms. Palliative care is given more importance.

"Primary care physician (PCP1_FGD)

"None of the women who approach us have breast awareness and are reluctant to do self-examination as they are not confident to do it. After clinical breast examination, I explain and demonstrate how to examine themselves. This instills confidence in them, especially those with benign breast diseases and they return for CBE at regular intervals report early if they find anything abnormal. A volunteer from NGO"(V1_IDI)

"I am 32 and my mother died of breast cancer. I know I am at a higher risk and wanted to have a preliminary examination. So, I approached our nearby PHC and seeing the young male doctor in the OPD, I got embarrassed to ask for a clinical breast examination. How I wish a lady doctor were there or the doctor suggest me to do it rather than I ask for it" CP-2

Training need – development of clinical skills for early detection

Methods of early detection of cancer are not dealt with adequately during undergraduate medical school. Knowledge gap and Training Gap among medical graduates attribute to poor practice. Many participants observed that clinical skills for early detection are lacking in doctors. Very few can do a proper clinical breast examination or a PAP smear. Majority claimed that they can identify oral pre-cancerous lesions but very few bother to look for them.

"*During our MBBS training days, we never got any proper exposure to cancer screening." PCP7_FGD*

"In our surgery postings, although we had examined breast lumps, we hardly got trained to examine normal breasts." PCP03_IDI

"During my UG period I had examined only 3 breast lumps and I never got a chance for cervical or oral cavity examination." PCP02_IDI

Old schools of thought about cancer and early detection are passed onto the younger generations. There is laxity on the part of the physicians to update their knowledge. Self-efficacy is another barrier and many physicians do not perceive their ignorance and confidently give incorrect advice. They examine only those who approach them with a complaint and refer them to higher centres.

At the secondary level, costly investigations are advised without considering appropriateness. It is common to advise excision biopsy by a radiologist or a pathologist in their reports and the surgeon promptly does it without proper planning, necessitating further surgery and compromising the quality of life and chance of cure in cancer.

"*Clinical Breast Examination is very subjective. Sensitivity depends on who does it. A proper CBE done by an experienced individual is a cost-effective method, but very few doctors in Kerala are confident to do a proper CBE" E5_FGD*

"Most patients presenting with breast lumps undergo excision biopsy; a majority of which are margin positive excisions. These patients require repeat surgery to remove the tumor from the breast and axilla. Sentinel lymph node biopsy may not be possible in many due to improper surgical scar and violation of planes. This leads to an increased chance of lymphoedema and a smaller number of breast conservation procedures. Even after mastectomy, residual breast tissue and inadequate nodal dissection are common, necessitating repeat surgery or radiotherapy. A properly planned and executed initial surgery could lead to a better quality of life in terms of single surgical procedure, less chance of arm edema, more chance of breast conservation, less requirement of radiotherapy, and a better chance of cure." (E2_IDI)

Focus of Training

Experts had the opinion that breast, cervix, and oral cancers should be given priority as it comprises the majority of cancers, and cost-effective methods of early detection are available and would enable possible cure. Increasing numbers of colorectal cancer among the younger population are also to be considered where early detection is feasible, and some had the opinion of including colorectal cancer also in the screening list. Experts had the opinion of not to screen for prostate cancer because of the lead time bias in the light of the quality of life of the individual concerned.

Potential Users of the APP

It was decided to include both Government health systems, and Private health care providers, Primary care physicians, Specialist surgeons, Gynaecologists at the secondary, tertiary levels as the target participants.

Perceptions of Primary care physicians regarding training and m health

Health system authorities felt mHealth intervention would be an innovative model of training for a wider reach in a short time and an opportunity to learn evidence-based updates directly from the experts. They also felt that this model could be used as a channel for individual communication and reach everyone quickly. Updates may also be delivered through this and enable the physician to clarify their doubts directly with the experts.

The majority of participants felt this to be a cost-effective training compared to the usual training which involved a lot of effort and time from the physicians. Training would build confidence among doctors and motivate doctors for opportunistic screening recommendations. Some had apprehensions regarding the training uptake as this is not a felt need in their practice and they hardly get time during office hours. They suggested that the app should be short and engaging but should contain the essentials.

Features, Design, and Functionality of the Mobile Application

Most of the experts and participants of FGD felt that Epidemiology, risk factors, early detection methods, and what each doctor should advice a person with and without symptoms, Diagnostic algorithms, Detailed examination steps with illustrations, and referral pathways are to be included in the module. They also felt including pre-and post-learning assessments, Case studies, and educational materials, Voice over-delivered directly by the authors, Slide shows and graphics will enhance the learning process. Reminders, alerts, and a Certificate upon

completion would motivate them to complete the training.

Implementation Phase: evaluating feasibility, acceptability, and preliminary impact on physician learning behavior

M-OncoEd (Mobile-based Oncology Education) Application was developed successfully and after thorough review and editing by the experts. Three modules were prepared by the experts with UpToDate evidence-based knowledge but were beyond the planned features and training time through the app. It was further curated with multiple meetings to arrive at the final content of the module (Delphi method). The final modules could deliver all the must-know and some good-to-know facts. An attempt was also made to impart clinical examination skills by incorporating pictures and narration by the experts.

It was decided to deliver as slides with voice over from experts so that the participants will get a feel of hearing directly from the experts

The module had provisions for pre and post-test for evaluating the effectiveness. The time spent on the module could be assessed. Feedback and suggestions could also be provided by the participants.

Selected thirty primary and secondary care physicians were requested to complete the modules. Their feedback from the app, inputs from the FGD were also considered during the finalization of the app. Most of the participants felt that this innovative Replicable Model with Centralized Content Delivery can ensure Quality Control in Training.

Implementation strategies

After thorough discussions with the authorities and the feedback from the pilot intervention, it was decided to invite primary care physicians in the government health system and some private care physicians in the broad-based intervention group. Official communications were sent to the district and taluk level authorities to encourage physicians to adopt training. Personal emails and SMS were also sent to the target participants. Later social media platforms like WhatsApp were also used to deliver the link to download the app.

Physician reaction to training invitation and training

Experts and members in the targeted recruitment group emphasized the need for training, and everyone in the targeted group downloaded the app and the majority completed the training. In the broad-scale recruitment group, there was a hesitancy to download and use the app and many primary care physicians did not find it so exciting. Delayed response/no response to official communication, personal emails, and SMS was indicative of the same. WhatsApp groups were created in each district including, Research team members and state-level authorities. Thirty-three such groups were created to deliver the app and to give technical support to the participants. A good number of physicians did not show any interest. Many perceived it as additional work and were not ready to do anything more than they were doing currently. Some had issues with their phones, and some had network issues that prevented them from attending, especially in rural areas. They felt that this is not a good approach to training as they had to depend on technology. However, the majority of physicians who downloaded the app found it to be very useful. Once they used the app, the general feedback was positive.

"I am so excited to see a mobile application for training for early detection of cancers. It should be engaging and should be able to complete in one go "PCP5_FGD.

Perception of Primary care physicians regarding training and MOncoEd

Most opined that the app helped them to unlearn and relearn many things. They believed that the knowledge gained was useful for their clinical practice. Majority of participants were thankful that they could receive evidence-based knowledge directly from the experts. Most of them find app learning an appropriate, cost-effective, and convenient mode of training.

"*This gave an excellent opportunity for me to unlearn many things and learn new things. I never tried to do a clinical breast examination as I was not confident with my skills, instead, I used to advise mammograms for every woman who presented with a lump or was concerned. This module gave an insight into the appropriate early detection methods. I never bothered to examine the oral cavity for any precancerous lesions even if I see a person with stained teeth with the habit of chewing. This training gives me an overview of what I can do even with the facilities at the primary setting." PCP3_FGD*

Perceived barriers and threats

Some said that everything in the guidelines suggested by the experts is not feasible as the facility and manpower are inadequate in the primary level settings. Low Perceived needs regarding training, Lack of motivation, lack of interest in learning, Low Perceived benefits; less/ No academic benefits, lack of facilities, community preference for women physicians for breast and cervix examination and less demand from the community were the barriers for some.

"I have a secure government job, and no one will give me credits if I do more or will not punish me even if I do not do extra." PCP4_IDI

An increase in work time and more responsibility were some of the Perceived threats. Self-efficacy according to some; was evident from their social media responses that they think they know the basic stuff to address the local issues and were reluctant to accept new knowledge.

User Recommendations

Some requested the incorporation of more videos and pictures and the addition of a module on colorectal cancer. Some opined that motivation from the authorities would help them perform more examinations. Continuing support through a mobile application will help them keep updated and motivated.

Training in the mHealth platform was found to be useful among primary care physicians to update themselves and this could translate to the community needs of early detection and downstage at diagnosis, thus contributing to reducing the burden of cancer care in India.

"When to do what was always a mystery! there are

many guidelines available on the internet but most are made for developed countries where the scenario is entirely different. This app is a real blessing." A medical officer who completed the Mobile learning app. PCP3_IDI

In conclusion, the paucity of organized early detection programs, lack of motivation and training of primary care physicians, and lack of initiative from the community could be the major reason for the increasing number of late detections of curable cancers. Mobile learning applications would be a cost-effective strategy to enhance early detection of Cancer in the Community and Health care providers in the primary setting who wish to learn directly from experts gets the opportunity. M-OncoEd was thus developed, the design of which was need-based derived from expert opinions and user requirements. The majority of users felt that modules provided practical knowledge which could easily be translated into their practice. Such applications can be developed in other areas of primary health care and is an efficient way of empowering health care providers, especially in the primary setting.

Discussion

This is the Qualitative study part of the mixed methods implementation research on strengthening the knowledge and skills of primary care physicians for early detection of cancers using mHealth. This study serves as an excellent example of using phenomenological design to understand the reality from lived experiences of the Experts to create a need-based model module for training and could report the reality during implementation. It also details the research paradigm on which this work is based (Brown and Dueñas, 2020b). This type of research depends on establishing a direct relationship with the participants, extracting realities, interpreting and observing their behavior is also reported by (Gopalakrishnan et al., 2020) in his mHealth study.

Epidemiologists and treating doctors in the apex institution felt that there is a gap in the knowledge and practice of doctors, and this could be one of the reasons for late detection, improper management, and increasing deaths among curable cancers. According to a report From National Cancer Registry Programme, India the majority of the patients with cancer were diagnosed at the locally advanced stage for breast (57.0%), cervix uteri (60.0%), head and neck (66.6%), *("Cancer Statistics, 2020: Report From National Cancer Registry Programme, India | JCO Global Oncology" n.d.*) Studies conducted in India showed that Breast cancer could easily be downstaged with a proper CBE, (Sankaranarayanan et al., 2011) (Mittra et al. 2021) and is a cost-effective method suited for low and middle-income countries. (Smith et al., 2006). M-OncoEd, an android app-based training program, training modules are curated and presented by experts in the field to offer e-learning opportunities to primary care physicians about cancers of the Breast, Oral cavity, and Uterine Cervix; a well-planned platform that emerged from this need. Clinical skills like CBE skill is imparted through this app.

Mobile health technology is a widely accepted method of training, especially in the health care field. (*"How Technology Could Transform Medical Training, Ease Global Shortage of Doctors" n.d.*), (Odendaal et al., 2020; Opoku et al., 2017) and MOncoEd was a well thought out pragmatic method to address the issue of training needs of doctors (Subramanian et al., 2021; Dankner et al., 2018). The medical field has applied mobile technology to remote learning in rural health education (Zawacki-Richter, 2009). This study used the RE-AIM Model as a framework (Glasgow et al., 2019),

During implementation, it was observed that the platform turned out to be useful for those who felt the need. It was a very informative, motivating, and cost-effective mode of learning saving much of their time and efforts compared to routine training (Ventola 2014). For many practicing doctors who are concerned only about the immediate health needs of the community; educating patients, motivating them for adopting early detection methods, performing examinations seemed to be an unreachable goal. Mobile-based training could be the platform for providing advanced knowledge to doctors who are motivated for training (Gonçalves-Bradley et al., 2020).

Increasing opportunistic screening and performing clinical examinations were noticed among those who completed the MOncoEd training module similar to medical students (Chase et al., 2018) also showed Practice change was noticed more among doctors from private hospitals compared to government hospitals. Physician motivation, demand from the community, and support from the other trained paramedical staff and community members can bring out better results.

Training and motivating primary care physicians in the early detection of curable cancers is a very important step in cancer control. Providing training and ongoing support from the experts make the healthcare providers confident in their services. This research brings evidence for using mobile applications to train providers to improve oncology care and to lay the foundations to design and conduct large-scale studies to further refine the mobile application and systematically assess the impact of the training tool in changing physician behavior. The M-OncoED application will serve as a platform for expanding features to provide training to a wider group of providers, including nurses and community health workers.

Author Contribution Statement

The authors confirm contribution to the paper as follows: study conception and design: RJ, SS, PA, SR, AL; data collection: AL, BG, VS, RS, SJ, MN; analysis and interpretation of results: RJ, SS, PA; draft manuscript preparation: RJ, SS, ZN, RK. All authors reviewed the results and approved the final version of the manuscript.

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